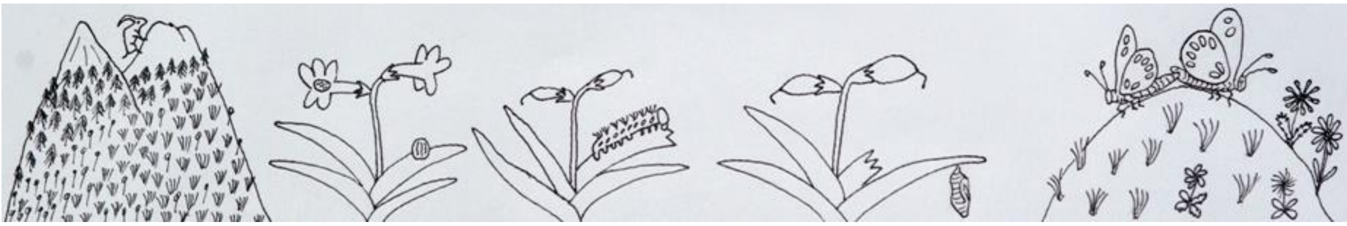
PAPILIO (NEW SERIES) # 27

March 2022   ISSN 2372-9449



BUTTERFLIES OF THE SOUTHERN ROCKY MOUNTAINS AREA, AND THEIR NATURAL HISTORY AND BEHAVIOR

{Text only. See Papilio (New Series) #28, 29, 30, 31 for photos}

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Introduction

This book reports the biology of the butterflies of the southern Rocky Mountains area, including all the species in Colorado, although surrounding areas are also discussed, especially the rest of the Southern Rocky Mts. in Wyoming and New Mexico and into Utah. This book presents what is known of the biology of the butterflies of Colorado and vicinity, including hostplants, eggs/larvae/pupae appearance and habits, behavior including flight habits and migration and mate-locating and mating and basking and roosting, and the flowers and other foods of adult butterflies, and natural history aspects of their biochemistry, plus mimicry, flight periods and number of generations, etc. It also includes taxonomic matters to assist identification of all the species and subspecies and forms. Much research on the biology of Colorado area butterflies has been done recently, but it has been published in many scattered publications and scientific journals and is not readily available, and some good research is unpublished; this book attempts to make it available, and provides the sources for good published research.

There have been several comprehensive books and some substantial papers on Colorado butterflies. F. Martin Brown (assisted by Donald Eff and Bernard Rotger) published the book "Colorado Butterflies" in 1957 (Brown et al. 1957). That book was a good start on the study of Colorado butterflies, as it provided black and white photos of each species, and many locality records, plus some other information on the species, but it had very little biological information. J. Scott, Scott L. Ellis, and J. Donald Eff (1968) reported new records and new species from the state. And J. Scott and Glenn R. Scott (1980) provided considerable information on the butterflies of south-central Colorado. Ray E. Stanford organized a relentless campaign to collect new county records of butterflies across the state and region, helped by myself and Mike Fisher and many others, leading to a fairly-complete set of county-record maps. Mike Fisher (2005-2017) published the book "The Butterflies of Colorado" in six parts. He has a great eye for the details of wing pattern of adult butterflies, and his book has great photos of the butterflies of Colorado, along with extensive discussion of the variations and identification of the butterflies, and county distribution maps. Readers should use that book (and a forthcoming condensed version) for its photos of butterfly adults and the distribution maps. But it was intended as an update of Brown's book and still contains little of the available information on biology of the butterflies.

I studied Colorado butterflies continuously from 1959 to 2019, except for a few years in California, where I got a Ph.D. in entomology from the University of California in Berkeley while doing research on butterfly mate-locating behavior and movements, and worked at several universities including the Univ. of California Davis for awhile. I mostly pioneered the study of mate-locating behavior of butterflies (Scott 1974a, 1976a, 1983a, 1973a), and this book greatly improves that information using ~100,000 field observations. The book reports courtship behavior also, with a meta-analysis that proves the ubiquity of male and female aphrodisiac pheromones in most butterflies. After getting my Ph.D. I saw a great need for a book on the biology of North American butterflies, so I thoroughly researched the literature and studied Colorado butterflies and in 1986 authored the 583-page book "The butterflies of North America. A natural history and field guide." published by Stanford University Press, which is still heavily cited in scientific publications on butterflies, even beyond North America. But I realized that hostplants and behavior of Colorado butterflies were still inadequately known, so I spent a huge amount of time in the field in the next few decades finding more than 3000 hostplant records (Scott 1992, 2006a), researching the eggs/larvae/pupae, accumulating more than 40,615 records of butterfly adults visiting flowers etc. (Scott 2014a), studying other behaviors and the taxonomy of Colorado butterflies, and naming several dozen new Colorado butterflies. Meanwhile other workers at Colorado universities and at the Rocky Mountain Biological Laboratory in Crested Butte in Gunnison Co. Colorado and others did good research on the biology of Colorado butterflies. Sometimes I cite hostplants determined in Utah by Clyde F. Gillette, or by J. Wolfe, J. Harry, & T. Stout (2010), and hostplants determined in Nevada by G. Austin (Austin & Leary 2008). So most of the available important research is summarized here.

The study of hostplants of Colorado butterflies is now comparatively complete (especially near Denver) because of decades of study mostly in the Front Range and vicinity, reported mainly in Scott (1992) and Scott (2006a). During my long study of Colorado butterflies, I accumulated 40,615 observations of nectar-feeding or adults feeding on other foods/mud, which I reported in a 190-page book on adult feeding and plant pollination (Scott, 2014a). All those adult feeding records cannot be repeated here, so I give just the most-commonly visited ones (flowers usually with more than 5 or 10 visits).

Study of Colorado butterflies since Brown's book resulted in the discovery of dozens of new species and subspecies residing in the state, and research—often with Mike Fisher and others—resulted in naming those new taxa and clarifying the status of other Colorado butterflies. The following papers are especially important in adding and studying multiple new Colorado taxa: Scott 1981c, Scott & Fisher 1998, Scott et al. 2006, 2008, 2014, 2017.

The first portion of this book discusses and summarizes the major behaviors and natural history of the butterflies, and is followed by the detailed treatment of each species arranged in taxonomic/ evolutionary sequence, and finally there are several appendices and some hopefully-interesting stories related to butterflies and their study and the pursuit of Southern Rocky Mts. edible plants and good recipes etc., a discussion of problems with scientific names, a glossary, and Literature Cited.

Literature citations that refer to just one species are given in that species' writeup, while references that are cited for multiple species are given in Literature Cited at the end of this book.

The text of this book is in one free downloadable issue of Papilio (New Series), and is followed by four more issues of photographs mostly of eggs, young larvae, mature larvae, pupae, and a few adults (it took four issues because photos greatly hog the megabytes). For pictures of adult butterflies and county distribution maps, use Mike Fisher's The Butterflies of Colorado book—the adult photos there are mostly excellent.

Abbreviations

A1-10 (abdomen segments 1-10). fw (forewing). hw (hindwing). L1-6 (larval stages 1st to 6th). T1-3 (thorax segments 1 to 3). unf (underside of forewing). unh (underside of hindwing). uns (underside). upf (upperside of forewing). uph (upperside of hindwing). ups (upperside). TL (type locality).

Mate-Locating Behavior of Butterflies

This section of the book discusses and summarizes general aspects of mate-locating and mating behavior of butterflies. (In the species accounts below in this book, the last paragraph text for each species reports details of mate-locating behavior—and often courtship--for each species in Colorado and vicinity.) Mate-locating behavior has been poorly studied for most of the world's ~17,280 species of butterflies. I started studying this behavior in butterflies in the 1960s, and have ~100,000 records of observed mate-locating behaviors in my notebooks. I published various papers on mate-locating behavior (Scott 1970, 1973a, 1974a, 1976a, 1983a), and recently (Scott 2010a) developed new names for describing mate-locating behavior, words that are necessary because most lepidopterists are not very knowledgeable about these subjects and report butterfly behavior in a misleading way by assuming that they behave like mammals or birds—a misinterpretation called anthropomorphism.

Mate-locating behavior is extremely important to butterflies in nature, because it allows the males and females to find each other, even when they are not abundant. If they just casually stayed near where they emerged from the pupa, males and females would almost never find each other and the population would become extinct. So at least one sex must fly to locate the other. In many butterfly species males do most of the mate-locating. In many species the females may fly some also to help locate a partner. In still other species females fly to some kind of rendezvous site to meet the waiting males, who previously went to that same rendezvous site. The latter species increase mate-locating efficiency by having special rendezvous sites in the habitat where both sexes are genetically programmed to go to mate: in those species the males generally go to the rendezvous sites and rest or fly around there while waiting for the females to arrive, they mate, then the females depart to lay their eggs. Some species also have special genetic times of day when they mate—rather than just mating all day--which reduces the time they must work to find mates. (Times in this book are 24-hour standard time.)

How should an observer determine the mate-locating behavior of a species? You must watch mostly males in nature, to determine how males and females find each other, where in the habitat they do it, and when during the day they do it. Whenever you see a male approach another butterfly (or other animal etc., as males may approach other flying insects or even birds etc.), it is generally for mate-location purposes, so you must record the location where it happened, whether the male was resting or flying before the interaction, and the time of day. To be complete in your observations of males interacting, record the location in the habitat (a hilltop, a gulch, a cliff, hillside swales, tiny woods clearings, prominent treetops, the hostplant, etc., peculiarities of that location such as the spatial orientation of other plants etc., whether he was resting on a bush or whatever, etc., anything notable), and record whether the male was flying or resting before he chased and investigated that other individual (also write down the height of his flight or the height of his resting site when he began the investigation flight), and record the time of day (24-hour standard time should be used to publish all results). Record anything interesting the female was doing (on a flower, or flying?), and record courtship behavior if any. Accumulate many observations, until you can confidently determine the species' mate-locating behavior. The time of day of mate-location may be the most difficult information to obtain, because you will have to watch during enough nice warm days with normal sunlight to get observations from early morning through afternoon; good data cannot be obtained when bad weather prevents normal behavior (except a few butterflies such as *Atrytone arogos* require cloudy conditions for mate-locating, and some SE U.S. and tropical species mate-locate at dawn or dusk).

Scott (1974a) wrote the first general treatise of mate-locating in butterflies (Shields 1967 wrote the first general treatise on hilltopping). In that pioneering paper I unfortunately used imprecise words to describe the major types of mate-locating behavior: I described species in which males wait at special sites in the habitat for females to arrive, using the words "perch" and perching behavior to describe them. And I used the words "patrol" and "patrolling" behavior for species in which males fly around most of the habitat to find females. Unfortunately people often use the word "perch" just for a butterfly sitting-resting, and they often use the word "patrol" for butterflies just flying about, sometimes even to lay eggs. Some people see a male that usually just rests and watches that darts out and investigates a passerby (which I called perching behavior) and then flies around the area a bit before landing again, and they call that latter brief flight patrolling. Those imprecise words and unrestrained usage cause endless imprecision and confusion and errors in the literature. In my 1986 book I modified the words to read "perch to await females" and "patrol to seek females" to more precisely describe mate-locating behavior, but the literature continued to have confused wording regarding mate-locating behavior. And the words perch and patrol are not as charismatic as the word territoriality, so many authors seemed to obsessively focus on describing "territoriality" in butterflies (they wrongly assumed that every time a male (such as a perching male) approaches another male he is fiercely attempting to drive it away to protect his "territory") and they mostly ignored precisely describing other aspects of mate-locating behavior such as the location and time of day. People often fail to precisely describe mate-locating behavior, in particular they often fail to describe the locations of mate-locating behavior, and they very often or usually fail to give the time of day when they mate-locate (most butterfly species mate-locate all day, but many mate-locate just during part of each day).

After thinking about these problems of faulty description of mate-locating behavior for a long time, Scott (2006a, and a thorough treatment 2010a) developed new precise words to describe mate-locating behavior of butterflies, words that cannot be confused with any other words. This book uses those precise unambiguous words:

PRECISE NAMES FOR DESCRIBING MATE-LOCATING BEHAVIOR:

They are defined as follows (inside the parentheses is the derivation of the names of these words):

Rait, raiting, raiters (males **R**est to aw**AIT** females): Males rest and watch, generally at a genetic mating rendezvous site, for females to arrive at that rendezvous site for mating, where males mostly rest there and then fly out to investigate any passing and incoming individuals to see if they are receptive females (whereupon they mate with any receptive females). After flying out and investigating that individual, they may fly around the site a short time to see if any females have arrived, before landing there again the majority of the time to watch.

Flait, flaiting, flaiters (males **FL**y to aw**AIT** females): Males fly around in a small genetic mating rendezvous site (and may occasionally land), to watch for females to arrive at that rendezvous site for mating, then they investigate those arriving individuals and mate with any receptive females. Flaiting males fly around mostly (most of the time, even when no passing individual is there), and rest less often, whereas raiting males mostly rest (raiting males fly around their mate-locating site less often, mostly only when they spot a passing individual).

Fleek, fleeking, fleekers (males **FL**y to s**EEK** females): Males fly farther (a substantial portion of the habitat, very often near hostplants) to search for receptive females for mating. (Thus, males of fleeking and flaiting species are usually flying when they see and investigate other individuals; whereas raiting males are mostly resting when they see passing individuals, then they fly out to investigate them).

Flent, flenting, flenters (one sex **FL**ies to locate the other sex by sc**ENT**): One sex flies often a considerable distance to locate a scent (pheromone) produced by the other sex. Most moth species flent, because most moths are nocturnal and they need a non-visual way to locate mates; flenting males fly (often far) to locate a scent (pheromone) that the female emits to lure the male for mating (the female is stated to be "calling" when she emits pheromone, often during just a small part of the night typical of the species), then they fly upwind to the female. (In the reverse, in some Hepialidae moths, the females flent to find the pheromone-emitting males.) The flenting male flies upwind in a zigzag path and uses the "stereo reception" of his two antennae to stay in the scent plume emitted by the female from a long distance away, even a kilometer with gentle wind (5 km in *Bombyx mori*). Most butterflies do not use this method, although field observations prove that many butterfly males (generally of fleeking species) can find hidden females from one or a few meters away using their scent. In many *Heliconius* butterflies and relatives, males are attracted to a pheromone emitted by female pupae and the male mates with the female while she is about to hatch from the pupa, but this pheromone may act only within a short distance maybe a dozen? meters or less (the precise distance is unstudied).

These words are unique (they are not in any dictionary) so cannot be confused with any other words, and they are precise. Each word can be used as a verb, or as a noun, or an adjective. For instance some butterflies rait (or flait or fleek), and the species that do that are raiters (or flaiters or fleekers), and they can be described as raiting (or flaiting or fleeking) species.

So in this book, if the males prefer to rest at a rendezvous site such as a hilltop and watch for females to arrive, I write that males rait on hilltops, and I use the word rait to describe where the male rests on the hilltop to rait (for instance males rait ~50cm up [above the ground] on bushes). If the males prefer that site but mostly fly around the hilltop while looking for other individuals to arrive, even flying when not disturbed by the watcher, I write that they are flaiting there (for example, when you find males of the flaiting species *Papilio eurymedon* on a hilltop, the male is generally lazily flying about a small clearing amid the trees, watching for a female to arrive; and if he flies 2m above ground there, I describe him as flaiting 2m up). (A hint on how to separate raiters from flaiters: raiting males usually fly mostly only if they spot a passerby, but if you walk onto a hilltop rendezvous site and scare a raiting male of *Hesperia pahaska*, he may be disturbed and fly around for a short time before landing again; whereas a male of a flaiting species such as *P. eurymedon* flies around the rendezvous site voluntarily most of the time even when not disturbed by the viewer.) {There are some butterflies such as the hilltop-rendezvous *Papilio machaon*/*polyxenes*/*zelicaon* and the gulch-rendezvous *Burnsius*/*Pyrgus* that often or most-often rest before investigating other individuals, but almost as often or as often fly before investigating other individuals, so they can be described as doing both raiting and flaiting behavior.} If you scare a raiting male, he may fly around the genetic rendezvous site for a short time before landing again, but of course that should not be called flaiting; flaiting is flying around the site often, even when not being scared by an observer or predator. If the males mostly fly around much of the habitat (not just in small rendezvous sites) to seek females I write that males fleek to locate their mates. I do not use the word patrol in this book because the word has too much ambiguity in reporting mate-locating behavior (some people sloppily use the word patrol for whenever a male is flying during mate-locating behavior, even after mostly raiting, and use it for both fleeking and flaiting species); I use the precise words above instead.

Note that the raiting, flaiting, fleeking, and flenting words describe the entire process of mate-locating in both males and females—the whole behavioral system that works to bring the sexes together for mating as quickly and efficiently as possible—so the species can multiply and avoid extinction.

Mate-locating behavior is highly evolved in each butterfly species, in order to quickly allow males and females to find each other without much bother and waste of time in order to perpetuate the species. For instance, in raiting species that mate-locate on hilltops, BOTH the males and females fly to hilltops due to genetic programming, where the males wait for the females to arrive, then when a female arrives and flies near a male he approaches and they mate, then after mating when the female's bursa copulatrix is filled with the male's spermatophore and sperm, its nerves send an electrical signal to her brain which makes her leave and shift into egg-laying behavior. Flaiting species do the same, except the male most often flies about the hilltop (rather than rests) while waiting for females to arrive. In fleeking species that have "gulching" behavior, the males fly up and down gulches to find females, and the females position themselves there and wait there to be discovered by a male (or fly some there until a male finds them), they mate, and then the females shift into oviposition behavior. In raiting species that are gulchers, the males rait in the bottom of the gulch to wait for females to come (males rest wait and watch at a specific spot (the spot usually genetically peculiar in height/vegetation etc.) for a comparatively long time of many minutes or hours or days, and sometimes they may fly to find a better site or just disperse a little often when disturbed.

There are good reasons why butterfly species evolve different mate-locating behaviors. If a mating rendezvous site occurs in just part of the habitat (characterized by peculiar topography or vegetation such as a prominent treetop etc.), raiting (or flaiting) behavior there is desirable because it keeps the males at that site (fleeking males would fly away). If the density of the usual population is low, raiting seems a better choice, because the male can spend most of his time resting at the genetic mate-locating site to save his energy. If density is high, only a few males could fit on a hilltop or some other small site, so fleeking would be a better choice so the males could fly everywhere that a female might occur in that large population. If the butterflies are common and the hostplants occur everywhere, fleeking might be best, to enable males to canvas all those places where females might be. Or raiting in special spots (cleared nooks, high treetops, etc.) might be a good method to locate mates if those sites are easier to find (by the butterfly) than finding a suitable mate by random search. If the species generally occurs in cold habitats, the males might be able to keep warm better if they flew a lot and became fleeking or flaiting species. Or they could rait and just bask to get warm.

Morphological adaptations occur in the wings and thorax muscles of butterflies—especially males—to perfect their mate-location (Scott 1983a). Raiting species tend to have the male forewing more pointed, with the ratio (maximum forewing length divided by length from wing base to tornus) greater, with the margin straight from about vein M_2 to the tornus, whereas fleeking species tend to have the male forewing margin more convex. Females of all species have the margin more convex. Raiting males tend to have more powerful thoraxes also to make fast takeoffs to overtake passing individuals, and they beat their wings faster. Basically raiting males tend to have "jet wings" and strong thorax muscles for powerful takeoffs and speedy flights to passerbys, whereas fleeking males and all females have "cargo plane" big wings for continuous flight (large wings in females are useful for long-range delivery of big loads of eggs to oviposition sites). (There are some exceptions, such as the fleeking *Danaus plexippus*, which have pointed forewings, so the differences between raiting and fleeking species seem to be greatest within genera or closely-related genera or groups that have both species, such as *Poanes*, or *Oeneis* versus *Erebia*, etc.) This difference may be better quantified (in large studies measuring many species) using "wing loading" of each sex, representing the measured ratio of whole-insect weight to forewing size/area.

I do not like the words "<u>territoriality</u>" and "<u>leks</u>" for describing mate-locating behavior of butterflies, because those words have numerous problems, and butterflies are not ferocious, they just want to mate. Butterflies are about the least-equipped to fight of any animals on earth, as their wings are fragile, their legs and palpi are easily broken off, they have a long narrow proboscis like a straw instead of jaws, their valvae "claspers" are weak and cannot be used for defense, their antennae are fragile, and they have no other defenses other than flying away or producing repellent-smelling chemicals or using anti-predator wing patterns. Butterflies have to avoid contact to keep from falling apart, and after a few weeks the wings of most butterflies are worn down to stumps merely from flying and bumping into flowers and leaves etc. When a male butterfly approaches another, basically he is investigating the other by approaching near enough to see and smell the other to see if it is a virgin female, and he has to get fairly close because butterfly vision is very good for spotting movement of passerbys and is useful to detect large areas of wing color but is rather poor for details of pattern and wing shapes. That is because the butterfly eye has fewer detectors (a few in each little bumplike ommatidium on their eyes) than the human retina. Butterfly mate-locating behavior is really nothing like the real territoriality of ferocious bull elephant seals or African Kob antelope or Prairie Chicken birds (the latter two are territorial in leks, in which females recognize each separate male and consciously choose the displaying male she likes best, in a thinking game of strategy), and the truly territorial males of other animals (vertebrates and dragonflies etc.) have real weapons and can inflict painful damage on other males in real fights for dominance. Butterfly males are trying to mate, and they don't want to waste time chasing other males when they could find a good spot that adequately fits their genetic site programming where they can mate-locate. This book reports that many species can adjust their mate-locating behavior according to their experiences in meeting other individuals, in particular many species mostly rait at particular sites such as hilltops when density is low and most can fit on the small mating site (hilltop), whereas at high density they may seek better places and fleek mostly about the hostplants which are frequently on slopes.

Many people use the word territoriality for raiting "perching" species, because they think that when a raiting male approaches another male he is aggressively trying to drive the other male away to "defend his territory". Actually the other male usually looks similar to a female, and the male has to come close to determine—using gross appearance and scent--whether the other butterfly is a male or a female, whereas he may be able to more quickly detect the wrong species from farther away if the other species differs somewhat in size, color, smell, and flight pattern etc. and thus requires less time to reject. Butterfly vision is not great; they can detect moving objects very well, and can see colors and even ultraviolet light and polarized light, but shapes and patterns cannot be determined very well, so butterflies have to come close to identify the other, often or usually using odor to identify it. Anthropomorphism is the process by which people misinterpret wild animals' actions as if they are people. Many people think the raiting male is territorial because he usually returns to where he was resting before he flew out to investigate another, but actually he has learned the site and knows where he can land while the other butterfly is unfamiliar with it so may fly away. The raiting male often stays on the genetic mating site (gulch or hilltop etc.) merely because that is the genetic mating rendezvous site of the species, where males and virgin females go to mate, whereas the oncoming butterfly may have a different mating system such as fleeking about the habitat. And when another butterfly is rapidly approached by a raiting male, the other butterfly might be afraid that the raiting male is a robberfly or dragonfly or bird or other predator, and no olfactory clues come from a rapidly-approaching creature to determine its identity, so the other butterfly may try to escape and fly away. And the raiting male is more likely to stay after investigating another because the other male may have identified the male as his species but does not want to bother staying at a site where he has to waste a lot of time and energy repeatedly flying to and investigating that raiting male. Sometimes when one male meets another male, they fly high up in the air in a vertical encounter; such behavior is more common in raiting species (which usually have lateral encounters, as they pursue the other male some no matter where they go), but often occurs in fleeking species also (see below) and often occurs in mated unreceptive rejecting females. Raiting species more often do those vertical encounters because those maneuvers do not take them far from their preferred genetic mating site, and raiting males often fly upward a little on their way to another butterfly, so the vertical component may increase the likelihood of a vertical encounter (in *Euphydryas editha*, vertical encounters were seen in a raiting population, only lateral encounters in a fleeking population). Two raiting males generally have encounters that range completely from a little downward to lateral to upward at every angle to near-vertical. And sometimes two males flutter around each other in a "ball", which also is more common in raiting species, because they are motivated to stay at their genetic mating site whereas fleeking species can just fly together sideways for a short distance to determine identity (a lateral encounter), then fly onward to find some receptive female. Some people use the word territoriality for raiting species that don't travel far, but mark-recapture studies show that some raiting species can travel hundreds of meters and then display the usual raiting behavior there, just because it also looks like a good genetic site (such as the right kind of gulch bottom) (see Scott 1975a--which found that raiting species may disperse as much as fleeking species--and see references in Scott 2010a). And there are fleeking species that are very local and are more colonial than most raiting species. To prove that a butterfly population is restricted from dispersing "territorial" requires marking and watching the butterflies, work which takes much time and effort and is seldom done today, so the word territoriality is not "operational" (easily and appropriately used). The word territoriality often distracts authors from properly reporting mate-locating behavior, as they write on and on about how "aggressive" the males are "defending" and "fighting" for their territory while they poorly report the locations where mate-locating occurs, and often/usually fail to report the time of day when the butterflies mate-locate.

Takeuchi et al. (2016) logically examined whether butterflies are territorial fighters competing with other males, and developed a simple mathematical model, and surveyed the literature on butterfly and other insect "contests", and concluded that Odonata dragonflies are territorial fighters, but butterflies are not and the male-male "territorial contests" reported are just attempts by the male to determine the sex of the other individual.

It's interesting to note that there are proven territorial butterflies—but they are LARVAE, not adults. This has been demonstrated in larvae of various species. Larvae of *Epiphile* and *Diaethria* (Nymphalinae) have long antlers on the head but few body spines, and A. Muyshondt reported an *Epiphyle* larva in El Salvador puncturing another larva's body with its antlers, and others locking antlers until death! And *Iphiclides podalirius* (Papilionidae) larvae in Europe lay silk as they crawl which has a slight odor, such that a larva prefers its own silk trail and will silk over another larva's trail (R. Weyh, U. Maschwitz), and if two larvae meet they may fight or the larger can silk the other to a branch. And European *Papilio alexanor* larvae are also reportedly territorial (D. Kahlheber). Some Lycaenidae and Pierini larvae are cannibalistic, and eat other larvae which are competing for the small portions of food available on flower buds/young fruits of a small hostplant.

In this book I only use the new proper words raiting, flaiting, and fleeking; I do not use anthropomorphic words or non-operational misleading words such as territory, lek, aggressive, defending, pugnacious, fighting, battles, intruder, contest, fierce, etc.

Misinterpretation of what happens when one butterfly meets another is frequent in the literature. When one butterfly approaches another male or a female or another insect, to really understand what is happening we often need more knowledge of which kinds of visual and chemical information are used and transmitted when they are nearby. Logical study of the visual and chemical signals used in those encounters suggests that there may be unexpected signals. For instance male butterflies generally have pheromones. In *Papilio machaon* and *P. glaucus* and *Argynnis* and many other butterflies, the male has a perfumelike pheromone used during courtship, and most other butterflies evidently have a male pheromone even if it cannot be smelled by humans. So when a male approaches and hovers by a male or female he would not be able to identify the other as male or female very well (unless she produces a female pheromone) because his own pheromone would be wafted around both individuals by his flapping wings, whereas the female could suddenly smell it and would know that she was near a male. Thus the males belonging to species with male pheromones—very many or most butterfly species--may remain longer in encounters with other butterflies to try to determine the sex by behavior (or maybe aided by using a female pheromone to identify the other individual as a female). This situation—males confused in encounters with other males, females confident of the identity of the other butterfly if it is a male—is <u>opposite</u> what the territoriality-obsessed writers think, as they wrongly believe that the male quickly detects the sex of a male intruder and intentionally fiercely drives the intruder away. The same situation occurs in *Battus philenor*, in which the iridescent blue uph of males is used by females to detect males, whereas the confused males do not use it to determine that the other butterfly is a male. If both sexes had different pheromones, the males could easily identify females, and females could easily identify males, but neither could easily identify adults of the same sex.

The location of mating is critical to butterfly success. The location of mate-locating of a species generally evolves because of the topography, the distribution of its hostplants, the usual abundance of the butterfly, etc., which favors certain sites during evolution (preferred mating sites are genetically inherited). Some species mate-locate at cliffs, many mate-locate on the hostplant, some on treetops, many in gulch bottoms, many in forest clearings, etc. Hilltopping and gulching are useful words used to describe the genetic mating sites in many species. Hilltops are frequent in the foothills, so there are many hilltopping species there. In contrast, on comparatively-flat plains there are more gulch bottoms and not many good hilltops, so there are many gulching species there. In forested areas, species may use the top of big trees as "hilltops" so there may be treetopping species there, and there may be species that mate-locate in meadow swales or in little clearings in the forest. Each butterfly species fine-tunes its preferred mating site to peculiarities that work for that species, and it is our job to observe them and determine those peculiarities. This book details what I have been able to observe about the peculiarities of Southern Rocky Mts. butterflies, using ~100,000 observations.

I found several dozen pairs of species in Colorado in which one species mates on hilltops, while a closely-related species mates in gulches. For instance *Hesperia pahaska* mate-locates on hilltops, while the similar *H. viridis* mate-locates in gulches (their habitats and hostplants and appearance are very similar). *H. pahaska* more often occupies foothills and mountainous habitats, whereas *H. viridis* occurs more often on plains where there are plenty of gulches but not many hilltops; in general the mating sites fit the distribution of the kinds of sites occuring in the habitat and range of the butterfly, where its hostplants grow.

A special process of natural selection of mating sites forces very rapid evolution of mating-rendezvous-site locations. During evolution, if there is genetic polymorphism of preference for mating-rendezvous sites (for example hilltops or gulches) in a single population, if more adults manage to mate on hilltops than gulches then the number of adults with hilltop genes will increase during each generation, and soon most will be hilltoppers, and the few that go to gulches will find even fewer individuals of the opposite sex in gulches to mate with than were there in the previous generation, so when the population size is low there may be no males or females going to the gulch and he/she cannot find a mate so the gulching gene disappears. If there is another species that has greater success mating in gulches, the same evolution will happen to them, as fewer and fewer go to hilltops until almost none go there and the hilltopping gene disappears and they all mate in gulches. The result is two species mating in separate sites, which increases mate-locating efficiency for each species. The special process of natural selection occurs if both species are sympatric in a habitat with both hilltops and gulches, because the evolutionary change in mating sites accelerates due to each species wasting time investigating the other species. Stating this rapid-evolution process a different way, if one species more-often hilltops and the other more-often gulches, a gulcher going to a hilltop will have to contend with numerous hilltoppers of the other wrong species there and will have to waste more and more of his time investigating them during each generation, and will have less chance to find a mate of his species; likewise a hilltopper going to a gulch will have his time wasted by all the gulchers there and will have to contend with fewer of his species. This process accelerates the switch of one species to hilltopping and the other species to gulching, because as the process proceeds the adults going to the non-popular sites encounter two problems: less and less of their own species, and having to bother with more and more of the wrong species further reducing their mating success. The two problems accelerate the evolution of mate-locating site to quickly make one species mate on hilltops, and the other species mate in gulches. They quickly divide up the mate-locating rendezvous sites to the benefit of both species. Natural selection can make a species mate-locate in a particular topographic/vegetational spot in the habitat, but it happens even faster when two species flying together end up mate-locating at different sites. That process seems to be partly why there are dozens of pairs of similar sympatric species that mate in very different rendezvous sites such as hilltops versus gulches.

Some species mate-locate throughout the habitat, and most of those are fleeking species. Other butterfly species mate-locate primarily at concentrations of the hostplant, and most of those are fleekers. Most hilltopping species are raiters, while some are flaiters. Gulching species can be raiters or fleekers, as the raiters wait at single spots in the gulch for some time, while the fleekers fly up and down the gulch. Raiting species usually prefer to rendezvous in some peculiar place in the habitat such as a special kind of nook in clearings in the woods or brush, a flat place in a gulch, a very rocky place in a gulch, a cliff, etc. Each species may have its own peculiarities of the places that it prefers to mate-locate.

Hilltops are usually small in area, and good hilltops are usually infrequent, so hilltopping species are generally not very common because few males can fit on the hilltop, yet they are great rendezvous locations where rare adults can go to find mates. That is why hilltopping species tend to be rarer than species which mate elsewhere. The hilltoppers in the Front Range foothills in spring were found to be rarer on average than the non-hilltoppers (Scott 1970). When the erroneous (due to too-few observations) mate-locating sites of several species (including *Hesperia juba*, *Erynnis icelus*, *E. afranius*, *E. telemachus*, *Euchloe ausonides*, *Argynnis coronis*, etc.) are corrected in that paper, the hilltoppers are actually even rarer than that paper reported, less than 1/4th as common as the non-hilltoppers.

In Colorado we now know that some usually-hilltopping species use hilltops when rare or uncommon, but during population explosions few can fit on the hilltop and most of the population of males fleeks about the hostplant on hillsides and flowers etc. to find females. *Chlosyne gorgone* and *Erynnis martialis* and *E. pacuvius* are good examples. In *Euphydryas editha* at a Colorado site, most matings evidently occurred on hilltops when the population was sparse, maintaining hilltopping behavior in the population, but when the population was abundant most matings occurred near the hostplant (P. Ehrlich & D. Wheye [citations under that species' account]). And species that are usually common generally fleek. When a species becomes common, raiting or flaiting males occur at the best rendezvous sites and others are forced onto less-ideal sites; for instance *Papilio zelicaon* males occur only on good hilltops when scarce, but when abundant males also rait/flait at crummier sites down the adjacent ridges in order to avoid wasting time investigating males on a crowded hilltop (but those males down the ridges may still mate, as a female flying upward toward the hilltop is likely to meet a male on the ridge before she can get to the hilltop).

Mate-locating butterflies very often or usually have genetically-preferred mating sites. But what happens when that preferred site is not available in a population of that species? They have to use whatever great or poor sites are available in their habitat. Thus *Strymon melinus* males prefer hilltops for raiting, but on a flat prairie I found a male raiting on top of my truck, the only higher place available. And *Papilio polyxenes* males can find the highest point of a meadowy rest stop along the interstate across the Great Plains, the only point slightly resembling their preferred hilltops; and males in a flat area may just fleek about to find females. *Papilio eurymedon* prefer to flait on ridgetop forest openings, but in places where there are no trees on the hilltop, the male flaits between a row of trees and a steep hillside on a little peak. *Papilio multicaudata* prefer to fleek up and down gulch bottoms, but in a flat city they adjust and often travel between the spaces between trees, places resembling a "canyon" in the forest. They adjust their behavior to what is available in their habitat.

The <u>time of day of mate-locating/mating</u> differs greatly in some butterfly species (they don't all just mate-locate & mate all day). Most butterflies mate-locate all day, but one cannot assume this; one must study each species carefully to determine its precise time of mating. Some butterflies mate-locate/mate just in early morning (*Notamblyscirtes*, *Neominois*) or most of the morning (*Epargyreus*, *Megathymus yuccae*?, *Poladryas*, *Lycaena arota*), some from mid-morning to late afternoon (*Limenitis arthemis*, *Aglais*, *Nymphalis*, *Apodemia*, *Satyrium titus*), some mid-morning to dusk (*Satyrium* *sylvinus*), some around midday to dusk (*Atlides halesus*), some mainly in afternoon (*Asterocampa celtis*, *Satyrium favonius*), some early afternoon to dusk (*Atrytone arogos*, *Vanessa*, *Polygonia*, *Satyrium californica*/*acadica*, *Strymon melinus*, many more hairstreaks), some in late afternoon to dusk (*Hypaurotis*, *Satyrium* (*Phaeostrymon*), *Danaus plexippus* & *D. gilippus*). In SE U.S. (*Lethe*) and in the tropics there are even crepuscular species (Brassolini etc.) that mate-locate at dawn <u>or</u> dusk (I have not read proof that any species mate locates/mates in <u>both</u> dawn and dusk). High-mountains and boreal species tend to mate all day, to take advantage of a limited number of sunny warm times during their cool flight period.

The location of mating and the amount of flaiting versus raiting and the height of raiting males (while resting and watching for females) and the height of flight of flaiting and fleeking species and the time of mating are finely tuned peculiarities of each species. So when males and females follow the genetic programming encoded in the DNA of each species, they can quickly find the other sex and mate and spread their genes in Darwin's process of natural selection, to benefit them and their species. This book summarizes about 100,000 of my notebook records of mate location (which I recorded from the late 1960s to the present) to try to describe those mate-locating peculiarities of each species.

When a mate-locating male meets another adult, various things can happen. If the female is receptive, courtship occurs and they may land without hovering or fluttering and rapidly join, then they mate (for 20 minutes to an hour or so depending on the species), then depart. If the other butterfly is an unreceptive female, she usually slows and then she and the male may hover or flutter and then may land and do more fluttering or vibrating and he may try to join and the female may show a variety of methods to repel him (vigorous fluttering is the most common female rejection behavior, a "rejection dance") or she tries to escape. If both butterflies are males, they may recognize that there is no possibility of mating and ignore each other, or they are unlikely to be aimed head-on so one may chase the other a bit in a "lateral encounter" (encounters occur at any kind of angle) then they separate, or if both males think the other might be worth investigating they may come near each other and fly around each other a short time in a "ball" (treated more below), or may come near each other and both fly at an angle or vertically one to several meters in a "vertical encounter" (treated more below).

Here are some detailed accounts from my notebooks of several behaviors frequently displayed by males when meeting other mostly-males:

<u>The Vertical Encounter</u>. When two mate-locating males meet, they may flutter near each other, or fly in a sort of ball around each other, or fly off in some odd angle, or sometimes fly vertically into the air, all basically to determine if the other is a receptive female. Some people think that they are fighting when they do this, but they rarely contact each other and it's difficult to fight when you don't have any weapons with which to fight. I recorded vertical encounters for many species, mostly raiting species. Vertical encounters are much more common in raiting species because the male has chosen his genetic mate-locating site, and flying vertically allows him to remain at that site better than flying a long way sideways and then wasting time flying all the way back. The vertical encounter is actually just the most-vertical extreme of thousands of encounters that go below laterally to laterally to every degree upward and finally perpendicular to the ground. Two adjacent raiting males are sometimes likely to investigate each other and rise upward in a vertical encounter, evidently because they are often aimed toward each other and their direction is altered upward (rather than downward into the ground) so they go upward for a while to determine the other's identity. In fleeking species, both males are flying laterally, so when they meet there is generally some resulting combined lateral direction (like ships that collided) so what happens is one chasing the other sideways for a bit or a few seconds until they identify the nonreceptive-female status of the other and continue on their journey to search for receptive females.

The vertical encounter is similar to one rejection behavior of females: she flies vertically some meters to try to escape the male, who may follow her upward, and then she may just try to fly off, while in the most classic maneuver done by *Poladryas* etc. after the vertical flight, she often zooms quickly down near the ground where the visual confusion with stuff on the ground and her speed makes it difficult for the male to follow her. Thus the vertical encounter is an effective way to get rid of the *Poladryas* male. Some males doing the vertical encounter may be trying to get rid of the other male by leading him up and away. When they come down again, one male knows a good spot to land, while the new male doesn't and may just wander off randomly in search of a good spot without the nuisance of dealing with another male already there.

I seldom recorded vertical encounters in my notebooks, as it is rather ordinary behavior in raiting species, but I did record vertical encounters for the following raiting species: *Epargyreus clarus* 3x, *Erynnis afranius*, *E. telemachus*, *Amblyscirtes phylace*, *Hesperia comma colorado* 2x, *Hesperia uncas*, *Atalopedes campestris* 8x, *Polites draco*, *Polites peckius* 3x, *Paratrytone snowi* 5x, *Oeneis uhleri* 7x, *Oeneis calais altacordillera* 1x, *Anaea andria* 3x, *Limenitis weidemeyerii*, *Vanessa cardui* often, *Nymphalis antiopa* 3x, *Polygonia gracilis zephyrus* 2x, *Junonia coenia* 3x, *Euphydryas chalcedona* "*variicolor*" 2x, *E. anicia brucei* 5x, *E. anicia capella* 2x, *E. bernadetta rorina*, *E. editha lehmani*, *Polydryas minuta minuta*, *P. minuta arachne*, *Phyciodes texana* 2x, *Apodemia mormo pueblo*, *A. nais*, *Lycaena dione*, *Satyrium behrii crossi*, *Callophrys dumetorum homoperplexa* 3x, *C. sheridanii*, *C. mossii schryveri*, *C. augustinus*, *C. polios*, *Strymon melinus* 3x, *Cupido amyntula*, and *Plebejus melissa*. *Phyciodes texana* and *Atlides halesus* do this also. Douglas & Douglas (2005) report numerous raiting species and numerous fleeking species whose males engage in vertical often-spiraling encounters high in the air.

I recorded vertical encounters for the following mostly flaiting species: *Burnsius (Pyrgus) communis*, *Papilio eurymedon* 6x, *Argynnis callippe meadii* 4x, and *Leptotes marina* (which raits, flaits, and fleeks). *Battus philenor* and *Papilio zelicaon* and *Limenitis archippus* are also known to have vertical encounters.

I recorded vertical encounters for the following mostly-fleeking species: *Colias alexandra*, *Colias philodice*, *Colias eurytheme*, *Pieris rapae*, *Pontia callidice occidentalis*, *Lethe eurydice* 2x, *Erebia epipsodea*. *Colias* species and *Erebia epipsodea* are also known to have frequent vertical encounters (Brussard & Ehrlich 1970, Scott 1974a). Douglas & Douglas (2005) record vertical encounters for numerous fleeking species.

<u>The Ball</u>. Sometimes several males investigate each other, and end up in a "ball" as they flutter next to each other for a while, sometimes even while they drift slowly downwind. Raiting species seem more likely to be in such a ball, because both males are in a genetic mate-locating site, so are more motivated to stay there, whereas two fleeking males that meet are moving laterally already so they just fly near each other long enough to determine the other butterfly is just unreceptive or maybe a male and they fly off to resume their search for receptive females.

I saw the "ball" often, and usually did not record it because it is rather ordinary behavior. But I did record the "ball" in the following raiting species: *Erynnis martialis* 2x, *E. afranius*, *E. telemachus*, *Amblyscirtes vialis* 8x, *Polites draco*, *Polites mystic dacotah*, *Notamblyscirtes simius*, *Papilio indra*, *Oeneis chryxus*, *O. polixenes* 5x, *Nymphalis californica timidar*, *Chlosyne gorgone*, *C. whitneyi damoetas* 2x, *Phyciodes pallida* 2x, *Lycaena rubidus*, *L. dione*, *Hypaurotis crysalus*, *Satyrium acadica*, *Callophrys dumetorum homoperplexa* 2x, *C. augustinus*, *C. polios*, *C. eryphon* 6x, *Plebejus glandon rustica* (raits and fleeks).

I recorded the ball in the following flaiting species *Papilio eurymedon*, *Papilio polyxenes*, *P. zelicaon*, *Erebia magdalena*, *Lycaena helloides*, *L. hyllus* (*P. eurymedon* just flaits, whereas the others both rait and flait frequently).

I recorded the ball in the following fleeking species: *Pholisora catullus*, *Hesperopsis libya*, *Piruna pirus*, *Pieris rapae* 2x, *Lethe eurydice* 9x, *Cyllopsis pertepida*, *Plebejus alupini cotundra*.

Courtship and Mating of Butterflies

About 98% of all females found in nature are already mated, so ~98% of observations of courtship in nature are of already-mated unreceptive females, because mate-locating behavior tends to be rather efficient and young virgin females may not fly very much, so completed courtships are rarely observed in nature. The best way to see completed courtships is to rear many virgin females, and then feed them honey-water until they are satiated, then release them in nature near males, and watch them mate. It is disappointing that my notebooks contain too few descriptions of completed courtships. But I studied dozens of species well, and gathered good descriptions for those and descriptions of completed courtships of many others. And there are several dozen good studies of courtship/mating of other species in the literature, which are summarized in this book. Scott (1973a) detailed mating behavior of butterflies.

The good news is that completed courtships involving highly-receptive virgins tend to be rather simple (with the female being mostly quiescent and accepting the male without complicated maneuvers to try to discourage the male, and the male quickly seizing his opportunity to mate without bothering with complicated maneuvers to try to make the female receptive), so courtships with unreceptive females are actually necessary to observe in order to learn the full variety of courtship/mating behaviors. Scott (1973a) even cited studies reporting successful experimental matings with newly-dead females in *Anthocharis charlonia*, *Hypolimnas misippus*, *Euphydryas editha*, and *Argynnis paphia* (death is the ultimate quiescent state). In contrast, less-receptive or unreceptive females show many more behaviors, and force the male to display his full repertoire of behaviors also to try to induce the female to accept the male. Courtship of *Junonia coenia* illustrates this well (Scott 1976b). So for many species I have been able to deduce and reconstruct what happens in matings with receptive and unreceptive females, and I note those cases with words such as "receptive females would presumably be quiescent and accept the male", and I have been able to report the special behaviors that unreceptive females use to repel males. These <u>rejection behaviors</u> include the <u>rejection dances</u> (usually vigorous female fluttering) and rejection postures (Pieridae females spread their wings and raise the abdomen vertically), flying vertically then sometimes quickly downward, moving the abdomen or wings so the male cannot join, dropping or crawling away or flying, and a few species have a repellent pheromone, etc.).

<u>The generic courtship</u> "typical" of butterflies is this: the male and female meet, the female may hover with the male hovering below or nearby to transfer pheromone, they land and the receptive female is quiescent while the male flutters/vibrates his wings to transfer pheromone and he bends his abdomen to join; while unreceptive females flutter to repel the male, and unreceptive females may also do many other things such as move their abdomen or wings so he cannot join, or crawl or turn away or drop into the vegetation or fly away. (Video would be required to best document courtship and mating behavior in butterflies, and I did none of that, so the exact frequency of wing vibrations and the exact angles of wing positions during courtship described below in the species accounts are just estimates.) In the simplest butterfly courtship, male and female meet, they land, and quickly join with no movements at all.

About 41 papers on courtship behavior of various butterflies including Ithomiini are cited by Imafuku, M., T. Kitamura, & A. Uchida 2021 (J. Lepid. Society 75: 14-24 esp. 23-24).

In butterfly courtship, information is exchanged between male and female to enable them to determine how to behave. That information includes chemical odors transmitted, and visual signals involving colors, major wing patterns, and movement of wings and bodies etc. Pheromones (odors used for communication) are important information for both sexes. Wing movements are used both to transfer pheromones and to maneuver near the other, and to inform the partner of the receptivity toward mating. Flight patterns are used, to position the pheromones near the partner, and position the wing major color patterns near the partner. The color (including ultraviolet—Scott 1974c details the ultraviolet patterns of North American butterflies, and Scott 1986a has photos of the major uv patterns) and major wing pattern and size of the male and female are used to tell the partner which species is involved. But fine details of wing pattern are generally not used, because butterfly vision is not as good as human vision for details of pattern, while butterfly vision is very good at detecting movement, so butterflies can detect vibrating wings and rapid movement of the partner or passing creatures.

Most butterflies of both sexes evidently have pheromones, even though definite pheromone-wafting structures (androconial scales on wings, a stigma, costal fold, hindwing glands, hair pencils on legs or wings or abdomen, or glands on abdomen etc. in males, various glands mostly on abdomen or small hair pencils etc. in females) may be present or absent in somewhat random fashion in the various butterfly species. Pheromones are produced in mostly microscopic glands, so may be produced on wings or body of butterflies despite the absence of large structures or androconial scales that help waft the pheromone during courtship. (During evolution, the first step is the production of a usable pheromone, and only later are structures evolved to more efficiently transmit that pheromone, so obviously there are many pheromones in butterfly species that lack high-quality transmission structures.) The text below lists the known chemical identity of pheromones for several dozen butterfly species. Males and females can have aphrodisiac pheromones (chemicals that make the opposite sex want to mate), and females may have anti-aphrodisiac (repellent) pheromones manufactured by the male and transferred to the female (esp. in Pieridae and Heliconiini, perhaps also in *Burnsius* in Pyrgini). We can now conclude that most butterflies have both male and female pheromones, which have received little chemical study compared to the thousands of pheromones now known from moths.

One of the main conclusions of this book is that the courtship behavior of butterflies is rather conservative (simple). Most butterflies have rather generic simple courtships, and comparatively few Nearctic butterflies have very specialized behaviors during courtship, and courtship behaviors tend to be rather similar in congeneric butterfly species, while those odd courtship behaviors reported for some butterflies seem to be much more common in tropical species (similar species have the same odd behaviors there, also). Because of this confident general conclusion that courtship is rather similar in most butterflies, it is obvious that the main species isolating mechanisms in butterflies must be pheromones of both males and females. When closely-related species are examined, their pheromone-emitting structures often differ, seemingly in random fashion. For instance, in *Erynnis* males, one species has only the tibial hair tuft to waft pheromone, six species have the tibial tuft and the forewing costal fold, and nine species have only the costal fold, while in females, all species have a transverse patch of scent scales on top of A7, and all but four species have the two ventral hairpencils of scent scales on A7. And in *Erebia*, only 26 of 69 species have obvious male androconial scales to waft pheromone. (Pheromones can occur without androconial scales because the pheromones are produced by microscopic glands in the wing membrane or exoskeleton, not by the scales.) Other isolating mechanisms may involve the overall colors of the wings, the major color patterns, and the major flight patterns or wing movements etc. of butterflies during courtship. The locations and times of mate-locating behavior would also keep species from interbreeding, unless related species have the same locations and times. Prezygotic sterility and postzygotic failure to grow are other isolating mechanisms.

Coupling during mating generally starts when the male crawls beside the female's abdomen and bends his abdomen laterally 180^o to grasp the whole ventral end of her abdomen with his two valvae ("claspers"), and his uncus fits into a membranous depression below her papilla anales (ovipositor) (exceptions are some Lycaenidae which use the gnathos as the main attachment device, and some hairstreaks insert both valvae into her mating tube=ostium bursa during mating). After coupling, he quickly turns to face away from her. Then immediately after joining nearly all butterflies just rest or bask, but *Danaus* & Pieridae males fly off in a postnuptial flight with the female dangling beneath. If a mating pair is startled, one sex may fly, the partner dangling below, and the sex that flies is generally fixed within whole families or subfamilies, as noted in the text for each major family/subfamily and species. During mating, the male deposits a "spermatophore" in the female; it contains sperm to fertilize the eggs, plus some whitish goo, both inside a soft proteinaceous sack, plus a narrow transparent hard "neck" that serves to partially block her mating orifice; the sperm go to the spermatheca, and those spermatophore materials are digested by the female in the next more-than-several days or a ~week and are partly used to grow her eggs.

Mating duration varies between butterflies (Scott 1973a), and can average just 15 minutes or a half hour or an hour in a particular species. Other happenings can lengthen that time: If the male mated recently, mating lasts longer (several hours or even overnight) while the male replenishes his mating fluids. Mating is longer in colder temperatures. Mating late in the day may last overnight and through several morning hours. Butterflies that make a sphragis such as *Parnassius* take ~3 hours to mate. Males can generally mate many times, whereas females of many species mate only once, and the number of matings per female varies greatly as females of other species often mate twice, and some can mate three or even four times (Scott 1973a table 7). The eggs are usually fertilized by the male who mated last with that female.

Females are usually able to mate on the day of emergence, whereas males may require a day or two before mating. Males generally emerge from the pupa a few days or more before females, creating an "emergence lag" in nature, in which males become common when the females start to emerge, enabling the males to be abundant when there are plenty of virgin receptive females, and allowing females to mate quickly with abundant males (Scott 1977a). This emergence lag also benefits the whole species, as more eggs are produced with the lag than without it.

Flight of Mating Pairs—the Sex that Flies when a Mating Pair is Disturbed ("Carrying Pair" Behavior)

Butterflies have interesting peculiarities. They take about 15 minutes to an hour or more to mate, and during that time if a mating pair is disturbed and becomes frightened, the sex that flies (with the other sex just dangling below attached by the coupled abdomens) is generally fixed in whole genera or subfamilies or families of butterflies, obviously because of genetic programming in that group of butterflies. This has been called "carrying pair" behavior, but the word carrying implies toting something with arms, so I do not like those words. I observed this behavior in ~1000 mating pairs of butterflies, and that information is tabulated below (Table 1). In most butterflies the female flies and the male dangles below, but in Pieridae and Danaini the male nearly always flies, and in Pyrgini and Polyommatini the male usually flies, while in Argynnina and Lycaenidae (Lycaenini and Eumaeina especially) males and females fly about equally often, except in Polyommatini the males fly about~2/3 of the flights, the female flies ~1/3. These results are basically the same as those concluded by Shields & Emmel (Shields, O., J. F. Emmel. 1973. A review of carrying pair behavior and mating times in butterflies. J. Res. Lepid. 12:25-64). {I was an author of that paper also, until my complaints about some of the writing resulted in my removal}.

Number of Mating Pairs found (in parentheses) and number of Males or Females of Mating Pairs Flying, for Each Butterfly Species

Hesperiidae, Eudaminae (1 pair): Epargyreus clarus 0
Hesperiidae, Pyrginae, Carcharodini (2 pairs): Pholisora catullus 1f
Hesperiidae, Pyrginae, Erynnini (64 pairs): Erynnis brizo 3f, E. martialis 1f, E. pacuvius 5f, E. persius 30f, E. telemachus 3f
Hesperiidae, Pyrginae, Pyrgini (10 pairs): Burnsius (Pyrgus) communis 5m2f
Hesperiidae, Heteropterinae (1 pair): Piruna pirus 1f
Hesperiidae, Hesperiinae, Thymelicini (1 pair): Oarisma garita 1f
Hesperiidae, Hesperiinae, Moncini (2 pairs): Amblyscirtes aenus 1f
Hesperiidae, Hesperiinae, Hesperiini (83 pairs): Hesperia comma 15f, H. leonardus montana 1f, H. l. pawnee 1f, H. ottoe 1f, H. pahaska 2f, H. uncas 1m, H. viridis 1f, Polites draco 1f, P. mystic 3f, P. peckius 13f, P. sabuleti 7f, P. themistocles 3f, Ochlodes sylvanoides 1f, Euphyes bimacula 1f, E. vestris 3f, Notamblyscirtes simius 2f
Papilionidae, Parnassiinae, Parnassiini (25 pairs): Parnassius smintheus (smintheus & hermodur) 4f (3f crawled)
Papilionidae, Papilioninae, Troidini (1 pair): Battus philenor hirsuta 1f
Papilionidae, Papilioninae, Papilionini (12 pairs): Papilio eurymedon 1f, P. indra 2f, P. polyxenes 1f, P. zelicaon 1f
Pieridae, Coliadinae (95 pairs): Eurema mexicana 1m, Colias alexandra 2m, C. edwardsii altiplano 1m, C. eurytheme 63m12f, C. philodice 36m, Zerene cesonia 3m, Phoebis sennae 1m
Pieridae, Pierinae, Anthocharini (5 pairs): Euchloe hyantis hyantis 1m, E. olympia 1m
Pieridae, Pierinae, Pierini (80 pairs): Pieris marginalis mcdunnoughi 4m, P. rapae 70m1f, Pontia callidice occidentalis 4m, P. protodice 5m1f, P. sisymbrii 2m
Nymphalidae, Libytheinae (1+ pairs): Libythea carinenta larvata 0

Nymphalidae, Danainae, Danaini (34 pairs): Danaus gilippus 2m, D. plexippus 21m
Nymphalidae, Satyrinae, Elymniini (4 pairs): Lethe eurydice fumosus 7f
Nymphalidae, Satyrinae, Satyrini (137 pairs): Coenonympha tullia 2m2f, Cyllopsis pertepida 7f, Cercyonis meadii 20f, C. oetus 20f, C. pegala 65f, Erebia epipsodea 1f, Neominois ridingsii 6f, Oeneis bore edwardsi 1f, Oeneis calais altacordillera? 1f, Oeneis chryxus 20f, O. melissa lucilla 1f, O. uhleri uhleri 3f (2 of these were too heavy to get into the air), Lasiommata megera 2f
Nymphalidae, Charaxinae, Anaeini (none)
Nymphalidae, Nymphalinae, Limenitidini (3 pairs): Limenitis archippus 1f
Nymphalidae, Nymphalinae, Heliconiini, Heliconiina (1 pair): Heliconius erato 0
Nymphalidae, Nymphalinae, Heliconiini, Argynnina (89 pairs): Euptoieta claudia 1m14f, Argynnis aphrodite 2m12f, Argynnis atlantis sorocko 3m, Argynnis callippe meadii 6m7f, Argynnis coronis 2m, A. cybele charlotti 1f, A. edwardsii 1m1f, A. hesperis 21m5f, A. idalia 1m, A. mormonia 3m1f, A. nokomis 1m, A. zerene 1m1f, Boloria eunomia 2f, B. titania helena 1f
Nymphalidae, Nymphalinae, Apaturini (no pairs): Asterocampa celtis 0
Nymphalidae, Nymphalinae, Nymphalini (8 pairs): Nymphalis antiopa 4f, Junonia coenia 4f
Nymphalidae, Nymphalinae, Melitaeini (144 pairs): Euphydryas anicia capella 1f, Poladryas minuta arachne 5f, P. minutaXarachne hybrids 5f, Chlosyne gorgone 24f, C. lacinia adjutrix 1f, C. leanira fulvia 1f, C. nycteis drusius 6f, C. whitneyi damoetas 1f, Phyciodes pcta 1f, P. mylitta 2f, P. orseis herlani 1f, P. pulchella 46f, P. diminutor 1f, P. tharos (tharos & orantain) 6f, P. tharosXcocyta hybrids 2f
Lycaenidae, Riodininae, Riodinini (3 pairs): Apodemia mormo 0
Lycaenidae, Lycaeninae, Lycaenini (27 pairs): Lycaena cupreus 1f, L. arota 1f, L. florus 2f, L. helloides 6f, L. heteronea 6m, L. rubidus 1m
Lycaenidae, Lycaeninae, Theclini, Theclina (7 pairs): Hypaurotis crysalus 1f
Lycaenidae, Lycaeninae, Theclini, Eumaeina (47 pairs): Satyrium acadica 1m2f, S. sylvinus 1f, S. saepium 4m3f, Callophrys augustinus 1f, C. mossii 1m1f, C. dumetorum (incl. apama) 1m2f, Strymon melinus 3m
Lycaenidae, Lycaeninae, Polyommatini (123 pairs): Leptotes marina 6m4f, Cupido amyntula 3m5f, C. comyntas 1m3f, Celastrina humulus 4f, C. lucia sidara 1m, Hemiargus isola 1m1f, Euphilotes ancilla barnesi 7m7f, E. enoptes enoptes 1f, E. battoides (ellisii) anasazi 2m, E. battoides battoides 1m, E. battoides ellisi 2m, E. rita coloradensis 1m, Glaucopsyche lygdamus 4m, G. piasus 2f, Plebejus melissa 5m2f, P. atrapreaetextus fridayi 1f, P. saepiolus 5m1f, P. icarioides 3m1f, P. alupini texanus 1f, P. glandon rustica 18m1f
Moths (~69): Gnophaela latipennis vermiculata (Pericopidae) 4f

Table 1. Copulating pairs seen, and sex flying when pair was disturbed.

Butterfly taxon	# pairs	Male flew	Female flew
Hesperiidae, Eudaminae	1	0	0
Hesperiidae, Pyrginae, Carcharodini	2	0	1
Hesperiidae, Pyrginae, Erynnini	64	0	42
Hesperiidae, Pyrginae, Pyrgini	10	5	2
Hesperiidae, Heteropterinae	1	0	1
Hesperiidae, Hesperiinae, Thymelicini	1	0	1
Hesperiidae, Hesperiinae, Moncini	2	0	1
Hesperiidae, Hesperiinae, Hesperiini	83	1	55
Papilionidae, Parnassiinae, Parnassiini	25	0	4
Papilionidae, Papilioninae, Troidini	1	0	1
Papilionidae, Papilioninae, Papilionini	12	0	5
Pieridae, Coliadinae	95	107	12
Pieridae, Pierinae, Anthocharini	5	2	0
Pieridae, Pierinae, Pierini	80	85	2
Nymphalidae, Libytheinae	1	0	0
Nymphalidae, Danainae, Danaini	34	23	0
Nymphalidae, Satyrinae, Elymniini	4	0	7

Nymphalidae, Satyrinae, Satyrini	137	2	149
Nymphalidae, Charaxinae, Anaeini	0	0	0
Nymphalidae, Nymphalinae, Limenitidini	3	0	1
Nymphalidae, Nymphalinae, Heliconiini, Heliconiina	1	0	0
Nymphalidae, Nymphalinae, Heliconiini, Argynnina	89	42	45
Nymphalidae, Nymphalinae, Apaturini	0	0	0
Nymphalidae, Nymphalinae, Nymphalini	8	0	8
Nymphalidae, Nymphalinae, Melitaeini	144	0	103
Lycaenidae, Riodininae, Riodinini	3	0	0
Lycaenidae, Lycaeninae, Lycaenini	27	7	10
Lycaenidae, Lycaeninae, Theclini, Theclina	7	0	1
Lycaenidae, Lycaeninae, Theclini, Eumaeina	47	10	10
Lycaenidae, Lycaeninae, Polyommatini	123	60	34
Totals	1010	344	495

My Notebook Observations of Mate-locating/Mating Behavior of Butterflies. A large amount of information on these behaviors are reported in this book, so details of my field data on those behaviors are of interest. The notebooks contain records of my visits to collect or study butterflies from 1959-2019. Each calendar date is entered, then the locality, then each butterfly species found, with the scientific name, the numbers found (mostly with the number of males and females, and whether they were in perfect + or imperfect - condition or the numbers seen (the first few years I recorded just the species and nothing else), and any interesting observations of behavior including oviposition or mate-locating or mating or flower feeding or roosting or basking or flight habits or predation etc.

I did not have enough time or need to computerize every redundant observation of mate-locating behavior found in my notebooks (I did computerize every observation of courtship and mating behavior), so I computerized only some of the basic observations and all of the more-informative ones, so maybe 80% of the ordinary redundant observations were not recorded (for instance, *Poanes taxiles* raits all day to await females, so if an observation was "*P. taxiles* perch gulch 10:00-14:00" it probably would not have been computerized, because it was very-redundant information. Probably only ~10% or less of the mate-locating entries were computerized.

This computerized file of ~460 pages included 10,238 paragraphs, of which several hundred were summaries of each species, leaving ~10,000 entries for the species entries, and because only ~10% of my notebook entries for mate-locating behavior etc. were computerized, this means that my notebooks contain roughly ~100,000 entries of observations of mate-locating behavior/mating. And some of these entries are summaries for various observations on the same species during the day (for instance one day's "P. taxiles perch gulch 10:00-14:00" were based on 6 observations that day), so I may have made a quarter million observations of mate-locating behavior in my life; the exact number is unknown. So mate-locating behavior is now well-known for most of the species, but not-so-well known for species far from my usual haunts or for some rare or limited-distribution species.

Times in this book are 24-hour standard time. Times were recorded in my note books as local time. Before computerizing, I used almanacs/internet to determine the days of the year when the various states changed to daylight-saving time (Arizona never did) and back, and wrote that information down at the start of each year's notebook entries. While computerizing, I changed the field times from my notebooks to 24-hour standard time in the computer.

To determine how often I was in the field observing butterflies at various times of day from1959-2017, I used the Replace All feature of Microsoft Word to count the time entries. For instance to find the number of observations between 07:00 to 07:59, I did the Replace All to replace [space]07: with [space]07:* The number of observations for each hour found in my computerized file is the following: 06:00-06:59—9, 07:00-07:59—84, 08:00-08:59—467, 09:00-09:59—1011, 10:00-10:59—1684, 11:00-11:59--1676, 12:00-12:59—1764, 13:00-13:59—1732, 14:00-14:59—1535, 15:00-15:59—863, 16:00-16:59—292, 17:00-17:59—102, 18:00-18:59—67, 19:00-19:59—17, 20:00-20:59—1. What this means is that from 1959-2017 I was in nature recording information during warm butterfly-flying weather the most from about 10:00-14:59, and was there a little less from 09:00-09:59 and 15:00-15:59. And I was in nature less from 07:00-08:59 because the butterflies were often just basking then because it was too cold to mate-locate, and because I wasn't present there yet (it's a waste of time to arrive before the butterflies are warm and behaving enough to be visible). And I recorded somewhat fewer observations in nature from 15:00-15:59 because of clouds or rain and I may have gotten tired and gone home; records after 16:00 are few because of bad weather and usually because I went home for supper.

Basking and Roosting

Butterflies are "cold-blooded", and do not maintain a constant body temperature, so they become immobile when temperature falls below about 16^{o}C (60^{o}F), and they seek shade and become immobile if the temperature reaches ~42^{o}C. But they have behavioral ways to maximize their active flight time, using techniques that attempt to maintain a body temperature between about 28-38^{o}C (82-100^{o}F). The best book listing thermoregulation behavior of butterflies is M. Douglas & J. Douglas (2005), because Matthew M. Douglas got his Ph.D. in Kansas by studying butterfly thermoregulation.

Butterflies can **bask** in the sun to get warm. The butterfly places its body and wings in a manner that maximizes the heat gained from sunlight. The most common behavior is called "dorsal basking", in which the wings are spread apart considerably or nearly flat, and the head is generally aimed away from the sun, so the body receives a maximum amount of sun. "Body basking" is a term applied when the wings are spread very little and the sunlight penetrates just the canyon formed by the wings to warm the whole top of the body; the canyon is desirable in windy weather when the wings block the wind which—if the wings were widely spread--would carry away the warm air surrounding dark sunlit dorsal areas of the body (but widely-spread wings might lessen wind carrying heat away from the lower part of the body). Dorsal basking is the usual basking method in butterflies, and body basking is just a variety of it (M. Douglas evidently uses body basking for adults that spread their wings 120^{o} or less, and uses dorsal basking if the wings are spread nearly/mostly flat, whereas I prefer to use body basking only if the wings are spread apart just a little ~20-45^{o} to keep the wind from removing heat from between the wings (most people don't use the words body basking at all). Body basking is evidently frequent in Lycaeninae (most blues). Hesperiinae bask dorsally, but they spread the hindwings more than the forewings. "Lateral basking" is the term used when an adult closes its wings and moves sideways to the sun, with the sunlight heating one side of the body and the wing base undersides. Lateral basking is used in Coliadinae (*Colias*, *Phoebis*, *Eurema*, etc.), most satyrs (*Neominois* usually basks laterally and *Oeneis* and *Erebia* often bask laterally also), most hairstreaks (except *Hypaurotis* and *Strymon*), the *Euphilotes* blues, and occasionally by numerous or most other butterflies.

The wings are mostly hard and have little blood circulation, so the wings are not as useful for gaining heat as the body, but if the wings are spread just a little (body basking) or much less than spread to the side, any wind blowing heat away from the top of the body can be lessened to increase the heating. And the heat gain can be maximized by changing the color, because black absorbs the most solar heating and white absorbs the least. That is why the body of many butterflies is black, especially the arctic/alpine species, and is why many butterflies have the wings blackish next to the abdomen (most *Papilionidae*, and *Colias meadii* has a black smudge on the ups wing bases running back on the hindwing next to the abdomen). And most Pieridae (such as *Colias*, *Nathalis*, *Pontia*, etc.) have the unh darker-"green" in spring (actually a mixture of black and yellow/white scales), which increases solar heating of air around the body compared to the paler summer color. *Parnassius* adults have the top of the thorax solid black, so sun can heat up the wing muscles rather directly, and the wings next to the abdomen are blacker to heat up the air next to the abdomen.

The length of the scales on the body can help absorb sunlight also or reduce heat loss, thus arctic/alpine butterfies generally have longer body scales, and such butterflies as *Boloria tarquinius* and *Colias meadii* are a little more furry; the latter has slightly longer "fur" at higher altitude. {Many night-flying moths such as Noctuidae have very furry bodies to keep warm at night.}

Some butterflies can "**shiver**" to get warm enough for flight (this is sometimes technically called "muscular thermogenesis"). They do it using the wing muscles inside the thorax, by contracting those muscles rapidly in just tiny amounts to ensure that the wings flap very little (only about 2mm at the wingtips) when they shiver. They usually shiver with the wings closed above the body, but some butterflies shiver with the wings out to the side. Shivering is known in some Hesperiinae (*Hesperia*, *Polites*, *Atalopedes*, *Atrytone*, *Poanes*), a few Papilionidae (*Papilio glaucus* & *eurymedon* shiver wings spread to the side), and many Nymphalidae, including Charaxinae (*Anaea andria*), Morphinae Brassolini, Danainae (*Danaus plexippus*, *gilippus*), Satyrinae (*Lethe eurydice*, *Cercyonis pegala*, [but not *Oeneis jutta*]), and many Nymphalinae including Limenitidini (*Limenitis archippus*, *arthemis*), Apaturini (*Asterocampa celtis*), Heliconiini (*Dione vanillae*, *Argynnis* spp. (all *Argynnis* vibrate with wings spread) [*Boloria frigga freija titania* do NOT shiver]), Nymphalini (all *Vanessa*, *Polygonia*, *Nymphalis*, *Aglais*). Pieridae and Lycaenidae are not known to shiver. One must look closely at a butterfly to see the small vibrations in the wings that indicate shivering, and more observations on this are needed.

If a butterfly becomes too hot, it can minimize its temperature by closing the wings and orienting them parallel to the sun's rays. Or it can fly into shade, fly onto places that are cooler than the hot ground such as a cooler rock, or it can fly to a moist spot where evaporation makes the spot cooler. Many tropical Riodininae rest under leaves (and may peek out if they are raiting there), perhaps to avoid overheating. *Papilio polyxenes* can lower the abdomen into the shade of the spread wings and pump the hemolymph "blood" from the cooler abdomen to the head/thorax.

Larvae can thermoregulate somewhat also. A larva can move to a sunny spot to get warm, or move into the shade. Generally larvae prefer cooler temperatures than adults, ~20-29^{o}C (68-84^{o}F), which is useful because evidently many or most butterfly larvae feed at night.

Females can help regulate the temperature of their eggs by placing them in spots that will not overheat yet will be suitably warm. Above timberline *Erebia epipsodea* places the eggs deep in a grass clump to keep them warm, while in the foothills they place eggs high up on a grass clump (on a dead stalk etc.) to keep them cooler. The Alpine Zone *Oeneis polixenes* and *Erebia magdalena* place their eggs on the side of a large rock to keep them warmer. *Cercyonis meadii* places its eggs at the edge of the shade cast by a nearby small tree to keep the eggs somewhat warm but not too hot. Egg placement in butterflies is a very complex process: the eggs should be placed where the young larvae eat, but thermoregulation is involved also to keep eggs alive, and predation must be minimized, so the female must biochemically taste the plants and also consider all of those other factors.

Roosting. When the sunlight greatly dims or the temperature greatly drops, adults move to a roosting site. Generally that is just near the top of a small plant or a bush or the low branch of a tree, to be less accessible to ground predators such as ants, mice, early-morning birds, etc. Some yellow Pieridae prefer to rest on yellower leaves etc. for camouflage, and white butterflies may choose white, etc. During a rain they may move farther into a plant to minimize the pounding. *Erynnis* have a unique roosting posture: they land on a twig, and wrap their swept-back wings up around the twig.

Most butterflies roost alone. But some roost gregariously, including some *Pieris rapae* and European *Pieris napi*, *Danaus plexippus*, *Aglais milberti*, *Nymphalis l-album*, *Heliconius* and relatives, and various tropical species (some mentioned by Scott 1986a). *Heliconius* roost in groups for defense, as they are Müllerian mimics with poisonous bodies, which teach the birds not to prey upon them; the group of adults usually "trap-line" between flowers near the roosting site, and return to that roosting site every night.

Dispersal and Migration

Butterfly species vary greatly in their dispersal ability. Some are very local; for instance *Hypaurotis crysalus* seldom fly beyond their clump of small oak trees, while *Danaus plexippu*s migrates thousands of kilometers from southern Ontario to southern Mexico. *Erebia "theano" stubbendorfii* and *Boloria improba* evidently move very little away from tiny-area local populations, and collecting could be very harmful to their populations. The dispersal magnitude in a species is generally hereditary. Flight movements serve to bring the sexes together, transport adults to flowers or other foods and mud, and enable females to find hostplants to lay eggs. But local conditions or weather extremes can affect the flight movements of a population. Species with little dispersal may travel more if the habitat is large or if the population density is so small that adults must travel farther to find mates, or they may have to fly farther to find flowers. Or a population explosion may result in emigration especially of females who are harassed by a large number of males.

Most butterflies disperse only a few hundred meters in their lifetime, but some disperse much more, and there is every intermediate between the sedentary and migratory species. Migratory butterflies in Colorado generally come from Mexico or just northward, where they have multiple generations. They overwinter there, and migrate northward to take advantage of the vast greenery northward during spring and summer, compared to the limited amount of greenery in Mexico— much of northern Mexico dries out in spring. Colorado is actually not the best place to find strong migrants, because the dry areas southward and the extensive mountains combine to reduce the number of migrants heading north from Mexico; Kansas and extreme SE Colorado receive more of those migrants.

The most dependable migrants to Colo. are *Danaus plexippus* (uncommon here), *Vanessa cardui* (absent to abundant), *Euptoieta claudia* (uncommon to abundant), and *Pontia protodice* (frequent to abundant). Less-frequent migrants are *Hemiargus isola*, *Atalopedes campestris* (often natives), *Nathalis iole, Junonia coenia, Vanessa spp.* (some may be natives), *Leptotes marina*, *Brephidium exilis*. Many weaker-migratory butterflies are seldom found in Colorado: *Lerema accius, Lerodea eufala, Oarisma* (*Copaeodes*) *aurantiaca, Hylephila phyleus, Erynnis funeralis, Papilio cresphontes, Battus philenor, Zerene cesonia, Phoebis/Eurema, Kricogonia lyside, Ascia monuste, Appias drusilla, Danaus gilippus, Adelpha eulalia, Mestra amymone, Marpesia petreus, Junonia zonalis, Phyciodes phaon, texana, Dione vanillae, Dryas iulia, Heliconius charithonia, Libythea carinenta, ?Ministrymon azia*. *Vanessa atalanta/virginiensis/carye* seem to be somewhat migratory also, the extent discussed in their text below. Migration occurs in few species of Colorado Papilionidae and Lycaenidae. Migration of all these differs greatly from year to year, depending mostly on the weather southward.

Several species that may disperse great distances differ by coming from the north, west, or east to Colorado. *Nymphalis l-album* very rarely migrates to Colo. from Montana or Canada. *N. californica californica* rarely migrates from California/Idaho and seldom reaches Colorado, and *Argynnis idalia* rarely strays from Kansas/central Nebraska or extreme E Colo.

The strong migrants such as *Danaus plexippus* and *Vanessa cardui* have many adaptations, including detecting the angle of the sun to the ground, detecting polarized light, a time-compensated sun-compass navigation system, hormones, etc. that regulate their migration (see *D. plexippus* and *V. cardui*). *Danaus* may have a magnetic compass to help navigate. The time-compensated sun-compass system enables migrants to fly the same direction all day (Scott, J. A. 1994b proved that system occurs in *V. cardui*, and it has been proven in a dozen other migrating butterfly species (including *Ascia monuste, Kricogonia lyside, Phoebis sennae, Vanessa atalanta*, *V. virginiensis, Junonia coenia, Libythea*) (butterflies do not fly at a constant angle to the sun and thus change their direction during the day, a bogus theory). Truly migrating butterflies fly in a straight line, and rise up and over houses /bushes etc. rather than try to fly around them.

The threat of freezing would seem to make a quick late-summer flight back southward to the overwintering site very important. And it is now known that *Vanessa cardui* does migrate south then. And in Florida, Thomas Walker's malaise traps caught eight migratory species frequently flying south (mostly E Sept.-M Nov.), including *Phoebis sennae, Eurema lisa, Junonia coenia*, *Dione vanillae*, and *Lerema accius*, while only two of those (*J. coenia* and to a slight extent *D. vanillae*) were caught flying northward in numbers in spring (April-M May). But fall flights south are often less visible to the casual observer.

Adult Foods

Adult butterflies feed with their tubular proboscis, which unrolls and operates like a crane, the basal part lifting it up and the rest lowering vertically into a flower. Adults of most butterflies feed mainly on flower nectar, and often feed on mud. Some butterflies also feed on sap and decaying fruit, and sometimes feed on moist soil/compost, raindrops, dung, uric acid, urea, honeydew from aphids etc., spittle from insects, carrion, blood, sweat, tears, wet rotting wood, moist fungus, etc. If a substance is too dry they can moisten it with a bit of saliva before sucking.

Scott (2014a) reported 40,615 records of adult foods, mostly visits to flowers in Colorado, in a 190-page paper. All those records cannot be reported here, so I mostly give just the commonest flowers visited. An important conclusion drawn from that vast compilation of flowers visited by butterflies is that the more you watch a species, the more flowers you see that are visited; the number of recorded flower species seems to increase without limit, thus for most common species about a hundred different flower species were recorded as visited.

The central question of butterflies visiting flowers is this: why do they visit some flowers, and not others? Every aspect of the butterfly-flower relationship has to be explored.

Flowers produce several kinds of **sugars** to attract pollinators, and butterflies generally like them all. The sucrose/(glucose + fructose) ratio in flowers does not seem to matter to butterflies, as the ratio is variable in popular butterfly flowers; it is >1 in many such flowers but also >1 in unpopular Fabaceae flowers and <1 in the popular Asteraceae flowers. The sugar concentration of flower nectar does not matter much to butterflies either, as they are not limited to just dilute nectar like the usual 20%-sugar nectar. 35-40% sugar is the optimum concentration to maximize sugar intake for insects that suck nectar like butterflies (detailed references in Scott 2014a), but *Thymelicus lineola* adults prefer flowers with 40-65% sugar, and various butterflies even visit sap, which is mostly sugar. Most butterflies care little about the amino acid concentration in nectar (although females sometimes produce more eggs if they imbibe more amino acids), and a higher concentration provides proven extra value for butterflies usually only if the hostplant soil was deficient in nitrogen.

Floral scents are important to butterflies, because the sense of smell of butterflies is far better than humans; this is an important largely-unknown aspect of butterfly visitation to flowers. These scents are small volatile chemicals produced mostly by flower petals, and nearly 2000 have been identified so far; perhaps the most popular of dozens of floral scents emitted by popular butterfly flowers are benzenoids (phenylacetaldehyde, benzaldehyde, benzyl alcohol), and monoterpenes (linalool) and irregular terpenes (oxoisophorone) (details in Scott 2014a); there are many other similar popular chemicals. These chemicals are smaller than the alkaloids etc. in hostplants that are used by females to determine where to lay their eggs. Every plant seems to emit a different composition of floral scents. Butterfly repellents are also known from flowers: some sesquiterpene and amino acid-derivative "aminoid" scents make flowers with those chemicals unpopular for butterflies.

The **shape of flowers** does not seem to matter for butterflies, as they land on flowers of about every kind of shape (they don't need a "landing platform" because their legs have claws and can grab any kind of flower), although the nectar cannot be deeper in the flower than the length of the proboscis. Colorado butterflies seem to like larger flowers or smaller flowers that are in noticeable clusters, and they seldom visit flowers with just single small florets. Most Colorado flowers that butterflies often visit are in clusters of many individual flowers (florets).

Butterflies usually visit flowers that grow at the **height** that the butterfly species flies, thus *Pholisora catullus* visits very low flowers, and *Papilio multicaudata* visits flowers ½-3m high.

In the tropics, *Heliconius* butterflies can "**trap-line**" between flowers and remember them day after day, but trap-lining is not known to occur in Colorado; *Hesperia leonardus* mostly travel between *Liatris punctata* flowers, but perhaps they are just speeding through the habitat and stopping on any *Liatris* that they randomly find.

The flowers visited by butterfly species are correlated with the **length of their proboscis**. Thus Lycaenidae usually have a short proboscis, so they frequently visit Asteraceae flowers, which have dozens or hundreds of short tubular florets in the center of the flower. Butterflies with a short proboscis, such as *Oeneis*/*Neominois*, *Anaea*, *Feniseca*, and *Hypaurotis*, seldom visit flowers (*Oeneis* sometimes visit them).

Butterflies can see all the **visible colors of light** that humans can see (violet, blue, green, yellow, orange, and red), using three or more optical receptors augmented by filtering pigments, and they can also see ultraviolet which humans cannot see, which is useful because many flowers have ultraviolet reflectance patterns (references in Scott 2014a). **Ultraviolet** flower colors can be important, but are no more important to flower visitors than other colors; ultraviolet patterns on flowers often just serve to direct a bee or other visitor's attention to the non-uv center (where the nectar is) of the uv bullseye.

Most butterfly species visit a great variety of different flowers, and commonly visit all **colors of flowers** and show little preference for the flower color. However, Colorado has a shortage of red flowers in nature, so butterflies don't often visit pure red flowers in Colo. (some tropical butterflies such as *Phoebis sennae* love red flowers, which are often commoner there, and *P. sennae* has a gigantic proboscis [that grew inside a giant pupal wing] and can feed on very large red flowers). In Colorado, long reddish tubular flowers are visited by hummingbirds, seldom by butterflies.

For Colorado butterflies in general, the most popular flowers are *Asclepias tuberosa* (unfortunately found only in southern Front Range foothills and very few other places), other *Asclepias*, *Apocynum*, thistles (*Cirsium, Carduus*, etc.), *Verbena, Monarda, Buddleja, Eriogonum, Sedum lanceolatum, Erysimum, Jamesia, Medicago sativa, Lythrum, Ceanothus*, many Lamiaceae, most *Penstemon*, *Lobelia siphilitica*, and most Asteraceae (*Aster*, *Carduus, Chrysothamnus, Cirsium, Echinacea, Erigeron, Gaillardia, Grindelia, Liatris, Machaeranthera, Pericome, Rudbeckia, Senecio* genera, *Solidago, Zinnia*, etc.), and surely more. Asteraceae is the most popular family.

But some butterflies show **strong flower preferences**. For instance *Hesperia leonardus* greatly prefers purple *Liatris punctata* flowers. *Piruna pirus* greatly prefers pink *Geranium cespitosum* flowers. *Polites sonora* prefers cream *Cirsium scariosum* var. *acaulescens* flowers that grow at ground level. *Argynnis aphrodite* greatly prefers rose-purple *Monarda fistulosa*.

The following summarizes the less-extreme distinct preferences for flowers--especially flower colors--displayed by Colorado species that seem detectable in my detailed published records (ultraviolet colors are not considered here): Some *Erynnis* visit all colors, but seven species (*icelus, brizo, martialis, pacuvius, persius, afranius, telemachus*) prefer white and yellow flowers. *Anatrytone logan* prefers purple flowers. *Poanes hobomok* visits all colors and seems to visit pink and red flowers more than most butterflies. *Parnassius* prefer yellow and white flowers. *Papilio multicaudata* visits all colors except it seems to shun yellow. *Nathalis* prefers yellow. *Colias* species prefer yellow and blue/purple. *Euchloe* prefer yellow and white. *Pieris* and *Pontia* visit all colors except pure red. *Libythea carinenta* prefers white and yellow flowers. *Cyllopsis* never visits flowers. *Coenonympha tullia* prefers yellow. *Cercyonis pegala* visits all colors whereas *C. meadii* and *C. oetus* prefer white and yellow; *Cercyonis pegala* also often visits sap. *Erebia* prefer yellow and white flowers, and *E. callias* adds a huge attraction for mud. *Neominois* and *Oeneis* seldom visit flowers but when they do they prefer yellow and white flowers. *Anaea* never visits flowers, and visits sap. *Argynnis* (*Speyeria*) species often visit all colors, except *A. aphrodite* prefers rose-purple *Monarda*, and the *A. callippe*-group (including *callippe*, *atlantis, hesperis, zerene*, *coronis*) more often visit yellow-white flowers and seldom visit red. *Boloria* most often visit yellow and white flowers. *Asterocampa* prefer sap, but also visit mostly whitish and yellow flowers. *Aglais milberti* and *Polygonia* prefer yellow and white, while *Nymphalis* prefer white and yellow; all those plus *Vanessa* seldom visit red, and *Polygonia* and *Nymphalis* and *Vanessa atalanta* often visit sap. *Euphydryas* prefer yellow and white. *Poladryas* prefers yellow flowers, and does not! visit mud. *Chlosyne* prefer yellow and white, except *C. whitneyi* also often visits blue flowers. *Phyciodes mylitta* & *P. pallida* prefer yellow and white, while other *Phyciodes* visit all colors but seldom red. Lycaenids in general prefer yellow and white flowers (as Scott and Scott 1978 noted), in part because their proboscis is small and evidently a larger proportion of small or short or open flowers tend to be white or yellow. *Apodemia* prefers white and yellow flowers. *Lycaena cupreus* prefers yellow flowers, while other *Lycaena* prefer yellow and white flowers, except *L. florus* and *L. dione* also often visit bluish ones; all *Lycaena* rarely visit red. *Hypaurotis* never visits flowers and often visits sap and raindrops. *Satyrium sylvinus* visits all colors of flowers except perhaps pure red, but most hairstreaks prefer yellow/white flowers. The mostly-southern *Strymon melinus* visits all colors including red, and likewise the mostly-southern Polyommatini="Polyommatinae" (*Leptotes, Brephidium, Hemiargus*) visit all colors, while most temperate zone Polyommatini prefer yellow/white colors. *Celastrina* prefer white flowers. *Eriogonum*-feeding *Euphilotes* prefer white and yellow flowers. *Glaucopsyche lygdamus* visits most colors except perhaps red. *Plebejus* prefer yellow and white flowers, except *P. melissa* and *P. saepiolus* also often visit bluish ones; all seldom visit red. (The overall conclusion from this paragraph is that numerous Colorado butterflies prefer yellow and white colors, whereas southward and in the tropics butterflies prefer more colors).

The flowers visited by butterflies differ in tropical areas from flowers visited in Colorado and evidently other temperate-zone areas such as northern Europe. As one example, there are more red flowers in the tropics, and the butterfly *Phoebis sennae* with very long proboscis is recorded as visiting ~100 flowers—frequently red—from S U.S. to Argentina, on internet photos identified by Scott (2014a). And Alpine Zone/arctic flowers are pollinated frequently by flies, although the flower visitations by Alpine Colorado butterflies do not seem greatly different.

To return to the central question (why do butterflies prefer certain flowers over others?), we have to use some logic. The butterfly brain is not big enough to analyze every aspect of a flower they see (the human-visible colors, the ultraviolet, the flower scents, the nectar composition, the size and shape and height of the flower, the length of the tube containing the nectar, the extent of clustering of flowers on a plant, etc.) to determine whether to land on that flower and sip nectar. Therefore the conclusion is that butterflies use <u>minimal standards</u> to select the flowers they visit; they visit any flower that seems adequate. Yet Scott (2014a) proved that most flower species in nature are NOT visited by butterfly species; many flowers are visited just by bees, tiny flies, birds, bats, etc. etc. Evidently a flower must have adequate—not repulsive--scent, reasonably bright colors and non-repulsive ultraviolet, adequate size and height, etc., and after landing must have access to adequate nectar. Then if the flower is satisfactory, the butterfly may learn to visit that flower species again in the future (butterflies do learn sometimes: *Nymphalis* can learn to prefer certain colors of flowers, and a satyr has been trained to come to certain sap-trees). *Euchloe olympia* individuals often prefer different flower species (M. Toliver 2020, J. Lepid. Soc. 74:106-120).

Do butterflies **pollinate flowers**? Some of them do. Large *Papilio glaucus*/ *multicaudata*/ *eurymedon* pollinate large reddish lily flowers (*Hemerocallis ~fulva*, 4 *Lilium* species, and others). *Hesperia leonardus* probably pollinates *Liatris punctata*. Various butterflies get yellowish bodies due to yellowish pollen from visiting Asteraceae flowers, and probably pollinate them. Scott (2014a) presents several pages of reports from around the world of butterflies that pollinate various flowers, including *Caesalpinia pulcherrima*, *Dianthus*, *Clerodendron*, *Phlox* (pollinated by *Colias, Pieris, Danaus, Polites*), *Cadaba*, *Aesculus*, *Cimicifuga*, *Lantana*, *Asclepias curassavica*, *Zinnia*, orchids (*Epidendrum*, *Gymnadenia*, *Platanthera* {*Platanthera* spp. pollinated by *Papilio troilus*, *glaucus*, *zelicaon*, *polixenes*, *Battus philenor*, *Danaus plexippus*, *Vanessa cardui*, *Polites mystic*, *Epargyreus clarus*, perhaps *Satyrium liparops*; and *Platanthera huronensis* pollinated in Colo. by *Erebia* *epipsodea*, *Vanessa virginiensis*}). Large butterflies esp. Papilionidae and Nymphalidae seem to be better pollinators than small butterflies. In general, those flowers worldwide that are definitely pollinated by butterflies have bright or white colors, a narrow floral tube to increase the likelihood that the head or proboscis will contact pollen, and the stamens and stigma extend outward to contact the butterfly's body (like the flowers of *Centranthus ruber*, *Lantana camara*, and *Buddleja davidii*, all reported to be butterfly pollinated).

However, the reality is that butterfly bodies are not built for pollinaton as are bees; the proboscis and legs are generally long—the legs stiltlike--and keep the scaled body far from the anthers and stigmas that must dispense and receive pollen if pollination is to occur, and the proboscis is operated like a crane with the outer part lowered straight downward to minimize contact with flower walls/pollen etc. Basically most butterflies worldwide and Colorado butterflies are "**nectar thieves**", which take nectar from flowers but rarely provide pollination. And in central California, Shapiro (2007) wrote that "butterflies are rarely if ever critically important as pollinators." And butterfly-visited flowers tend to last a long time before wilting, because the pollen-transfer rate is low. And the flowers popular with butterflies generally have many other pollinators also, so the plants would survive without butterfly pollination.

But "electrostatic attraction" might produce more pollination: plants generally become negatively charged in warm still air, while flying insects including butterflies become positively charged as they fly, so when a butterfly lands on a flower some pollen grains can leap across (minus and plus charges attract) and could achieve some pollination (see references in Scott 2014a).

Some butterfly species visit the flowers of their hostplants, and have at least a remote chance to pollinate them (butterflies with *Eriogonum* hostplants, *Apodemia nais*, *Plebejus saepiolus*, and some Asteraceae-feeding Melitaeini, for instance). Other butterflies such as *Poladryas* never visit their beautiful hostplant flowers (*Penstemon*), apparently because the proboscis is too short.

Many butterflies in drier habitats use "down valley flight" (Scott 1973d) to find flowers and mud. They fly down to the gulch/valley bottom where there is likely to be water and flowers, then fly down valley because mud is more likely to be lower down in intermittent gulches. They find mud and flowers at the lower part of the gulch, feed, then they may fly uphill, especially if they mate-locate on hilltops in which case they would fly to a ridge top then fly to a hilltop at the top of the ridge. I observed *Atlides halesus*, *Satyrium saepium*, *Oeneis uhleri*, Calif. *Callophrys*, and *Euphydryas anicia bernadetta* doing this down-valley flight.

Nearly all butterflies visit **mud**, often to get sodium (males especially desire sodium), and to avoid dessication. Numerous papers starting with K. Arms, P. Feeny, R. Lederhouse 1970 (Science 185:372-374) report that male butterflies visit moist places (wet sand, mud, etc.) to gather sodium, and the sodium is partly transferred to females in the spermatophore, then females digest the spermatophore and use the sodium to help make their eggs. But both sexes visit water sources if they get dehydrated, so females are a minority of visitors to mud. Butterflies sometimes congregate at mud, especially males at a wet spot that is a good source of sodium: dozens may congregate together, including *Papilio glaucus* ssp., *Colias*, *Nymphalis californica*, various blues (Polyommatini), etc. A decoy butterfly can attract them, as an approaching butterfly evidently thinks that if many others are packed together, there must be a lot of sodium and an absence of predators.

While observing the Arizona skipper *Apyrrothrix araxes*, I observed **amphibious behavior**: they land on the surface of a deep puddle, and actually float there with wings spread flat on top of the water, they lower the proboscis to suck the water, then when finished they just flap their wings and blast off into space.

Some butterflies--mainly Nymphalidae--love **sap and fermented fruit**. Colorado butterflies that frequently visit sap are *Cercyonis pegala*, *Cyllopsis pertepida*, *Megisto cymela*, *Anaea andria*, *Limenitis*, *Adelpha*, *Asterocampa celtis*, *Nymphalis*, *Polygonia*, *Vanessa atalanta*, *Hypaurotis*, occasionally *Aglais milberti*, and occasionally other species. Sap-feeding is rare in Hesperiidae, Papilionidae, Pieridae, and Lycaenidae. And four+ tribes of tropical Nymphalinae frequent sap. Butterflies that are frequent sap feeders land on the trunk above the sap, then crawl down to it and rest upside down while they feed (there are many photos of *Lethe, Nymphalis, Polygonia, Vanessa* upside down); this occurs because the sap is thinner at the top and the legs are less likely to get stuck there, whereas at the bottom the sap is thicker and the butterfly risks getting stuck and maybe becoming fossilized in amber. *Nymphalis antiopa* sometimes feeds on dilute sap, retains the nutrients, then raises the abdomen and squirts waste fluid out into space. Even butterflies with a short proboscis such as *Anaea* and *Hypaurotis* can feed on sap, and a short proboscis might even be beneficial for imbibing very thick fluid (tropical *Morpho* have a specialized short proboscis with transverse fissures to help imbibe fruit juices). Butterflies such as Nymphalini that often visit sap also tend to often visit rotting fruit. Butterflies are attracted to sap and rotten fruit by odor (sap is usually not very visible on a tree). A mix of sucrose and ethanol and acetic acid is maximally attractive to most sap feeders. Rotting fruit feeders have similar attractants: aliphatic esters in ripe fruit are attractive to fruit feeders, and acetic acid etc. and ethanol and other alcohols in fermenting fruit are also attractive, whereas amino acids are mostly unattractive. Traps are often used to catch fruit-feeding butterflies (to make the bait, mix rotten fruit such as peaches and sugar and let it ferment for a month or more with a slightly-open lid): traps work by placing the bait on a flat surface, and after feeding the butterfly flies upward into a net cone and through a hole at the narrow end of the cone into a net cage.

Dung and carrion are fed upon occasionally by butterflies. Ammonium in dung is attractive. The optimum mixture to attract carrion and dung feeding butterflies evidently should consist of mostly dimethyl sulfide (an attractant in carrion), and less p-cresol and indole or skatole (attractants in dung) (Scott, 2014a).

Some butterflies (mostly skippers with long proboscis such as *Epargyreus, Piruna, Euphyes, Poanes*, and *Amblyscirtes*) feed on bird dung using “fluid recycling”: they exude clear fluid from the end of the abdomen onto the white bird dung, extend their long proboscis back under their body to near that spot, then suck up the liquified dung; they may do this for 10-30 minutes or longer. They evidently get sodium and nitrogen (uric acid) from the dung.

Urea is visited by many butterflies of all families, including sap-feeding Nymphalidae, evidently mostly to get sodium, and perhaps to get some nitrogen (from ammonium).

Killer flowers. I observed *Asclepias* and *Apocynum* flowers (both in family Apocynaceae) killing butterflies in Colorado: a dozen *Euphydryas anicia capella* and one *Phyciodes pulchella* died when their proboscis got caught in the stamen column slits of *Apocynum androsaemifolium* (a *Glaucopsyche lygdamus* female was killed in Neill 2007 photo), and one *Pieris rapae*, one *Polites mystic*, and one *Polites themistocles* died when their proboscis got stuck between corona and petals of *Asclepias speciosa* flowers.

Larval Foods

All the growth of butterflies takes place in the larval stages, as eggs and pupae do not feed and adults only sip water or nutritional/sugary fluids to get a little boost of nutrition/energy or avoid dehydration. Larvae usually eat plant leaves, sometimes flower buds/fruits, and seldom (*Megathymus*) the roots. Many Pierinae (*Anthocharis*, *Euchloe*) and Lycaenidae eat flower/buds/fruits, and some (including *Papilio machaon* group, *Pieris*, *Chlosyne leanira*, *Euphydryas*, *Euptoieta*, and many Lycaenidae) eat fruits, flowers, plus leaves.

Colorado butterfly species usually eat Angiosperms (flowering plants), sometimes eat Gymnosperms (Pinaceae, Cupressaceae). The original butterfly about 100 million years ago probably ate Fabaceae (legumes), which are Angiosperms that were abundant when butterflies first evolved; various groups in all butterfly families still eat Fabaceae (Eudaminae and Pyrginae-Erynnini in Hesperiidae, primitive Baroniinae in Papilionidae, primitive Dismorphiinae and also Coliadinae in

Pieridae, and numerous Nymphalidae and Lycaenidae). Some groups of Papilionidae switched to Aristolochiaceae, and others switched to Magnoliaceae, Annonaceae, and many other dicotyledons. Some Pieridae switched to Brassicaceae. Several groups of butterflies later switched to Gymnosperms (*Neophasia*, some *Callophrys*, etc.). Some butterflies (Satyrinae and most Morphinae in the Nymphalidae, a few Eudaminae and nearly all Heteropterinae/Hesperiinae in the Hesperiidae) switched to monocotyledons (Poaceae grasses and Cyperaceae sedges, palms, Asparagaceae [*Agave*, *Nolina*], Cannaceae/ Marantaceae, etc.) but recent DNA work shows that monocotyledons are mostly offshoots of some dicotyledons. Many Nymphalidae, Lycaenidae, and the dicotyledon-feeders within Hesperiidae have switched hostplants hundreds of times. So now nearly 140 plant familes are eaten by North American butterflies. And some butterflies outside of Colorado (*Feniseca* in Lycaeninae, Miletini) have switched to eating aphids, some Costa Rica Satyrinae eat ferns, some tropical Eumaeini eat cycads, and some Polyommatini eat ant larvae. It is difficult to deduce the evolutionary details of all that hostplant switching.

Considerable work has determined the chemical formulas of many of the biochemicals in plants that are chosen by butterfly females when they search for hostplants to lay their eggs. Some butterflies are good chemists, as the females choose specific plant chemicals that they require to be present—chemicals that occur only in a small number of hostplants--before they will lay an egg on that plant. Those females use their sense of smell (organs on antennae, labial palpi, leg tips, and ovipositor) to determine whether to oviposit on a plant. Scott (1986a) details the chemicals used by many of those butterflies. A good example is the Pierinae butterflies attracted to glucosinolates (mustard oil glycosides=mustard oil glucosides) in Brassicaceae, Capparidaceae, Resedaceae, Bataceae (and southward, *Ascia monuste* is also attracted to mustard oils in unrelated Tropaeolaceae, and *Appias drusilla* is attracted to mustard oils in unrelated Euphorbiaceae). Iridoid glycosides are frequent in Plantaginaceae, Scrophulariaceae, Orobanchaceae, Acanthaceae, Verbenaceae (even Caprifoliaceae, Valerianaceae, Lamiaceae, and Boraginaceae), and are eaten by various Melitaeini and *Junonia* etc. The *Papilio machaon* group is attracted to particular oils in Apiaceae, Rutaceae, and unrelated Asteraceae (*Artemisia* etc.) that stimulate larval feeding. Other plant family groupings that are probably chosen biochemically are these: Urticaceae, Cannabaceae, and Ulmaceae; Passifloraceae, Turneraceae, and Violaceae; Chenopodiaceae, Amaranthaceae, Bataceae [Bataceae also has glucosinolates], even Aizoaceae; Lauraceae and Magnoliaceae; Apocynaceae and Loganiaceae; Poaceae and Cyperaceae.

Most butterflies eat only a few hostplants, and are adapted to the chemicals etc. in those plants. The reason is that plants may produce fewer seeds/rhizomes etc. after herbivore damage, so they have evolved to produce chemicals to discourage insects from eating them. There are thousands of chemicals in plants that serve to repel insects, including alkaloids, rotenoids, steroids, glycosides, tannins, terpenes, terpenoids, organic cyanides, ecdysone mimics, linear furanocoumarins, napthoquinone, etc., and those repellent or poisonous chemicals manage to repel nearly all other insects. The intestines of butterflies and moths produce microsomal oxidase enzymes to neutralize and digest plant poisons, and these enzymes are more abundant in butterflies whose larvae eat many plant species than in species that feed on just a few plant species. Most insects can detoxify only a small number of plant poisons, so most butterflies can eat only a few of the world's known plants. However, some insects evolved along with the plants, and manage to detoxify those chemicals, and even use those chemicals to help find those hostplants. For instance Brassicaceae contain mustard-oil glycosides in some cells and the enzyme myrosinase in other cells, and when the plants are crushed by insect jaws those chemicals meet and produce mustard oil which poisons most insects, except Pierinae butterflies that detoxify them, so now the Pierinae use the mustard-oil glycosides to locate those hostplants, and the mustard oils actually stimulate larval feeding. Another example: linear furanocoumarins in Apiaceae plants poison most insects, but make *Papilio polyxenes* larvae grow faster. Napthoquinone in *Plumbago* plants prevents some Lepidoptera larvae from molting, but

Leptotes cassius butterflies eat those plants. Rotenone extracted from *Derris* plants is commercially used to poison insects and fish, but *Polygonus leo* skippers southward eat *Derris*. And Sapindaceae plants produce fish poison, but neotropical *Epiphile* butterflies eat the plants. So the end result is that only a few insects can eat the plant(s) that produce each kind of repellent/poisonous chemicals—those insects are highly adapted to those few plants—and worldwide there are several hundred thousand species of plants, and far more species of herbivorous insects (moths & butterflies, beetles, Hemiptera, Homoptera, sawflies, grasshoppers, Katydids, stick insects, etc.), each of which can eat only some of those plants.

Some butterflies that eat plants with chemical defenses have evolved biochemical mechanisms to tolerate the poisons and actually use those poisons to reduce predation. The poisons are still present in their larvae and (usually) adults and even may be actively concentrated, and if those poisons cause predators such as birds or lizards to vomit after trying to eat them, those predators will learn to avoid them. The poisonous butterfly species will then benefit from lowered predation, and another butterfly species may then evolve to mimic that poisonous species in order to benefit from lesser predation. This is called mimicry, when one "mimic" species evolves to resemble a poisonous "model" species to benefit from lesser predation. If several butterfly species are poisonous and mimic each other, they are called Müllerian mimics. If the mimic is palatable but resembles the poisonous butterflies, that mimic is called a Batesian mimic.

Many plants also evolved physical defenses to discourage insects and other animals from eating them. Some plants evolved thick tough leaves, spines on leaves or stems or fruits, thick hair, hooked hairs, high levels of silica in grass, raphides (calcium oxalate crystals), all in order to discourage munchers. Sawtooth leaf edges (on grasses/sedges etc.) could bend in the wind and cut into animals. Gums and resins and milky sap are exuded from chewed places of some plants to repel the chewer. Some *Passiflora* plants produce fingerlike false stipules from leaf stem bases, which attract *Heliconius* egg-laying, and then fall off carrying the eggs away. Some Brassicaceae produce false usually-orangish "eggs" (actually stipules), to convince Pierinae butterflies to fly away without laying more eggs (if there are too many eggs, the resultant larvae may cannibalize each other or all may eat the plant to the ground and then all the larvae will starve). Some plants exude thick sap to deter insects (Pinaceae, *Asclepias*, *Lactuca*, etc.).

But in some butterflies, egg laying females also choose their hostplants by shape rather than just biochemistry. Many butterflies that eat trees and shrubs (some *Papilio, Nymphalis, Polygonia, Limenitis*, *Satyrium*, *Callophrys*, and *Vaga*) eat Rosaceae, Salicaceae, Fagaceae, Betulaceae, Oleaceae, and other families scattered over the family tree, apparently choosing them partly by shrub and tree shape instead of just by biochemistry. Among the grass feeders, some Hesperiinae choose grass species as hostplants apparently based on the biochemistry of those grasses, while others seem to choose their grasses by shape (large clump shape in *Stinga morrisoni*; tall skinny "hay" grasses for numerous Hesperiinae and Heteropterinae).

And some butterflies feed on unrelated plants of numerous plant families. Examples are *Strymon melinus* and *Celastrina neglec*ta and *C. echo* whose larvae feed on flower buds/fruits of numerous plant families; *Vanessa cardui* (prefers thistles), *V. virginiensis* (prefers Inuleae), *Euptoieta claudia,* and many *Boloria* feed on numerous families. Scott (1986a) notes other butterflies that feed on several unrelated plant families: some *Papilio, Colias, Callophrys dumetorum* (*affinis*), *Leptotes*, *Plebejus, Hemiargus*, *Phyciodes picta*, and *Erynnis*. *Calycopis cecrops* larvae eat detritus (old fallen leaves etc.) of many families. Neotropical trees evidently have less poison in flower buds, because many tropical Eumaeini hairstreaks feed on flower buds of many different tree species.

Eggs, Larvae, and Pupae

Butterflies have complete metamorphosis, meaning that they start life as an egg, which hatches into a tiny 1st-stage caterpillar, which grows ~60% then molts into the 2nd stage, and repeats this molting about four times so that there are about five larval stages "instars" (Lycaeninae usually have just four, *Argynnis* six, and Riodininae may have 6 or more), then the larva molts into a mostly-immobile pupa, from which an adult emerges. Insects with incomplete metamorphosis such as grasshoppers lack the pupa: they start as an egg, then a nymph hatches and molts multiple times into larger nymphs, and those nymphs are basically just wingless grasshoppers, and finally at the last molt wings appear in the adult grasshopper.

Scott (1986a) has drawings of the shapes of butterfly eggs, and details the morphology and physiology of immatures of butterflies. Eggs breathe through tiny holes throughout the shell, and sperm enters at the top to fertilize it through holes in a larger pit or circle (the "micropyle") spot.

Most females can mate immediately, so most females can oviposit eggs within a day or so after emergence. But others such as *Danaus plexippus* mate at age 4-11 as they have mostly immature eggs when emerged.

Ovipositing females generally have a characteristic flight pattern: instead of flying rapidly and purposefully, they flutter slowly near plants and investigate them closely, and sometimes land on a plant, where they drum the plant with their forelegs which has tiny spines that puncture the plant a bit and use the chemical taste/odor cues to determine whether to oviposit (their antennae and labial palpi also detect various odors, and their ovipositor probably also has odor detectors), then to lay an egg they bend the abdomen tip down and forward and generally glue the egg onto the plant.

Glue is present to attach eggs to plants or twigs etc. in all Colorado butterflies, except in three species of *Polites* skippers, in which the egg drops into the turf grass hostplant, which is generally a soft monoculture so glue is not needed. (*Agathymus* skippers in Ariz.-Tex.-Mex. lay eggs without glue, which drop into the base of their *Agave* hostplants). And in *Cercyonis pegala* and relatives, the female lands on the host, and bends her abdomen down and forward, and shoots an egg out and the egg has glue so it sticks to the first thing it contacts, which may be a leaf/stem there or just below, or may fall down into the litter debris or soil. (I do not know any butterfly species that oviposits during flight.) In some *Satyrium* hairstreaks, the female places several eggs into a hole on the hostplant branch (or a dirt hole beside the trunk) and the female glues a "glue window" which hardens over the eggs and evidently protects them from weather and parasitoids/ants etc.

Adult females usually can lay many eggs. Here are some counts of the maximum number of eggs a female can lay in her lifetime while being well-cared-for in the lab: *Papilio polyxenes* 435, *Colias alexandra* 600, *C. eurytheme* 700, *C. philodice* 762, *Pieris rapae* 800, *Pieris marginalis* 300, *Pontia protodice*/*P. callidice* 330, *Appias drusilla* 1000, *Danaus plexippus* 715, *Cercyonis pegala* 300, *Vanessa cardui* 700, *Nymphalis antiopa*/*N. californica* >500 (250 in one cluster), *Aglais milberti* 900, *Junonia coenia* 962, *Euphydryas editha* 731-1200, *Argynnis idalia* 2450, *Heliconius charithonia* 1000, *Chlosyne lacinia* 1169, *Phyciodes cocyta* 700, *Lycaena phlaeas* 150, *Plebejus melissa* 200. It would seem that Nymphalidae can lay the most eggs, with Pieridae not far behind. Papilionidae lay fewer eggs, and Lycaenidae lay evidently fewer--200 or less. Hesperiidae (guesstimates based on my rearing, the large size of their eggs, and James & Nunnallee 2011) evidently lay the fewest <100. The maximum number laid seems to depend on the size of the egg, and the size of the butterfly, and considerable genetic heritage.

Most species lay their eggs singly, then they fly to find another place to lay an egg. But some lay eggs in small clusters, of one to a small number of eggs, including *Battus philenor*, *Lethe eurydice*, *Boloria eunomia*, *Asterocampa celtis*, *Apodemia mormo*, *Satyrium fuliginosum*, *S. californica*, *S. acadica*, *S. sylvinus*, *S. titus*. *Polygonia interrogationis*, *P. comma*, & *P. satyrus* oviposit singly or in a stacked pile of up to nine on the hostplant. Some always oviposit in small clusters, including *Neophasia menapia* (eggs laid in a row), *Ascia monuste*, *Appias drusilla*, *Nymphalis l-album* (averaging 26), *Thymelicus lineola* (lays in a string inside a leaf sheath). Some always oviposit in large clusters of dozens to hundreds of eggs, including some Nymphalini (*Aglais milberti*, *Nymphalis californica*, *N. antiopa*), and Melitaeini, and their larvae then feed communally. Females of species that lay their eggs in large clusters (those Nymphalini, Melitaeini) may take an hour or more to carefully examine plants to find a large cluster of great succulent plants for all those hungry larvae. In some species with large clusters, the larvae may live in silk nests (*Aglais milberti,* and some Melitaeini).

Females of most butterflies oviposit on the leaves of their hostplants, in which case they usually place the egg on the leaf uns, or occasionally on a stem etc. Except *Pholisora* and the *Papilio glaucus* group and most *Colias* oviposit on leaf ups, and *Limenitis* lay the egg on the ups near the leaf tip.

But some butterflies do not oviposit on leaves. Many Pierinae and Lycaenidae oviposit on flower buds/young fruits, and larvae eat those. *Oeneis chryxus* and *O. jutta* oviposit on twigs/branches/bark (above sedge mats/swards). And some *Hypaurotis*, *Satyrium*, and *Nymphalis antiopa* oviposit on twigs/stems. Satyrinae almost always oviposit on DEAD parts of the hostplant, such as dead dried leaves or dead stems sticking up from the hostplant grass/sedge clump, and only rarely oviposit on green leaves. Some Satyrinae and *Lycaena cupreus* oviposit on rocks beside the hostplants, evidently in part to help keep the eggs safe and warm. Many *Lycaena* and *Satyrium fuliginosum* and *S. titus* oviposit on litter near the base of the hostplant, not on the plant itself. Female butterflies usually oviposit only on plants the larvae can eat, but there are exceptions: *Parnassius*, *Megisto cymela*, *Argynnis*, some *Boloria*, some Satyrinae, and some Hesperiinae oviposit haphazardly near the hostplants so the eggs may be on detritus rather than leaves. *Parnassius* and most *Lycaena* and *Satyrium* eggs, plus *Argynnis* 1st-stage larvae, hibernate without feeding, so the haphazard oviposition is not very harmful (but *Notamblyscirtes* also hibernate at 1st-stage but oviposit on its hostplant).

If too many eggs are laid on a plant part, the larvae might eat all of that plant part and starve. So in some species females inspect the plant a little and if they see eggs already there, they refuse to lay. *Battus philenor*, Pierinae that have Brassicaceae hostplants (*Pieris*, *Anthocharis*, etc.), and *Heliconius* that eat *Passiflora*, all inspect potential oviposition sites this way. In Pierinae, a water-soluble pheromone on new eggs is smelled by other females who then refuse to lay there (see *Pieris rapae*). And the eggs of many Pieridae turn orange after a day, which evidently makes it easier for other females to detect those orange eggs and refuse to lay; but the pheromone may deter more females than the orange color. Cannibalism occurs in most of these butterflies, as a larva may eat eggs that it finds, so the female tries to avoid laying too many eggs in one spot. Some *Passiflora* species sprout fake eggs made out of stipules etc., to trick female *Heliconius* and relatives to depart without laying eggs.

Scott (1986a) has drawings of the various shapes of larvae and pupae, and details their anatomy and functioning. First-stage larvae differ greatly from older larvae, because they are usually rather simple with simple color patterns and few body projections, and most families have comparatively few hairs that are called primary setae (Hesperiidae, Pieridae, and most Nymphalidae), while Papilionidae and Lycaenidae butterflies have some extras called secondary setae. Many Nymphalidae have scoli (branching spines) on older larvae (2nd-stage larvae have both the primary setae and the scoli). Older larvae in all butterflies have hundreds of small setae (secondary setae). Older larvae often have complicated color patterns.

Larvae (caterpillars) are basically feeding machines, so they mostly have rather simple behavior. They usually feed on leaves or flower buds where the egg was laid. Larvae have two chewing mandibles on the uns of the head which move sideways--apart then together--to bite off a chunk of the food. The tip of each mandible has many conical projections to rip off the food in all butterflies, except grass feeders (Satyrinae and Heteropterinae/ Hesperiinae) have the tip of each mandible a straight shear (without projections) to cut through the tough fibers (which may contain silica) of grasses and sedges. Scott (1986a) has drawings of the many different shapes of butterfly larvae, young and old, and details the morphology/physiology of larvae. The young larva especially moves little, because it is small and can’t move far, and if it falls off it may not be able to find another hostplant and may die, because most butterflies can eat very few plant species among the hundreds that may be found in that habitat. The larva has a spinneret on the bottom of its head behind the mandibles, which it uses to lay a zigzag trail of silk onto the hostplant where it lives; the six true legs have sharp points that can cling to that silk, and the five pairs of prolegs on A3-6 and A10 have numerous crochets (tiny little hooks) that swing out and hook into the silk to prevent falling off the plant (crochets were the inspiration for the invention of velcro). Older larvae of many or most species feed at night, and crawl down and hide in detritus below the hostplant by day, so they need the silk and crochets to help move up and down the plant.

Some larvae live in silked nests. *Aglais milberti* and *Euphydryas* may cover a large part of the hostplant with silk and live inside. Solitary larvae of *Vanessa* live in a silk nest made of hostplant leaves or (*V. virginiensis*) plant parts. Some/most *Polygonia* live in a leaf nest made by curling the leaf down around the larva. *Vanessa* and *Anaea* and some *Papilio* do the same, but the leaf is curled upward around the larva (less curved upward in *Papilio*). Overwintering *Limenitis*/*Adelpha* make a similar heavily-silked curled leaf nest "hibernaculum" for hibernation. Some *Apodemia* live in a silked leaf nest. Hesperiidae live in a nest made by cutting and folding over a flap of leaf when the larva is young, or rolling a leaf into a tube or silking several leaves together into a tube when the larva is older. *Megathymus* live in a tunnel bored in a *Yucca* root. 1st-stage larvae of some *Phyciodes* (esp. *P. batesii*) may live on top of a weak silk web over the area of the eggshells on a leaf.

The physics of Lepidoptera silk is important for how it is used to make nests. A silk thread shrinks to 70% of its length after it is laid (T. Fitzgerald et al. 1991 J. Insect Behav. 4:21-32), so the larva can just spin silk threads across a leaf top, and the leaf curls as each thread shrinks, and the more silk is laid the more the leaf shrinks, until soon a tube is formed and then the larva can silk the two edges together at ~6 spots to form a nice leaf-tube nest. Or, silk threads between two adjacent leaves can draw them together, to make a nest of several leaves. And a small larva can chew two cuts into the edge of a leaf, then use silk to fold the flap into a tube around the larva.

Older larvae can sometimes be sexed: On males, there are two internal pale testes middorsally on ~A8, visible at least in Hesperiidae. And in *Limenitis* at least, the older male larva has two midventral bumps in the middle of A8 (each with a short hair), but in females that spot has just two transparent patches of exoskeleton.

When the larva is fully fed, it generally crawls away fast for a few hours, to find a pupation site far from its eating site to make it more difficult for parasitoids/predators to find it. As a result, pupae are generally very difficult to find in nature. Pupae are immobile, except the three abdominal joints between A4-7 can move, enabling the pupa to wiggle some, which helps to remove and discard the shed mature larval skin. In some Lycaenidae those movable joints may produce very faint squeaks due to file and ridge structures rubbing together.

Some pupae live in nests. *Parnassius* larvae wiggle rearward into soil litter or pebbly ground, and pupate in a slight silk nest "cocoon" there. Some *Erebia*, *Neominois*, *Oeneis* (those three have a rudimentary cremaster), *Boloria* and *Argynnis* (they hang from a cremaster) and some Lycaenidae make a slight silked nest of leaves/debris and pupate inside, which may be near the feeding site. Hesperiidae larvae near pupation produce a waxy powder from the underside of A7-8 which powders a leaf nest where the pupa forms, and waterproofs the nest (*Hesperia ottoe* does not make this powder).

Pupae of butterflies have many different shapes (shown by Scott 1986a), and they are secured to some support in different ways. When the larva finds a pupation site, it generally spins a silk pad onto which it then hooks its rearmost prolegs; this silk pad is usually pale cream or tan, but is pink in *Polygonia oreas*. Most Papilionidae and Pieridae pupae generally rest upright on the cremaster, and a silk girdle around T3-A1 junction acts as a belt to secure the middle of the pupa. Nymphalidae pupae generally hang upside down from the cremaster. Lycaenidae pupae are basically horizontal, secured by the silk girdle and mostly by an often-small cremaster. Hesperiidae pupae are usually attached by a cremaster and by a girdle--oftenY-shaped--around the middle, inside a silked-tube nest. *Megathymus* pupae lack a girdle, and a wide rounded cremaster can be used to move up and down in their root tunnel. Pupation would appear to be hazardous, because the larva attaches its hind prolegs to the silk pad, then sheds its skin and must attach its cremaster to that silk pad without falling (Nymphalidae larvae and pupae hang from that silk pad so could die if they fall). They solve the problem using a ligament connecting the anal region of the larva with the anal groove of the pupa (J. Osborne, in W. H. Edwards 1878. On the pupation of the Nymphalidae. Can. Ent. 10:224-231.). That ligament connects the pupa to the larval skin after the skin is nearly shed, then the abdomen tip/cremaster gyrates around and hooks onto the silk pad, and the pupa gyrates and breaks the ligament and the larval skin falls off; the gyrations also force the crochets more securely into the silk pad. A PBS TV show nicely shows how the *Danaus plexippus* pupal cremaster pulls dorsally out of the larval skin and moves posteriorly and probes around to attach it to the silk pad.

Pupae can be sexed using midventral sex-marks on A8-9: the male has two hemispherical bumps on A9 with a short groove between them; the female has a long groove on A8-9 (see fig. 5 of Scott 1986a).

Predators and Parasitoids of Butterflies

Butterflies have numerous enemies. Bacteria, viruses, and fungi may attack the early stages, and nematodes may attack larvae. Rearing larvae in low density conditions and frequent changes of fresh food helps reduce such diseases.

Various wasps and flies are parasitoids on eggs, larvae, and pupae. Parasitoid larvae consume and eventually kill the butterfly. Parasitoid wasps (Ichneumonidae, Braconidae, Pteromalidae, Chalcidoidea, Encyrtidae, Eulophidae, Scelionidae, Trichogrammatidae, and others) usually lay an egg inside the egg or larva, and the larva hatches and gradually consumes the fluids and finally kills the host and emerges as an adult wasp. Usually just one wasp emerges from a butterfly larva or pupa. Eggs of some wasps can divide inside the host and produce many wasps. Sometimes a doomed butterfly larva will have dozens of white cocoons of wasp pupae on the outside. Trichogrammatidae wasps are tiny only ~1mm in size, and lay an egg inside butterfly eggs (I once put *Neominois* females inside a net over a potted grass hostplant at the habitat to get eggs, and Trichogrammatid wasps were so small they went right through the fine mesh and laid eggs in my *Neominois* eggs, so later I reared a dozen tiny wasps). Parasitoid flies (Tachinidae, some Sarcophagidae, and others) are also parasitoids, and may lay an egg on the outside of the butterfly larva, then the larva burrows inside and finally consumes the host. Some flies oviposit numerous tiny eggs on the hostplant, and a butterfly larva eating the hostplant may allow a fly egg to get past the crushing mandibles, then the fly feeding inside the larva consumes it to produce another fly.

Tiny flies such as Ceratopogonidae and tiny mites sometimes attach to adult butterfly wing veins and suck the hemolymph (blood). Mosquitoes rarely feed on larvae.

Predatory arthropods eat butterflies. Ants are common nearly everywhere except the Alpine Zone, and evidently eat the most butterflies. Adult wasps (Vespidae, Pompilidae, etc.), ladybird beetles, lacewings, praying mantises, assassin bugs, carabid beetles, and spiders eat eggs larvae and pupae. Tiger beetles occasionally catch wandering larvae. Robber flies are common in the warmer parts of Colorado and sometimes catch adult butterflies and eat them. Ambush bugs (yellow and black bugs often on Asteraceae flowers) and crab spiders rest camouflaged on flowers and capture many adult butterflies. Dragonflies rarely catch butterflies. Spider webs catch a few butterflies.

Vertebrate predators such as birds, lizards, and mice eat butterflies when they can (frogs and toads aren't very common in Colorado and salamanders are rare). Adult butterflies are often found with a "beak mark" of missing scales on the wings, which means a bird grasped it with its beak but the butterfly flapped its wings and escaped when the bird tried to swallow it. Lycaeninae adults do "hindwing rubbing", moving the left and right hindwings alternately forward and back several mm, and those butterflies often have an orange-around-black "eyespot" near the unh tornus (many Lycaeninae lack this eyespot and sometimes have a tail that mimics an antenna); it has been found experimentally that birds are often fooled into thinking that they should peck at that eyespot, and when they do they end up with just pieces of wing and the butterfly escapes. Adult butterflies in nature are often found with the hw tornus missing, often due to a failed bird etc. attack.

Mimicry and Butterfly Defenses

Mimicry is common in butterflies worldwide, and many mimicry complexes have been documented in North America (eight+ were discussed by Scott 1986a). In mimicry, one prey species is poisonous to predators, and called a model, either because its larvae eat poisons in its hostplants and those poisons are accumulated internally to make the butterfly poisonous to predators, or because its larvae biochemically manufacture the poisons. Predators taste and reject the poisonous models, and then another prey species—the mimic--evolves to look similar to the poisonous model, in order to benefit from not being eaten by predators. The poisonous species involved in mimicry are called models; if a mimicing species is tasty it is called a Batesian mimic, or if it is also poisonous it is called both a Müllerian model and a Müllerian mimic. All of those butterflies involved in mimicry benefit by being killed and eaten less often. The adult models in mimicry frequently have tough bodies that can resist a strong pinch by a bird or human (*Parnassius*, *Battus*, and *Danaus* adults are quite tough) and educate some bird etc. not to attack them again. Models tend to be conspicuously colored also, and tend to fly fairly slowly, advertising their unpalatability. Mimicry works best if the tasty Batesian mimics are less common compared to the models (if the tasty ones were commoner birds would not learn to reject any of them).

However, in Colorado most of those known mimicry complexes do not occur, usually because the participants are absent or rare. Only a few documented Müllerian mimicry complexes operate fully in Colorado:

<u>White adult butterflies</u> in Pierinae whose larvae feed on Brassicaceae and related Capparidaceae (*Pieris*, *Pontia*, *Anthocharis*, *Euchloe*, *Ascia*, *Appias*) are evidently a Müllerian mimicry complex, along with white *Parnassius* (Papilionidae). *Pieris rapae* and *P. napi* and another British white (containing allyl isothiocyanate) were found to be noxious to predators by N. Marsh & M. Rothschild, and H. Pough & L. Brower found that *Ascia monuste* is less palatable to birds than most butterflies, although the adults of the other Colorado Pierinae species have evidently not been tested for distastefulness. In Brassicaceae, the following chemistry occurs: Glucosinolates (=mustard oil glycosides=mustard oil glucosides) are in some cells, and the enzyme myrosinase is in other cells, and crushing by larval mandibles mixes them to produce the poisonous sulfur-containing isothiocyanate (=mustard oil, chemical formula S=C=N=R where R is the remaining large or small compound that differs in the numerous kinds of mustard oils). Isothiocyanate=mustard oil is the chemical that tastes horseradish "hot" to humans—which repels most animals who try to eat those plants. Those Pierinae butterflies are fully adapted to those chemicals, thus females oviposit on plants with mustard oil glycosides, and mustard oils stimulate those Pierinae larvae to feed. Pierinae evidently lessen any harm from eating mustard oils because (according to Wikipedia) whites and orange tip butterflies possess "nitrile specifier protein" which diverts glucosinolate hydrolysis toward nitriles rather than reactive isothiocyanates. *Parnassius* adults smell bad and are noxious and have tough bodies that can resist a pinch, and their bodies irritate human nasal passages (adults and larvae are noxious, T. Eisner). Perhaps the white females of *Colias* form alba also benefit from this mimicry and are thus Batesian mimics?

A Müllerian mimic complex in the Colorado mts. consists of beautiful <u>larvae</u> of the drab-gray-adult geometrid moth *Meris alticola* and of the butterflies *Euphydryas anicia* and *E. editha* and *Poladryas minuta arachne*; those larvae have white and black bands with orange spots (less black in *anicia*) (*Euptoieta claudia* larvae are similar but have more orange, plus black); all except *Euptoieta* are poisonous due to iridoid glycoside (Scott 2016c) that repels birds. The plains *P. minuta* near-*minuta* is orange and black, so belongs somewhat less to this complex, and *Chlosyne leanira fulvia* may belong less also (larvae are mostly orange and black); they evidently also have iridoid glycosides.

From S Wyo. to NW Colorado, *Euphydryas editha* and *E. anicia* [*bernadetta*] *rorina* older larvae are similar (banded with white and black, with a row of orange scoli), and both evidently have iridoid glycoside poisons. So this is probably the same Müllerian mimicry complex, though larvae are known from few locations.

An apparently-Müllerian mimicry complex of older larvae transversely-marked with black, whitish/pale-green, and reddish spots/stripes, includes: 1) the poisonous models *Danaus plexippus* & *D. gilippus* (they are uncommon and rare in Colorado); 2) the *Papilio machaon* complex (*P. machaon*, *P. polyxenes*, *P. zelicaon*) (these have skin distasteful to birds [T. Jarvi and others] and have noxious osmeteria similar in shape to *Danaus* projections that they evert to repel predators [the chemicals repel ants spiders and other insects]); and 3) larvae of *Pontia chloridice* & *P. sisymbrii* (*Anthocharis cethura* is similar but does not occur in Colo.) (these have noxious mustard oils). (The moth *Schinia gaurae* [Noctuidae] is similar but does not occur in Colo. and its larvae may be inside *Oenothera* flowers.)

Some other mimicry complexes mostly function poorly in Colo.:

Adelpha eulalia adults (large dark-brown wings with white stripe and orange fw apex) is probably the model in a complex with Batesian mimic *Limenitis lorquin*i for birds that migrate from Mex.-SW U.S. to NW U.S., but their ranges overlap only a tiny amount in N Utah, and both are scarce in Colo. (*Apatura* females in Mex. are evidently also in this mimicry complex, as Batesian? mimics). The main mimicry complex is in Calif.-Ore. where the similar *Adelpha californica* is distasteful to Blue Jays and the Batesian mimic *Limenitis lorquini* adults are edible to them (Prudic et al. 2002).

In an E U.S. Batesian mimicry complex of adult butterflies, the model *Battus philenor* has noxious aristolochic acids, and is mimicked by *Papilio troilus*, *Papilio polyxenes* females, *P. glaucus glaucus* female black form nigra, *Limenitis arthemis astyanax*, and *Argynnis diana* females. But these are all rare or absent in Colo., except *P. polyxenes* which is therefore not helped by that mimicry.

Adults of *Danaus plexippus* and *D. gilippus* (with cardiac glycosides) and *Limenitis archippus* are involved in mostly-Müllerian mimicry in E U.S.: the orange-brown *D. p. plexippus* is mimicked by *L. a. archippus* in most of the range, in Florida the reddish-brown *D. gilippus berenice* is mimicked by reddish-brown *L. a. floridensis*, and in S U.S. the brown *D. gilippus strigosus* is mimicked by brown *L. a. watsoni* and *L. a. obsoleta*. Those *Danaus* are poisonous with cardiac glycosides, and *L. archippus* was once considered tasty but actually sequesters phenolic glycosides from its hostplant *Salix* making it distasteful (Prudic et al. 2007). However, in Colorado *D. gilippus* is rare, and *D. plexippus* is uncommon and *L. archippus* is not very common either, but perhaps occasionally somewhere on the E plains the latter two may be common enough for mimicry to work to reduce their predation a little.

Elsewhere, there are major mimicry complexes. Neotropical *Heliconius* and Ithomiini and some *Phyciodes* and Acraeini etc. adults are involved in large spectacular mimicry complexes (the tiger complex, clearwing complex, blue-winged complex, tawny complex, etc.). In California, adult *Euphydryas chalcedona chalcedona*/*E. c. sinecat* and *Chlosyne leanira leanira* are evidently models (with poisonous iridoid glycosides), and *Chlosyne palla palla*/*C. p. eremita* females, *Phyciodes pulchella pulchella*, and *P. orseis orseis* are evidently Batesian mimics—at low altitude those are blackish, but at high altitude in the Sierra Nevada they all become orangish as *E. c. sierra*, *C. l. alma*, *C. p. altasierra*, *P. p. montana*, *P.o. herlani* (Scott 1986a p. 73).

At low altitude in W Ore.-NW Calif., black larvae with yellow or orange spots of *Parnassius clodius* mimic poisonous millipedes (*Harpaphe haydeniana*; D. McCorkle, J. Emmel).

Mimicry helps reduce predation by vertebrates such as birds, but invertebrates such as robber flies and ambush bugs and spiders do not care about mimicry and do prey upon butterflies. Although some spiders in latin america reject distasteful Danainae & Heliconiina by odor (the orb-web spider *Nephila*, J. Vasconcellos-Neto & T. Lewinsohn 1984 Ecol. Ent. 9:337-344).

Other defenses. In nature I very rarely saw birds eating butterflies, and birds eat few of them partly because butterflies just do not look like food to them (R. Coppinger). Only 12% of bird attacks on flying *Pieris rapae* are successful (M. Wourms & F. Wasserman 1985 J. Lepid. Soc. 39:239-261). Butterflies have large wings and small bodies and are hard to catch, so are mostly not worth the bother to try to catch and eat, compared to a large fat grasshopper.

Butterflies have many other ways to avoid being eaten by predators. Larvae of Nymphalinae have branching spines (scoli) to repel predators. *Limenitis* larvae have clubs on the thorax they use to dislodge ants etc. Some larvae esp. of Riodininae have thick hair that may be a problem for some predators such as ants. Hesperiidae larvae live inside leaves rolled and tied with silk, making it difficult for predators. Some Hesperiidae pupae have a head cone, aimed at intruders into their tube nest. *Amblyscirtes* skippers have two unique dracula fangs on the bottom of their head that they wham up and down to maim ants and parasitoids etc. that try to invade their silked-tube leaf nest. *Heliconius* (without dracula fangs) was noticed to wham its head down onto ants evidently to disable them. Larvae and pupae in large clusters (*Nymphalis*, *Euphydryas*, E U.S. *Asterocampa clyton*) can twitch in unison when disturbed, making a large display that disconcerts some predators. Adults of various Nymphalidae (*Cercyonis*, *Nymphalis*, *Polygonia*, *Euphydryas*, *Poladryas*) can feign death when handled, which may allow the butterfly to escape if it is ignored by a predator which then flies off.

Eyespots on the wings of *Junonia coenia* startle birds, providing some protection. Older larvae of *Papilio troilus* and *P. glaucus*-group have eyespots on an enlarged thorax, which (esp. *troilus*) makes them look like the head of a snake, and the orangish osmeterium is forked like a snake tongue, so many birds are surely scared away by the sight of a snake head with forked tongue. Many Lycaeninae adults have an eyespot on the rear corner (tornus) of the unh and many also have a tail there (mimicing an antenna), and Lycaeninae do "hindwing rubbing", moving the left and right hindwings alternately forward and back ~2mm, which tends to attract a bird's peck to that tornus rather than to the body, sparing the life of the butterfly which can fly away minus that piece; and many hairstreaks have that tornus elongated so the bird peck will be less likely to mash the abdomen. Hairstreaks with a well-developed unh tornus eyespot suffer from more bird attacks on the tornus than other hairstreaks (R. Robbins). Many large *Papilio* such as *P. polyxenes* have an unh tornus eyespot and adjacent tail, which may also focus bird attacks on that spot rather than the body.

Camouflage is used by numerous butterflies to avoid being eaten. The uns resembles a leaf in *Anaea*, *Nymphalis*/*Aglais*, *Polygonia*, and *Libythea*, as they rest on twigs or bark. If a bird approaches, they may spread their wings and display bright ups colors that may startle the bird. Most butterfly larvae rest under leaves, rather than on top where they would be more visible to predators. Many adult butterflies resemble rocks, or dirt, or leaves. Many pupae resemble leaves or stems, or resemble dead, curled, hanging leaves. Pupae of many Papilioninae and some Pieridae are brown or green to match where they pupate (on brown wood or green leaves). *Limenitis* larvae hibernate in hanging curled leaves that they silked to the branch. Older larvae of *Limenitis* and many *Papilio* resemble large brown and white bird droppings. Many Lycaenidae larvae are the reddish or yellowish color of the flower buds/flowers on which they feed, and some *Callophrys* even change color to match the color of their food. Numerous larvae are green like their hostplant leaves. Many Satyrinae are banded with brown and cream bands and lines, resembling dead grass blades of their hostplant. Larvae and many pupae of most butterflies hide to avoid being eaten, in litter, under bark, under leaves, under/among rocks, in hollow stems, inside pods, etc. etc. Many—perhaps most—butterfly larvae feed at night, to avoid daytime predation. Roosting adults may roost on objects they resemble--a yellow *Phoebis* butterfly on yellow leaf for example.

Butterfly larvae can defend themselves with chemical discharge, as noted elsewhere in this book in the accounts for each species and families, subfamilies, tribes. Larvae of butterflies have several special systems of direct chemical-emission defense against predators such as ants, systems that are used by whole families: 1) Papilionidae have the osmeterium, a forked structure that older larvae evert from the neck just behind the head when attacked, which wafts noxious chemicals (see Papilionidae). 2) Hesperiidae, Pieridae, and Nymphalidae older larvae have a ventral neck gland (often called prosternal gland, seldom called adenosma), which produces a musky odor containing numerous chemicals (James et al. 2012), evidently for defense. Osborn & Jaffe (1998) reported that the *Dione* ventral neck gland repels ants with carboxylic acids (acetic, linoleic, oleic acids) and terpenes (alpha farnesene) and perhaps other chemicals. *Heliconius erato* uses the ventral neck gland to get rid of ants, by squirting some non-volatile stuff onto an attacking ant and silking it into a ball then passing it back beneath the body with legs and prolegs until it is past the rear (Borges et al. 2014, who list numerous references on the ventral neck gland). 3) Lycaenidae (including Riodininae) have numerous larval structures (mostly on older larvae) including perforated cupolas, honey glands/nectary organs, eversible tubercles, dendritic setae, mushroom setae, vibratory papillae, etc. that emit chemicals or honeydew and function in relationships with ants, to fool and bribe the ants to not eat them (ants may milk Lycaenid larvae and treat them like little cows) and to bribe ants to protect them from parasitoids and predators; these structures are discussed further under the Lycaenidae family, subfamily, and tribe writeups below. Lycaeninae larvae are mostly sluglike with thick "skin" and tiny retractable heads to lessen the damage from ant mandibles, and they do not move when touched (movement may provoke ant attack). 4) In addition, larvae of various butterflies emit noxious chemicals from small setae on the body (numerous Pieridae and Nymphalidae, some Papilionidae and Hesperiidae, specifically 1st stage=L1 larvae, sometimes L1-4); they emit a drop from the seta tip, which in Pierinae (see *Pieris rapae*) contains chemical mayolenes (major components palmitic acid and stearic acid) for defense against ants etc.

Adult Flight Time, and Diapause

A single flight period of an insect--lasting a few weeks or several months--generally roughly fits a "normal distribution", a bell-shaped curve in which most adults emerge and fly about the middle top of the curve, and some fly earlier or later forming the spread-out sloping base of the curve. (A normal distribution mathematically arises when each observation point on the curve has many independent things acting on it to produce the x and y values at that point—such as the quality of the larval food or the temperature at the place where the egg or larva grew or pupa were positioned, etc.) Mark-recapture studies prove that adults of the average butterfly in nature in Colorado live only about a week, with females averaging several days longer than males. Scott (1974b) summarizes the studies on lifespan of butterflies. Males emerge a few days (or a week if the life cycle is very long) earlier than females, a genetically-programmed emergence lag that speeds the location of mates (Scott 1977a) in these ways: When females emerge, they are met by a large population of virile earlier-emerging males, which reduces the time needed for the female to find and mate with a good male. And the males are positioned abundantly during the earlier part of the flight when most females emerge from pupae, which increases the likelihood that the male will find a virgin female who will lay many eggs to propagate the species, instead of an old female who is already mated and has few eggs left to lay. Thus the emergence lag benefits both sexes and lowers the time needed for males and females to find a good mate. And it also benefits the entire population by increasing the number of eggs laid by females of the whole generation (these benefits are proven by mathematical approximation and computer simulation, Scott 1977a). That emergence lag is implemented physiologically by the larger size of females compared to males--the larger females take more time to grow than the smaller males. An average single-generation butterfly flight in Colo. may take roughly 3 weeks to two months, with young adults predominating at the start and old ones at the end. Spring flights last somewhat longer than summer flights in Colo., because of cold and warm weather fronts in spring, and north-facing slopes are colder than warmer south-facing slopes in spring (in summer the snow has melted on N-facing slopes and sun shines more vertically in summer) causing adults to fly later on the N-facing slopes, and growth rates are slower in the cooler temperatures of spring (Scott & Epstein 1987).

In some species the adults live longer than a week. If adults aestivate such as in several *Argynnis* species, they may live 2-3 months before ending their aestivation and ovipositing then dying. And of course hibernating adults may live 7-9 months or longer through summer and fall and winter to early spring.

The timing of a generation in nature depends on several major factors. The local climate is very important, because on the warmer plains butterflies start flying in late April or earlier and can fly into October usually, whereas in the Alpine Zone butterflies generally have just one generation every ~two years, and fly mostly M July-Aug. (rarely L June & M Sept.).

The number of generations also influences the time of flight. A single-generation species flies just during one period during the season even on the plains, while a species with two generations will appear during two different periods with peaks usually in later spring and later summer, and one with three generations may fly through most of the Colorado growing season. Butterflies in Colorado most-often have just one generation, but many have two, and some have three or seldom four generations that each take little more than a month. In butterflies with three or more generations, the later generations may overlap so much that there appears to be just one very long flight from the second generation to the last. The warmer the climate, usually the more generations (because cold climates have short growing seasons, and insects develop faster in warmer climates), so tropical species may have more than six yearly generations unless there is a drought season after a rainy season. And Alpine Zone butterflies take two years (biennial) or more from one generation to the next, so they have just one generation per two years and may be absent on the in-between years. At least one lower altitude species *Oeneis chryxus* is biennial, even in the foothills, and flies in even-numbered years. Alpine/Arctic butterflies are increasingly being found to sometimes overwinter three years rather than the usual two (*Boloria improba*, some *Colias*, evidently *Chlosyne whitneyi*, some *Euphydryas*) (they are called multiannual), so they may appear in one year, then be absent for two years and reappear the 3rd year. Or some of those Melitaeini individuals may live one, two, or three years.

The stage that overwinters has a great effect also on the time of flight: adult overwinterers (*Polygonia*, *Nymphalis*, *Aglais*) are the first to appear in spring, as they just emerge from their crannies and mate-locate and reproduce. The species that hibernate as pupae are next to emerge, in spring. Then the species hibernating as older larvae appear, then those hibernating as half-grown larvae, then those hibernating as young larvae, then those hibernating as eggs (mostly in L June-July in Colo.).

So to determine the probable flight time of a butterfly, one should first learn the hibernation stage of the species, then estimate the time it will take from the end of winter for adults to appear. One should also learn the hostplants eaten by the larva, because the duration of larvae depends greatly on the nutritional quality of their food: the aphid-eating *Feniseca* in eastern N.A. develops from laying of egg to emergence of adult in just 3 weeks (no Colorado butterflies eat aphids), whereas flower bud/fruit feeders (such as many Lycaeninae and Pierinae) may take only ~one month, and leaf feeders may take 1 ½ months, but grass feeders take roughly two (if the grass is tender like *Poa pratensis* lawn grass) or three or even four months (for wild tougher grasses) to develop, and the root feeders (*Megathymus*) may take 6 months or longer.

The timing of the parts of the butterfly life cycle is greatly influenced by **diapause**. An insect in diapause is mostly dormant (like hibernation of vertebrates): it does not mate-locate or grow, either during winter (hibernal diapause) or in summer (aestival diapause). The purpose of diapause is to enable the insect to survive a bad-weather time in its life cycle by becoming dormant. Scott (1981b, and 1986a) details the diapause stage of North American butterflies. In hibernal (winter) diapause, the hemolymph (the blood of insects) thickens with glycerol (and/or sorbitol, alcohol, trehalose in some insects), the water content of the hemolymph lowers (from 80% to 55% in *Limenitis* larvae), and free water is converted into gelatin-like colloid, all to prevent damage from freezing, just as glycerol serves as antifreeze in car radiators. The physiology of diapause has been well-studied, and is complicated (Scott 1986a). The photoperiod (the number of hours of daylight each day) and to a lesser extent the temperature, control the entry of a butterfly into diapause, and the critical number of daylight hours that induces diapause is different for populations that occupy different latitudes (it has to be, because in spring and summer the number of hours of daylight increases with latitude), so for all the species with a wide latitudinal range, the critical day length inducing diapause is longer northward. Diapause is also controlled by the hormones involved in metamorphosis, which are produced in the brain and prothorax gland and (for egg diapause) the subesophageal ganglion. Hibernal diapause ends after there is a certain minimum length of time of cold (usually several months), then development can proceed if the weather gets better. But various butterflies that overwinter as pupae such as *Euphilotes* could end diapause after a few months of cold, but adults only emerge after the pupa has spent a precise additional length of time, in order to make the adults emerge from pupae at the exact time that their *Eriogonum* hostplants grow flower buds; different *Eriogonum* species bloom at different times, so the *Euphilotes* pupae are genetically programmed to synchronize the adult butterflies with the local flower bud/blooming time of their hostplant.

Diapause can occur in any of the life stages of butterflies—the egg (often or usually with the 1st-stage larva dormant inside), any stage of larvae including unfed 1st-stage, or 2nd-3rd-stage larvae, or half-grown 3rd-stage, or unfed 4th–stage (in most *Phyciodes*), or 4th-5th stages (such as *Oeneis*) or the mature fully-fed 5th-stage larva, or the pupa, or the adult prior to egg-laying (aestivating). Diapausing eggs and pupae do not turn into larvae or adults, diapausing larvae do not molt, and diapausing adults may feed but they do not mate-locate or lay eggs. A given species generally has only one particular diapause stage, which is genetically fixed, except for those biennial Alpine Zone species which diapause in two different stages (commonly young larvae the 1st winter, then older larvae the 2nd in *Oeneis* and *Colias* etc.). For instance, the temperate zone *Phyciodes* always overwinter in unfed 4th-stage larva (not the 3rd stage, an often-repeated error); when 3rd-stage *Phyciodes* larvae in nature detect a sufficiently long photoperiod, the next 4th-stage diapauses, so to rear them easily I gather only eggs or 1st and 2nd stage *Phyciodes* larvae in nature, and rear them under a constantly lit light bulb in lab which prevents them from going into diapause (this light bulb trick works for rearing many butterflies). The hibernal diapause stage is so genetically fixed in evolution that entire subfamilies or tribes of butterflies have the same diapause stage: Colorado Papilioninae all diapause as pupae, Parnassiinae as eggs with larva inside (biennial arctic *P. eversmanni* diapause as egg the 1st winter, pupa the 2nd). Most Coliadinae hibernate as larvae, Pierinae as pupae. In Theclini, one group (*Satyrium* etc.) hibernates as eggs, the other (*Callophrys* etc.) as pupae. Colorado Lycaenini hibernate as eggs, except Eurasian-origin *L. phlaeas/cupreus* as larvae. Polyommatini groups hibernate as larvae or pupae (a few as eggs). Our few Riodininae hibernate as larvae. In Nymphalidae, *Danaus*, *Anaea*, *Nymphalis*/*Aglais*, *Polygonia*, and *Vanessa* hibernate as adults, while other Nymphalidae including Satyrinae and Apaturinae hibernate as larvae. Hesperiidae usually hibernate as larvae. In the Arctic/Alpine Zone warm weather lasts only several months, so butterflies have two-year life cycles (or more—an Arctiid moth takes 7 years), and most (notably *Colias*, *Neominois ridingsii pallidus*, *Oeneis*, *Boloria*) diapause as young larvae the 1st winter, old larvae the 2nd. Alpine Zone *Chlosyne whitneyi damoetas* seems to always diapause as half-grown larvae under rocks for multiple years, and every year only a few of them manage to find a hostplant and grow to adults. *Euphydryas* seem to do the same thing even at lower altitudes, and any kind of stress—scarce or dry hostplants etc.—also seems to throw them into diapause, and they can spend 2-3 years or more in diapause.

Hibernating eggs are positioned strategically near the future food for tiny hatching larvae, in two different ways. In *Satyrium* etc. hairstreaks, the egg is laid on twigs or stems of hostplant shrubs or small trees, to position them near young leaves growing the next year. In most *Lycaena, Parnassius*, *Satyrium fuliginosum*, *S. titus*, and *Plebejus melissa*, the eggs are laid mostly in litter under & near the herbaceous hostplants, where they remain until new plants grow the next year.

Some larvae that diapause gain an extra stage that is specially adapted to hibernal diapause. For instance in *Chlosyne gorgone*/*nycteis* 4th-stage larvae hibernate, in a special reddish-brown skin, and they reportedly go on to have six larval stages, rather than five for just-summer generations (W. H. Edwards). Hibernating larvae may lose their green color also: *Plebejus icarioides* hibernating larvae are brown rather than green, many fully fed mature Pyrginae larvae turn reddish-brown before hibernation, and some Hesperiinae larvae (E U.S. *Problema byssus*) become darker. In *Euphydryas editha* the aestivating larva supposedly develops a thicker hairier exoskeleton to withstand summer drought. *Cyllopsis pertepida* larvae and pupae are different (brown versus green) in regions where there are two generations.

In arid environments, butterflies may diapause multiple years (sometimes 5 or 7 or 11) especially as pupae, when there is a drought. This is frequent in butterflies in arid SW U.S. and NW Mex. Many Papilioninae and Pierinae pupae can hibernate multiple years, and often do so in Colo. even if there is no drought. And *Chlosyne sterope* and *Euphydryas* can hibernate/aestivate multiple years. In deserts, the diapause stage may endure for years, and then when finally there is some heavy rain, they may end diapause, and adults may emerge from diapausing pupae, or diapausing larvae may end diapause and grow to adulthood, and large flights may ensue.

Summer-only aestivation is being proved in more and more butterflies, but usually in dry-summer climates far from Colorado. Adult females of various *Argynnis* diapause in the summer (*A. edwardsii*, *aphrodite*, *coronis*, and evidently *idalia* in Colorado, *cybele* in E U.S., and *hydaspe*, *callippe*, *zerene*, and *coronis* in Cal. and/or C Wash.), then at the end of summer they oviposit either near green violets or on litter above dormant *Viola* roots that they can smell even though the leaves had senesced and dried and blown away. *Ochlodes sylvanoides* and *Hesperia comma* & *H. juba* larvae and *Cercyonis pegala* and *C. sthenele* adult females aestivate in arid summers in C Wash. In California *Coenonympha tullia california* aestivates in the dry Mediterranean-climate summer. Those species aestivate for several weeks to several months, and generally end their diapause before fall. More species aestivate in the Mexican spring/early-summer dry period (such as larvae of *Argynnis nokomis*), and in the dry season in Costa Rica (*Eurema daira* and many others), etc., whereas in Colorado there are not many summer-only aestivating species because summers don't get very dry.

Some butterflies have long diapausing periods that include both summer and fall/winter. Butterfly species that have only one yearly generation always diapause when they develop to the genetic diapause stage, for instance spring *Callophrys* species develop to the pupal stage, then diapause as pupae even though it may be in June. Then that stage—the *Callophrys* pupa for example--diapauses through the summer <u>and</u> the next winter. Another example is *Notamblyscirtes simius*, as its unfed 1st-stage larvae diapause from July through summer and fall and winter and early spring, then finally eat and produce adults in ~June. *Nymphalis* spp. do the same. One could therefore call the first part of that lengthy diapause aestivation, and then call the winter part hibernation, or just call the whole period diapause; the word aestivation seems to be best used just for summer-only diapause.

Butterfly Species Accounts (Arranged by Phylogenetic Relationship)

Hesperiidae Skippers

About 4000 species of skippers occur worldwide, 2/3 of them in America, mostly in the tropics. They are called skippers because the thorax is usually thick with powerful muscles and they have a faster flight than most other butterflies (although some skippers fleek to find females and have smaller thoraxes and weak flight). They are unique in having the antenna club bent, either at the base or middle or the tip. The R veins on the forewing are all unbranched. The larvae look rather simple in shape, but some may have conical horns or tails. Nearly all Hesperiidae larvae live inside a silked-leaf nest. The larval neck is usually narrower than the head to enable the larva to turn and silk together leaves etc. into a tube or sandwiched nest, where most larvae live and pupate. Young larvae make a nest by cutting a slot into the leaf edge at two places to create a flap, then silking the top of the flap to curl it (the silk shortens as it dries to curl the flap), and gradually it curls up and over the larvae and the larva silks it to the rest of the leaf and lives inside that nest. Older larvae may curl a whole leaf into a nest, or silk two or more adjacent leaves into a nest. All Hesperiidae older larvae have a ventral neck gland, which produces chemicals to try to repel predators such as ants (James et al. 2012 noted the gland in *Epargyreus, Cecropterus "Thorybes", Pyrgus, Oarisma, Polites*). Older larvae generally have a comb just below the anus to flip away the pellets (the anal comb is also reported in one species of Papilionidae and several Pieridae) to prevent the scent leading parasitoids to the larva. Possible oil droplets exuded from setae of very young larvae were reported in *Polites themistocles* (James & Nunnallee 2011) and may be more prevalent (*Erynnis* and *Pyrgus* 1st stage larvae have enlarged seta tips, which perhaps exude droplets); those droplets in other butterflies such as *Pieris rapae* repel predators such as ants. Pupae are in a silked-leaf nest loosely sealed at the ends to permit adult escape; the pupa can be attached by a silk girdle and the cremaster, and may rest in a Y-shaped silk girdle inside the leaf nest made by the larva. Like Papilionidae, the living eyes have no special spot-pattern reflections (Sibatani 1973), whereas Pieridae, Nymphalidae, & Lycaenidae often have complicated patterns.

Some people once considered skippers to be closer to moths than what they considered to be real butterflies, and even today some butterfly people do not study skippers (~10% of butterfly books mistakenly do not include skippers), but the morphological studies and DNA studies show that skippers are closely related to other butterflies, and actually a group of "moths"—Hedylidae--are now considered to be primitive proto-butterflies from the base of the Hesperioidea-Papilionoidea tree, even though they show some characteristics of moths. Hesperiidae is usually considered to be in its own superfamily Hesperioidea. The phylogenetic tree of Heikkela et al. (2011) based on numerous physical and DNA traits placed it on a branch with Hedylidae (butterfly moths) which branch was the sister group to Pieridae-(Nymphalidae-Lycaenidae), and placed Papilionidae at the base of the butterfly tree, and lumped all of those into just one superfamily Papilionoidea; but their tree suffers from megastuffing with superficial trivial/duplicated characters, and the good strong characters got lost in that mess. (Anyway, Hesperiidae skippers are real butterflies.)

Hesperiidae, Subfamilies Eudaminae and Pyrginae Herb, Shrub, and Tree Skippers

The "Pyrginae" have now been split into several other subfamilies, including Eudaminae (containing *Epargyreus*, *Zestusa*, and *Cecropterus "Thorybes"*), and Pyrginae (the remainder including *Pholisora*, *Erynnis*, *Pyrgus*, and relatives). There are about 1500 species of all of those worldwide, and their larvae nearly always eat dicotyledon plants. Adults are brown or blackish or colorful with blue or other colored markings especially in the tropical species. The base of forewing vein M_2 is about equidistant between Veins M_1 and M_3. Adults bask by spreading all the wings equally in dorsal basking.

Hesperiidae, Eudaminae Spreadwing Skippers and Cloudywings

Adults usually rest with wings closed. Colo. species are medium to large in size, and are fast fliers.

Epargyreus clarus Silver-Spotted Skipper

Identified by the large unh silver spot. Colorado adults are ssp. ***clarus*** (the unf gold spot in cell CuA_2 is attached to spot in cell CuA_1 versus unattached in other ssp. including Ariz. ssp. *huachuca*) {ssp. *californicus* has plain brown unh submargin, missing the cream cloud of other ssp.}. However the TL of *clarus* is Va. where the larval head is reddish, whereas Colo. and perhaps Conn. larvae have black heads, so Colo. evidently has a nameable **new ssp.** if this head color proves to be mostly different.

Habitat mostly valley bottoms on the plains and lower foothills. Hostplants in Colorado tall Fabaceae with large leaves: *Glycyrrhiza lepidota* (the most common host, a 1m native plant which in late summer produces large brown burs that stick to clothing), *Robinia pseudoacacia*, *neomexicana* (both small trees that are widely planted although the latter is native in S Colo.), *Amorpha fruticosa* var. *angustifolia* (a rare introduced bush in Colo., but popular in E U.S.). Several dozen other mostly-large-leaved Fabaceae are eaten elsewhere. Often common.

Eggs green then cream with a bright red ring and a red dot on top, sometimes reportedly becoming orange, laid singly on ups of host leaves. Larvae eat leaves at night. Young larvae live in a folded-over silked leaf flap, older larvae live in a nest of several leaves silked together. Older larva light yellow-green, with many black transverse lines and a row of black transverse dashes near the front of each segment, prothorax black on top and red beneath, prolegs yellower, true legs red, sometimes a small anterior suranal plate on A10; head black in Colo. and C-W U.S. (usually reddish-brown in E U.S.), with a large orange spot in front of the tiny whitish eyes. They reportedly face intruders and use those orange eye-like spots to scare them away. They have a red ventral neck gland that evidently emits chemicals to repel ants etc. Provoked larvae reportedly spit a bitter-tasting greenish fluid (Minno et al. 2005), maybe from the ventral neck gland at least in part. Older larvae can snap dung pellets far away using the anal comb. Pupa dark reddish-brown, some mottling on abdomen, T1 spiracle large and black. The pupa hangs horizontally from the cremaster plus a silk cord of ~3 silk threads slung about the middle. Pupae hibernate.

One flight, L May-M Aug., mostly M June-July. An adult was found in early Oct. in Boulder, evidently a rare second generation.

Adults visit flowers of all colors; favorites are *Apocynum cannabinum, Cirsium arvense, Glycyrrhiza lepidota, Medicago sativa, Monarda fistulosa, and Trifolium pratense*; they visit mud and occasionally dung, urine, carrion. Adults bask dorsally, but never open their wings very far. Males and females sometimes rest under leaves.

Males rait to find females, as they rait an average of 1.2m up (20cm to 3m, n=18) on vegetation (rarely on rocks) in valley bottoms (meadows/wetlands/clearings) and gulch bottoms, from early morning to ~13:30 when they quit mate-locating and hang upside down from leaves in the shade. Based on hundreds of observations, this somewhat-variable quitting time is genetic and not due to overheating. In courtship, the male encounters the female and may even bump into a hanging female, they land with the male behind (his head sometimes touching her abdomen) and he flutters with wings open fairly wide (beating the wings ~20-160º spread, or sometimes just flicking his wings, evidently to waft pheromone) usually just below the female (sometimes beside her), and the male joins. Unreceptive females flutter to repel the male, and crawl and fly away and may fly vertically then away. Females can mate several times.

Zestusa dorus Short-Tailed Skipper

Easily identified. The antenna club is long and evenly curved. The hw has a short little tail.

Habitat the *Quercus gambelii* zone in extreme SW Colorado. Hostplants tree Fagaceae: associated with *Quercus gambelii* in Colorado; hosts *Q. emoryi* & *arizonica* southward. Common.

Eggs laid singly on host leaves, sometimes on buds. Larvae eat leaves, and live in rolled-tube leaf nests. Older larva greenish-yellow or pale whitish-yellow, a dark heart-line edged by yellowish or creamy, a dorsolateral yellowish or creamy line; head orange-yellow on top blending to mostly orange-brown below, with a large creamy patch in front of eyes. Pupa dark reddish-brown, with a chalky crust, short projections on prothorax. Pupae hibernate.

One flight mostly May.

Adults frequent mud, and surely visit flowers.

Males rait on *Quercus* branch tips at the edge of a hilltop, at least in afternoon (Scott 1976a).

Cecropterus "Thorybes" mexicana mexicana **Mountain Cloudywing**

Smaller than *C. pylades*, it occurs at higher altitude, the male lacks a costal fold, and the unh has numerous brown striations. The male valva differs from *C. pylades* and is more like *C. bathyllus*. (The name *Thorybes* evidently applies only to *Thorybes*=*Cabares potrillo*.) Ssp. *nevada* from TL Calif. looks the same as Mexican ssp. *mexicana*, so Colo. has ssp. ***mexicana***.

Habitat middle-elevation foothills to Subalpine. Hostplants in Colorado herb Fabaceae: *Lathyus lanszwertii* var. *leucanthus*. In N New Mex. hosts are *Trifolium longipes=rusbyi* and *Vicia americana*. Sometimes common.

Eggs laid singly under host leaves. Older larva pinkish-tan (some are dark-brown, probably turning darker just before hibernating), a darker heart band, a dorsolateral yellowish band or row of spots (absent on very dark larva), a cream slight lateral ridge, collar black, neck red-brown; head very-dark reddish-brown or black. Mature larvae probably hibernate.

One flight end of May-M Aug., mostly June in foothills, mostly L June-July in upper Canadian and Subalpine Zones.

Adults visit flowers of all colors, mud, sometimes dung. One strayed 1+ miles from the foothills to Green Mtn. in Jefferson Co.

Males rait all day generally on hilltops, but if no ridgetops are available they rait (occasionally flait) on protruding hillsides or even in swales; they rait on low 10-33 cm tall vegetation/rocks (less often on the ground) to await females. In courtship, the male vibrates ~60^o-spread wings next to the female, who if receptive for mating would presumably remain quiescent and accept the male.

Cecropterus "Thorybes" pylades pylades **Northern Cloudywing**

Larger in size than *C. mexicana*. *C. pylades* males have a costal fold, unlike other *Cecropterus "Thorybes"*. The fw spots are smaller than those of *C. bathyllus*, and the white fw spot in fw cell CuA_1 is usually just a small lower spot, never a bar as in *bathyllus* (if it is larger it is aimed toward the other postmedian spots). The valva differs: the end is rounded on the bottom.

Habitat throughout the mountains in Transition and lower Canadian Zones open forest and brushy areas, mostly found in the lower foothills. Hostplants in Colorado herb Fabaceae with "pea vine" tendrils: *Lathyrus polymorphus incanus*, *L. lanszwertii* var. *leucanthus*, *Vicia americana*; at least 8 other genera of Fabaceae elsewhere. Usually uncommon in Colo.

Eggs pale greenish-cream or cream, sometimes becoming slightly-yellowish-cream with a slight pink flush around top of egg, with 15-17 vertical ribs, laid singly under host leaves. Larvae eat leaves, and live in nests of silked rolled leaves. Older larva fairly light reddish-brown in Colo. (brown in ?Ore., Neill 2007) (reportedly also greenish-brown, or in E U.S. may be yellowish-brown) (larvae turn rich reddish-brown just before hibernating), with a blackish or dark-brown heart-band, an ochre dorsolateral line slightly edged by darker ground color, an ochre lateral line (edged by brownish esp. below), prolegs brown, true legs brown or black, suranal plate dark-brown, collar black, neck brown; head black or maroon-black. Larvae shoot frass pellets away at high speed with their anal comb. Pupa reddish-brown (elsewhere blackish-brown or slightly greenish-brown), head and T1 darkest, outer part of wings paler reddish-brown or lighter brown, top of thorax and abdomen have darker areas, intersegmental areas between A4-7 light-brown, wing cases yellowish-brown. Pupa is attached to silk cords by cremaster and by a 6-silk-cord sling under body. Fully-fed mature larvae turn reddish-brown and hibernate.

One flight M May-M July, mostly L May-L June.

Adults visit flowers of all colors including *Cirsium* etc., and often visit mud, sometimes urine. Adults bask dorsally, and do not spread their wings fully, unlike *Erynnis* etc.

Males rait all day in little clearings among bushes (often *Cercocarpus montanus*, occasionally small trees), generally on hilltops/ridgetops where available but usually OFF the very top several meters to as much as 5, 6, 6, 9, 12, 15, or 15m from the very top, as they rait on average 1/3-1/2m up (on the ground to 2/3m up). If a hilltop is far away they may rait on a shelf on the mountainside. (In W Texas they may often rait in gulches.) In courtship, the male flutters near the female to transfer pheromone (no completed courtships were seen).

Cecropterus "Thorybes" bathyllus Eastern Cloudywing

A rare stray to Colo., at Two Buttes Res., Prowers Co., E June 1975. This species is a little smaller than *C. pylades*, males lack the costal fold, and the fw has large whitish spots (the spot in fw cell CuA_1--a rectangular bar all across that cell--is next to the spot in cell M_3). The male valva differs from *pylades*, and is more similar to *C. mexicana*.

Habitat open and brushy areas and forest edges esp. oak. Hostplants numerous herb Fabaceae in E U.S. (most of those hosts are absent in Colo. except *Astragalus*, *Phaseolus*, *Hedysarum*, *Glycine* are present). Common in E U.S.

Eggs pale greenish, laid singly beneath host leaflets. Larvae eat leaves, and live in nests of silked leaf tubes. Older larva like *C. pylades*, brown (tinged with green) or greenish-white or tan (the brown larva probably turning darker just before hibernating), with a darker middorsal line and a tan dorsolateral line, probably a tan lateral line; collar and head black. Pupa greenish-brown (with dull brown marks) or dull brown. Fully-fed mature larvae hibernate.

Several generations M-Apr.-M Oct. in Missouri, E May-M Aug. in Iowa.

Adults sip flower nectar of most colors including *Cirsium*, *Asclepias*, etc., and sip mud.

Males rait on vegetation ½-1.5m above ground in open areas such as clearings or forest margins (esp. hilltops) to await females, probably all day.

Hesperiidae, Pyrginae

The recently-redefined subfamily Pyrginae now contains three tribes that occur in Colorado, the Carcharodini (including *Pholisora*, *Staphylus*, and *Hesperopsis*), Erynnini (containing *Erynnis*), and Pyrgini (containing *Pyrgus*, *Burnsius*, *Heliopetes*).

Hesperiidae, Pyrginae, Carcharodini Sootywings and Scallopwings

Adults usually rest and bask with wings flat. There are numerous neotropical species, many mostly black and requiring examination of the male genitalia to identify. In many species the males fleek low to the ground to find females.

Staphylus hayhurstii Hayhurst's Scallopwing

The hindwing margin undulates, and the wings are mottled, unlike *Pholisora catullus*. Males have a costal fold. Only one record: several people caught it in a wooded area in Lamar in Prowers Co. (SE Colo.) May 16-20, 2007. Maybe it will spread due to global warming. (A record from "Loveland, Larimer Co. July 29, 1942 Arthur H. Moeck" was a large unconfirmed range extension, evidently mislabeled.)

Habitat open areas and weedy lots. Hostplants herb Amaranthaceae (includes Chenopodiaceae) in E U.S., including *Chenopodium album*. {Other hosts incl. *Celosia nitida*, in Fla. *Iresine diffusa* [the only host given by Minno et al. 2005]=*canescens*, and in Fla. *Alternanthera flavescens* [a wider-leaf plant more widespread in Fla. which record is based on H. Dyar's "*Iresine flavescens*" which is dubious? because it only occurs in Puerto Rico & Virgin Is. although *I. f. keyensis* occurs in Fla. Keys but has narrower leaves so is less likely to be the plant Dyar intended to specify]}. Often common in E U.S.

Eggs deep-orange-brown with wide cream ridges, laid singly on uns of host leaves. Larvae eat leaves at night, and live in silked-leaf nests. Larva deep green (turning reddish at maturity), heart-band darker, a yellowish dorsolateral line, a paler line between spiracles, collar light-brown on narrow cream neck; body & head covered with short white hair; head blackish, somewhat cleft vertically. Pupa pale olive-brown (pale orange-brown on abdomen), with a whitish bloom. 3rd-stage larvae hibernate.

Two flights about M May-June and L July-Aug. eastward. Adults rest and bask with the wings spread, often on uns of leaves.

Adults visit at least purple (such as Lamiaceae), yellow (such as *Melilotus*), and white flowers, and mud. They bask with wings outstretched.

Most *Staphylus* fleek all day in low spots to find females.

Pholisora catullus catullus Common Sootywing

Identified by the solid black unh and the rounded wings. The number of white fw spots varies, and females have more spots than males. Occasional adults of ssp. ***catullus*** have submarginal white dots on hw (most adults have those dots in the S Sierra Nevada Calif. ssp. *crestar*).

Habitat the plains and lower foothills, in low weedy areas. Hostplants in Colorado herb Amaranthaceae (includes Chenopodiaceae): *Amaranthus retroflexus, blitoides, albus, palmeri,* (and probably *A. hybridus*), sometimes *Chenopodium berlandieri*, possibly *C. album* (records of the smooth-black-seed *album* may be misidentified *berlandieri* which is much more common and has pitted black seeds) (I did not find it on Colo. herbaceous *Atriplex rosea*/*patula* plants, which look like they might be good hosts but are not). *Celosia* are hostplants elsewhere, but occur in Colo. only as cultivated flowers, and have not been found to be hosts yet. Reported hosts in other plant families are all errors. Sometimes common, usually uncommon in Colo.

Eggs reddish-tan, with ~9 bumps around the top, laid singly on host leaf ups. Larvae eat leaves at night, and live in silked nests (a cut flap of leaf folded over for young larvae, a whole leaf folded into a nest for older larvae). Older larva green or light-green (in W.Va. sometimes light-yellowish- green), with ochre-yellow areas or tints, a middorsal dark-green band, in Colo. & esp. in E U.S. a weak darker-green dorsolateral band edged by creamier-green, a weak supraspiracular ochre-yellow line, a tiny pale dot beneath each short knobbed tan hair, a black collar divided middorsally on white background/neck; head black with short tan hairs. Larvae feed at night, and shoot dung far away. Pupa chitin-brown, but covered with a bluish-white bloom (a waxy pruinose surface), T1 spiracle red-brown with black center and protruding, numerous hairs on head, top of thorax, and abdomen (the hairs ~1/3mm, shorter than *P. mejicanus*); the pupa in front view resembles a baby seal. Pupates in loosely-silked "cocoon" nest within leaves etc. mostly in litter. Fully-fed mature larvae become crimson where the integument folds (reddish-green where it is stretched), then hibernate.

Several flights M May-M Sept., representing at least two generations M May-E July and L July-E Sept.

Adults visit low flowers of all colors, and mud. Adults usually keep the wings mostly spread when they land, and they bask that way also (dorsal basking).

Males fleek all day 5-10 cm up in gulch/valley bottoms/roadside ditches to seek females. In courtship (W. Capman 1990, Great Lakes Ent. 23:151-157), the male pursues the female and they flutter together until she lands, and the male flutters and may walk around her and bends his abdomen to mate immediately if she is receptive (I saw the male and female flying rapidly in a ball, the male below, female and male going around each other, they landed and the male fluttered his ~120^{o}-spread wings rapidly at small amplitude and bent abdomen to attempt to mate a less-receptive female, and finally he left); unreceptive females sit with wings folded and turn to avoid the male. Two newly-emerged females flew upward toward passing males and fluttered in air with them then landed and they mated without any fluttering. Matings occurs at least 09:30-15:00. If the mated pair is disturbed, the female flies, the male dangling.

Pholisora mejicanus Mexican Sootywing

Identified by the bluish-black unh with black veins; the upf white spots are variable, and--like *P. catullus*--males have fewer spots than females. It occurs along the mountain front from just N of Colorado Springs (an erroneous Jefferson County record was misidentified *P. catullus*) southward to Raton N.M. to Mexico, in the rain shadow of the mountains. It is a mystery why it mostly occurs E of the Rio Grande in Colo. & NM and is missing in Ariz./Sonora.

Habitat the lower foothills (nearly to Salida in the Arkansas Canyon) and W edge of the plains in Colorado Springs to Raton, NM, mostly in low weedy areas such as gulch bottoms, roadside ditches, and ditches beside railroad tracks. Hostplants in Colorado herb Amaranthaceae: *Amaranthus retroflexus, blitoides=graecizans*. *Chenopodium* is reported in N.M. I found larvae with *P. catullus* on the same *A. retroflexus* plant. Uncommon.

Eggs reddish-tan, with ~9 bumps around the top, laid singly on host leaf ups. Larvae eat leaves, and live in silked-leaf nests like *P. catullus*. Older larva green, with ochre-yellow areas, a middorsal dark-green band may be edged by weak yellowish, a weak darker dorsolateral band edged by weak yellowish, spiracular line of tracheae may be visible, a tiny pale dot beneath each long unknobbed tan hair, a black collar divided middorsally; head black with long tan hairs; body and head hairs about twice as long as those of *P. catullus*, without knobs. Pupa chitin-brown, but covered with a bluish-white bloom, T1 spiracle red-brown with black center and protruding, numerous hairs on head and top of thorax and abdomen (the hairs ~0.5mm longer than those of *P. catullus* but about the same in number). Differs from *P. catullus* by having larval and pupal hairs about twice as long, and lacking knobs. Mature larvae probably turn somewhat reddish and hibernate like *P. catullus*.

Two flights, end of May-start of July and L July-Aug.

Adults visit low flowers of all colors including *Verbena bracteata*, and mud. They bask and land with wings mostly spread (dorsal basking).

Males fleek all day 5-10 cm above ground in low spots such as gulch bottoms, street gutters, and ditches along railroad tracks etc. to seek females. One hostplant *Amaranthus blitoides* often grows in cracks in sidewalks, and I found males fleeking along street gutters in the town of Raton, New Mexico. They have a fluttery flight that is fairly fast, like *P. catullus*.

Hesperopsis alpheus alpheus Saltbush Sootywing

Identified by the checkered fringes and the rounded wings and mottled ups. Colo. seems to have just ssp. *alpheus* (TL Colfax Co. NM) (Nev. *oricus* seems to be a synonym).

Habitat the Upper Sonoran Zone upper plains and W Colo. lowlands. Hostplants shrub Amaranthaceae (Chenopodiaceae): associated with *Atriplex canescens* in Colo. (a known host westward). Usually scarce in Colo., sometimes uncommon.

Eggs have the ridges & peaks white, tan in the hollows, laid singly on the host mostly on leaves. Larvae eat leaves, and live in silked-leaf nests. Older larva pale-bluish-tan, heart-band darker, lateral ridge a little paler, covered with numerous white points (setae), without a dark collar, neck cream; head blackish, with short rusty hair (setae). Pupa evidently tan. Mature larvae probably turn more reddish on top, then hibernate.

Two flights on the plains and W Colo. lowlands May -M June (L Apr.-May in W Colo.) and July-E Aug. (the latter perhaps partial), one flight mostly June at higher altitude in Arkansas Canyon and San Luis Valley (sometimes L Sept. lower San Luis Valley).

Adults visit flowers of many colors, including *Erigeron pumilus* and *Medicago sativa*.

Males fleek all day in gulch bottoms or about the hosts on flats or hillsides to seek females, ~5-10 cm above ground. {Ssp. *gracielae* males in Ariz.-S Calif. fleek low ~30cm up and may explore up on a hostplant bush *Atriplex lentiformis* or fly through it, at least in morning and early afternoon.}

Hesperopsis libya lena **Mojave Sootywing**

The gray-cream unh of males and cream unh of females is unique in Colo.-Mont. ssp. ***lena***; both have a single paler dash on unh center. Males have fewer upf spots than females. The first generation is reported to be darker than the second. I named ssp. *confertiblanca* from Colorado, and it supposedly has a hoary band at the base of the ups fringe, and a dark line at the base of the uns fringe, compared to Montana ssp. *lena* which lack the hoary band and line, but those traits are absent on most of my Colo. adults, so I consider *confertiblanca* to be a synonym of *lena* or at most a weak ssp. (valid ssp. *libya* in Calif. has the unh black with some cream spots).

Habitat the arid brushy desert lowlands in W Colo., where it flies on arid slopes with much dirt and grayish bushes. Hostplant in Colo. shrub Amaranthaceae (Chenopodiaceae): *Atriplex confertifolia*. {Hostplant is *A. canescens* in the rest of the range (Calif., N.D., Ore. etc.).} Locally common.

Eggs tan on top, whitish-tan on sides (in Calif. dull orange, changing to soiled-white), laid singly on host including leaf ups. Larvae eat leaves, and live in a silked nest between adjacent leaves. Older larva (Calif.) pale-bluish-green covered with numerous whitish points (setae), three rows of black dots on each side, collar white; head black with short orange hair. Pupa light-brown, thorax and wing cases blackish, A1-3 light-brown, intersegmental areas of abdomen darker than rest of abdomen, wing veins and antennae darkly-edged. Fully-fed mature larvae become rosy in color evidently when they prepare to hibernate.

Two flights, M June-M July and L Aug. at least.

Adults visit various flowers including *Chrysothamnus, Helianthus, Medicago sativa*. They fly rather fast, mostly between bushes of the hostplant. Adults bask dorsally. They roost on top of the hostplant.

Males fleek ~40 cm above ground mostly about the canopy of the host on slopes (often lower slopes) and gullies, and land frequently on the hostplants, at least in morning and early afternoon (probably all day). The black upperside and cream underside somehow makes them a little hard to see as they ramble about somewhat fast.

Hesperiidae, Pyrginae, Erynnini Duskywings

Colo. species of Erynnini all belong to *Erynnis*, a dozen species that are similar enough that close attention to details of wing pattern are necessary to identify them, and an examination of the male genitalia will generally accurately identify them. Males may have a costal fold on the forewing margin and a tibial tuft on the hindleg tibia, and females have a lenticular scent patch on top of A7 and may have hair pencils on the uns of A7, all of which waft pheromones for mating, and those structures are useful for identification. Adults rest with wings flat, but roost in a unique way: upside down beneath a twig of a bush or tree with the wings moved dorsal to the body and wrapped around the twig. It's interesting that unreceptive *Erynnis* females evidently never do the strong fluttering of wings to repel the male (that is a rejection dance used by a majority of butterflies).

Erynnis icelus **Aspen Duskywing**

Adults of *icelus* and *E. brizo* lack translucent white fw spots. *E. icelus* differs from *brizo* in these traits: adults are smaller, the upf has a postmedian row of chainlike spots like *E. brizo* but those upf spots are usually more blurred especially where the spots beyond the discal cell are usually thinner and often shorter (the male "*icelus*" photo in Mike Fisher's The Butterflies of Colorado looks too much like *E. brizo*), the male hind leg tibia has a hair plume that wafts pheromone and fits between thorax and abdomen (absent in *E. brizo*), the palpi are longer, and the valvae differ. Also, the upf postbasal area is darker, the spots blacker. The hw fringe is brown. All Colo. *Erynnis* have a costal fold on the male upf costa that wafts pheromone during courtship. I deduced the evolution of *Erynnis* from numerous traits of adults and their genitalia and eggs larvae pupae etc. {Scott 2006a, Papilio (New Series) #14 p. 58-63}.

Habitat the upper foothills to Canadian Zone, near aspen. Hostplant in Colorado tree Salicaceae: *Populus tremula tremuloides*. Females oviposited on seedlings in Colo., but C. Guppy saw ovips. on new growth high in the trees in BC. so they may just prefer new growth. Recorded on *Betula* (Betulaceae) in E. U.S. and even the legume *Robinia* in the Appalachian Mts., but there is no evidence for those in Colo. Uncommon.

Eggs cream, turning red, laid singly on young host leaves. Larvae eat leaves, and live in nests of silked tied leaves. Older larva whitish-green or light-green, sometimes with a yellowish tint on top, a dark heart-line, a white dorsolateral stripe, prothorax yellower, collar of all *Erynnis* greenish (the neck creamier); head light reddish-tan (in Colo. & E U.S.) or darker reddish-brown (in Wash.), a brown or black rim around head, the dark heads have a black stripe on coronal sulcus that forks downward along the adfrontal areas, and in Colo. a black area narrows then widens as it runs from top to bottom of front of head (see photo), whereas elsewhere the light heads have just a narrow inverted red-brown V on adfrontal sulcus and they have a large paler-tan W (the middle may be weaker) on front of head. All *Erynnis* heads have a rounded protrusion on upper side where a "horn" would be, but *E. icelus* and *E. brizo* lack the ~three small bumps on that mound that other *Erynnis* possess. Larvae can shoot frass far away, evidently using the anal comb. Pupa dark reddish-brown with lighter wing cases, a weak darker heart-band and a tan dorsolateral stripe on abdomen; or pupa yellowish-brown (some reportedly green), mesothorax and abdomen often yellowish or tan, the wings greenish-tinted on paler pupae. Mature larvae turn yellowish-cream and hibernate.

One flight L May-M July, mostly June.

Adults especially visit white flowers, sometimes other colors, and mud.

Males rait all day in slight depressions/swales near the aspen hostplant, as they rait an average of 71 cm up (33-100cm, N=10) to await females, and males sometimes fleek about aspen groves to seek females. {*E. icelus* and *E. brizo* lack the female hair pencils that pop out of the end of the female abdomen, which are used in courtship in all other *Erynnis* species except *E. martialis* and *E. pacuvius*.}

Erynnis brizo burgessi Banded Oak Duskywing

Larger than *E. icelus*. The male (and female) hind leg lacks a black hair plume, the upf appears more banded because the postmedian chain of spots is more uniform, the upf is brighter at the base (the upf postbasal spots are brighter and have grayish centers), and the male valva differs. The upf of ***burgessi*** is reportedly grayer than ssp. *brizo* of E U.S., and the lower process of left valva is shorter. The hw fringe is brown. The male has a costal fold on upf to dispense pheromone.

Habitat the lower-altitude *Quercus* zone. Hostplant in Colorado low tree Fagaceae: *Quercus gambelii*. Common.

Eggs slightly greenish-cream, turning red, laid singly on young host leaves or leaf buds. Larvae eat leaves, and live in nests of silked rolled/tied leaves. Older larva pale-grayish-green (sometimes slightly browner at front and rear) with darker middorsal line and cream dorsolateral stripe, spiracles red-brown; head with esker-like ridges like those of *E. icelus* (other *Erynnis* lack them), yellowish-brown to dark reddish-brown, with an orange spot at base of mandible, and sometimes an orange spot near side and another just below the bump where a horn would be positioned. Pupa green, or probably brown. Fully-fed mature larvae become yellowish-cream (with a peach color on thorax and rear) and hibernate.

One flight M April-M July (most common May-June).

Adults often visit white and yellow flowers, sometimes blue etc., and frequent mud, sometimes dung. Adults bask by spreading the wings ~80°. Adults roost under twigs by spreading wings flat against the twig, like a Noctuid moth. Several adults strayed 1 mile from the foothills to Green Mtn. west of Denver.

Males rait all day on hilltops, as they rait an average of 38 cm up (0-1m, N=12) on ground or vegetation to await the arrival of females. Males often flait about the hilltop after investigating passerbys. Males very often (usually when adults are abundant) fleek ~20 cm up among hillside *Quercus gambelii* to seek females. In courtship, the male overtakes the female, she hovers/flutters and the male flutters under her and rises up to touch or nearly touch her as they fly about, then they land (each with wings spread ~80-100° apart) and join. Females of *E. brizo* (also *E. icelus*, *E. martialis*, *E. pacuvius*) lack abdominal hairpencils whereas other *Erynnis* including *E. afranius* & *E. telemachus* possess them, but females still may possess a pheromone. During mating, both valvae scrape across the female's abdomen, the right valva pressing a little more often and farther. Mating lasts ~43 min. If a mating pair is disturbed, the female flies, the male dangling.

Erynnis martialis **Mottled Duskywing**

Easily identified by the marginal and submarginal rows of unh cream spots, each edged basally by a brown spot (the postmedian spots are brown zigzags). The upf is mottled gray and brown and sometimes violet-tinged. There are rings of slightly-grayish hairs around abdomen. The male has a costal fold on upf that wafts pheromone, but lacks a tibial tuft on hind leg, and females lack the abdominal hair pencils on uns of A7 present in most other *Erynnis*. The hw fringe is brown.

Habitat lower foothills. Hostplant in Colorado bush Rhamnaceae: *Ceanothus fendleri*. Common in Colo.

Eggs cream when laid, turning light-orange, then pale yellow as larva develops inside, laid singly on flower pedicels and other parts of host. Larvae live in silked-leaf nests. Older larva light-green, heart-band dark-green, a subdorsal cream band, rear rim of A10 tan; head black with three rusty-brown-orange patches positioned along side of face that are weakly connected by brownish-black (the upper patch just below 4-5 big subdorsal cones (tiny "horns") (the collective horn larger than most *Erynnis*). Pupa light tan-green, uns and wings pale olive-green, abdomen greenish-cream with a faint cream subdorsal band, heart-band darker, movable areas of A4-6 segments gray, pupa hairier than most *Erynnis*; pupa attached upside down in silked-leaf nest by cremaster and a multistrand silk cord around middle. Mature fully-fed larvae become yellowish-cream and hibernate.

One flight E May-M July (most common M May-June), rarely E Aug. and E Sept.

Adults seem to prefer white and yellow flowers including *Ceanothus fendleri*, and often visit mud. Adults bask with the wings ~150° spread.

Males rait all day on hilltops (in N.Y. also), as males usually rait low on plants or rocks averaging ~28 cm up (0-100cm, n=44), but the average jumps to 51cm when we add the four highest observations (244, 300, 300, 400cm up, N=48) which mostly occurred when the ground was hot. Where the hostplant and adults were very abundant (Ralston Butte in Jefferson Co. in the years after a forest fire) most males fleeked about the host on a hillside while only a few were on the hilltop. While mating the right valva bends more often than the left when pressing across the female's abdomen (the membrane anterior to lamella). If a mating pair is disturbed, the female flies, the male dangling.

Erynnis pacuvius **Pacuvius Duskywing (Buckthorn Duskywing)**

Identified by the mottled medium-brown & black basal 2/3 of upf, and east of the continental divide usually characterized by the white hw fringe (ssp. *pacuvius*), which has ~3-4 short brown spots on the base of that white hw fringe, though some adults have brown fringe. There are rings of slightly-grayish hairs around abdomen. The male genitalia is very distinctive. Ssp. ***pacuvius*** with white hw fringes occurs in most of Colorado (rare specimens in N-C Colo. have brown fringes); ssp. **near-*lilius*** evidently occurs on the W slope in NW Colo., where the hw fringe is mostly brownish, based on few specimens. The male has a costal fold on upf that wafts pheromone, but lacks a tibial tuft on hind leg, and females lack the female abdominal hair pencils present on A7 uns in most other *Erynnis*.

Habitat the foothills and lower Canadian Zone. Hostplant in Colorado bush Rhamnaceae: *Ceanothus fendleri*; assoc. *C. velutinus* in Larimer Co. & Ore., and Austin & Leary (2008) report *C. velutinus* as a host for *lilius* in Nevada, so it may be a host in NW Colo. Adults become common in places where the forest has burned and the host explodes. Usually uncommon.

Eggs cream or greenish-cream, becoming rich orange (I reported no color change in Colo., but that was evidently a mistake, as they become bright orange in Wash. [James & Nunnallee 2011]), laid singly on new host leaves, mostly on ups. Larvae eat leaves at night, and live in silked-leaf nests. Older larva light-green (slightly yellowish-green in some, slightly bluish-green in many), a green heart-line, a cream dorsolateral band, lateral ridge slightly creamier, collar greenish, rim around A10 creamy; head reddish-brown with three orangish areas (an elongate patch in front of eyes, a smaller dashlike patch on side of face, a large long streak extends from front of bumpy horn diagonally to near adfrontal area (the horn larger than most *Erynnis*), paler heads may have a darker spot on frontoclypeus, ventral rim dark-brown, rear rim black all around head. Pupa uniform blackish-brown (dark-brown in Wash.), slightly darker oranger-dark-brown on abdomen & wing tips, pupa hairier than most *Erynnis*; pupa rests in nest of silk cords in loose netting, the cremaster attached to silk nest and pupa hanging from silk Y-shaped sling at joint T3-A1. Mature fully-fed larvae hibernate after the diapausing larva turns pinkish on front & rear then entire body turns tan-pink, the thorax grayish.

One flight May-E July in foothills, June-July higher up.

Adults seem to prefer white and yellow flowers but visit all colors, including *Ceanothus fendleri* and *Senecio* (*Packera*) *canus*, and often visit mud. Both sexes bask with wings spread somewhat.

Males rait all day on hilltops, on the top or often in little clearings a few meters off the highest point, as males rait an average of 34cm up (0-1.5m, N=25). But where the host and adults are very common (including Ralston Butte after the forest fire) males fleek about the host and may dip down over the host to seek females. In courtship the male overtakes the female, the female hovers while the male hovers below her and flies up to contact her multiple times, then they land (the male with wings spread ~70^{o} the female ~100^{o}) and they join. Mating lasts ~42 min. During mating the right valva bends in the middle and presses across the female's abdomen while the left valva moves little. If a mating pair is startled, the female flies, the male dangling.

Erynnis funeralis Streamlined Duskywing (Funereal Dusky Wing)

Identified by the white hw fringe, and the very narrow fw, which has a tan area between the blackish discal cell and the small white spots. The male has a costal fold on upf and a hair plume on hind leg and females have hair pencils on the end of the uns of A7 on abdomen, all dispensing pheromones. The male valvae are distinctive. A rare stray in Colorado in the summer, immigrating from southward, but breeding occurs here sometimes, because several adults I found are rather fresh. R. Carpenter (2015) analyzed photos and records of it from E U.S., and deduced that it is a regular migrant, which expands its range northward from S Ariz./Tex./Mex. every spring an average of 24km/day (although the slope of his fig. 3 line for July-Oct. indicates a spread northward of only 11 km/day) to occasionally reach Rhode Island, Ont., N. Mich., S.C., and Fla. (it seldom gets east of Indiana, and most records far northward are July-Oct.), and it breeds along the way 1-2 generations so that most of the adults found northward are in nice condition due to local emergence and many are findings of several adults. People have not seen a return fall migration, but they haven't seen the northward migration either, maybe because the skipper is fast and is scarce northward (if it flies high in the air it would not be seen). {SE U.S. *E. zarucco* with brown fringes and wider fw evidently spreads northward a lot also [Scott 1986a map] so there may be some confusion with *funeralis*, and in Fla. Keys some *zarucco* have whiter fringes as if interbreeding with *funeralis* has occurred. They are considered separate species despite similar hostplants and genitalia etc., because intergradation elsewhere has not been reported (or well studied), and the fw shape especially differs. T. Walker's malaise traps in Fla. caught few or no *zarucco* migrating.}

Habitat Subtropical to Transition Zone open areas southward, straying to Colorado in every habitat, one record from top of Gray's Peak in Clear Creek Co. Colo. 14272' & two from the Eisenhower Tunnel ~11,000'. Hostplants Fabaceae: numerous herbs and some trees southward incl. *Robinia*, *Vicia*, and it eats *Medicago sativa* in Calif. (I found a male raiting in a *M. sativa* field and one on *M. sativa* flower near my house in Denver, both in nice non-migratory condition). A rare stray.

Eggs cream, turning orange, laid singly on hostplant leaves. Larvae eat leaves, and live in silked-leaf nests. Older larva (photo Tveten & Tveten 1996) pale-green, yellowish in intersegmental folds, a dark-green middorsal line, a pale yellow or cream dorsolateral band; head very dark or brown with three yellow or ochre or orange spots around edge of face (one in front of eyes, one on side, one at top), a blackish W on lower front, the "horn" bump weak. Pupa vivid green, with yellowish-white clouding on wings, suspended by silk girdle and cremaster. Mature larvae hibernate.

Several flights most of the year farther south. Over the years in Colo. I have found about 6 adults, June 30-Aug. 2, on the plains and foothills and two in the Subalpine Zone; several recent were fresh.

Adults visit various flowers including *Medicago sativa*, and often visit mud.

Males rait in gulch bottoms (based on several Colo. observations, plus Bailowitz & Brock 1991), evidently all day, to await females (raiting 1.5m above ground in my one observation). If a mating pair is disturbed, the female flies, the male dangling.

Carpenter, R. 2015. The funereal duskywing, *Erynnis funeralis* (Hesperiidae): seasonal range expansion into eastern North America. J. Lepid. Soc. 69:114-124.

Erynnis baptisiae Wild Indigo Duskywing

This eastern U.S. skipper is the size of *E. persius*, but the male upf is not as hairy, and the upf has a paler patch just inside the white dots (similar to that of *E. funeralis*, which is much larger with narrower fw and white hw fringe). The male left valva resembles that of *E. afranius*. The hw fringe is brown. The male has a costal fold on upf and a hair plume on his hindleg, while the female has hair pencils on the end of her abdomen segment A7 uns, all dispensing pheromones. Only one Colorado doubtful record so far: along RR, 2 mi. E Arriba, Lincoln Co. July 30, 1972 (coll. R. Stanford, det. A. Warren), reported associated with "*Baptisia*" but that genus does not occur in Colo. and the plant was supposedly *Psoralidium*=*Psoralea*, an unlikely host. Confident evidence of presence is needed. It is known from Platte Co. Wyo., and I found one in Sioux Co. in NW Neb.

Habitat Gulf Coast to Transition Zone open woods and brush. Hostplants herb and shrub Fabaceae: unknown in Colo., elsewhere in E. U.S. hosts are *Baptisia* 7 sp., *Securigera* (*Coronilla*) *varia*, *Crotalaria sagittalis*, *Lupinus perennis*, *Thermopsis villosa*, *Astragalus canadensis* in Wis., *Sesbania vescicaria*, *Apios americana*, *Vicia*; these plants are absent in Colo. except for *A. canadensis* (rare), *Vicia*, and *S. varia* (Crown Vetch, an introduced weedy pink flower). In E U.S. about the late 1960s it discovered the introduced S. *varia* and began exploding on it (in N.Y., Ala., Wis. etc.); that pretty flower has invaded Colorado and is now common even in Denver, so *E. baptisiae* may soon populate at least the easternmost counties of Colorado which may have a moist enough climate for it. Common on *Securigera* in E U.S., otherwise uncommon.

Eggs cream, turning pink, laid singly on host leaves. Larvae eat leaves, and live in silked-leaf nests. Older larva pale-green, a dark-green middorsal line, a dorsolateral cream line, a weak tracheal line along spiracles, collar green and neck cream like other *Erynnis*; head variable mostly black or mostly light-brown depending on the extent of black, the darkest heads all black except for three red-brown patches (a tiny patch in front of eyes, a larger patch on side of face, a larger subdorsal dash [with thin creamier dash down center] from below rudimentary "horn" angling toward frontoclypeus a short distance), the palest heads mostly light-brown with those three patches creamy-centered then blended into reddish-light-brown covering most of face, with black markings on front of face (blackish on top of frontoclypeus, a black funnel-shaped mark beside frontoclypeus attached to a brown streak between the top two red-brown patches, a vertical black dash over coronal sulcus widens into a black small spot just above frontoclypeus, all forming the homolog of the "W" that is found in *E. persius*/*E. afranius*), rear rim of head black. Full-grown mature larvae hibernate.

Adults visit various flowers such as *Apocynum*, *Rubus*, *Trifolium*, and very many others of all colors often white and yellow (Iftner et al. 1992), dung, and sip mud.

Mostly two flights, probably May-E June and July-Aug.

Males rait all day on low shrubs in open areas to await females, and may flait often there esp. in afternoon.

Erynnis afranius Afranius Duskywing (Bald Duskywing)

The same size as *E. persius*, but males lack the extensively gray-hairy upf of male *persius*. It resembles *E. baptisiae* somewhat on upf, but has slightly more gray upf scales and occurs west of *E. baptisiae*. The hw fringe is brown. The male has a costal fold on upf and a hair plume on his hindleg, while the female has hair pencils on the end of her abdomen and a dorsal strip of scaleson A7, all dispensing pheromones. The male left valva differs greatly from *E. persius* because the middle process is fingerlike without any keel (like *E. baptisiae*). Males rait in gulches (on hilltops for *E. persius*). Females cannot be distinguished well from *E. persius* (even female genitalia cannot be distinguished) and the upf is variable and similar, so their identity must be guessed based on association with males.

Habitat lowland canyons and valley/gulch bottoms; adults are generally uncommon, and they occur only in the lower foothills and plains in Colorado, never in the Canadian Zone. Hostplants in Colorado herb Fabaceae: *Thermopsis rhombifolia* var. *divaricarpa*, *Lupinus argenteus, caudatus, Astragalus* (a possible ovip. in Colo., and a record of *A. crassicarpus* in Canada). Larvae on *Lotus wrightii* in Ariz., which occurs in SW Colo. Uncommon (I found it common once at Wheatridge).

Eggs cream, then become reddish-orange, laid singly on leaf uns and sometimes petioles, especially on new growth of the host. Larvae eat leaves, and live in silked-leaf nests. Very young larvae often make a nest in a tiny young unexpanded leaf which is already folded. Older larva light green (sometimes light yellowish-green, occasionally grass-green), a dark-green middorsal heart-line, a cream dorsolateral line, collar greenish; head blackish-brown on rim and rear, the front ochre-brown (red-brown in Utah), a large blackish-brown W on lower face (a horizontal bar fills upper half of frontoclypeus and extends laterally to middle of gena and a dark-brown streak angles up from it to temple), three ochre patches around face (a spot in front of eyes, a larger spot on side of face just below the streak, an ochre subdorsal dash terminated anteriorly by an ochre spot), the notch along coronal sulcus edged by blackish-brown sometimes with a tiny blackish-brown dot near frontoclypeus, sometimes adfrontal cleavage line visible as an inverted brown V. Pupa light-green (vivid green in Calif.), abdomen light-yellow-green, head and middle of wings slightly tan on some; pupa held in place in "cocoon" nest by silk girdle and cremaster. Mature larvae become more orangish-peach on front and rear and on intersegmental areas, and then hibernate fully grown.

Two generations, M April-May, and July-E Sept. (2nd gen. mostly M July-E Aug.).

Adults prefer yellow/white flowers, often on *Medicago sativa*, and often visit mud. Adults bask dorsally.

Males rait all day in gulches (and gully banks and low spots of meadows) to seek females; they rait on the ground or 0.5-1.5 meters up (averaging 67cm up); males often flait in circles a lot before landing, and at Wheatridge Colo. in a meadow with abundant hosts and adults, males often fleeked about the hosts to seek females (males usually rait at the usual low density). In courtship, the male overtakes the female, she hovers and he hovers below transmitting his pheromone (from costal fold and hind leg), then receptive females would presumably land and mate (unreceptive females may fly high in the air and away). The female abdomen (A7) has a dorsal strip of evident pheromone scales and two ventral hairpencils.

Erynnis persius Hairy Duskywing (Persius Duskywing)

This common skipper is the size of *E. afranius*, but is identified by the numerous gray hairs all over the male upf, giving the upf a slightly obscured appearance. The hw fringe is brown. The male has a costal fold on upf and a hair plume on his hindleg, while the female has hair pencils on the end of her abdomen, all dispensing pheromones. The left valva of the male has a boot-shaped middle process with a unique wide keel on the inside. Males hilltop (*E. afranius* males are gulchers). The female ups is not more spotted than *E. afranius* as claimed, and I cannot distinguish them by female genitalia either (*persius* is far more common and widespread than *afranius*).

Habitat everywhere in the mountains except dense forest, from foothills to Subalpine Zone. E. *persius* is extirpated in most of E U.S. (N.C. to Maine to Ohio), but is the commonest *Erynnis* in Colo. Very common.

Hostplants in Colorado herb Fabaceae: *Astragalus flexuosus, hallii, canadensis, Thermopsis rhombifolia* var. *divaricarpa, Lupinus argenteus* (normal var., and white-flowered var. ~*ingratus* with non-folded leaves), *Oxytropis splendens*.

Eggs pale yellowish-green or pale yellow, turning dark reddish, laid singly on host leaflet uns (sometimes on stems or leaf buds, often near new growth or flower buds). Larvae eat leaves, and live in nests of rolled/tied leaves. Older larva light-creamy-green, slightly pinkish in intersegmental areas, heart-band darker green, a narrow cream dorsolateral band, a very faint paler spiracular band of tracheae; head black with ochre-cream patches (a rectangle on forehead lateral to coronal sulcus extends upward then turns laterally and narrows and runs a short distance to side of head, where it barely touches an oval patch on side of face, an oval patch medial to eyes), lower part of head forms a large black W (head often blacker with smaller and paler tawny patches than *E. afranius*, which may cover a a tiny dark-ochre spot on lower corner of frontoclypeus on some larvae) (some heads mostly ochre [T. Emmel & J. Emmel & Mattoon 1992], with the upper ochre-cream patch merged with its twin on other side and only a tiny brown dot is beside bottom of coronal sulcus in that merged forehead ochre-cream area, and the middle patch is nearly merged with upper patch also, while on frontoclypeus there is only an upper brown dot and a lower transverse brownish dash), a blackish rim around bottom and the rest of head. Pupa brown, abdomen yellower-brown, cremaster blackish. Fully-fed mature larvae turn yellowish-cream and hibernate.

One flight, M May-E July in foothills, mostly June-July at higher altitude.

Adults prefer white and yellow flowers, including *Astragalus flexuosus, Lesquerella montana, Sedum lanceolatum, Senecio* (*Packera*) *canus, S.* (*P.*) *fendleri, Thermopsis rhombifolia* var. *divaricarpa*, and very often visit mud, sometimes dung. Adults bask with wings widely spread. Roosting adults land under a twig and (while upside down) wrap the wings and legs around the twig.

Males rait all day on hilltops to await females, as males rait an average of 20 cm above ground (on the ground to 50 cm up, n=15). In courtship, the female flies slowly and the male flutters under her (often darting back and forth) and may touch her to transfer his pheromone, they land (both with wings mostly spread) and the male joins (evidently after she closes her wings some). Unreceptive females may rise high in the air and then away. Mating lasts ~36 min. During mating, the male bends his left valva in the middle and scrapes it across her abdomen, without affecting her two hair pencils [Scott 1979b, J. Lepid. Soc. 32:304-305 first noticed this in *E. persius*; and Scott 2006a, Papilio (New Series) #14:59-63 reported how other *Erynnis* use the left or right valva or both in the scraping]). If the mating pair is startled, the female flies, the male dangling.

Erynnis telemachus Gambel-Oak Duskywing

Identified by the large size, the grayish upf with long gray hairs, and the little brown circle (its center paler) near the unh apex, and females have an hourglass-shaped white unf median spot. The hw fringe is brown. The male has a costal fold on upf to waft pheromone, but lacks a hindleg hair tuft, while the female has hair pencils on the end of her abdomen to dispense pheromone. The male valvae are distinctive.

Habitat the *Quercus* zone from lower foothills to Canadian Zone. Hostplant in Colorado low tree Fagaceae: *Quercus gambelii*. Common.

Eggs cream, turning pink then bright-red, laid singly mostly on twig tips next to newer leaves. Larvae eat leaves, and live in silked-leaf nests. Older larva slightly-grayish light-yellow-green, heart-band darker gray, a light-yellow dorsolateral line, lateral ridge a bit yellower, collar greenish; head light-brown with neon-orange spots [so shockingly bright they seem to glow] around side of face (a large spot on lower face medial to eyes, a smaller patch on side of face, a larger patch [tapered to a point on bottom] on front of each bumpy "horn" ridge), uns rim of head black, rear rim of head brown. Pupa unknown, but the similar *E. juvenalis* is reddish-brown, the abdomen ochre-yellow with rear edge of segments a little reddish-brown. To rear oak feeders, it is best to place a female into a net bag secured around the end of a nice green young oak branch, then she will oviposit inside and you can peek in and photograph/harvest the immatures when you wish. Mature fully-fed larvae turn tanish-cream or yellowish-cream then hibernate.

One flight, L April-E July (mostly L April-June) in foothills, M May-July at higher altitude.

Adults prefer white and yellow flowers, including *Barbarea orthoceras*, and often visit mud. Adults bask dorsally by mostly-spreading their wings. Adults roost upside down by wrapping their wings and legs around a twig.

Males rait all day in gulches to await females, as they rait on vegetation or rocks an average of ~65cm up (20-100cm); sometimes they fleek on saddles or hillsides ~20cm up near the host. In courtship, the male overtakes the female, who hovers while the male flies under her 3cm and rises up ~2-3 cm to bump her up to 10-20x, they land and she spreads wings 100^{o} while he lands and may butt her head and flick his forewings ~2x/sec. to place her antennae between his forewing costal folds, then they either mate, or if the female is unreceptive they may repeat these elements. During mating the male bends his left valva in the middle and scrapes the outer portion across her abdomen. The female has two hair pencils near the end of her abdomen, which remain after the scraping. If a mating pair is disturbed, the female flies, the male dangling.

Erynnis horatius Horace's Duskywing

Adults are large in size like *E. telemachus*, but in summer the upf is more-brown than *E. telemachus* (not at all gray in summer, although **spring adults** are somewhat grayer on upf), there is no brown circle with tan center near unh apex (present on *E. telemachus*), and females lack the white hourglass-shaped unf median spot (present in *E. telemachus*). The hw fringe is brown. The male has a costal fold on upf to waft pheromone, but lacks a hindleg tuft, while the female has abdominal hair pencils to dispense pheromone. The male valvae are distinctive.

Habitat the Quercus zone in the lower mountains. Hostplant in Colorado small tree/brush Fagaceae: *Quercus gambelii*. Numerous *Quercus* hosts elsewhere, esp. red oaks. Uncommon.

Eggs cream, turning orangish, laid singly esp. on tender young leaves of saplings. Larvae eat young leaves, and live in nests of rolled or tied leaves. Older larva (photo Tveten & Tveten 1996) whitish-green (with slight bluish- and yellowish-tints), heart-band darker green, a dorsolateral slightly yellower line, prothorax greenish; head reddish-brown (very dark brown in Fla. but tan at Houston), with three orange patches around side of face (one near eyes, one laterally, an elliptical patch below protrusion where a horn would be). Pupa green to dark green to brown, the front blacker. Mature larvae hibernate.

Two flights, M April (May north of El Paso Co.)-start of June, and L June-M Aug. (most often L July, rarely E Sept.); in W Colo. approx. April-May and June-July.

Adults visit flowers of all colors, even red, and mud. Adults bask with wings spread ~130^o like all *Erynnis*. Adults can wander a few km away from *Quercus*, as adults W of Denver strayed at least four times to S end of S Table Mtn., Genesee Mtn., and Green Mtn.

Males rait all day on hilltops to await females, raiting an average of 49 cm up (on ground to 1m up, N=15); they rarely fleek among flowers to seek females.

Erynnis tristis tatius White-Edged Duskywing

A rare stray to Colo., easily identified by the ~4 long white spots on the unh margin (next to the white fringe). One record, a worn male coll. Roxborough Park, Douglas Co. Aug. 8, 2019 by S. Mark Nelson (and two others with white fringe perhaps *tatius* were also seen), perhaps an artificial transport because native populations are far southward. The male has a costal fold, and the female has hair pencils on abdominal segment A7 uns.

Habitat Upper Sonoran Zone oak woodland in S NM-S Ariz. Hostplants various *Quercus*.

Eggs pale yellow, turning deep orange, on new growth of *Quercus*. Larvae eat young leaves, and live in silked-leaf nests. Larva pale grayish-green, a dark middorsal line, a yellowish dorsolateral line; head orange-brown, with three pale-orange areas on each side. Pupa olive-gray, wing cases darker, a pale dorsolateral line on abdomen. Larvae hibernate.

Several flights Mar.-Oct. in S Ariz. Adults visit flowers and mud. Adults can fly up to 1 km to hilltops.

Males rait all day on hilltops. In courtship of Calif. ssp. *tristis* (Shields 1967), the female arrives at the hilltop and flies slowly about, the male nears the female and flutters behind and below her and rises up often-repeatedly to contact her and transfer pheromone, she lands, he lands and joins. Unreceptive females fly vertically to repel the male.

Quercus gambelii few trees north of the main range

Q. gambelii ranges from far southward to the Southern Rockies, and largely disappears N of Turkey Creek just SW of Denver. But a few scattered trees at the northern end of its range in the Front Range of northern Jefferson Co., Colorado are occasionally eaten by oak feeders. They are listed here: One clump Apex Gulch ~1mile up between 1st & 2nd waterholes. One clump Clear Creek Can. at tunnel 1. One tree on ridge SE divide between Idledale Gulch and Mt. Vernon Canyon, a 2nd tree on S-facing slope just SE hilltop overlooking ranch/barns SE of that divide. Big tree just N I-70 at top of Mt. Vernon Can. Four trees in gulches W of Red Rocks amphitheater. Several seen up gulch to south of Bear Creek in O'Fallon Park. Large clump of small trees in gulch going south of Tucker Gulch just N of Crawford Hill.

Hesperiidae, Pyrginae, Pyrgini Checkered Skippers, White Skippers

These species mostly combine white with blackish, and some are very whitish, hence the common name. Adults bask dorsally, and rest with wings spread, but roost with wings closed.

Pyrgus centaureae loki Grizzled Skipper

Identified by the lack of a white spot at the base of upf cell CuA_1 which is present in other *Pyrgus*, and the Alpine/Subalpine Zone habitat. The unh has reddish-brown spots along the unh margin, whereas there are larger brown areas there in *P. ruralis* & *P. xanthus*. The uph has a white postbasal spot (sometimes weak), but it is in cell Rs, versus in the anterior part of the discal cell in *P. ruralis*/*P. xanthus* and absent in *P. scriptura*. The ups is covered with long gray hairs for warmth. The male has a costal fold. The Rocky Mts. ssp. ***loki*** has an olive-brown and blackish unh.

Habitat Subalpine and Alpine Zone moist meadowy valley bottoms, including 10,400' on Grand Mesa. Hostplants in Colorado herb Ericaceae: *Vaccinium cespitosum* (females oviposit on this and larvae eat it). Probably Rosaceae in Colo.: *Potentilla diversifolia* and *Fragaria virginiana glauca*, because adults are often associated with those in Colo. and *Potentilla canadensis* is the host in most of E U.S., and *Fragaria virginiana* is the host in Mich.; I have followed females near *F. virginiana glauca* in Colo. but so far have not seen ovipositions on it. It eats Rosaceae: *Rubus chamaemorus* in N Europe and the N. Amer. arctic and many ovip. seen on that at Churchill, Man. In Colo. my lab larvae ate *Vaccinium* and *Fragaria* well, and ate some *P. diversifolia* and *Sibbaldia* [Rosaceae]; probable-Utah lab larvae ate *Potentilla glandulosa* & *Fragaria vesca* (Wolfe et al. 2010); and James & Nunnallee (2011) found that Wash. females oviposit on *Potentilla fruticosa* in lab and larvae eat it, whereas young larvae refused *Fragaria virginiana* and died but older larvae ate it. This may be another polyphagous "bog" butterfly. Locally common.

Eggs yellowish-cream (white to pale green in Wash.) with ~21 vertical ribs (14-16 in Wash.), laid singly on host leaf uns. Larvae eat leaves, and live in silked-leaf nests. Older Colo. larva light slightly-olive-greenish-brown (whitish-bluish-green or pale yellowish-green in W. Va., reddish-tan in Mich., brown in Wash.) with tiny paler striations, heart-line darker or brown, a slightly-darker or browner dorsolateral band edged by two tan or paler lines, A10 darker than rest of body (no suranal plate) (but oranger at rear rim in Wash.), spiracles orange, legs black, collar reddish-brown with small black seta bases (collar black in earlier stages); head black. Larvae feed at night. They snap frass pellets away, evidently using the anal comb. Pupa reddish-brown with numerous black dots and dashes, A4-7 segments red-brown on movable joints then mostly black then with checkered black and white rear, wings and thorax often covered with white wax, cremaster black (photos from Wash. in James & Nunnallee 2011, W. Va. Allen 1997). Hibernation stage: Mature larvae could hibernate in Wash. based on slow growth of L5 of ssp. *loki* (James & Nunnallee 2011). Wolfe et al. (2010, evidently Utah *loki*) report that attempts to get pupae to emerge the next spring failed (suggesting pupae hibernate?). M. Nielsen (1985 J. Lepid. Soc. 39:63) reported Mich. ssp. *wyandot* "larvae finished feeding in lab and overwintered as pupae"), but Nielsen (1999) changed his mind and wrote that the larva overwinters in a nest of dried leaves, and his larva photo is a little pinkish (related butterflies become pinker as mature larvae hibernate). Allen (1997) reports W.Va. *wyandot* larvae pupate in late summer and overwinter in leaf shelters of several leaves tied together on host or nearby. Considering *loki* is biennial at high altitude, in Colo. they probably hibernate as young larvae, then pupae (*wyandot* flies M Apr.-M May in W.Va., May-E June Mich., so they probably hibernate as pupae there).

One flight L June-Aug. (mostly M July-E Aug.). Adults are biennial and fly only in odd-numbered years throughout Colo. (and Wind River Mts. Wyo.) (they are rare in even years, except it has been found in even years on Grand Mesa) (flies mostly odd years in E Canada & Churchill Man.).

Adults usually visit yellow flowers, including *Arnica cordifolia*, *Senecio* (*Packera*) *crocatus*=*dimorphophyllus*, and *Taraxacum officinale* (but *wyandot* often visits white, some yellow, sometimes ~purple), and sometimes visits mud. They bask dorsally (with wings spread).

Males mate-locate all day in depressions and gentle slopes in moist valley bottoms (often between *Salix* shrubs in carrs) on or near the ground, as they fleek ~5-6cm above ground/vegetation, but they don't fly far so they fleek and rait about equally often, and they flait frequently also (meaning flying in a localized depression rather than wandering elsewhere); they rait more often at lower temperatures when they frequently bask. In courtship, the male overtakes the female, she hovers while the male hovers below, they land and both have wings spread (the female 50-135º spread), and the male vibrates his 110º-spread wings a little to waft pheromone, and bends his abdomen to join. Unreceptive females spread their wings and vibrate them to reject the male, while the male may hover beside an unreceptive female and bump into her to attempt to seduce her with pheromone from his upf costal fold.

Pyrgus ruralis ruralis **Two-Banded Checkered Skipper**

This small skipper has a white X on upf, and a white uph postbasal dot like *P. xanthus* (missing in *P. scriptura*), but it occurs mostly farther north, the male has a costal fold on front of upf, the unh is redder brown (including the base of the black marks in fringe), and the unh margin has a large brown triangular spot in cell Rs and smaller brown spots in cells M_3 and CuA_1. The black scales in the hw fringe extend fully to the edge like *xanthus* (only halfway through the white fringe in *P. scriptura*).

Habitat Canadian-Subalpine Zone wooded valley bottoms. Hostplant herb Rosaceae: assoc. *Potentilla pulcherrima* in Colo., evidently in Utah *Potentilla glandulosa*, *Fragaria vesca* (Wolfe et al. 2010), and elsewhere those genera and *Horkelia* are hosts. Lab larvae in Wash. eat *Fragaria, Potentilla fruticosa* leaves and flowers, and *Vaccinium scoparium* leaves. Uncommon in Colo.

Eggs white or light-green when laid, turning gray finally, laid singly on host leaf uns. Larvae eat leaves, and live in silked-leaf nests. Older larva green, a dark middorsal line, a subdorsal darker band edged by yellowish lines, a pale line along spiracles, a lateral yellowish stripe, collar black with white front; head black. A higher-altitude Wash. population had faster development than a low pop. (James & Nunnallee 2011). Larvae pupate in the final leaf nest, attached by the cremaster. Pupa dark gray on head thorax and wing case, chestnut brown on abdomen, all but wings have 100+ subdorsal and sublateral black dots and dashes, pupa covered with numerous long white setae. Pupae hibernate in Wash. & Utah.

One flight, May-E July (mostly L May-June).

Adults visit flowers and mud.

Males mate-locate all day, using raiting or fleeking about equally often, as they rait (more often seen in Colorado) an average of perhaps ~5cm above ground or vegetation, or fleek (more often seen in Siskiyou and El Dorado Cos. Calif.) 10 cm up in valley/gulch bottoms or grassy swales to find females. Fleeking males often stop. Courtship is probably similar to that of *P. malvae* in Britain, which may fly in a zigzag pattern with the female and in a soaring spiral, and the male contacts her at each turn to transfer pheromone from his wings (V. Temple 1953 Entomologists' Gazette 4:160).

Pyrgus xanthus **Mountain Checkered Skipper**

Resembles the equally-small *P. ruralis*, and both have a white uph postbasal spot (missing in *P. scriptura*), but males lack a costal fold, the white unh spots are larger, the unh margin has a tan band (wide at the apex, tapering to absent at the rear), and the black dashes on the hw fringe extend to the edge of the fringe (only halfway in *P. scriptura*). Scott (1975e, J. Lepid. Soc. 29:213-220) reported the morphology and range and habits of *xanthus* and *P. ruralis* and *P. scriptura*. The range of *P. xanthus* overlaps the range of *P. ruralis* by just 3.2km in Jefferson Co. (between Pine Junction and SW of there) or possibly a little more, perhaps? because they can mate with each other but no fertile hybrids are produced, so they annihilate each other when they meet (that same process may be what happens between *Cercyonis meadii* and *C. sthenele* near Casper Wyo., where neither species exists).

Habitat prairie or clearings in open–woods valley bottoms, from the higher foothills (the two lowest records are from the base of Waterton Can., and uncommon in the Black Forest just S of Elbert SE of Denver) to upper Canadian Zone. Hostplants in Colorado herb Rosaceae: *Potentilla pulcherrima*, *hippiana*. *P. pulcherrima* is evidently preferred, because females prefer to oviposit inside flowers and *P. pulcherrima* blooms when adults fly, whereas *P. hippiana* blooms later, in July. (*P. anserina* is not a hostplant.) {In N New Mex. *P. subviscosa* is a major host and females oviposit in its flowers, while in the Sacramento Mts. NM *P.* "*ambigens*" is the host, which flowers later than the E May flight.} Uncommon in Colo.; twice I found it abundant in N and S NM.

Eggs pale green, laid singly preferably on host flowers (stamens etc.), sometimes on leaf bases. Larvae eat leaves, and rest in silked leaf nests (several leaflets silked together for older larvae). Young larva grayish-green, a darker-gray heart-band. Older larva olive-green or creamy-green with dark heart-band, a weak darker dorsolateral band edged by yellower lines, a lateral yellowish line, near-pupation top half turns slightly-reddish (reddish-yellow on intersegmental areas), T1 has a narrow greenish front with wide black collar, legs black; head black. Pupa when new greenish with dark-orangish-brown abdomen, but after a day bluish-blackish-gray (the head, thorax, & wings have become glaucous) with black pattern, outer part of wings dark-olive-green, front of head blackish, blackish lines edge the appendages, wing veins pale glaucous, abdomen dark orangish-brown including intersegmental areas, front half of each abdomen segment black (the black rim widest anteriorly), a middorsal blackish band on thorax (weaker on abdomen), a row of black abdominal spots just beside middorsal area, a subdorsal black band on thorax becomes black spots on abdomen, supraventral black spots on abdomen. Pupa attached by cremaster in silked-leaf nest. Pupae probably hibernate.

One flight, May-E July (mostly M May-M June), L Apr-June in N New Mex.

Adults visit flowers of all colors, dung, and mud. Adults rest and bask with wings mostly spread. Adults fly only 3-5 cm above ground.

Males rait and fleek all day about equally often, preferably in depressions and small gully bottoms. At the usual low density they usually rait in little gulches several meters deep and broad where they rait ~3-5cm up. Males also mostly fleek on flats ~3-5cm up, and near abundant hostplants during the occasional population explosion; they only fly short distances before stopping. In courtship, the male overtakes the female, and they flutter as the male flies up to her multiple times from below to transfer pheromone (from the hindleg tibia hair plume, which all *Pyrgus* possess except *Burnsius* "*Pyrgus*" *communis*), they land and the male may flutter, and the female may flutter if she is unreceptive (receptive females presumably remain quiescent and accept the male--no completed courtships were seen).

Pyrgus scriptura **Small Checkered Skipper**

Adults are very small, and they are a little hard to see. The spring generation (**form pseudoxanthus** has larger white spots resembling *P. xanthus*/*P. ruralis*), while later generations are darker with smaller spots (=*apertorum* which was named in Nev. as a ssp., but is actually just the spring form). *P. scriptura* is identified by the black dashes in the hw fringe extending only halfway to the edge, and the uph base lacks the white postbasal spot of *P. xanthus* and *P. ruralis*. Males lack a costal fold. The unh marginal spots are very evenly colored, yellowish-tan outwardly.

Habitat open prairie, at low altitude in SW Colo. and the plains, the Wet Mountain Valley, and San Luis Valley. It has disappeared just W of Denver (where it was found around Green Mtn. and South Table Mtn.) due to development. Hostplant in Colorado herb Malvaceae: *Sphaeralcea coccinea*, generally on short hosts in drier habitats than *Burnsius communis*. (Elsewhere host usually *Malvella leprosa*.) Uncommon to common.

Eggs cream, laid singly on host leaves. Larvae eat leaves, and live in silked-leaf nests. Older larva green or whitish-bluish-green, heart-band darker green, a subdorsal somewhat darker band edged by whiter lines, weak lateral darker above paler bands, collar light- or dark-brown (the front part white); head black or dark-brown. Pupa dark brown. Pupae hibernate in a thin "coccoon" (T. Emmel, J. Emmel, & B. Drummond 1992).

Three flights on the plains (L April-May, M June-L July, and L Aug.-M Sept.), probably two in Wet Mtn. Valley-San Luis Valley (probably L May-June, M July-L Aug.).

Adults visit flowers of all colors including *Heterotheca villosa*, also mud and manure. Adults rest and bask with the wings spread more-or-less wide.

Males rait and fleek about equally often all day, as they rait (usually in gulch bottoms) or fleek (usually on flats) ~5-15cm up to find females; flying males land often (whereas *Burnsius communis* can fly farther).

***Burnsius* ("*Pyrgus*") *communis* Checkered Skipper (Common Checkered Skipper for ssp. *communis,* White Checkered Skipper for ssp. *albescens*)**

Identified by the tiny white upf submarginal and marginal spots (the true *Pyrgus* lack them), and the absence of the hind leg hair plume (present on males of true *Pyrgus*). The unh marginal marks (esp. in cells M_1 and M_2) are rounded (triangular in other *Burnsius* species from S Ariz.-Mexico). Males are whiter than females. Colorado has *B. communis* ***communis***. And *B. communis* ***albescens*** possibly occurs in Colorado, or soon will occur due to global warming; *albescens* is now usually considered to be a distinct species differing only by its male valva from *P. c. communis* (its valva is less domed on the middle of the top, and the constricted tip of the valva has just two small points on top, whereas ssp. *communis* has the middle top of valva mounded upward and the narrower tip of valva has a projection upward topped with two sharp longer points [Burns 2000]—there is considerable variation in these valva traits). Earlier people such as John Hafernik concluded that there is considerable variation in the valvae which involves some intergradation. Austin (1986) examined >500 Nevada valvae and concluded that *communis* kinds were widespread there but *albescens* kinds and "intermediates" were at lower altitude and more southern locations, and he considered them subspecies, although his "intermediates" could be lumped with *albescens* as they lacked the higher twin points of *communis*. Chris Durden reportedly has a Texas male with one valva *communis*, one valva *albescens*. But Burns (2000) concluded that there is just variation without intergradation. However it appears that *albescens* may be just a valva polymorph of *B. communis*, with the *albescens* valva genetically linked to preference for hotter habitats, because when it invades a new area due to global warming the *albescens*-valva butterflies replace the *communis* valva butterflies perfectly, in the same places at the same times (Florida has the best documented replacement of ssp. *communis* by ssp. *albescens,* documented by J. Calhoun 2002 J. Lepid. Soc. 56:98-103); expanding and displacing is typical of gene-frequency change, and is not typical of the introduction of foreign species into a native species' range (the native species tends to persist for some time, although less abundantly). Also, the mtDNA of *communis*-valva butterflies in the Sierra Nevada of Calif. is the same as the southern U.S. *albescens*-valva mtDNA and unlike northern U.S. and other northern Calif. *communis*-valva mtDNA (Shapiro 2007), which casts great suspicion on the hypothesis that there are two species. {Notable here is polymorphism of the valvae of *Papilio dardanus* across Africa which are similar to these *Burnsius* valvae, and differ in shape and a long spine which is dominant in inheritance to the recessive lack of spine (J. Turner, C. Clarke, P. Sheppard 1961, Nature 191:935-936.)} *B. c. albescens* now occurs in warmer climates, from S Calif. to S. Ariz.-NM to S Texas to Fla., south to S Mexico, while *B. communis* occurs in most of U.S. northward, and at higher altitudes in S Ariz.-NM plus higher altitudes south to S Mexico; *albescens* is expanding northward due to global warming. There are only three inadequate records of *albescens* in Colorado: One specimen is labeled just "LP CO" presumably for La Plata Co. in SW Colo. Another male labeled "Alamosa/vii-9 Col." and "Barnes/Collection" from the San Luis Valley. A female with similar label stating "Lavetta Col. vi.21." (perhaps meaning La Veta in Huerfano Co.) could be *albescens* but females are nearly impossible to identify. The latter two records were evidently collected by William Barnes or employees in 1900; all three records have minimal data so may be mislabeled. Three *albescens* are known from NW New Mex. (Toadlena beside the Chuska Mts., San Juan Co., evidently R. Holland in the Gillette Museum CSU collection). Simple rearing studies in cages would solve this *communis*/ *albescens* problem: someone should catch females and rear her eggs, sex the pupae using the sex marks at the base of the cremaster (two adjacent midventral bumps on A9 in male, a long groove in female) and sort male pupae separately from females, identify them all using examinations of valvae of the first few emerging males of each family, then place them into cages with potted *Malva* with the four possible combinations of sex and ssp. (place males with females of the other ssp., and some males with females of the same ssp. for controls), then rear them in the cages to determine any reproductive isolation and the inheritance of the valva shapes. {Another mess in S Mex. involves *albescens* at higher alt. and *Pyrgus* "*adepta*" at lower, as males with valva of *albescens* or *adepta* both may have or lack a costal fold. But *adepta* generally lacks the costal fold, and may intergrade? with *albescens* in Jalisco according to Vargas. E. Pfeiler and five others (2021, J. Lepid. Soc. 75:137-138) could not resolve *albescens* and *adepta* and *communis* with barcode and other genes.}

Habitat of ssp. *communis* open areas throughout Colorado, except uncommon in Subalpine Zone and a rare stray in Alpine Zone; habitat of ssp. *albescens* open areas in hotter areas of S U.S. Hostplants of ssp. *communis* in Colorado herb Malvaceae: *Malva neglecta* in towns, *Sphaeralcea coccinea* & *parvifolia* in native areas, *Sidalcea neomexicana* in moist meadows. Hostplants of *albescens* southward herb Malvaceae: *Malva*, *Sidalcea*, *Sida rhombifolia*, *Malvella*, *Sphaeralcea*, and assoc. *Malva parviflora*. Common.

Eggs of ssp. *communis* greenish-white or pale bluish-green, becoming yellowish-cream before hatching, laid singly on ups or uns of host leaves but mainly on new growth and leaf buds. {Eggs of *albescens* greenish-white similar to ssp. *communis*.} Larvae eat leaves, and very young larvae live in nest of a flap of leaf edge folded over and silked, older larvae live in nests of leaves bent down and silked together etc. Older larva yellowish-green (described variously as yellowish-white to green or grayish-yellow-green to whitish-green), heart-band dark-green, a darker green dorsolateral band edged by yellowish, a paler band encloses ochre spiracles/tracheae, a very weak paler lateral band, legs black, body covered with pale short hair, collar widely black on front and narrowly black on rear with middle red-brown except black laterally, larvae covered with Y-shaped setae; head black. {Older larva of *albescens* yellowish-pale-green or yellowish-white, a middorsal dark-green band, a subdorsal grayish-green band edged by yellowish lines, A10 may be slightly pinker, covered with whitish hair, collar like *communis* rear black with red-brown anteriorly; head black (Allen et al. 2005 & Minno et al. 2005 photos) covered with short whitish hair}. Larvae feed at night. They flip their dung far away evidently using an anal comb. Pupa tan except wings and thorax usually light olive-green, dark lines edge the wings veins and appendages, some brown dashes and a dark-brown W on head, numerous black specks all over pupa including near-middorsal and subdorsal and subspiracular rows, covered with pale hairs, attached by cremaster crotchets and evidently by silk girdle in wide-mesh silk "cocoon". {Pupa of *albescens* similar to ssp. *communis*, light-brown or greenish-brown, with many small dark-brown spots and dashes on thorax and abdomen.} Fully-fed mature larvae turn rosy bright pinkish-red on top of abdomen (including dorsolateral band) (the contrast with green sides makes the larva pretty) and hibernate. {Diapause stage of *albescens* unknown or lacking.}

About three flights for ssp. *communis* (perhaps four in years with few freezes) at lower altitude L April-Oct. (rarely M Nov.), the first generation obviously L April-E June, but thereafter the records are continuous L June-Oct. but with excess records at one-month periods in L June, L July, then many records with lesser record spikes in Aug. & Sept (fewer records in Oct.). My guess is that there are three or sometimes four generations per year at low altitude, usually two mostly June-Aug. at middle altitudes. *Malva neglecta* is very hardy and grows most of the year (its leaves aim toward the sun throughout the day to maximize sunlight), providing food for caterpillars most of the year. Multiple flights for ssp. *albescens* L April-Oct. in S Ariz., absent or a late-summer stray in S Colo.

Surprisingly, the western N.A. butterflies are resident N to SW Canada, but E N.A. butterflies are resident only N to about Kentucky, suggesting a genetic difference. In Ohio, it is reported to be an uncommon/rare regular immigrant from SE U.S. (Iftner et al. 1992), and it is a resident only near the Ohio River S edge of Indiana (Belth 2013), and it is just an immigrant into Penn. (Monroe & Wright 2017), and it is just a stray into SW Ontario (Layberry et al. 1998), and in Iowa it is claimed to be a "common nonoverwintering resident", from April to Oct. (Schlicht et al. 2007). Thus in E U.S. it is a native only to SE U.S. and is just a stray northward. Yet from the plains to the Pacific it seems to be a native resident: In Wash. it is native with two generations (James & Nunnallee 2011), in BC it has 2 generations M May-M June & Aug. and is evidently a resident (Guppy & Shepard 2001), in Alberta it has two gen. May 17-Sept. 17 (mostly June & Aug.) (Bird et al. 1995) as an apparent resident, and it is a resident in S Alta.-S Sask. and extreme S Man. (Layberry et al. 1998). It "May not survive winters in northern portions of South Dakota" but it has "two or three broods" May 20-Nov. 13 (Marrone 2002) so it is probably resident in S.D. Colorado butterflies seem to be native, and I have not seen them migrating. Evidently the E N.A. butterflies are a different biological critter that does not survive cold winters well, and the W N.A. butterflies diapause well and survive winters even in SW Canada. So those two critters have to be added to the mess of the two critters with different mtDNA, and the two critters with different male valvae.

Adults visit flowers of all colors, including *Centaurea maculosa, Chrysothamnus* (*Ericameria*) *nauseosus, Heterotheca villosa, Medicago sativa, Taraxicum officinale,* and often visit mud, sometimes dung and aphid honeydew. Adults rest and bask with wings largely spread (dorsal basking). Adults roost on weeds or bushes or trees 0.1-1.4-5m up.

Males rait and flait and fleek all day to find females (my notebook extracts record the words "perch" or "rait" 67 times, "flait" 29 times, and "patrol" or "fleek" 49 times [some of which were just flaiting]), as males fly vigorously ~3-10 cm above ground and fleek widely about the habitat, and may find swales near the hostplant where they fly about [often flaiting, in the air for a longer time than simple raiting] and often rait as they land to await females. Males rait more often if good swales are available, and at lower temperatures. I once saw a male flaiting about a patch of *Centranthus ruber* flowers in a sloping yard for more than five minutes, on Sept. 29 when no other place had butterflies. In courtship, the male overtakes the female who flutters as much as 1.5m up while the male flutters with wide amplitude 2-5cm under her and they zigzag up and down some as he rises up to contact her (evidently with his costal fold to transfer pheromone) ~5 or more times, they both land (with wings spread more or less wide) and the male joins, or sometimes both flutter a bit before he joins. Males may hover over landed females, and after landing he may flutter with more or less wide amplitude next to unreceptive females. An unreceptive female may flutter after landing to repel the hovering or landed male, or she leans and rotates away from the male or even kicks her legs, or she flies 5-20m in the air and away, and she may expose red glands near the abdomen tip for some reason (a now-repellent pheromone?). If a mating pair is startled, either sex may fly, the partner dangling. {Mate-location unknown for ssp. *albescens*, presumably the same as ssp. *communis*.}

Austin, G. 1986. *Pyrgus communis* and *P. albescens* (Hesperiidae) in Nevada. J. Lepid. Soc. 40:55-58.
Burns, J. 2000. *Pyrgus communis* and *Pyrgus albescens* (Hesperiidae, Pyrginae) are separate transcontinental species with variable but diagnostic valves. J. Lepid. Soc. 54:52-71.

Heliopetes ericetorum **Northern White-Skipper**

Males are mostly white on ups, females mostly black. The unh pattern is simple, the uph has black marginal crescents/triangles, and the unf base is white.

Habitat arid open lowlands. Rarely found in Gunnison, Mesa, and Montezuma Cos. etc. in W Colorado, multiple sightings only from West Creek near the Dolores River from 1969-1983. A mysterious species that seems to be sporadic in occurrence throughout its range (is it just a stray to Colo.?) though it may be more common in Washington. Hostplants various herb and sometimes shrub Malvaceae westward, including *Iliamna rivularis* (present in W Colo.), *Sphaeralcea* and *Malva* and *Alcea rosea*. Very rare in Colo.

Eggs pale-yellow, turning white, with some tiny spikes pointing outward, laid singly on uns of terminal young host leaves. Larvae eat leaves, and live in silked nests of rolled or tied leaves. Larvae feed mostly at night. Young larvae eat halfway through the leaf, producing "window panes". Older larva slightly-yellowish whitish green (some larvae described as greenish-yellow), heart-band green, a slightly-darker dorsolateral wide band edged by two thick yellowish or yellowish-white lines, 1-2 lateral rows of dashes, covered with unbranched pale setae, collar narrowly brown on rear and white in front/neck; head black. Late-season larvae are pink-tinged (Allen et al. 2011) (or are golden-brown, James & Nunnallee 2011), probably because—like *Burnsius communis*—the fully-fed mature larva turns pinkish dorsally and hibernates. Larvae shoot frass away with their anal comb. Pupa reddish-yellow (wings & head slightly violet) or yellow-brown with numerous blackish spots on top of thorax and most of abdomen (including several lateral and subdorsal rows). Fully-fed mature larvae hibernate.

Adults have two generations probably May-June and L Aug.-Sept. in Colo. (a female found in L May, males after mid Aug.). Adults fly fast, and may migrate seasonally (altitudinally?) in spring and fall. Adults evidently have large dispersal ability.

Adults visit flowers (*Eriogonum corymbosum* in Colo.) and mud. They evidently rest and bask with wings partly spread.

Bailowitz & Brock (1991) suggest that males rait and flait in gulches to find females, and in Wash. they often fleek in canyon bottoms to seek females.

Hesperiidae, Heteropterinae Skipperlings

Heteropterinae are usually small in size. The few species (~<50) occur in America and the Old World. Their basking posture is different from Hesperiinae (with which they were once combined), because all wings are spread equally in dorsal basking. The antenna club lacks the very narrow tip (apiculus) of Hesperiinae and instead the club is pointed-sausage-shaped and bent in the middle. The palpi extend forward from the head "porrect" like many Pyrginae. The hw discal cell is very long. The fw vein M_2 is parallel to and equally-distant between vein M_1 and M_3 as in the former-Pyrginae subfamilies. They flutter more slowly than many other skippers, and males often fleek to find females. Larvae eat grasses, and live in silked-leaf tube nests on their grass hostplants. Pupae are also in a silked-leaf tube nest, the end loosely-silked to permit escape.

Piruna pirus Russet Skipperling

Identified by the small size and spotless russet unh. An interesting little butterfly, the only Colorado member of Heteropterinae, which I spent a lot of time studying.

Habitat mostly valley bottoms from the foothills (and plains adjacent to the mts.) to Canadian Zone woodlands, that are moist enough to have tall hay grasses preferably in partial shade. The lowest location is at 4500' in Purgatoire Can. in Las Animas Co. along with a grove of aspen. Hostplants in Colorado 17 Poaceae hay grasses (wide leaves, usually tall and non-clumped) mostly growing in shade, and many near water: *Agropyron* (*Elymus, Elytrigia*) *repens, Bromus* (*Bromopsis*) *inermis* (both are abundant introduced weeds), *Dactylis glomerata, Agrostis gigantea, Bromus* (*Bromopsis*) *lanatipes, Agropyron* (*Leymus*) *ambiguus, Agropyron* (*Elymus*) *canadensis, Agropyron* (*Elymus*) *trachycaulum*, (the following have fewer host usages) *Phleum pratense, Muhlenbergia racemosa, Glyceria striata*, occasionally *Leersia oryzoides, Agropyron* (*Thinopyrum*) *intermedium, Phalaris* (*Phalaroides*) *arundinacea, Achnatherum* "*Stipa*" *scribneri, Calamagrostis canadensis, Agropyron cristatum desertorum*. Common, sometimes abundant.

Eggs slightly-greenish cream when laid, turning ochre-cream, hemispherical with a circular depression on top, with faint vertical ribs on lower 1/3 of egg, laid on grass uns, preferably in partial shade of bushes or tall *Cirsium arvense* etc. especially along gulch/valley bottoms, laid ~10-40cm (commonly ~15-20cm) above ground. Females fly slower than the fast males and often rest on vegetation 1/3m up and when ovipositing fly slowly among the taller plants only averaging ~20 cm above ground. Larvae eat leaves, and silk the nest into a tube with leaf edges attached at top with~7-8 multistrand cords of silk, then larva lives inside nest usually with head downshaft and eats the leaf basal to the nest for ~20-30 mm except for the midrib (leaving the midrib is unique in Colo. Hesperiidae), and larva eats the leaf tip distal to the nest, so the resultant nest consists of the vertical leaf blade then 2-3cm of midrib then the drooping larval nest then the eaten tip of the leaf; ~70% of larvae rested in nest with head facing basally (leading to leaf base). Older larva green, heart-line dark-green edged by a pale-green band, a subdorsal white line edged by dark-green, then a pale-green narrow band, side and venter green; head light olive-green, an orange-brown (russet in Utah photo) stripe extends upward from eyes #1-4 then narrows and terminates as it reaches top of head, this stripe is sandwiched between a cream band similarly narrowed at top and a cream band which is still wide at the top and is very narrow just in front of eyes (all 3 bands end at the same spot near top of head), coronal sulcus & adfrontal cleavage line pale-green, labrum white, eyes black. Pupa slightly translucent, mostly green, yellowish-green on rear of wings & abdomen, a greenish-cream band on T2-A8 just beside middorsal green band, then a narrow subdorsal yellowish-cream line on T2-A8, head horn is slightly-pinkish translucent cream, a cream spot beyond proboscis tip, proboscis extends only to wingtip; attached by cremaster and silk girdle between T2-3 (the ends attached to nest), head usually up in nest. Half-grown larvae hibernate (esp. 4^{th}– & 5^{th}–stage of 6 stages, sometimes 3^{rd}-stage).

{Error: The photo on right on page 6 of Papilio (New Series) #28 is actually *Hesperia uncas uncas* mature larva; the same photo is duplicated for *H. uncas* on page 8.}

One flight mostly L June-July at low altitude (sometimes E-M June), L June-E Aug. in San Luis Valley.

Adults visit many flowers of all colors, but more than half of its visits are to pink *Geranium caespitosum* (adults are not quite large enough to pollinate it--their proboscis etc. often contacts the anthers, but they seldom touch the stigmas), and many to *Medicago sativa*, *Apocynum*, often *Cirsium arvense*. They visit mud. They can recycle bird dung, as they land on the dung, drip nectar/fluid from the abdomen, and suck up the dissolved food with their long proboscis extending back under the body. Adults rest with wings closed or spread somewhat; in cool weather they close the wings, and roost with wings closed. When nectaring they usually spread all wings 60-70^o from vertical (sometimes 0^o [closed], commonly ~90^o). Adults bask dorsally, with all wings spread equally wide (unlike the Hesperiinae basking posture with hw spread much more than fw), from 10^o (body basking) to ~20-140^o (dorsal basking, most often ~70^o), compared to 0^o [all wings raised] in very hot weather). They can vibrate their wings to warm up. Predators: one male had a sparrow beak-mark on a forewing, and 3 males were caught in spider webs.

Males fleek all day mostly in gulch/valley bottoms, as they fleek several cm above the canopy of vegetation or through the vegetation (~33cm up through clusters of big *Cirsium arvense* plants) (they can fly higher over tall vegetation even 2m above ground, and mostly fleek above a tall canopy ~1.2-2m above ground) all day to seek females. When one male encounters another, they may fly in a zigzag fashion together or have a fast brief chase, or a tumbling circle, then they separate. In courtship, the male overtakes the female, both hover with the male ~5-7cm below for 1-10 sec. and both may zigzag back and forth repeatedly, they land with the male behind (both with wings mostly spread) and they mate if she is receptive, or both may flutter widely (wings ~45-70^o from vertical—both sexes keep wings mostly spread during courtship) and the male may attempt to mate, before leaving. The male flutters evidently to transfer pheromone. Unreceptive females flutter vigorously when landed to repel the male, or they fly away fast to try to escape after they hover, fly down into vegetation to escape him, or if she is landed she may close her wings to avoid detection by males flying overhead. If a mating pair is disturbed, the female flies, the male dangling.

Hesperiidae, Hesperiinae Grass Skippers

Hesperiinae occur throughout the world, with perhaps as many as 2500 species. Adults are mostly orangish or brown, and their antenna club is oval with a small point angling from the tip called an apiculus, or sometimes the club is oval but just bent slightly toward the tip. Adults bask a special way, by spreading the hindwings toward the side, but the forewings are spread only about 45^o (other Hesperiidae bask dorsally with all wings spread equally). Males often have a “stigma” patch of androconial scales on the dorsal forewing. On adult forewings, the base of vein M2 is closer to vein

M_3 than M_1, unlike Pyrginae and other subfamilies (described above) that were once lumped into Pyrginae. Larvae generally eat monocotyledons (usually grasses, often sedges). Larvae live in silked-tube nests, mostly on the hostplant but some species make their silk tubes in plant bases or soil litter. Larvae are usually tan or green with dark head and black collar, and some have two short tails and two conelike horns. Pupae may have a projecting cone on head and often have a long proboscis extending beyond the wing cases. Pupae are also in a silked-leaf tube nest, the end loosely-silked to permit escape. Many species have a very fast flight, but some species fleek fly rather slowly and fluttery.

Hesperiidae, Hesperiinae, Megathymini, Megathymina Giant Skippers

Megathymini are special skippers whose larvae live inside the roots of *Yucca* (the subtribe Megathymina) or inside the large leaves of *Agave* or similar plants (the subtribe Aegialina). Until recently they were considered to be a separate subfamily Megathyminae, based on their tunneling habits, but they belong to Hesperiinae because of similar forewing veins, antenna club, basking posture (hindwings spread widely, forewings spread partially), larval setae, and the monocotyledon hostplants. About 20 medium-sized Megathymini species occur in SW U.S. and Mexico (one barely ranging into Central America). Adults can fly very fast with their powerful thoraxes, and there is little hope of catching some of them with a net. Males sometimes feed on mud, but adults never feed on flowers. The larval head is small compared to the large thorax, enabling the larvae to turn around in their burrows. Females glue their eggs onto leaf tips (in Megathymina) (the Aegialina land there and drop their eggs which roll into the base of the hostplant). Mescal is bottled with a larva of the Maguey Worm *Comadia redtenbacheri* (a Cossidae moth), tequila is not bottled with any larvae, and Megathymini larvae are never bottled in mescal or tequila, according to Wagner (2005 p. 485) (though maybe the Mexican *Aegiale*="El Gusano del Maguey" are roasted and sold as snacks). Pupae are like other skippers, except the T1 (prothoracic) spiracle does not have a plateau behind it that would scrape against the burrow wall. Pupae of Megathymina have a long broad cremaster they use to move up and down in their burrow.

***Megathymus yuccae coloradensis* Yucca Skipper**

Identified by the large white anterior triangular spot on unh, and the absence of the unh postmedian/ postbasal spots that are present on *M. streckeri*. Colo. has ssp. ***coloradensis*** which has rather small postmedian fw spots in W Colo. (Mesa-Montezuma Cos. etc.) and most of E Colo. But adults from Baca Co. in extreme SE Colo. have larger spots than most E Colo *coloradensis* (TL Colorado Springs), so the Baca Co. butterflies may be a different variety or perhaps nameable ssp. {Most of the named ssp. of *M. yuccae* are worthless, and actually most of the "species" and subspecies of all giant skippers are subspecies or sometimes mere synonyms (such as *Agathymus mariae* ="*gilberti*"), because H. A. Freeman and the Stallings and Turner clan competed with each other to see who could name the most species and subspecies, resulting in taxonomic inflation, then later K. Roever named another "species". Unfortunately, most of the Stallings & Turner collection and even much of the Roever collection ended up eaten by dermestid beetles, reduced to piles of dust by miniature tunnelers.}

Habitat open areas with abundant *Yucca* from the plains and lowlands up to the San Luis Valley-South Park. Hostplants in Colorado bushy Asparagaceae (formerly Agavaceae): *Yucca glauca, harrimaniae, baileyi, baccata*. Assoc. *Y. angustifolia*. Usually uncommon in Colo.

Eggs pale bluish-green, becoming pinkish-white and finally yellowish- brown, laid singly usually glued on/near the tips of host leaves, esp. on young plants. Young larvae eat leaves, often silking young leaves into a silk nest. Young larva red; collar & head black. Older larvae burrow into the root, and make a cigar-shaped tube "tent" of silk and dung that usually sticks out among the topmost leaf bases. Older larva creamy or tan, collar blackish, suranal plate black or brown; head black. Pupa brown-black, pale on abdomen, covered with powder in the burrow, as the pupa can move up and down in the burrow using the bristly broad spatulate cremaster {the larva powders the burrow with wax from the ventral A7-8 glands on the larva (like other Hesperiidae), to smooth the movement in the burrow}. Mature larvae hibernate.

One flight April-M May on plains and S of the San Juan Mts., evidently L April-E June at higher altitudes, May-M June San Luis Valley. It is rare near Denver (I saw one in Jarre Canyon April 30), but can be very common in SE Colorado when found in *Yucca* roots.

Adults (especially males) sometimes visit mud evidently to cool down, but reportedly do not sip mud and do not visit flowers.

Males rait on hillsides and flats near the larval hosts, at least in morning (Scott Ellis observed raiting behavior 09:00-11:00 then "the males seem to disappear in the afternoon", Scott 1976a; this should be studied, K. Davenport in Butt. of the Sierra Nevada writes on a cloudy day they may fly most of the day). In courtship, the male lands beside the female, and may flutter his wings somewhat to transfer pheromone.

***Megathymus* (*cofaqui?*) *streckeri* Strecker's Giant Skipper**

Resembles *M. yuccae*, but lacks the whitish triangular spot on front of unh, the wings are broader, the unh of *M. streckeri* usually has many postmedian and often postbasal spots, the unh postbasal spot is often absent and is smaller than the median spot at the front edge, the upf postmedian band usually shrinks toward the rear, females usually have very large fw spots, and the inward edge of the yellowish uph margin is usually more scalloped. Ssp. **texana**=*leussleri* occurs in E Colorado and has larger uph yellowish postmedian spots esp. on females (the key identifying feature being that row of large uph postmedian spots on females). (Ssp. *texana* TL is "Dallas, San Antonio" in S-C Tex. "restricted" to Kerrville, and specimens from there resemble *leussleri* TL Nebraska specimens thus *leussleri* is a syn.) (*M. streckeri* is evidently related to *M. cofaqui*, and SE Tex.-La. has an unnamed ssp. with *cofaqui*-like females, which might be considered a link between *cofaqui* and *streckeri*, suggesting that *M. streckeri* could be called *M. cofaqui streckeri*, although that odd unnamed ssp. in SE Texas-La. is otherwise not especially intermediate.) Many SE Colo. butterflies have larger spots, so that may be a distinctive variety. Ssp. ***streckeri*** occurs in the San Luis Valley and SW Colorado-NW NM-Ariz., with smaller slightly-less-orangish spots, and its females mostly lack those postmedian uph spots. {Unfortunately, research on this geographic variation is primitive and people have not studied Holland's name *albocincta*, and *M. streckeri* populations are quite variable, and more than 50% of the names of species and subspecies of giant skippers are worthless synonyms as there was a race to see who could name the most "species" and ssp., and such niceities as statistics were ignored.}

Habitat open large areas with abundant *Yucca* on plains and open prairie-sageland. Hostplants in Colorado bushy Asparagaceae (Agavaceae): *Yucca glauca* for ssp. *texana*, *Y. glauca* (San Luis Valley), *harrimaniae* (W Colo. incl. Gunnison & Mesa Cos.), *baileyi* (La Plata & Montezuma Cos.) all for ssp. *streckeri*. Ssp. *texana* eats *Y. elata* (introgressed with *glauca*) in Quay Co. of N New Mex. Uncommon, but it may be common in places where *Yucca* is very abundant in a large area.

Eggs light-green, turning reddish, laid singly on leaves (mostly on small plants, mostly on uns of young-leaves, often far from the base). 1st-stage larva red, collar and head black. The larva does not eat leaves, and instead burrows into the stem then down into the root, packing dung behind it, without making a tent, and finally when it is about to pupate the larva comes to the surface through stem or soil and builds a tent with silk and bits of soil or plants, then powders the tent-burrow and pupates (a leaf rake is about the only hope of finding a powder-coated burrow). Larva yellowish-white, collar brownish, suranal plate yellowish-white; head dark reddish-brown. Pupa pinkish-yellow on abdomen, wing cases pinkish-brown, head gray, T1 dark-brown; cremaster broad, short, and bristly so the pupa can move in the powdered root burrow. Older larvae hibernate.

One flight, M May-June on SE plains (rarely M July) and Durango in SW Colo., M June-M July at higher altitude (June in Gunnison Co.).

Adults do not visit flowers or sip mud. Females make "crackle" sounds when they fly, which perhaps attracts males? Adults bask with hindwings spread more than forewings, so when they do this on a *Yucca* stalk they resemble one of last year's opened *Yucca* pods, for camouflage; on grass clumps the underside camouflages them. When scared the males can fly ~12m straight up.

Males rait, as they rait on hillsides and flats where the hostplants are abundant all day (including afternoon according to Scott and Scott Ellis, in Scott 1976a) to await females, and make flaiting circuits around the vicinity and return, and may fleek about sometimes to seek females. Males fly ~½m above ground, whereas females fly lower and slower and more unidirectionally. The uph wing base of males has very long black hairs, evidently used to waft pheromone during courtship.

Hesperiidae, Hesperiinae, Thymelicini Orange Skipperlings

Thymelicini skippers are tiny, which qualifies them as Skipperlings, and are mostly orange (sometimes brownish-orange), so I will call them Orange Skipperlings, to separate them from the Heteropterinae skippers which are also called Skipperlings but are brown in color. The peculiar courtship dances of these species seem to suggest that they are closely related. Most species fleek, but *Oarisma* (*Copaeodes*) *aurantiaca* raits to find females.

Ancyloxypha numitor Least Skipperling

Identifed by the tiny size, the broad brown ups borders, and orange on most of uph, and the orangish unh with slightly paler veins.

Habitat moist grassy streamsides and canal sides and meadows on the plains. It was first found in Colorado in 1972 in Baca and Yuma Counties, and gradually moved westward and populated nearly the entire set of permanent streams on the plains, and now occurs near Vineland just east of Pueblo (1983) and in Las Animas Co. and in Coal Creek in Jefferson Co. and just around Denver and W of Longmont (2003). Hostplants Poaceae: many hay grasses are recorded elsewhere, I found these hosts in Minn.: *Agropyron* (*Elymus*, *Elytrigia*) *repens*, *Phalaris* (*Phalaroides*) *arundinacea*, *Bromus* (*Bromopsis*) *inermis*, *Echinochloa crus-galli* (*Leersia oryzoides* is known in E U.S., plus other hosts that are absent or unlikely to be used in Colo.). (*Poa pratensis* is evidently an error, not a host, because females ignore and fly fast over *Poa* lawns; maybe it could grow nearly tall enough, but the leaves are too narrow.) Common in E U.S., and perhaps it will become more common in Colo.

Eggs pale orangish-yellow, soon developing an orange-red ring except on top (so overall appearance orangish), laid singly on host leaves. Larvae eat leaves, and live and pupate in rolled-tied leaf nests. Older larva green (sometimes orangish-tinged), a dark heart-line, a creamy lateral line edged by a little darker-green, collar black on rear and white on front; head creamy-tan with brown vertical stripe near coronal sulcus then adfrontal cleavage line, a vertical red-brown or blackish narrow stripe down middle of the red-edged frontoclypeus, a brown vertical stripe widens down side of front, rear rim of head blackish, a white spot in front of eyes, black and white along mandible; wax-powder glands present on underside of A5-8 (but only on front of A8) (other Hesperiidae have powder glands only on A7-8). Pupa yellow-cream, wings/appendages browner, head to T2 brown, with various brown marks and bands on top to sides of abdomen. 4^{th}-stage larvae hibernated in my Minn. larvae.

Two flights, about M June-E July and Aug.-E Sept.

Adults visit flowers of all colors, including *Medicago sativa* and *Verbena hastata*, and sometimes visit mud. Basking adults spread hw more than fw, as usual for Hesperiinae. Adult flight is weak and fluttery.

Males fleek all day to seek females, as they fly weakly ~10 cm up (higher if the grass is high) among the grass in roadside ditches/streamsides/valley bottoms, and they dip into low spots. They can fly fast if crossing non-host clearings (including *Poa* lawn grass) or if scared. In courtship, the male may hover over a landed female, and/or may fly several irregular "loops" 5-7cm diameter over a resting female. Unreceptive females flutter to repel the male, and P. Opler notes that they may quickly flex their wings below the plane of their body.

Oarisma edwardsii Edwards' Skipperling

The unh is mostly yellowish-orange with tawny--not white--veins and the rear is orange (occasionally with a black streak), unlike *O. garita*. The fw is shaped more like a right-triangle, and the hw is more triangular and shorter anteroposteriorly, and the antenna shaft is more checkered on uns than *O. garita*. The foreleg tibia lack spines unlike *O. garita*, and the valva is narrower and notched.

Habitat foothills open areas with grasses and *Cercocarpus* bushes and small *Quercus gambelii* and some pine trees, often in and near gullies, in more xeric habitats than *O. garita*. It seems to be growing scarce in the Wet Mountains, due to overgrowth of brush and trees. It does not occur north of the Arkansas River watershed. In SW Colo. I think it was recorded in error from Dolores, Archuleta, Mineral, and Rio Grande Cos. (it is not known from the Chuska Mts. in NM, and the San Luis Valley would seem to be too cold for it). I found it in Mexico City. Hostplants dry-land Poaceae: "deergrass" (evidently *Muhlenbergia rigens*) in Ariz. (J. Glassberg 2017 A Swift Guide to Butt. N.A.); perhaps polyphagous like *O. garita*. Uncommon.

One flight mostly L June-M July.

Adults visit numerous flowers of all colors incl. *Cirsium* and *Medicago sativa* and the 13 listed by Scott (2014a), and seldom if ever visit mud.

Males fleek all day to seek females, ~20 cm up in grassy places between bushes, throughout the habitat but more often in valley bottoms than on hillsides. Flight is fairly-slow and steady like *O. garita*.

Oarisma garita Garita Skipperling

Identified by the stubby fw, the mostly-brown ups, the orangish unh with white veins, and small size.

Habitat open areas from foothills to Montane Zone, even the plains at Wheatridge in Denver. It is the most polyphagous monocotyledon-feeding butterfly: hostplants in Colorado are a wide variety of grasses and sedges (short and tall, narrow- and wide-leaved, clumped and nonclumped): Grasses (Poaceae): *Poa pratensis* mostly the "native" drier-meadow ssp. *agassizensis* (the most frequent host in the Front Range foothills [the J. Ackerfield and W. Weber & R. Wittmann floras and R Shaw Grasses of Colo. books all differ in the status and defining traits of *pratensis* & *agassizensis* and Shaw states that the panicle branches are scabrous in *pratensis*, ~smooth in *agassizensis*--maybe all are escaped and differ largely because of soil moisture]), *Bouteloua gracilis, Bromus* (*Bromopsis*) *inermis, Hesperostipa* "*Stipa*" *comata, Agropyron* (*Elymus, Elytrigia*) *repens, Agropyron* (*Elymus=Sitanion*) *elymoides* "*longifolius", Muhlenbergia montana, filiculmis, Achnatherum* "*Stipa*" *robustum, Agrostis gigantea, Koeleria macrantha*. Also sedges (Cyperaceae): *Carex inops "pensylvanica" heliophila, C. praegracilis, C. pellita=lanuginosa*. Common.

Eggs green (elsewhere creamy-white), oval in dorsal view, laid singly mostly on host leaves/stems. Larvae make NO nests, a unique trait, and are striped like Satyrinae, and thus depend on camouflage like Satyrinae larvae. Older Colo. & Wash. larva green, a wide middorsal dark-green band with very narrow white line down its center, edged by a medium-width white band, then many greenish-white and dark-green bands/lines then a lateral white ridge; head dark green. An older Ariz. larva brown, with a cream band next to heart-band and many paler whitish lines next to reddish-brown lines on each side, presumably a paler lateral ridge, the rear sharply pointed with small notch; head brown. Colo. pupa cloudy green, a 1.5 mm head horn with pinkish-tan tip, proboscis tip red-brown, extending 1.5 mm beyond wings, head and outer wings whitish-green or green, white and yellow-white lines on body & wings like those of larva (a whitish band beside darker heart-band, and a lateral white line), underside cloudy whitish-green. {Ariz. pupa probably brownish} Older 4th-stage larvae hibernate.

One flight, M June-M July in the foothills and plains edge, L June-E Aug. at higher altitudes.

Adults visit flowers of all colors, including *Apocynum androsaemifolium, Astragalus* spp., *Erigeron pumilus, Eriogonum subalpinum, Geranium caespitosum, Sedum lanceolatum,* and rarely visit mud. Adults fly rather slowly above the grass.

Males fleek all day in fairly-tall grassy areas throughout the habitat including meadows and valley bottoms (even grassy flats on ridges, less often on hillsides), flying steadily without hopping, slowly to sometimes faster, ~20 cm up (above the grass). In courtship, the male encounters the female, both may hover briefly or fly about a little with the male ~7cm below her, the female lands with wings partly spread, the male lands just below her while fluttering his wings rapidly (maybe 5-10x/sec., usually at small amplitude but wider when he jerks) and jerks the front or rear part of his body to rotate his body axis quickly from vertical to aimed ~60° left (or right), one jerk every half-second or second (in many courtships he appears to jerk his whole body from side to side below her without rotating his axis) and during this fluttering/jerking display he bends abdomen to try to engage; if the female is unreceptive she vibrates her wings somewhat or moves away when his abdomen touches, or she flies. If a mating pair is disturbed, the female flies, the male dangling.

Oarisma (*Copaeodes*) *aurantiaca* Orange Skipperling

Identified by the tiny size, the pointed fw, the orange ups and unh except the unh veins are slightly paler than the background orange. This tiny orange butterfly was first found in Colorado in Yuma Co. in Sept. 1973, then in Washington Co. in 1975, plus later records from Las Animas, Douglas Co., Adams Co. (north Denver), Boulder, and Baca Cos. It reproduced once in north Denver, but is evidently somewhat migratory so may be killed by freezing winters; it is evidently spreading north due to global warming.

Habitat open woodland etc. Hostplants Poaceae: unknown in Colo., very-poorly-known grasses southward including *Cynodon dactylon* (which is rare in Colo.), plus an ovip. on *Bouteloua curtipendula* in S. Ariz., and eggs on *Aristida* sp. in Calif. Common in Ariz.-Texas, a rare stray to Colo.

Eggs cream, large, laid singly on host. Larvae eat leaves and make triangular notches in the leaves; they do NOT make a silk nest, requiring larvae and pupae to be camouflaged. Older larva green (Allen et al. 2005 have nice photo), with a pale middorsal line edged by wide purple bands that become red on each of the two pointed tails, and two wide dark-green bands on each side, the bands narrowed on a sharp notched tail, collar reddish; head cream with two pink vertical lines near coronal sulcus extending from rear to front, and a purple area on each side, with two sharp conical horns. Some larvae are evidently green, pale green, or tan. Larva reportedly "shakes" when it crawls. Pupa light straw, with brown middorsal and lateral lines, two white subdorsal lines on each side (lower line edged by pink), and a long horn on head. Hibernation stage poorly known, perhaps no diapause.

Several flights April-Oct. southward, migrating north at least July-Sept. in Colo.

Adults visit flowers of all colors, and sometimes visit mud. They have a very fast flight.

Males rait all day in gulch bottoms, raiting ~1/2-2/3-1m up on grass, twigs, or rocks to await females. They have a very fast straight flight so are a bit hard to see with their tiny size. In courtship, the male pursues and they land, the female vibrates her nearly-vertical ~20-30°-spread wings while the male below spreads his wings (fw spread ~85° [my drawing shows the hw spread 120° and not fluttering], or the wings average 120° spread [in another drawing—the former drawing is probably more frequent]) as he flutters them with small amplitude in bursts while he jerks his body to either side of the female (as does *Oarisma garita*) and tries to join; receptive females are presumed to remain quiescent and accept the male, while unreceptive females flutter their wings to repel the male, and fly away.

Thymelicus lineola **European Skipper (European Skipperling)**

Identified by the small size, the orange coloration (yellowish-orange on uns often with slightly-paler veins), the blackish veins near the ups margins, and the short narrow male upf stigma. First introduced to North America from Europe in 1910, it rapidly conquered boreal habitats in most of the continent. It was first found in NW Colorado in 1985, and now occurs in the entire NW corner of the Rocky Mts. in Colorado, and below the dam at Taylor River SWA in Gunnison Co. (Nancy Crosby) and is now in Rocky Mtn. Nat. Park on the E slope.

Habitat upper Transition and Canadian Zone meadows with tall "hay" grasses. Hostplants Poaceae hay grasses: usually *Phleum pratense* in Europe and N. America, and associated with it and *Dactylis glomerata* in NW Colo.; elsewhere in N. A. also *Phalaris* (*Phalaroides*) *arundinacea*, *Agrostis alba*, occasionally *D. glomerata*, *Agropyron* (*Elymus*, *Elytrigia*) *repens*, *Avena sativa*, *Festuca elatior*, *Lolium perenne*, *Poa compressa*, *Holcus lanatus*. Very common where it occurs in Colo., but it may become less common if parasitoids adapt to it.

Eggs pale-greenish-yellow turning whitish, flattened like hole-less doughnuts, laid with little glue in strings inside a grass sheath around a lower stem (some in dried seed heads) so some may fall out. Larvae eat leaves at night, and live in silked-leaf aerial nests in the upper third of the grass, but the last several stages may not make a nest. Older larva green, with dark-green heart-band edged by white stripe blended laterally, a yellowish subdorsal line, a subspiracular whitish line; head green, with a long light-brown or black vertical wedgelike stripe that widens down middle of front and encloses a narrow dark-brown inverted Y along coronal sulcus and adfrontal sulcus, frontoclypeus greenish, beside all that is a vertical whitish or yellowish stripe that is edged sometimes by an equally-wide reddish-brown or black stripe, side green. Pupa green, abdomen paler or more yellowish (with stripes like the larva), head with a tan slightly-hooked horn projecting forward, cremaster tan. Pupates inside a loose-mesh silk cocoon in litter or in tied-leaf nests. Eggs hibernate (the larva inside).

One flight M-L July.

Adults visited mostly purplish flowers in Colo., including *Cirsium arvense, Medicago sativa, Trifolium pratense*, but the many flowers listed for Ohio (Iftner et al. 1992) show that all colors are enjoyed, and they prefer thick-nectar *Trifolium pratense*, *Medicago sativa*, and *Vicia* flowers elsewhere, and adults seldom visit mud. One adult exuded saliva onto a stone then sucked it up, perhaps to gain sodium. In E. N. America adults often become trapped in the slipper of *Cypripedium* orchids and die, whereas native skippers are immune to that fate. Males can sometimes live >15 days. Males can feed and fly at >20^{o}C, females at >22^{o}C because females are heavier; both can bask at 20^{o}C, and basking can raise their body temperature 12^{o}C; adults are inactive when sunlight is <100 W/m^2 (K. Pivnick & McNeil 1987 Ecol. Ent. 12:197-207). Adults roost on grass stalks.

Males fleek in meadows/hayfields/roadside ditches to find females, evidently all day, with a somewhat fast meandering flight (females fly slower), and often rest on grass blades etc. (At low density some males may rait on grass stems.) Males fleek an average of 36cm above ground and spend >50% of their time flying, while females fly ~57cm up (Pivnick & McNeil 1985) and fly much less often (because females require higher temperature and do not need to mate-locate). In successful courtship, they found that the male lands just behind and slightly to the side of the landed female (if the female was flying the male would presumably flutter near her a little and she would land) and walks and touches the under side of her wing (her fw if she was basking, or her hw if wings closed) with his antennae and bends his abdomen to mate, and she walks forward about a body length and he follows and joins; if his abdomen does not find the right spot he flies and often tries again; if the male approaches directly behind and touches both her left and right wings the mating was usually unsuccessful. Unreceptive females flutter the forewings while the hindwings are held outward in the basking position, which repels the males, and if the male persists she can lower her vibrating forewings and raise her abdomen so the male cannot join. (Males reject other males with the same posture, fw raised and hw to side.) Mating lasts ~59 min.; females usually mate just once (males up to 5X). Sodium in the male's spermatophore transferred to the female increases the longevity and fecundity of females (Pivnick & McNeil 1987 Physiol. Ent. 12:461-472).

K. Pivnick & J. McNeil 1985. Mate location and mating behavior of *Thymelicus lineola* (Lep.: Hesperiidae). Ann. Entomol. Soc. Amer. 78:651-656.

Hesperiidae, Hesperiinae, Moncini

This tribe has recently been singled out from the large assemblage of Hesperiinae skippers, evidently? because of DNA. They are small in size. There are several dozen species of *Amblyscirtes* in SW U.S. and Mexico. They generally rait in small gulches or valley bottoms all day to await females. *Lerema* and *Atrytone* have similar larval head patterns.

Amblyscirtes aenus aenus Bronze Roadside-Skipper

Identified by the gray-brown unh with blurry tan spots, the checkered fringes, and the brown ups with some tawny coloration. In SE Colo. and adjacent W Okla. the unh varies from many tan spots, to none (**form erna**); I reared several adults from a female erna from Black Mesa, Okla., which produced regular spotted *aenus* adults, proving it is just a form (J. Scott 1977b, J. Res. Lepid. 15:92), evidently intergrading toward ssp. *linda* in E Okla.-Mo.-Ark.

Habitat rocky gulches in the foothills and canyons. Hostplant in Colorado Poaceae: *Agropyron* (*Leymus*) *ambiguus*, *Achnatherum* "*Stipa*" *scribneri*, and surely other wide-leaf grasses. Ariz. larvae eat *Bouteloua curtipendula* and *Bromus* (*Bromopsis*) *anomalus* (J. Brock, in Bailowitz & Brock 1991). Uncommon.

Eggs cream, laid singly on host leaf uns. Larvae eat leaves, and live in aerial silked-leaf tubes. Older larva in Colo. greenish-white, heart line gray-green, a faint lateral whitish band, a narrow brown collar; head cream with orange-brown pattern (a vertical narrow band on frontoclypeus, a line along adfrontal sulcus extends upward along coronal sulcus a bit, a wider band along adfrontal cleavage line narrows to a sharp vertical point [only *A. aenus*, *A. cassus*, *A. nysa*, *A. vialis*, *A. alternata* have this separate point], and its medial side angles up to join a wide band along coronal sulcus, a band extends around head from eyes up to top of head where it narrows meeting twin on other side), rear rim of head also orange-brown (blackish beside neck) (ssp. *megamacula* in S Ariz. larva bluish-white; head white with russet bands etc.). Older larvae have two dracula fangs (present on all *Amblyscirtes*) on lower head, which they deploy by whacking the head up and down or scraping the fangs around the nest opening to damage or repel intruders to the nest. Pupa creamy-yellow, abdomen cream, proboscis extends to base of cremaster. Mature fully-fed larvae hibernate.

One flight L April-E July (mostly M May-June).

Adults occasionally visit flowers of all colors, sometimes visit mud, and recycle bird dung using drops from their abdomen rear.

Males rait all day ~1/2 m up in rocky gulch bottoms, as they rait especially on large rocks in rocky areas of the gulch, even small rock cliff-like places in tiny gulches on a hillside or near a hilltop. They fly a little slower than *A. oslari*. In uncompleted courtship the male flies under the female a few cm to transfer pheromone. If a mating pair is startled, the female flies, the male dangling.

Amblyscirtes eos Dotted Roadside-Skipper

Identified by the bright white unh spots edged by black on a slightly-brassy-creamy-gray unh, and the upf white spots without a spot in the discal cell.

Evidently a scarce recent immigrant in SE Colo., it seems to be spreading northward from New Mexico, and was first found in Baca Co. in extreme SE Colo. in 1968 and became widespread from there to Pueblo and El Paso Co. by 1969-1971, and by 2007 it was found north in Douglas and Jefferson Co. It is evidently reproducing at least south of the Black Forest.

Habitat the SE plains. Hostplant unknown Poaceae, evidently hay-grasses: the hay-grass *Panicum obtusum* is probable host in SE Ariz. (Bailowitz & Brock 1991), and *Sorghum halepense* is stated to be a host by Wolfe et al. (2010). Scarce in Colo. so far.

Older larva (Allen et al. 2005, which has photos of most *Amblyscirtes*) pale-bluish-green, heart-line slightly darker, collar narrow black; head cream with red-brown pattern (a triangle over adfrontal sulci, a weak vertical band on bottom of frontoclypeus, a wider but narrow band from fang base upward narrows to run along coronal sulcus to top of head, an equal-width band from eyes goes around head to slightly-notched top), rear rim of head presumably brown.

Several generations, about May-E June, L June-July, and E-M Sept. Adults sometimes visit flowers including *Astragalus* esp. purplish ones, and mud.

Males rait in gulch bottoms all day, preferably raiting low on flat mostly-grassy "bench" areas on or just beside the gulch bottom. In courtship, they both hovered with the male below then they landed; at this point unreceptive females fly whenever the male tries to join.

Amblyscirtes nysa Mottled Roadside-Skipper (Nysa Roadside-Skipper)

Identified by the peculiar black unh patches, shaped like an N on the right wing. The ups is blackish with small white fw spots.

Two rare strays are known from Colorado. One was from Lake Dorothy in southern Las Animas Co., the other near Lamar Community College, Prowers Co. May 15, 2017 Eric Eaton.

Hostplants Poaceae including hay and turf grasses in Ariz.: *Digitaria*, *Echinochloa*, *Paspalum*, *Setaria*. Common in Ariz.

Eggs cream, laid on host leaves and stems. Larvae eat leaves, and live in tubular nests of silked leaves. Older larva (J. Heitzman 1964 J. Res. Lepid. 3:154-156) pale bluish-green, with a dark-green middorsal stripe, collar green; head white, with bright orange-brown pattern (a vertical narrow line on frontoclypeus, a line along adfrontal sulcus, a narrow band along adfrontal cleavage line [with a lateral offshoot rising to a sharp vertical point] at top meets a narrow band along coronal sulcus, a band extends around head from eyes up to top of head where it narrows and meets twin on other side), a very narrow brown band on rear rim of head. Pupa bright cream, with orange-brown shading on head, proboscis extending ~3mm beyond wings, formed in a loose cocoon of cut leaf among litter at hostplant base. Half-grown to mature larvae hibernate.

Several generations May-Oct. in New Mex., straying northward. It may be slightly migratory in Missouri etc. Adults sometimes visit flowers, and mud.

Males rait in gulch bottoms all day to await females, as they rait usually on the sandy or cement/dirt ground or sometimes on low 5-10 cm rocks in the gulch.

Amblyscirtes oslari Prairie Roadside-Skipper (<u>not</u> Oslar's Roadside-Skipper)

Identified by the gray unh with weak postmedian spots, and the rusty-brown ups with weak or no pale spots. The unf discal cell is slightly reddish, and the fringes are only weakly checkered. The outer part of the stigma is broad, the lower part short and thick. Ernest J. Oslar mislabeled thousands of butterflies and other insects etc. (Scott 2016b), so he should not have any butterfly named after him.

Habitat open areas with gulches on the plains and foothills, but into the Canadian Zone in a few places in the Wet Mts. Hostplants in Colorado Poaceae: usually *Bouteloua curtipendula* (the short-floppy-leaf variety), rarely *Schizachyrium "Andropogon" scoparius*, rarely the secondary host *Andropogon gerardii*. Fairly common.

Eggs cream, laid singly on host leaf uns, on sunlit places. Larvae eat leaves, and live in aerial silked-leaf tube nests. Older larva light-yellow-green, sometime pale-bluish-green, heart-line slightly darker, collar narrow black; head cream with orange-brown pattern (turning brownish-black on ventral

¼ or ½ or rarely completely brownish-black) (a wishbone over adfrontal sulci, a vertical band on frontoclypeus, a wide band from fang base upward [touching adfrontal cleavage line] forms a broad band over coronal sulcus and narrows to top of head, a wide band from eyes goes around head to top), rear rim of head orange-brown (blackish-brown ventrally). Pupa head tan, thorax yellow-green, abdomen greenish-blue-cream then tan-yellow-cream, wings pale-yellow-green, heart-band darker on abdomen, proboscis brown where it extends 4-6 mm beyond wings. Mature fully-fed larvae hibernate.

One flight, L April-E June on the upper plains in SE Colo., L May-E July (seldom to M July) in the foothills and above.

Adults sometimes visit flowers, esp. purplish ones, and mud.

Males rait in gulches all day to await females, raiting mostly on rocks on the gulch bottom but sometimes on sand or dirt on trails/roadside ditches, averaging ~23 cm up (0-~60 cm up, N=24). Males fly a little faster than *A. aenus*. In courtship, the female and male do a zigzag dance about 7cm from each other (the zigs about 10-15 cm each way, the male presumably below her) before landing, and the male may hover around a hovering female and a landed female; the unreceptive female flutters to repel the male and flies away (receptive females would surely be quiescent and accept the male).

Amblyscirtes vialis **Common Roadside-Skipper**

Identified by the unh which is black basally and grayish near the margin, and the upf which is blackish with several white slivers along the front edge then three larger white subapical spots, the front spot larger. The fringes are strongly checkered, like *A. nysa*. The fw tips are a bit more rounded than other *Amblyscirtes*.

Habitat mostly wooded valley bottoms/gulches from the plains edge to Canadian Zone. Hostplants in Colorado Poaceae hay grasses (mostly in partly-sunny spots of valley bottoms): *Agropyron* (*Elymus*) *canadensis*, *Bromus* (*Bromopsis*) *lanatipes, inermis, Agropyron* (*Elytrigia*) *trachycaulum*, *Phleum pratense*. (Larvae die on *Poa pratensis*, a constantly-repeated error in the literature.) Moderately common but never very common.

Eggs cream, with a slightly-sunken spot on top, laid singly on leaf uns (mostly on horizontal spots averaging ~40 cm up). Larvae eat leaves at night, and live in a nest of silked rolled leaf after chewing leaf nearly to midrib for 2-3mm basal to nest. Older larva whitish-bluish-green, heart-band gray, collar narrow & black; head glaucous-cream (the whitish bloom is caused by numerous long flakelike white hairs—other *Amblyscirtes* lack this whitish frosting and have shorter hairs—Minno et al. 2005 show a photo of "*vialis*" without white frosting, suggesting the frosting is just wax flakes, but that photo on his p. 205 lacks the vertical dark spike and is clearly *A. hegon* as that erroneous head matches his p. 203 *hegon* photo) with orange-brown or blackish-orange brown pattern (frontoclypeus with vertical line or filled with orange-brown or blackish-orange-brown, a line on adfrontal sulcus, a line on fang then adfrontal cleavage line extends up to a vertical band edging coronal sulcus [this vertical band edged by whitish], a long band extends from above fang to a vertical sharp spike, a band near eyes runs up around head and narrows at top were it meets vertical band), rear rim of head broadly blackish-chestnut-brown or black. Larvae pupate in nest in litter at ground level. Pupa (in E U.S.) green, head slightly reddish, proboscis reddish beyond the wing cases. Fully-fed mature larvae hibernate.

One flight mostly L May-E July (sometimes M May-L July), mostly June-M July at higher altitude; two flights in NE Colo. near Nebraska (incl. Washington Co.) May-L June and a second generation in Aug.

Adults prefer purplish flowers, including *Astragalus flexuosus*, but visit others, and often visit mud. Adults roost on plants such as ½m *Centaurea*. One adult evidently strayed from the foothills one mile to Green Mtn. west of Denver.

Males rait all day in lushly-vegetated (even partially shaded) small clearings (typically roughly 4m X 4m in area) in gulch/valley bottoms, as they rait an average of 41cm up (0-150cm, N=25) on vegetation (seldom on rocks or the ground). When two males chase they may fly in a ball (in circles) or one is ~5-8-10cm above the other and they zigzag multiple times (up to 5) while traveling ~4m (2-5m) away then one male usually returns. This is surely similar to courtship behavior between male and female. Males hover over or flutter next to females to transfer pheromone; completed courtship was not seen.

Amblyscirtes phylace **Redhead Roadside-Skipper**

Identified by the orange head (the palpi uns are orange), and the unmarked black wings (bluish-black on unh) with whitish fringes. The male upf has a tiny stigma.

Habitat open hilly areas, mostly in the foothills in the Front Range, but there are a few records into/near the Canadian Zone toward the south (Rosemont 9800' Teller Co.; Rock Creek 8200' El Paso Co.; Pass Creek just N La Veta Pass 9200' Huerfano Co.) and *phylace* has not been found in the foothills south of the Arkansas River. Hostplant in Colorado Poaceae: usually *Andropogon gerardii*, rarely *Bouteloua curtipendula*. Uncommon; rare in S Colo.

Eggs cream, laid singly on leaf uns. Larvae eat leaves, and live in silked rolled-leaf nests. Older larva whitish-green, heart-band grass-green, collar narrow, black; head cream (slightly tinged with tan on many larvae) with orange-brown (dark-brown in Ariz.) pattern (a vertical line in frontoclypeus, an inverted wishbone on adfrontal cleavage lines, a wide band from fang base up to top middle of head [this band widest near lower end of coronal sulcus), a wide band from eyes up around head to top where it narrows and meets coronal band], rear rim of head orange-brown all around head). Larvae swing their heads side to side evidently to use the two fangs beside the mandibles to damage an invader such as an ant. Pupa pale dull yellow, abdomen mottled yellow-white, rear of each A4-7 segment chitin-brown, front of head slightly tan, heart-band slightly darker esp. on A5-8, proboscis chitin-brown where it extends 3-4.5mm beyond wings. Fully-fed mature larvae hibernate.

One flight L May-June (mostly June), L June-E July for those Canadian Zone sites. Adults visit flowers of all colors, esp. purplish, including *Oytropis lambertii*, and sometimes visit mud.

Males rait all day in gulch bottoms to await females, specifically on flat grassy areas in the gulch bottom typically ~2-5m wide (extremes 1-7m or more) where males rait an average of ~20cm up (0-35cm, N=11). In courtship, the male pursues the female, both hover with the male below and to the side of her, then they land with the male behind, then if the female is receptive she presumably would accept the male, but unreceptive females fly away.

Lerodea eufala **Eufala Skipper**

A rare stray to SE Colo. (records from Prowers, El Paso, Costilla, and Conejos Cos.). The unh is gray-brown with very weak postmedian paler spots; the ups is blackish-brown often with small whitish upf spots including a small one or two in the fw discal cell (Colo. *Amblyscirtes* lack discal cell spots). Males lack a stigma. The hw is a bit more elongate than most similar skippers.

Habitat open lowland grassy places mostly in valley bottoms, in natural areas, ditches, and lawns. Hostplants (unknown in Colo.) Poaceae: numerous grasses southward including turf grasses (*Cynodon dactylon* [rare in Colo.], *Setaria*) and hay-grasses and large grasses etc. (*Echinochloa crusgalli*, *Oryza sativa*, *Saccharum officinarum*, *Sorghum*, even *Zea mays*); five large hostplant grasses in Fla. (Minno et al. 2005) do not occur in Colo. A record on Cyperaceae: *Carex spissa* in Calif. Common in S Ariz.-S Tex., straying N as far as Minn.-Mich.-N.J., a rare stray in Colo.

Eggs pale yellowish-white or greenish-white, laid on host leaves and stems. Larvae eat leaves, and live in rolled silked leaf nests. Older larva (Allen et al. 2005, Minno et al.2005) green or pale bluish-green, the heart-band dark-green edged by a yellowish line, a creamy or yellowish dorsolateral line, a yellow-creamy lateral line, collar green; head like *Amblyscirtes*, white with reddish-brown frontoclypeus, adfrontal sulcus brown, black or reddish-brown adfrontal areas join a black wide stripe over coronal sulcus that narrows at top of head, a reddish-brown stripe runs beside the above almost to top of head, lateral to that is white, a red-brown band extends from eyes up around side to top of head, white behind that [but rear rim of head perhaps red-brown like *Amblyscirtes*?]. Pupa green, with a dark-green middorsal line and a whitish subdorsal band, the head with a long straight horn. Evidently no diapause stage.

Multiple flights southward, a rare stray to Colo. ~Aug.-Oct., suggesting it cannot survive strong freezes. Adults visit flowers of all colors, including *Heterotheca canescens*, and probably visit mud. Shapiro (2007) notes that adults will pitch upward to visit *Vicia* flowers upside down, and notes that upon alighting adults "shrug" the wings several times before folding them.

Males rait all day low (~5-10?cm up) in grassy swales and flats and along irrigation ditches to await females (Scott 1976a).

Lerema accius **Clouded Skipper**

One rare stray was found 3 mi. W Ellicott, El Paso Co. CO Sept. 5, 1967 Samuel A. Johnson. The ups is dark-brown with small white fw spots including ~3 near the costa and three white slivers along the unf costa; the unh is brown with a dark median wedge area bordered by grayish, and a grayish blended margin.

Habitat grassy fields and open woods. Hostplants Poaceae southward: 50+ species (Minno et al. 2005 etc.), mostly hay grasses etc. (even large grasses such as corn and *Sorghum*) and some turf grasses. Common in SE U.S.

Eggs whitish, laid singly on hostplant leaves. Larvae eat leaves at night, and live in silked-leaf shelters. Older larvae snap frass pellets away using the anal comb, so the scent of that frass will not attract parasitoid wasps/predators; they may chew the leaf to the midrib so their nest droops downward. Older larva (photos in Minno et al. 2005, Allen et al. 2005, Tveten & Tveten 1996, and in "The Book of Caterpillars") granular pale-greenish or gray-white, a dark heart-line, a creamy dorsolateral line, a narrow creamy supralateral line within darker bands, a wider cream lateral line, black collar thin with white front edge; head white with 5 vertical red-brown or black stripes, the front one along coronal sulcus then narrows through frontoclypeus (it may be interrupted at top of frontoclypeus), adfrontal sulcus and adfrontal cleavage lines black or red-brown, beside them a brown/black spear extends upward nearly to top, a black spike on side runs to top of head where it narrows into a reddish line that joins the reddish stripe down coronal sulcus; bottom of head orangish and black near mandible. Pupa greenish-white or pale-green, heart-band a little darker edged by paler, a long cone projecting forward from head, proboscis extends to abdomen tip.

Flies all year in Mex. It migrates north sparsely in the spring, and in Fla. flies south abundantly in fall (migratory butterflies caught in malaise traps in Fla. by T. Walker [1978 J. Lepid. Soc. 32:181]). Migrants can reach Va. by July, N.Y. by Sept., where they may attempt to breed.

Males rait near the ground on semishaded forest edges or small clearings, presumably all day.

Atrytone arogos iowa **Arogos Skipper**

The ups borders are very wide, and the ups veins and unh are yellow. Males lack a stigma. A very strange butterfly in many ways. Colo. has ssp. ***iowa***, the western ssp. that is much paler with tawny females compared to ssp. *arogos* along the Atlantic coast which has mostly brown females.

Habitat prairie and foothills flats and slopes near *Andropogon gerardii*. Hostplants in Colorado Poaceae: usually *A. gerardii*, rarely *Bouteloua curtipendula*. (*A. gerardii* also assoc. in Minn., Neb., N Okla. and eaten eastward; *Schizachyrium "Andropogon" scoparius* is shunned in Colo. but is eaten in S Kansas and eastward). Two grasses not in Colo. are eaten in Fla. (Minno et al. 2005). Common locally near the host along the Front Range foothills.

Eggs slightly-yellowish-cream, developing two reddish rings (the lower faint or rarely absent, rarely the two rings coalescing, and one egg was mostly red-pink), lower edge of egg angled outward, laid singly on host leaf uns. Larvae eat leaves, and live in nests of rolled or tied leaves. Older larva creamy-green (often yellowish in middle of thorax), a dark gray-green middorsal line, a tan collar (brown in SE U.S.); head tan, an orange-brown line along adfrontal sulcus runs up beside coronal sulcus, an orange-brown inverted V on frontoclypeus contains a vertical orange-brown line, an orange-brown spike runs from above mandible to near top of head, an orange-brown spike on side of head goes along rear rim upward and onto other side. Pupae variable, yellow-cream in palest females (thorax turns brown, wings orange-brown, abdomen orangish-yellow) to smoky black on head and thorax in males (wings dark-gray, abdomen medium-gray) (this butterfly has the most difference between sexes of any butterfly I know), proboscis extends 3 mm beyond the wing cases; there is no silk girdle and the cremaster is wide without crochets and is not attached. Early 4th-stage larvae hibernate, in a hibernation nest consisting of two leaf blades, then a 2-3 cm pair of "stilts" as each leaf is eaten down to the midrib, then a silked-tube nest with larva inside that is closed by silk mesh at the top.

One flight July (but I once found two pupae in Larimer Co. in mid Sept. that emerged—two flights occur regularly only eastward in SE Kansas etc.).

Adults visit flowers of all colors, including *Asclepias speciosa, Carduus nutans, Cirsium arvense* (favorite), *Helianthus pumilus, Heterotheca villosa, Liatris punctata, Medicago sativa, Monarda fistulosa, Solidago altissima* "*canadensis*", and often visit mud. Prior to the mating period and on warm sunny afternoons adults appear quite sluggish as they just feed on flowers and do not chase. Adults clean their antennae several times by rotating the head and using one foreleg to clean the lowered antenna, then they use the other leg to clean the other antenna.

Males rait on hillsides (most often in slight swales low on hostplant slopes) or flats covered with *Andropogon gerardii* in Colo. and Minn. and Neb. (on *S. scoparius* in Kansas) in afternoon to dusk (~13:20-17:45), by raiting ~10 cm up there, but they only mate-locate during cloudy and sometimes even slightly-rainy weather (only dark clouds or moderate rain stops them); raiting males rapidly vibrate their wings during cloudy periods to heat up sufficiently for the extremely rapid flights they make during mate-location (raiting flights toward passerbys) (females shiver also) (the fw may shiver more than hw during this vibration). This is extremely-unusual mate-locating behavior, but it has been thoroughly proven in multiple observations in those three states. In courtship, the male pursues a flying female, both hover with the male near and below her, they landed and she fluttered her wings a bit 20^{o}-spread and he fluttered a lot behind/below her and tried to join, she flew and both fluttered and flew again, they landed again then she was quiescent and the male fluttered just a bit and bent his abdomen to join.

Hesperiidae, Hesperiinae, Hesperiini

The Hesperiini tribe includes several genera that are closely related (*Hesperia* and *Polites* are very similar, and are somewhat similar to *Hylephila* and *Atalopedes*) and have larval heads with a common color pattern; many other genera are less closely related.

Hylephila phyleus phyleus Fiery Skipper

Identified by the short antenna, and the yellow unh (brownish-yellow in some females) with many small dark spots. Extending outwardly from the orange ups postmedian band are orange veins (orange veins are on upf and uph of males and at least on upf of females). Males are mostly orange on ups, females are dark-brownish with orange bands. Ssp. ***phyleus*** in Colo. and most of the huge neotropical range generally has numerous uns dark spots {ssp. *muertovalle* from Death Valley Calif. and the Colorado River area in NW Ariz.-Las Vegas-adjacent Calif. has small weak spots, and the ups is paler}.

Habitat low altitude lawns and grassy places in valley bottoms. Many flights southward, a rare stray to Colorado later in the summer, first found 1999 and now known from nearly all the plains counties, as global warming proceeds. Hostplants numerous Poaceae grasses in Calif. southward and in SE U.S. including several turf grasses: *Cynodon dactylon, Digitaria sanguinalis, Poa, Panicum,* *Eragrostis*, *Paspalum*, *Distichlis*, etc. Probably eats *Poa pratensis* in Colo. Southern U.S. favorites are *Cynodon dactylon* (rare in Colo.), *Stenotaphrum secundatum* (absent). Common southward.

Eggs pale bluish-white or greenish-white, laid singly on host leaf uns, sometimes on nearby plants etc. Larvae eat leaves, and live in hidden silked-leaf nests that are horizontal near base of hostplant incl. in sod of mowed lawns. Older larva dark yellowish-brown, gray, greenish-brown, or dull green, with brown heart-band, a faint dorsolateral paler stripe and faint darker lateral stripe, a tiny black dot (seta base?) near top of A2-6, neck whitish, the narrow collar dark brown or black, neck white; head dark brown or black, with black vertical stripe along coronal sulcus edged by a red-brown or tan vertical stripe. Larvae take ~9 weeks in lab. Pupa yellowish-brown (sometimes reddish or pale green or creamy-tan), with brown dorsal streaks/mottling, a blackish middorsal line, and a black subdorsal stripe on thorax, sometimes several brown streaks near top of head, abdomen with black lateral spots, T1 spiracle large & red-brown.

Adults visit many flowers of all colors, and probably visit mud. Adults can vibrate their wings to get warm (D. Wilson 1968, Adv. Ins. Physiol. 5:--).

Many generations southward, all year in S Ariz.; mostly migrant strays late in summer (June-Sept.) in Colo.

Males rait all day on grassy swales, the low point of lawns, and similar sites, as they rait on low prominent plants or even on hedges. Males often do not return after chasing from their raiting spots, and dispersal is great for both sexes (~100m between captures, I. Shapiro 1977). In courtship (I. Shapiro 1975), a raiting male pursues a flying object (such as the female) and often touches it (and her) with his head and antennae (nectaring males usually failed to chase passing females), the male lands behind the landing female, the male thrusts his head between the quiescent female's hindwings (touching her genital region), then he rapidly flutters his wings while moving to her side or front (to transfer his pheromone), then moves to her side and bends his abdomen to join. Unreceptive females do her rejection dance of opening the wings ~45^{o} spread and rapidly fluttering them to repel the male, or she raises her abdomen so he cannot join, or flies away. Males court virgins longer than mated females, suggesting females may have a special pheromone. Mating lasts 40-72 min.; females generally mate just once, sometimes twice. If the mating pair is disturbed, the female flies, the male dangling.

Shapiro, I. 1975. Courtship and mating behavior of the Fiery Skipper, *Hylephila phylaeus* (Hesperiidae). J. Res. Lepid. 14:125-141.
Shapiro, I. 1977. Interaction of population biology and mating behavior of the Fiery Skipper, *Hylephila phyleus* (Hesp.). Amer. Midl. Naturalist 98:85-94.

Hesperia uncas **Uncas Skipper (White Vein Skipper)**

Identified by the white unh veins everywhere, around the normal pattern of white spots, with brown filling many spaces between the white veins; the ups has dark-brown areas with white spots and all males and most females have tawny central and basal areas. *Polites rhesus* has similar white veins on unh, but has larger black areas there, and its ups is black with white spots (both species have a tan rectangle in the middle of the unh chevron, divided by a whiter vein in *H. uncas*), and *rhesus* is smaller. Several ssp. occur in Colorado. Ssp. ***uncas*** occurs E of the continental divide (my specimens from the San Luis Valley and one from the alpine zone next to South Park are ordinary ssp. *uncas*), (and evidently in Moffat Co. or they may be intermediate to *lasus*) Ssp. ***tomichi*** in the montane Gunnison Basin (near or intermediate to *tomichi* in South Park, perhaps near *tomichi* in NW San Luis Valley) has a blacker ups. Ssp. ***lasus*** in lowland W Colorado including Delta Co. has slightly oranger ups.

Habitat prairie, open woodland, and sagebrush, on the plains and lower mts., sometimes into the Canadian Zone, and occasionally found on high Alpine Zone peaks (above Hoosier Pass, and Galena

Peak in Sangre de Cristo Mts.). Hostplants in Colorado Poaceae: *Bouteloua gracilis*; adults of ssp. *uncas* and *tomichi* seem closely associated with *B. gracilis*. A *Stipa* host listed in Florissant Butterflies book may refer to a California record (hosts elsewhere are *Stipa* and *Erioneuron* and other *Bouteloua* spp.). Usually uncommon, sometimes common at perfect raiting sites.

Eggs pale greenish-white, turning white, laid singly on or near the host. Larvae eat leaves, and live in silked-tube nests in plant base/soil. Older larva light-brown, collar of all *Hesperia* black, white anteriorly; head blackish or dark brown, the side of front sometimes paler brown, with a cream vertical stripe along coronal sulcus of forehead above a cream inverted-V-shaped mark dorsally along adfrontal sulci, a cream spot near lower corner of frontoclypeus, sometimes creamier in front of eyes. Pupa light brown, with brown spots on abdomen, proboscis extending 1.3-4mm beyond legs, cremaster uniquely wide with more crochets which are less hooked than other *Hesperia*. *H. uncas* may resemble the ancestor of *Hesperia* because on 1st-stage larva the suranal anterior setae resemble posterior setae, the sublateral ring-pores are larger than those of *H. juba* and *H. comma*, the pupal proboscis extends well beyond the legs, and the pupal oval-fields and dorsal setae differ from those of *H. comma*, and the cremaster is peculiar. (Scott 1975g reported early stages of numerous *Hesperia*.) Larvae hibernate (roughly ~half-grown).

Two generations on the plains (and probably SW Colo.), mostly about M May-E July and M July-E Sept.; just one generation for ssp. *lasus* in lowland W Colo. M May-M June; one generation at higher elevation (including ssp. *tomichi*) M June-July (some to M Aug.). *Hesperia* take ~3-4 months to rear in lab, but a June 8 egg produced a female that emerged Aug. 29, so two generations on the warm plains seem possible (J. Scott 1992 Papilio NS #6 p. 102) (in Kansas and Texas there are evidently two gen. {McGuire 1982}).

Adults visit flowers of all colors, esp. yellow and white, including *Carduus nutans, Chrysothamnus* (*Ericameria*) *nauseosus, Cirsium, Opuntia polyacantha, Eriogonum lonchophyllum*, and sometimes mud. An adult strayed several km to Wheatridge Aug. 20, 1992.

Males rait all day on special low "ridgetops" (open areas on small gently–sloping ridgetops or low mesas extending from a large hilltop or plateau—other *Hesperia* such as *pahaska* rait on the big hilltops/ridgetops, while *H. uncas* chooses the lower-down gentle subsidiary ridgetops/little mesas), as they rait on or near the ground (sometimes on rocks or plants, 0-15cm up). Males sometimes chase females from flowers on slopes. In courtship, the male overtakes the female, both flutter as they land, the male flutters to transfer pheromone, and receptive females would presumably be quiescent and accept the male, but the female is usually unreceptive and vibrates her wings nearly closed or ~30°-spread or sometimes flutters them with greater amplitude as the male tries to join, which repels the male who departs. If a mating pair is disturbed, the female flies, the male dangling.

McGuire, W. 1982. Notes on the genus *Hesperia* in Texas: temporal and spatial relationships. Bull. Allyn Mus. #73:1-21.
Scott, J. A. 1975g. Early stages of seven Colorado *Hesperia* (Hesperiidae). J. Lepid. Soc 29:163-167.

Hesperia juba **Juba Skipper (Jagged-Border Skipper)**

Identified on upf by the jagged submarginal contact of orangish color contrasting with dark-brown border, the white unh spots mostly have jagged corners, the rear spot of the unh postmedian band is offset toward the wing base and the anterior two spots of that postmedian band tend to be stacked one on top of the other, and the unh background is grayish-green. This species apparently moved into the Front Range of Colorado in the mid 1900s, because Brown et al. (1957) recorded it only from extreme western Colorado, and I found it in Boulder and Douglas Counties in 1962. It is reported to be somewhat migratory in Oregon (Warren 2005) where adults emerge in spring at lower altitudes and migrate higher in the mountains; adults were seen flying swiftly during that migration. No migration has been reported in Colorado (M. Fisher found it once at timberline 12000' W of Lake City in

Hinsdale Co. where it maybe flew up from the canyon below), but adults may have strong movements that enabled them to populate the Front Range. From Sept. to April, larvae eat young green sprouts of the horrible weedy winter annual grass *Bromus* (*Anisantha* for splitters) *tectorum*, whose introduction from Eurasia into western N.A. and Colorado facilitated the migration of *H. juba* into the Front Range by giving it an important host for larval development from Sept. to April to produce the first yearly generation. That introduction resulted in fires ignited in the May-June dry *B. tectorum* grass, fires destroying some of the sagebrush habitat in western U.S. (harming Sage Grouse).

Habitat open woodland/brushland in lower mountains. Hostplants in Colorado Poaceae including turf and clump grasses and winter annuals/perennials: in late spring-early summer often *Poa compressa, pratensis* (incl. the "native" ssp. *agassizensis*), *Koeleria macrantha, Agropyron* (*Pascopyrum*) *smithii*; in fall and late-winter-early spring usually *Bouteloua gracilis*, and often two grasses that are dead or dormant in July-M Sept. namely *Bromus* (*Anisantha*) *tectorum* (eggs found on dead seed heads) and *Poa secunda* (dormant in summer), and rarely *Bouteloua curtipendula, Aristida pupurea, Hesperostipa* "*Stipa*" *comata*. *B. tectorum* produces stickers that clog butterfly nets and pants and socks, and it dries out in May and easily catches fire. *Distichlis spicata* is a host evidently in Utah (Wolfe et al. 2010). *Carex douglasii*, *Poa bulbosa*, *cusickii*, *pratensis*, *secunda* are hosts in Nevada (Austin & Leary 2008). Other grass hosts elsewhere are *Stipa* near *nevadensis*, *Bromus rubens*, *Agrostis idahoensis*, *Deschampsia elongata*. Usually uncommon.

Eggs creamy-white, after 5-7 days turning very faintly pinkish then dull grayish-white, without a flange, laid singly on or near the host. Larvae eat leaves, and live in silk-tube nests in plant bases/soil. Older larva light-brown or slightly reddish-brown, collar black, white anteriorly; head blackish, with a cream vertical stripe along coronal sulcus of forehead above a cream inverted-V-shaped mark dorsally along adfrontal sulci (these cream marks may be ochre in Wash.), a cream spot in lower corner of frontoclypeus. Pupa light brown or blackish, with brown spots on abdomen, movable abdomen joints orangish-brown, proboscis not extending beyond legs, the setae hooked. Mature eggs, L1, and L2 hibernate in Wash. (adults do NOT hibernate, contrary to an erroneous published report by A. Shapiro in Calif.): eggs laid in Wash. in Sept. hatched and later hibernated as 1^{st}- or 2^{nd}-stage larvae, while eggs laid in Oct. diapaused (with 1^{st}-stage developed inside) until Feb. or March; after winter, in spring those larvae grow and produce 1^{st}-gen. adults, which lay eggs and larvae grow into mature 5^{th}-stage larvae which make a strong leaf nest and aestivate therein for 3-6 weeks in July-Aug., then they pupate and adults emerge as the 2^{nd} flight (James & Nunnallee 2011). Colorado eggs always hatch in lab, so Colo. larvae generally hibernate, probably mostly as 2^{nd}-stage, sometimes as 1^{st}-stage and probably sometimes as 3^{rd}-stage. Larvae grow faster than most *Hesperia* so can have two generations/year (oviposition to adult in lab not much more than two months for *juba*, versus 3-4 in most *Hesperia* [Scott 1975g]).

Two flights, M April-June (mostly M May-June) and M Aug.-E Oct. (mostly M-L Sept.). Larval aestivation may or possibly may not occur in Colo., because summers are not especially hot and arid in Colo.

Adults visit flowers, often white and yellow ones especially *Chrysothamnus* (*Ericameria*) *nauseosus*, and often visit mud.

Males rait all day in gulches to await females, as males rait an average of ~29cm (10-40cm, n=5) up on vegetation (sometimes on stones) in the gulch bottom. (One sighting was of a male on a hilltop in Delta Co. chasing a *H. pahaska* where there were no gulches.) If a mating pair is disturbed, the female flies, the male dangling.

Hesperia comma Common Branded Skipper

The L July-Sept. flight period helps identify *H. comma*. The upf border does not blend with the orangish much, the unh spots are generally well-developed (silvery to cream to tawny in color) except in some ssp. *ochracea* which have small or rarely absent unh spots. The postbasal unh pale spots are generally almost touching (sometimes connected), whereas they are mostly a little farther apart in other *Hesperia* (esp. *H. viridis* & *H. pahaska*). The male uncus is blunt (like *H. juba, uncas, woodgatei*, and *ottoe*), the male valva teeth are close together, and the female lamella helps identification (see drawings in Scott 1986a). Several ssp. occur in Colo. Ssp. ***idaho*** (unh grayish-greenish-tinted ochre, with silver chevron) occurs on the western slope especially away from the high mts., and also occurs in the Front Range foothills in the Poudre River drainage and on the shortgrass prairie flats/mesas near the Wyoming Border in Larimer/Weld Cos. (it intergrades with ssp. *ochracea* southward in Larimer Co.), north to W. Neb. and Mont. and Ida.-Utah-Nev.-E Calif.-Wash.-S BC. Ssp. ***colorado***=*sublima* (brownish unh with silver chevron) occurs in Subalpine and AlpineZone on the continental divide in the Front Range to the N end of the Sawatch Range (R. Stanford reported it above 9000' near Aspen), and is evidently a little less dark from there to the San Juan Mts. (where it can be called near-*colorado* as it does not range into the upper subalpine or alpine tundra much there and evidently intergrades with *idaho* a little). At lower altitudes it intergrades with *idaho* and *ochracea* and *oroplata*, and along the Arkansas River from Tennessee Pass/Leadville to Salida it shows clinal intergradation into *oroplata* (Scott 1975f). Nick Grishin found that the high-altitude populations have different genes affecting the thorax muscles (maybe helping them in lower-oxygen high altitude?, as raiting males fly fast there on hilltops even in winds). Historical records and unh color suggest the two types of *colorado* were collected in the range of ssp. *ochracea* or *idaho*, not at Twin Lakes in Lake Co.; but DNA of the lectotype and paralectotype *colorado* (mtDNA plus three pieces of nuclear DNA) seems to conclusively prove they were actually collected near Twin Lakes July 13 1871 by T. Mead, who then caught a *H. comma* near *colorado* male July 20 1871 northward at Oro City near Leadville in a rocky gorge, as he noted at the very end of his letter 151 after his salutation (and DNA proves the Oro City origin of that darker specimen he called "Hesp. 7"). DNA and unh color show somewhat different clines, and the mtDNA results differ from the nuclear gene results (as seems to be typical in butterflies). Action by the ICZN on a submitted petition (Scott & 11 other authors 2018, Case 3709, Bull. Zool. Nomenclature 75:88-121) will fix the nine disputed names in *H. comma* if implemented; here I use the traditional names *colorado* and *oroplata*, because TL Twin Lakes area populations are near the middle of the cline in unh color but average somewhat darker on unh slightly closer to the alpine ssp. (as proved by Scott 1975f, plus photos of adults from Granite etc. in the petition) (and adults from Granite near Twin Lakes have considerable high-altitude DNA) than to the pale S Colo. ssp. *oroplata* (the unh darkness is the only usable operational way to define the high-altitude ssp. which varies from yellowish to dark-brown on unh but averages darker brown; the darker higher-altitude unh coloration is useful for thermoregulation.) {The name *sublima* is also objectionable because the main usage of that word is for the popular Sublime brand of marijuana, the brand involved in numerous court cases in Arizona.} So regardless of the outcome of that petition, *colorado* is the proper name for the alpine/subalpine ssp., because the TL near Twin Lakes has butterflies that are closer to the dark end of the cline. Ssp. ***ochracea*** (unh variable but most often pale and tawny, with cream or often whitish or sometimes somewhat tawny chevron that is usually normal size but sometimes small or rarely absent) occurs on the E slope Front Range (including the plains in the Black Forest), where it intergrades with *idaho* in S Larimer Co. and intergrades a little with *oroplata* southward (at the south end of South Park and around Pikes Peak) (the type specimen was collected by Ernest Oslar so noone knows where it came from, so the petition will fix that). Nick Grishin and others found that the creamier chevron is due to genes on the Z chromosome introgressed from ssp. *assiniboia* that currently occurs from N South Dakota to Canada (in my 1986a book I synonymized *ochracea* to *assiniboia*). Foothills *ochracea* are more tawny on unh more like *assiniboia*. Ssp. ***oroplata*** (unh tawny with silver chevron) occurs along the Arkansas River Valley (it intergrades clinally with *colorado* from Salida *oroplata* north to Tennessee Pass near-*colorado* then alpine tundra has even darker *colorado,* Scott 1975f) and the San Luis Valley, southward to northern New Mex. Ssp. ***mojavensis*** from the Spring Range of S Nevada and the Kaibab Plateau of N Ariz. is like ssp.

oroplata but the uns is a little darker (somewhat intermediate to ssp. *susanae* of C Ariz. & C NM, thus could be considered a synonym) and it provisionally occurs in the Chuska Mts. and extreme SW Colo. S of the San Juan Mts. (where I have seen few specimens), and adults from Ouray Co. seem similar to *mojavensis* but higher-altitude butterflies there may be similar to near-*colorado*.

Habitat grasslands and open woodland and even low-alpine tundra. Hostplants in Colorado for ssp. *ochracea* Cyperaceae: *Carex inops "pensylvanica" heliophila*, *C. rossii*, and Poaceae: often *Bouteloua gracilis*, *Bromus* (*Anisantha*) *tectorum* (eggs laid on dead seed heads, larvae later eat the growing sprouts in fall and spring), occasionally *Schizachyrium "Andropogon" scoparius*, *Bouteloua curtipendula*, rarely *Aristida purpurea*, *Poa pratensis* (usually the "native" ssp. *agassizensis*), *Hesperostipa* "*Stipa*" *comata*. For ssp. *oroplata Bouteloua gracilis*. For ssp. *colorado Carex rossii*, *deflexa* var. *boottii=brevipes*, *foenea*, and the grass *Festuca brachyphylla coloradensis*. At middle altitudes (including the South Platte Canyon) and tundra, sedges Cyperaceae are evidently eaten most often as most eggs are found on them. Common to abundant.

Eggs creamy-white, with a slight flange around the base (the lower side sticking out a bit, unlike other *Hesperia* including *H. juba* and *H. leonardus* which have vertical sides), developing a slight pinkish tint after 5-7 days, laid singly on or near the host. Larvae eat leaves, and live in silked-tube nests in hostplant bases/soil (sometimes under dried cow dung etc.). Older larva light-brown or brown, a faintly-darker heart-band, collar black, neck white; head dark brown to blackish, with a cream vertical stripe along coronal sulcus of forehead above a cream inverted-V-shaped mark dorsally along adfrontal sulci, a cream spot on each lower corner of frontoclypeus above mouthparts, mostly pale around eyes, usually paler cheek area as head mostly paler tan on side of face (Scott 1975g). Pupa light brown, with brown dashes on abdomen (few ventrally), proboscis extending very slightly to 1.3mm beyond legs, cremaster narrow (head may be brownish-gray, abdomen pinkish-tan; Wash. pupae may be yellowish-tan, greener on thorax & wings). Eggs usually hibernate (evidently 1st-stage larva inside the egg) (1st-stage larvae rarely hibernate in Wash.) (and mature fully-fed larvae aestivate for 4-6 weeks in Wash., James & Nunnallee 2011), but for the biennial ssp. *colorado*, eggs and evidently 2/3-grown larvae hibernate (ssp. *colorado* larvae/pupae take only ~72 days in lab, versus 3-4 months for lowland *Hesperia* incl. *H. c. ochracea*, suggesting that *colorado* might be annual, and adults fly every year on Tennessee Pass and most other locales, but *colorado* is evidently biennial near Guanella Pass based on few years of study (A. Warren), so the faster development evidently allows it to exist in the Alpine Zone (few other *Hesperia* occur in the Alpine Zone: the unstudied *H. miriamae* in the Sierra Nevada/White Mts. of Calif., and *H. nevada* occurs in Calif. alpine zone sometimes).

One flight L July-E Oct., mostly L July-Aug. for *idaho*, Aug.- Sept. for *ochracea* (rarely E Oct. on Green Mtn.), mostly M July-M Aug. (sometimes E July) for the high-altitude ssp. *colorado* which is evidently biennial or multiannual (biennial *H. comma* at Churchill Man. and high alt. Alta. fly even years, Alaska odd years).

Adults visit flowers of all colors, including *Aster laevis*, *A. porteri*, *Carduus nutans*, *Centaurea maculosa*, *Chrysothamnus* (*Ericameria*) *nauseosus* (the most popular), *Grindelia squarrosa*, *Heterotheca villosa* (very popular), *H. pumila*, *Liatris punctata* (very popular), *Dieteria=Machaeranthera bigelovii=pattersonii*, and often visit mud. Adults are attracted to blue clothing, thinking it is a flower. Basking adults spread hw more than fw as usual in Hesperiinae. Adults shiver their wings to keep warm. In Britain, heavy grazing (by rabbits) is needed to maintain colonies; a colony can be repopulated naturally if it is <9km from another (C. Thomas & T. Jones 1993 J. Anim. Ecol. 62:472-481).

Males rait all day, mostly on hilltops if available, as they rait mostly on the ground or on rocks on the ground (sometimes on vegetation 5-30 cm up). But hilltops are often absent, and males very often court at flowers, therefore especially at high density they may mate-locate more on flowers and can mate-locate at mud, and some males of ssp. *colorado* rait on a rocky area of a uniformly-steep ski chute. In courtship, the male overtakes the female and flutters below her to induce her to land, after landing the male may flutter his wings widely to transfer pheromone, when a receptive female would presumably be quiescent and accept the male, but an unreceptive female spreads her wings ~30° (seldom 15°) and vibrates them a little or sometimes flutters her wings at somewhat greater amplitude to repel the male, or she jumps away if his abdomen touches her, or flies away. If a mating pair is disturbed, the female flies, the male dangling.

Scott, J. A. 1975f. Clinal intergradation of *Hesperia comma colorado* (Hesperiidae). J. Lepid. Soc. 29:156-161.

Hesperia woodgatei **Apache Skipper (Fall Skipper)**

Identified by the very long antenna shaft with tiny clubs (and a white patch on base of club), the small posterior spots on the dark-brown unh, and the late flight period. Only two sites are known for this Ariz.-Tex. species in Colorado, S of the Spanish Peaks State Wildlife Area (W section) in W Las Animas Co. just north of the NM border, and in Archuleta Co. just N of Chama, New Mex.

Habitat open Ponderosa Pine woodland, from 7000-8500'. Hostplants: oviposits on a sedge *Carex planostachys* in C Texas, on the grass *Bouteloua uniflora* S of Saltillo, Mex. Sometimes common in SE Ariz.

Eggs pale yellow, turning white.

One flight mostly L September.

Adults visit flowers, and presumably mud.

Males rait all day on hilltops to await females, by raiting on rocks or the ground with wings closed (unless basking) in sunny clearings at/near the hilltop (the preferred clearings change throughout the day as shadows change).

Hesperia ottoe **Ottoe Skipper (Prairie Skipper)**

Closely resembles *H. leonardus pawnee* with its uniformly yellow unh, but flies in June-July (versus Aug.-Sept. for *pawnee*), males lack the dark patch below the upf stigma (present in *H. l. pawnee*), the stigma has hidden black dust (yellow in *pawnee*), females have the ups border more blended into the ground color, females usually have smaller upf white spots than *pawnee* (but they have a mostly-translucent postmedian spot in fw cell CuA_1 like *H. l. pawnee* and *Atalopedes* females), and the genitalia differ. Adults in Colorado are slightly paler than those far eastward (some females in Wis. have some dark unh smudges in a chevron and postbasal smudge, but those spots are absent in western Great Plains butterflies including Colo.).

Habitat prairie, or open foothills slopes. Hostplants in Colorado Poaceae: usually *Andropogon gerardii*, often *Bouteloua curtipendula*, rarely *Bouteloua gracilis* and the sedge Cyperaceae: *Carex geyeri*. In Minn. females often ovip. on *Schizachyrium "Andropogon" scoparius*. Also found on *Bouteloua hirsuta*, *Dichanthelium* (*Panicum*) & *Sporobolus* etc. eastward. Adults are most common near *A. gerardii*. Usually uncommon, sometimes very common on flowers.

Eggs cream, with no flange (a very slight one), laid singly usually on host in Colo. (but in Minn. most often laid on disc flowers of *Echinacea angustifolia* perhaps because cows avoid them, then the larvae drop off and crawl to many grass clumps). Females can lay 200 eggs and live 3 weeks in lab and a male lived 19 days in nature. Larvae eat leaves. 1st-stage larvae rest on leaf ups; older larvae live in silked-tube nests high on the grass (except during winter diapause and spring in Minn., when they live in silked shelters in grass litter/soil) (*H. ottoe* is the only *Hesperia* that makes aerial nests [except in hibernation]). Older larva in Colo. medium gray-brown or slightly-greenish brown, A2-9 with a slight reddish tinge, heart-band darker or faintly-darker brown, neck white, collar wide & black with ventral black satellite; head black with cream or tan stripe beside coronal sulcus, a cream or tan stripe laterally edging adfrontal sulcus, a tan ellipse in each side of frontoclypeus, a brown crescent (concave dorsally) medial to anterior eyes; Minnesota larva light greenish-brown, head dark brown;

mature larva does not produce waxy powder. Pupae in Colo. vary somewhat from greenish to light-brown, blacker on head & thorax and appendages, many variable blackish markings on thorax and abdomen {Scott 2006a, Papilio (New Series) #14:47 details early stages}. Usually 4th–stage (of ~6) larvae hibernate (5th-stage also reported, but based on flight period in Colo. half-grown larvae are more likely to hibernate). R. Dana studied it in Minn. (1991, Univ. Minn. Agric. Exp. Station Bull. #594:63p.).

One flight, mostly L June-M July.

Adults visit various flowers esp. purplish, including *Carduus nutans* and *Monarda fistulosa*, and sometimes visit mud. In Minn. they visit mostly *Echinacea angustifolia*, often *Verbena stricta*. Adults don't move far, up to 256m.

H. ottoe is a puzzling species that does not mate-locate like other *Hesperia*: males evidently rait on flowers all day to find females, on hillsides or flat valley bottoms, but they also fleek sometimes. In NW Neb.-S Minnesota, males seem to rait all day mostly near the top of a slope (on the S-facing side of a river valley) where the incline "breaks" toward the top flat crop field, and they often feed and rait on *Echinacea* flowers (~40cm up) there and chase from those flowers. In Colorado, I have not seen males raiting on the top of slopes or hilltops, instead they rait and feed on flowers (~40-200cm up) and chase other butterflies from there, usually on E-facing slopes at the Front Range mountain front and also on flowers along an irrigation ditch at the bottom of a slope, all day. Males sometimes fleek: in Colo. I once saw a male evidently fleeking for 10m near the host on one of those long slopes; in Minn. adults most often rait near the top of a small slope, but often fleek about the habitat to seek females, often between *Echinacea* flowers. In courtship (Dana 1991), the male pursues the female and flutters near her to transmit pheromone, they land, and if the female is receptive they quickly join. Unreceptive females jerk the wings forward (flutter) as in *Hesperia dacotae*. If a mating pair is startled, the female flies, the male dangling.

Dana, R. 1991. Conservation management of the prairie skippers *Hesperia dacotae* and *Hesperia ottoe*. Basic biology and threat of mortality during prescribed burning in spring. Univ. Minn., Minn. Agric. Exp. Stn. Bulletin #594. 63 p.

***Hesperia leonardus* Blazing Star Skipper (Colo. ssp. have been called the Pawnee Prairie Skipper & Pawnee Montane Skipper in conservation reports)**

Identified by the late flight (M-Aug.-M Sept.), the large size, the browner streak just below the male stigma, and the contrasting ups borders on females. Colorado has two ssp., one on the plains and mountains edge, the other in the South Platte Canyon system. Ssp. ***pawnee*** occurs on the Great Plains, and on the lower foothills at the edge of the plains in the Front Range and Wet Mts., and has a yellow unh like *H. ottoe* with no or a few yellowish spots. *Ssp.* ***montana*** occurs in the mountains along the South Platte River system (~6500-7500'), and has the unh mostly brown (varying from yellowish to dark brown, rarely russet brown, in different individuals) versus yellowish on plains ssp. *pawnee*. Ray Stanford and I independently discovered the actual location of ssp. *montana* in 1962 (the original specimens lacked proper locality data) (Scott & Stanford 1982). Ssp. *montana* was threatened by the proposed Two Forks Reservoir, which would have drowned most of the lower part of its habitat and might have made the ssp. vulnerable to very cold weather or to large fires; it is a Threatened Species in the Endangered Species Act and is illegal to collect. The giant Hayman Fire burned a huge area but luckily spared most of the *montana* range; when young trees take over a grassy area *montana* disappears (at Nighthawk etc.), so fire beneficially creates new habitat for the butterfly. The famous Colorado botanist William Weber complained to me that the butterfly's derailing the Two Forks Reservoir caused the city of Aurora to steal water from many South Park wetlands and pipe it to Aurora, thereby destroying many of those wetlands (the destruction of Colorado continues at a rapid pace, especially along freeways in the mountains, and on the plains from Fort Collins to Pueblo where huge developments tapping groundwater will soon run out of water). Ssp. *pawnee* and E U.S. ssp. *leonardus* (red-brown unh) look grossly different, yet they intergrade fully in C Minn.-W Wis. (Scott & Stanford 1982) and also in Mills, Monona, Harrison, & Pottawattamie Cos. Iowa (S. Spomer & T. Orwig 1991 Lepid. News #2 p. 30; S. Spomer et al. 1993 J. Lepid. Soc. 47:291-302).

Habitat of ssp. *pawnee* prairie, or chaparral or open foothills woodland. Habitat of *montana* Transition Zone open Ponderosa Pine forest on crumbly-soil "grape nuts" of the Pikes Peak Granite. Hostplants in Colorado of ssp. *pawnee* Poaceae: *Bouteloua gracilis*, rarely the grasses *Bouteloua curtipendula*, *Bromus* (*Anisantha*) *tectorum* (eggs on dead seed heads, larvae later eat green sprouts), *Sporobolus cryptandrus*, and rarely the sedge *Carex inops "pensylvanica" heliophila*. Rarely eats *Stipa ~viridula* in Minn. Hostplants in Colorado of *montana* Poaceae: *Bouteloua gracilis*, sometimes *B. curtipendula*; assoc. with *Schizachyrium* (*Andropogon*) *scoparius* at Crossons, which might be a rare host in Colo. (often eaten by ssp. *pawnee* in Minn.). Common, often abundant.

Eggs greenish-white, turning white (sometimes appearing pale-pinkish), lacking a flange, egg larger than other *Hesperia* including *H. juba* and *H. comma*, laid singly haphazardly on or near the hostplants. Larvae eat leaves, and live in silked-tunnel nests in hostplant bases/soil. Older larva light-brown or brown; collar black, white anteriorly; head dark brown, with a cream vertical stripe along coronal sulcus of forehead dorsally above a cream inverted-V-shaped mark dorsally along adfrontal sulci, a cream spot on lower corner of frontoclypeus above mouthparts (present on all *Hesperia*), a V-shaped pale area between eyes and lower corner of frontoclypeus, side of face with a wide paler (creamier-tan) area. Larva similar in both ssp., *montana* head slightly darker. Larvae take much longer to develop in lab than the two-generation *H. juba*. Pupa light brown, with brown/blackish spots on abdomen, proboscis extending 1 mm beyond legs; *montana* has fewer blackish spots. Eggs always hatch in lab for *pawnee*, therefore 1st-stage larvae usually hibernate in nature, perhaps sometimes 2nd-stage.

One generation, M Aug.-M Sept. (sometimes E Oct.) for *pawnee*, M Aug.-E Sept. for *montana*.

Adults of *pawnee* visit flowers of all colors, often *Chrysothamnus* (*Ericameria*) *nauseosus*, but usually *Liatris punctata*, and sometimes sip mud. Adults of *montana* visit various flowers, but usually *Liatris punctata*, often *Aster*, *Carduus nutans*, sometimes *Heterotheca villosa*, sometimes half-a-dozen others, incl. *Helianthus*. Adults are attracted to blue clothing, thinking it is a flower. Ssp. *leonardus* in E. U.S. prefers purple flowers incl. *Liatris* (Iftner et al. 1992).

Males of *pawnee* mostly rait but also fleek: they rait all day preferably on hilltops to await females, as they rait an average of 27 cm up (0-1.5m, N=21), but males also rait sometimes on or near *Liatris punctata* flowers on slopes or flats, and on flats and sometimes on slopes they very often fleek between *Liatris* to seek females (my notebook extracts contain 50 mentions of the word "perch" and 12 of the word "patrol"). They greatly prefer to be near *Liatris punctata*. When males approach blue pants thinking it is a flower, they make an audible flapping sound. In courtship, the male overtakes the female, both flutter and then land, when the [unreceptive] female vibrates her 20^o-spread wings (or flutters them at greater ~45-60^o amplitude) and the male often vibrates or flutters his wings at fairly small amplitude also behind her as he attempts to join; receptive females would quiescently accept the male, while unreceptive females flutter to repel the male and move away when he attempts to join, or they fly. In Minn., R. Dana noted that when males discovered virgin females that he placed on *Solidago* inflorescence, they landed and nudged or bumped the females until they flew, and then males flew near the females (transferring pheromone then evidently), and they landed and immediately joined. If a mating pair is disturbed, the female flies, the male dangling. Males of *montana* rait all day on/near *Liatris punctata* flowers, by raiting on or beside it (an average of ~10cm up), or males fleek between *Liatris* to find females (they seem to "trap-line" between *Liatris*, though they may encounter them randomly rather than remember their locations). In courtship, the male overtakes the female, they flutter with him hovering below her, they land and he flutters to transfer his pheromone, when an receptive female would be quiescent and accept the male, whereas the unreceptive female flutters her

30-40^o-spread wings to repel the male and she pulls away or flies as he tries to join. If a mating pair is disturbed, the female flies, the male dangling.

Scott, J. A., & R. E. Stanford. 1982 “1981”). Geographic variation and ecology of *Hesperia leonardus* (Hesperiidae). J. Res. Lepid. 20:18-35.
Scott, J. A. 1975g. Early stages of seven Colorado *Hesperia* (Hesperiidae). J. Lepid. Soc. 29:163-167.

Hesperia pahaska Yellow-Dust Skipper (Pahaska Skipper)

Similar to *H. viridis*, but the dust inside the male stigma is yellow (black in *viridis*) (run a long pin/needle aimed toward the thorax through the stigma to extract some dust to examine), the unh postmedian band is usually straight at the rear (the last spot usually projects outward toward the tornus in *H. viridis*), and the unh postmedian spot in cell M_1 does not overlap ½ of the shorter spot in cell Rs (the two spots usually do not overlap at all, while they overlap in *H. viridis*). The male and female genitalia are distinctive. Ssp. ***pahaska*** occurs in most of Colo. including Moffat, Garfield, Archuleta Cos. and Rio Arriba Co. NM, and has dark ups borders, while ssp. ***martini*** in the lower river basins in W-C Colo. (Delta, Mesa, Montrose Cos. etc.) has oranger ups especially the borders.

Habitat open woodland and prairie in the lower mts. (mostly below the Canadian Zone) and upper plains. Hostplant in Colorado Poaceae: *Bouteloua gracilis*. Common, sometimes abundant.

Eggs pale greenish-white, turning creamy-white. To oviposit, females flutter slowly and lay eggs singly on *Bouteloua gracilis* leaf underside, usually near the outer edge of a clump. Larvae eat leaves, and live in silked-tube nests in plant base/soil. Older larva light-brown or brown, collar black, white anteriorly; head dark brown/blackish, with a cream vertical stripe along coronal sulcus of forehead above a cream inverted-V-shaped mark dorsally along adfrontal sulci, a cream spot near lower corner of frontoclypeus above mouthparts, side of face dark (heads darker than *H. leonardus* and *H. comma* etc.). Pupa light brown, with brown spots on abdomen, proboscis extending 3-4mm beyond legs, cremaster narrow. Larvae hibernate (surely roughly half-grown).

One flight June-M July at lower altitude, mostly M June-E Aug. at higher altitudes. Two flights for ssp. *martini* L May-M June and L Aug.-Sept. Reported to have two flights in extreme SE Colo. (two gen. occur in Tex. ~Apr.-May & M Aug.-M Oct. averaging 3-4 mo. apart)

Adults visit flowers of all colors, including *Astragalus drummondii, Cirsium arvense, C. vulgare, Oreocarya suffruticosa, Erysimum asperum, Opuntia polyacantha, Oxytropis lambertii, Penstemon secundiflorus*, and sometimes visit mud. Adults bask dorsally by spreading forewings ~45^o from vertical, hindwings ~70^o; in very hot weather adults rest in shade under a tree or rest on its shaded boughs. Scott (1974h) studied this species. Adult lifespan in my mark-recapture study averaged about a week. Adults are fairly sedentary and seldom move more than a few hundred m (an average of about 200m in my study).

Males rait on hilltops all day to await females, as they rait usually on rocks (often on the ground, rarely on bushes or pinyon twigs logs etc.) averaging ~30 cm up (0-170cm, N=25). In courtship (several completed courtships were seen), a female flies near the raiting male, who pursues the female and flies within 5 cm of her, she flutters and lands, the male may flutter about the female for a short time, then he lands and bends the abdomen laterally to mate. The male sometimes flutters his wings rapidly with moderate amplitude after landing and the female may flutter her wings slightly or crawl or fly a short distance. Unreceptive females upon landing flutter their wings at small amplitude (~30^o spread) to greater amplitude (vertical to horizontal) about 10x/sec. to reject the male, which inhibits the male’s fluttering and the male often flies away. The male has a pheromone on the yellow dust in his stigma, and the virgin female seems to also possess a pheromone because males remain longer behind young females and several males relocated several females by approaching from downwind. If the mating pair is disturbed, the female flies, the male dangling. Females generally mate just once, seldom twice and rarely thrice. Many or most females mate on their second day.

Scott, J. A. 1974h ("1973"). Adult behavior and population biology of two skippers (Hesperiidae) mating in contrasting topographic sites. J. Res. Lepid. 12:181-196.
Scott, J. A. 1975g. Early stages of seven Colorado *Hesperia* (Hesperiidae). J. Lepid. Soc. 29:163-167 (correction: the labrum of 1st-stage larvae actually has 12 setae also).

Hesperia viridis Black-Dust Skipper (Viridis Skipper)

Very similar to *H. pahaska*, but the posterior postmedian unh spot is usually aimed toward the tornus (the corner) (the first male "*viridis*" photo in Mike Fisher's The Butterflies of Colorado looks too much like *pahaska*) (some *H. pahaska* females have this, but in *viridis* females the upf border is usually blended into the ground color much more), and the male microandroconial mass (dust inside the male upf stigma) is blackish (it is yellow in *pahaska*). The unh postmedian spot in cell M_1 overlaps ½ of the shorter spot in cell Rs. Male uncus and valva and female lamella are distinctive. There is nothing green about this skipper, so the common name "Green Skipper" is ridiculous. Records for the San Luis Valley are questionable (based only on two records from B. Rotger from Costilla and Rio Grande Cos. listed in Brown et al. 1957 which are dubious and are probably *H. pahaska* as noone else has reported *viridis* from that valley which is a little too cold for it). SW Colo. *viridis* records seem to be valid from Montezuma, La Plata, Archuleta Cos., and males from Unaweep Can. in Mesa Co. are valid with black microandroconial mass, so the Montrose San Miguel Ouray Cos. records are also valid. But Gunnison Co. seems too high for *viridis*, and Rio Blanco is another B. Rotger record in that book, Garfield Co. is just AMNH in that book and may be another E. Oslar mislabeling, so those two counties may be errors.

Habitat prairie and open woodland. Hostplant in Colorado Poaceae: usually *Bouteloua gracilis*, sometimes *B. curtipendula*, rarely *Hesperostipa* "*Stipa*" *comata*, *Andropogon gerardii*. (Sometimes ovip. on *Erioneuron*, *Buchloe* elsewhere.) Uncommon, sometimes common.

Eggs pale greenish-white, turning creamy-white, laid singly on or near the host. Larvae eat leaves, and live in silked-tube nests in plant base/soil. Older larva dark brown or brown; collar black, white anteriorly like all *Hesperia*; head dark brown (or blackish), with a cream vertical stripe along coronal sulcus of forehead above a cream inverted-V-shaped mark along adfrontal sulci, a cream spot near lower corner of frontoclypeus above mouthparts (all these pale areas darker on some larvae), side of face variable (dark or a large ochre area there and sometimes ochre medial to eyes). Pupa light brown, abdomen pinkish-tan, head and thorax and abdomen with blackish-brown mottling, abdomen with rows of blackish-brown dashes, proboscis orangish where it extends 2.5mm beyond legs, cremaster narrow. Larvae hibernate (surely roughly half-grown).

There is just one generation L May-M Aug. (some to E Sept.) everywhere. But the lengthy emergence is very strange, because the collection records L May-E Sept. might suggest two flights, but two generations are impossible because the larvae/pupae of all *Hesperia* take four months to grow in the lab (except *H. comma colorado* and *H. juba* are somewhat faster). There are several generations in Texas mostly Apr.-May & M Aug.-M Oct., so maybe Colorado populations have just one gen. with variable emergence times. The few Wet Mtn. Valley records are mostly in July (one M Aug.).

Adults visit flowers of all colors, including *Cirsium arvense, Monarda fistulosa*, and often visit mud. All *Hesperia* including *viridis* approach blue pants thinking they are flowers.

Males rait all day in gulch bottoms to await females, as they rait on rocks or ground (seldom on plants) an average of ~16cm up (0-50 cm, N=16) in the gulch bottom. In courtship, the male overtakes the female who flutters/hovers and he flutters below, they land, when a receptive female would be quiescent and accept the male but the usual unreceptive female flutters rapidly to repel the male, who departs. If a mating pair is disturbed, the female flies, the male dangling.

Scott, J. A. 1975g. Early stages of seven Colorado *Hesperia* (Hesperiidae). J. Lepid. Soc. 29:163-167.

Hesperia nevada nevada Nevada Skipper (Montane Skipper)

Identified by the dark-yellowish-green unh when fresh, the unh spot in cell CuA_2 is positioned more inward than the postmedian band and barely touches the band, the upf orange is blended into the border, and the small size. The male uncus is a very long undivided point, and the female lamella is distinctive. Butterflies in South Park and other high-altitude areas are rather dark-yellowish-green on unh, while those from lower altitude Front Range are slightly less greenish and more tan. Adults from North Park (Jackson Co.) are darker-green on unh and could be considered a **distinct subspecies**.

Habitat upper foothills and Canadian Zone (rarely up to timberline) open woodland, sagebrush, and montane prairie. Hostplants in Colorado Poaceae: In Jefferson Co. usually short bunchgrasses: *Festuca saximontana* (the favorite), often *Koeleria macrantha*, sometimes *Hesperostipa* "*Stipa*" *comata*, rarely *Bouteloua gracilis*, *Poa pratensis agassizensis*, *Danthonia parryi*, *Muhlenbergia montana*. Bunchgrasses elsewhere: in South Park and W slope *Festuca idahoensis*; on W slope *Hesperostipa* "*Stipa*" *comata* sometimes; in Wet Mts. *Koeleria macrantha* at least. Usually uncommon, sometimes common.

Eggs creamy-white, laid singly on leaf uns of the host or nearby. Larvae eat leaves, and live in silked-leaf nests in leaf bases/litter/soil. Young larvae produced no nests in lab. Older larva dark slightly-reddish brown, a weak middorsal heart-band, collar black, neck white; head black with cream stripe along coronal sulcus (*H. nevada* develops this stripe earlier than other *Hesperia*, in L2), an ochre stripe dorsally along adfrontal sulcus, an ochre oval in lower corner of frontoclypeus, and an ochre crescent medial to eyes. Larvae feed at night. Larvae produce profuse white waxy powder beneath A7-8 and pupate in a silked "cocoon" nest in litter/soil. Pupa has dark brown thorax and head and black wings, abdomen orange-brown with brown dashes and spots, proboscis apparently extends several mm beyond wings. 3^{rd}-4^{th}-stage larvae hibernate. (Immatures studied by James & Nunnallee 2011).

One flight end of May-E Aug., but mostly June-E July at lower altitude and L June-July near timberline.

Adults visit flowers of all colors, including *Astragalus agrestis*, *Erysimum capitatum*, *Oxytropis lambertii*, *Sedum lanceolatum*, and often visit mud. Adults fly very fast and beyond 4m disappear from sight. Interestingly, adults sometimes land using just the rear four legs; they clean the antennae with forelegs.

Males rait all day to await females, preferably on hilltops but at moderate abundance they also rait on gentle preferably-convex slopes (where they occasionally fleek between *Erysimum* flowers), as they rait on the ground or on rocks (seldom on low plants) an average of 5cm up (0-15, N=14). In courtship, the male overtakes the female, both hover and then land, the male spreads his wings 40-50^o or more and flutters, and the female flutters her partly-spread (~25-35-45-60-70^o) wings; receptive females presumably would be quiescent and accept the male, while unreceptive females flutter and move away and fly away.

Polites (*Yvretta*) *carus* Mexican Cobweb Skipper (Carus Skipper)

Resembles *P.* (*Y.*) *rhesus* but the unh is grayish-yellowish-tan, the black unh patches are much smaller, the unf fringe is light-brown not white, the ups spots are creamy to pale-yellow, and the male has an upf stigma. (Like *P. rhesus*, the ups is black with white spots, the unh is covered with white lines on every vein, the unh spots are mostly edged distally and basally by black, the unh postmedian spots form a straight row, and the abdomen has whitish rings on top [mostly just ventrally in *rhesus*].) Known in Colo. only from the southern slope of the Mesa de Maya (at Carrizo Creek in Baca Co.).

Habitat open areas with grasses. Hostplant reported oviposition on *Bouteloua gracilis* (source unknown), and a report of *Muhlenbergia rigens* in Ariz. Often common southward.

Several flights March-Nov. in New Mex.-Ariz.; so far L Apr.-E May in SE Colo. and probably also Aug.-Sept. because there is a record (error?) in Sept. at Holbrook in Furnas Co. Neb.

Adults visit flowers such as *Astragalus*, and mud. They fly fast, but are less wary than *P. rhesus*.

Males in S Ariz. rait on flat bare areas in valley bottoms (at least 12:00-14:00, probably all day) to await females. Hilltopping is reported in Ariz. & Tex.

Polites* (*Yvretta*) *rhesus **Prairie Cobweb Skipper (Rhesus Skipper)**

The unh pattern of tawny, black, and white spots plus white veins is similar to *Hesperia uncas* but exaggerated because there are more large black areas including a postmedian black patch (where vein CuA_2 is black on this black patch, not white), and there is a large tan patch beyond the unh discal cell (where vein M_2 is usually tan not white). There is no orangish on ups of males or females (*H. uncas* has ups orange except in some females). Other distinctive traits: the wing fringes are white (whitish-tan or brownish in *P. carus*), and the medial edge of each tegula (on the thorax) is edged by white.

Habitat shortgrass prairie, and open woodland (mostly Pinyon Pine) on the plains to the Wet Mtn. Valley and San Luis Valley, all below the Canadian Zone. I once found a female in a grassy foothills saddle E of Tinytown, the only record along the foothills near Denver; it was never seen there again. There is a specimen from Delta Co. (the Mesa Road in E June) that seems valid, a possible sight record from Mesa Co., and reported from Archuleta Co., so it may be widespread there; widespread on E slope including the San Luis Valley in Colo. Hostplant in Colo. Poaceae: *Bouteloua gracilis*. They do not use nearby *Buchloe dactyloides* even though it looks very similar (leaf tops are sparsely hairy in *Buchloe*, hairless in *B. gracilis*). Usually uncommon, occasionally common.

Eggs whitish green, laid singly on host leaves. Larvae eat leaves, and live in hidden silked-tube nests in hostplant lower leaves & soil. Older larva light-gray (slightly bluish)-green, some larvae much redder, being tan or brownish-green, but are brownish-red sublaterally and posteriorly (brownish-red on top of last few abdominal segments), heart-band slightly darker, lateral ridge (below spiracles) on paler larvae yellow-cream and suffused with reddish-tan in middle of each segment, collar mostly black; head black, a cream stripe along coronal sulcus, cream adfrontal inverted V on lower front of head, a cream crescent in front of eyes, cheeks widely covered with gray. Pupa (deformed) thorax pale green tinged with brown, abdomen pale creamy-green with cream clouds visible inside, A4-7 more chitin-tan, heart-band green on abdomen. Mature fully-fed larvae hibernate.

One flight end of April-start of June on the plains & lower foothills, M May-June at higher altitude.

Adults visit flowers of most colors, and prefer *Astragalus drummondii, Erysimum asperum,* and *Oxytropis lambertii* where those are present, and occasionally visit mud. Adults fly very fast.

Males rait evidently all day in shortgrass prairie on places with gentle topography (males rait on slight ridgetops or 2m mesa tops, or slight swales, or slight slopes or flats), to await females. I have only late-morning/afternoon raiting records! At some sites they primarily rait on low ~¼m flowers (and chase others from there) whereas at other sites they rait on short grass (preferring the low ~8cm *Buchloe* rather than the host grass to land on).

Polites sabuleti **Saltgrass Skipper (Crunchgrass Skipper, Sandhill Skipper)**

This small butterfly is identified on the unh, by longer pale spots in unh cells M_1 & M_2 (like *P. draco* and *P. peckius*), a yellow U-shaped basal mark, and pale veins. The unh has a black sliver-like spot below vein CuA_2 like *Polites carus*, but the ups is orangish, unlike the black *P. carus*. The unh spots are yellowish in males and cream in females, and do not contrast as much with the background as they do in *P. draco*, and the uph usually has yellow projections along the veins that reach toward the edge. Ssp. ***ministigma*** (small male stigma, yellower ups) originally occurred only in the closed-basin in the San Luis Valley (including just S of the Great Sand Dunes, W Crestone, Monte Vista Wildlife Refuge, E Alamosa, SW and NE of Russel Lakes); and a slightly-oranger version of it occurs precariously in the Arkansas River Canyon from Coaldale weakly to Salida which may be exterminated by now. Ssp. ***sabuleti*** (=*alkaliensis*) occurs in the rest of Colo., and has larger stigma, oranger ups (our butterflies look little different than the ssp. *sabuleti* I caught on lawns at Berkeley, Calif., and *alkaliensis* and *genoa* are synonyms of *sabuleti*, and *basinensis* is another synonym slightly intermediate to the distinctive NW Nev. ssp. *sinemacula*). Ssp. *sabuleti* has obviously expanded onto the Colo. plains in the last 50 years (and is continuing to expand there) and into SE Wyoming and W Nebraska. And just in the last two decades ssp. *sabuleti* has moved north into the San Luis Valley in the town of San Luis and evidently Fort Garland, and to the S edge of the Russel Lakes State Wildlife Area in the NW part of the valley (M. Fisher), where it has two generations and evidently eats irrigated grasses; ssp. *ministigma* occurs just S of the Russel Lakes SWA in one generation, so one wonders whether the two-generation ssp. *sabuleti* will displace or genetically alter the single-generation *ministigma*.

Habitat grassy areas in valley bottoms, especially alkaline areas on *Distichlis spicata stricta*. Hostplants in Colorado Poaceae "crunch-grasses" (short turflike grasses with grayish-green leaves that make a crunch sound when stepped on): at Barr Lake *Distichlis spicata stricta* and *Hordeum jubatum* are both major hosts, *Poa arida* and *Puccinellia distans* are occasional hosts; "lawn grass" in W Colo. (and the crunchgrass *Cynodon dactylon* is eaten elsewhere and perhaps in Grand Junction). The ssp. *ministigma* hostplant is the crunch-grass *Sporobolus airoides* (previously misidentified as *Eragrostis trichodes*), and this grass occurs at some ssp. *sabuleti* sites also. *P. sabuleti* occurs on some lawns in Garfield and Mesa Cos. in western Colo., but on the plains usually on more natural places such as cattle pastures or human-influenced grassy places. M. Epstein once found ssp. *sabuleti* on the W rim top of Grand Mesa. In SW Colo. and N New Mex. adults are in meadows of *Poa ~pratensis* (often *Sporobolus airoides*). An ovip. on *Carex* in Calif. but larvae refuse *Carex*. At Barr Lake females prefer to oviposit on the cattle-chewed spots of the former host meadow, so ungulate grazing seems to be desirable to maintain populations of this butterfly and remove the weeds (I read that the park bought those irrigated meadows and removed the cattle and now the *P. sabuleti* may be gone). Common.

Eggs pale (slightly-bluish)-greenish-cream, laid singly on host leaf uns but more often on *Juncus compressus* stems/leaves (which larvae refuse to eat) near the host (in Calif. they sometimes oviposit on *Carex filifolia* which larvae also refuse). Eggs are mostly laid on cow-chewed places of meadow where grass only grows 4 cm high, explaining why populations can occur on drier-grass lawns in W Colo. (they have not invaded moist-grass *Poa pratensis* lawns in Denver). Larvae eat leaves, and make silked-tube nests in hostplant bases/litter/soil. Older larvae greenish-light-brown in most larvae, brownish-green in others, middorsal band dark-brown (A10 has blackish middorsal spots and a subdorsal blackish band all forming a blackish UU mark, or these marks may vary to weak), collar black behind whitish area like all *Polites*; head black with cream stripe beside coronal sulcus and cream band beside adfrontal sulcus, a cream curve in front of eyes. In other states larva purplish-brown or green or light-gray mottled with brown, with middorsal blackish band and sometimes a dark subdorsal line and lighter lateral band, the head cheeks sometimes whitish or black. Larvae pupate in loose silk "cocoons." Pupa head-thorax-wings brownish-green, abdomen greenish-yellow tinged with brown, abdomen has brown middorsal band and weak lateral and subventral spots, proboscis red-brown where it extends 2mm beyond wings. Half-grown larvae evidently hibernate (pupae are reported to hibernate, which is doubtful).

One flight M June-E Aug. (once Sept. 7) for single-generation ssp. *ministigma*; two generations for ssp. *sabuleti* on the plains and San Luis Valley and W Colo. lowlands in June and L Aug.-start of Oct.

Adults visit all colors of flowers except perhaps red, including *Aster ericoides, A. lanceolatus hesperius, Solidago* (*Euthamia*) *occidentalis*, and sometimes mud.

Males rait all day in low spots of alkaline flats with the hostplant, or sides of irrigation ditches, and on flowers on flat land, as males usually rait ~3cm up on cattle-chewed spots (sometimes 10-15cm up) to await females. They fly rather fast. In courtship, the male overtakes the female, both hover then land, when receptive females would presumably not flutter and accept the male, but most females flutter in peculiar fashion (flicking the wings 20-50^o or 0-80^o-spread ~5X in a burst of maybe 1/5 sec., and maybe 2-5 bursts in ~4 sec.—these are inaccurate estimates made without benefit of video); fluttering is the rejection dance of females, which repels males, who depart. If a mating pair is startled, the female flies, the male dangling.

Polites draco Rocky Mountain Skipper (Draco Skipper)

Identified by the unh postmedian spots, the longest spot in both cells M_1 & M_2 (pointed basally along vein M_2) as in *P. sabuleti*, but *draco* is much darker, and the unh is brown sometimes with a greenish tint, with contrasting cream spots and no cream veins. It mostly replaces *P. sabuleti* at higher altitude. The unh postmedian spots (including the spot mentioned above and that in cell CuA_2) point inwardly more than in *Hesperia*, the unh spots are generally larger, and the male has a larger upf black stigma above a black patch compared to *Hesperia*. F. Brown (1962. The variation of *Polites draco* with altitude. J. Lepid. Soc. 16:239-242) found one a little lower than 8000' near Ouray, Colo. and noted that adults are paler at lower altitude, darker with altitude up to 13,000', but I have not noticed much change.

Habitat Canadian Zone-lower Alpine Zone grassy areas and valley bottoms. A few records are in the upper foothills (such as Tinytown, Tucker Gulch, & the top of Crawford Gulch, all Jefferson Co., and in the Wet Mts., in E-L June). Hostplants in Colorado Poaceae (mostly small bunchgrasses or turfgrasses): on E slope the favorites are *Koeleria macrantha*, *Festuca saximontana*, *Poa pratensis agassizensis*, *Festuca idahoensis*, *F. arizonica*, occasional hosts *Agropyron* (*Elymus=Sitanion*) *elymoides* "*longifolius", Hesperostipa* "*Stipa*" *comata* or *Poa nemoralis interior*; on W slope *Festuca idahoensis*. Usually uncommon.

Eggs very pale green, laid singly on hostplant leaf uns but ~40% of the time eggs are laid on uns of nearby dicotyledons. Larvae eat leaves, and live in silked-leaf tube nest that must be in clump base/litter/soil. Older larva uniform dark brown, a middorsal blackish-brown band (weak on thorax), a faint dorsolateral blackish-brown band, rear rim of A10 black connected to subdorsal and middorsal blackish band, collar black; head black without white markings, although there may be a trace of dark-brown stripe along coronal sulcus in the photo of T. Emmel, J. Emmel & B. Drummond (1992). Pupa thorax brown, abdomen ochre, a middorsal abdominal brown band of dashes and ovals, a faint lateral band of brown dashes containing spiracles, brown dashes and spots on lower parts of abdomen, proboscis reddish-brown extending beyond wings to cremaster base. The larva is darker and the head lacks the pale markings of *sabuleti* and A10 is blackish on rear rim unlike *sabuleti*. The pupa is darker than *sabuleti* and the proboscis is longer. Larvae probably hibernate about half-grown at low altitude, probably biennial at high altitude hibernating as young then old larvae.

One flight, mostly M June-July; in upper foothills E-L June, near timberline M July-M Aug. (rarely E Sept.).

Adults visit yellow and white and less often bluish-purple flowers, including *Astragalus agrestis, Erigeron pumilus*, and visit mud. Some adults roosted in pine trees 3m up.

Males rait in swales (gulch bottoms, or swales on slopes) all day to await females, as they rait mostly on the ground on dirt or low rocks (sometimes twigs etc.) in those swales. Occasionally males were seen to flait in hillside swales, or "trapline" between flowers in a moist swale. In courtship, the male overtakes the female, they flutter/hover with the male 5 cm below her, and they land, when the receptive female would presumably be quiescent and accept the male, but most females are unreceptive and after landing she vibrates her 30-45^o-spread wings or flutters her partly- or mostly-spread wings which repels the male who sometimes flutters with wide amplitude behind her to transmit pheromone but usually just leaves. If a mating pair is startled, the female flies, the male dangling.

Polites peckius Peck's Skipper (Yellow-Patch Skipper)

Identified by the very wide unh postmedian (very wide in cell M_2) and postbasal yellow patches, the postbasal patches extending onto cells $Sc+R_1$ & CuA_2 (absent in those cells in other *Polites*). Colorado has an immigrant ssp. and a native ssp. Ssp. ***surllano*** occurs on the Great Plains from Missouri & Iowa & S Minn. to S.D. & Wyo. southward, and the plains of Colorado, and has a smaller yellowish unh patch usually with strong brown veins across the patch. Ssp. *surllano* evidently moved into NE Colorado recently from Nebraska/Kansas, because the first one was found Aug. 31 1965 in Bluebell Canyon near Boulder by Don Eff and I found more in 1971 on Green Mountain in Lakewood, then it became abundant through 2001 (one could see 100/hour on Green Mtn.), then both it and *P. themistocles* became scarce in the Denver region for about a decade, perhaps because the parasitoids of *P. peckius* finally followed and became common in Denver, but in the 2010s both species became common again in Denver as the larvae may have evolved some immune resistance to the presumed parasitoids. Ssp. ***peckius*** occurs in E U.S. and Canada and the Rocky Mts. south to the native populations in the eastern Gunnison Basin of Colo. and the White Mts. in Arizona, and has a much larger unh yellowish patch with weak or no brown veins across the patch. Ssp. *peckius* is known so far in Colorado from just two specimens from the lush valley bottoms of the eastern Gunnison Basin (Cochetopa Creek, 13 mi. S of Parlin, 5 mi. N Cochetopa 8800' July 30, 1933 Leigh Chadwick, given to F. M. Brown; and Tomichi Creek near Dawson Creek July 21, 1981 J. Scott) in the Canadian Zone of eastern Gunnison County and adjacent Saguache County in late July, with a larger unh patch and both specimens evidently with weak veins across the patch (assuming Brown et al. 1957 figured the Parlin specimen along with a female from some other state, which seems correct because Brown wrote he had only one specimen). Ssp. *peckius* also occurs in the White Mts. of E-C Arizona where the patch is large without brown veins, as a relict from the main ssp. *peckius* range in the northern Rockies and Canada and E North America (I think the Colorado specimens of ssp. *peckius* are not imports from E U.S.).

Habitat lawns or grassland swales on the plains or adjacent foothills for ssp. *surllano*, Canadian Zone moist meadows near streams for Colo. ssp. *peckius*. Hostplants in Colorado Poaceae: *Distichlis spicata stricta* in some cattle pastures, *Poa pratensis* in Denver lawns, perhaps *Bromus* (*Bromopsis*) *inermis* in a weedy grassy spot. *Leersia oryzoides* is recorded eastward. Mowed lawns are good habitats because females drop eggs without glue and larvae live in silk tunnels in the turf-soil interface, so larvae avoid the mowers and are very difficult to find. Common.

Eggs cream, becoming tan-cream or developing irregular tiny reddish mottling, laid singly without glue so eggs fall into the litter. Larvae eat leaves, and make silk-tube nests in grass bases/litter/soil, at or below ground level. Older larva of *surllano* dark-brown (thorax more slate-brown, abdomen more orange-brown), a blackish heart-line, A10 with blackish UU marking like *P. sabuleti*, collar black behind white (in other states ssp. *peckius* larva may be uniformly maroon-brown or gray-brown with similar markings, and may have several weak tan and brown lateral bands such as a darker band below spiracles); head black, a brown stripe along coronal sulcus, adfrontal area brown, a brown crescent in front of eyes (these markings tan in ssp. *peckius*). Pupa brownish-black, wings legs & mouthparts more bluish-gray on black, proboscis extends 5 mm beyond wings to cremaster (in other states pupa may be reddish-brown with white wing cases and appendages). 3rd-stage larvae hibernate in N Wash. (James & Nunnallee 2011).

Two flights for ssp. *surllano* like *P. themistocles* (rarely April 5) L May-E July and L July-M Sept. Ssp. *peckius* has one generation probably ~M July-E Aug.

Adults visit all colors of flowers even red and pink, but usually visit purplish-blue-violet flowers, including *Buddleja davidii*, *Cirsium arvense*, *Liatris punctata*, *Lychnis coronaria*, *Medicago sativa*, *Salvia farinacea*, *Zinnia elegans* (Iftner et al. 1992 lists many flowers in Ohio that show the same preference), and mud.

Males rait all day in grassy swales including meadows, lawns, roadside ditches near the host, lake edges, etc. to await females, as raiting males rest an average of ~31 cm up (10-60cm, N=13) (only ~5cm on lawns), plus males sometimes rait on flowers ~30-120 cm up. In courtship, the male pursues her and both flutter, they land and the generally unreceptive female vibrates or flutters with wings partly (sometimes widely) spread (the hw spread a bit wider than fw) and the male behind often vibrates partly-spread or flutters widely to transfer pheromone and attempts to join (when she moves or flies) or he just rests and flies away (receptive females would remain motionless while the male joins). If a mated pair is startled, she flies, the male dangling.

Polites themistocles themistocles **Tawny-edged Skipper**

Resembles *P. origenes*, but the male upf stigma is in three parts, like a tilted J on the right side, and females have a strong orange streak on the upf costa. On males the orange spot at the base of upf cell CuA_1 just beyond the stigma is usually present but smaller than *P. origenes*. Females generally lack paler patches on uph, and males generally lack unh spots. The male valva differs.

Habitat urban lawns and meadows mostly in valley bottoms/sloping swales, from the plains to the lower Canadian Zone (seldom in Subalpine Zone such as Montgomery in Park Co.). Hostplants in Colorado Poaceae: major host *Poa pratensis agassizensis* in nature and *P. p. pratensis* on lawns (the nests cannot be found on lawns, but I once found a newly wing-hardened male barely able to fly a bit which tried to rise up from a lawn), occasional host *Koeleria macrantha*. (Other hosts in E N.A. several *Panicum* sp. [incl. *Dichanthelium*], *Digitaria*, *Glyceria*). Mostly common.

Eggs cream, becoming dirty-cream with numerous reddish dots so egg appears mottled pale-pinkish (or the reddish dots may cluster into dozens of large red spots on the cream egg in Wash.), laid singly sometimes on host leaf uns, but in Colo. most eggs are laid on uns of nearby dicotyledon leaves. Larvae eat leaves, and live in silked-tube nests in host bases/litter/soil. Older larva brown (in Colo. but not Wash. ochre brown on abdomen, thorax more gray-brown perhaps with slight greenish tint [just dark brown in Fla.]), heart band blackish-brown, (there may be a dorsolateral band of brown spots in E U.S., and weak dorsolateral and lateral browner lines in Wash. and lateral lines in W.Va.), A10 top tan with black U-shaped rim around top and blackish subdorsal band and a blackish middorsal band on A10 (these A10 marks absent on photo of Allen et al. 2005), collar black behind whitish; head black with a brown stripe along coronal sulcus, adfrontal area brown, a brown spot on each side of frontoclypeus, several brown spots near eyes (those head markings are reported to be orange in Wash., whitish in Ore. and BC, versus just unmarked black in three E U.S. states, see James & Nunnallee 2011, athough Allen 1997 reports occasional white vertical stripes; there may be some kind of cline in larval pattern). Pupa mostly greenish with complicated pattern of darker-green and brown (pupa greenish-brown with darker middorsal stripe, abdomen tan with tiny darker spots in Wash. and often in E U.S.), proboscis extends 2.5mm beyond wings (sometimes 0mm in other states). 3rd-stage larvae hibernate in Wash. (the same as my finding of half-grown larvae in Colo.). (Pupae reportedly but doubtfully hibernate.)

Two flights L May-E July and M Aug.-M Sept. on the plains and evidently lowland SW Colo., in the mountains mostly one flight M or L June-E. Aug. (some L Aug.).

Adults visit flowers of all colors, including *Carduus nutans, Gomphrena globosa, Medicago sativa, Salvia farinacea, Tagetes patula, Taraxacum officinale, Verbena bipinnatifida, Zinnia elegans* (favorite), *Buddleja davidii*, and sometimes mud.

Males rait all day to await females, in grassy swales, depressions in meadows, and lawns, as they rait an average of ~16cm up (5-33, N=6; only ~5cm on lawns), and males often rait on flowers. Males often fleek over swales or flowers to seek females. In courtship, the male overtakes a passing female, they may hover then land, he flutters his wings a bit to transmit pheromone as he lands close behind, and an unreceptive female opens (often ~45^o spread, the fw less than hw) then vibrates them ~1/3 sec. (or flutters her partly- or mostly-spread wings) to repel the male, if she vibrates her wings he also spreads his wings ~30^{o} and vibrates them ~1/4 sec. to spread pheromone, unreceptive females may fly and they may vibrate again, he may bend his abdomen to try to mate but she moves/flies, until finally he quits (receptive females would surely remain quiescent and accept the male). If a mating pair is startled, the female flies, the male dangling.

Polites origenes rhena **Cross-Line Skipper**

Resembles *P. themistocles*, but slightly larger and darker, identified by the straighter upf male stigma, on males the orange spot at the base of upf cell CuA_1 (just beyond the upper part of stigma) is much larger than the small sometimes-absent same spot on *P. themistocles*, females nearly lack an orange upf costal streak (it is reddish-brown on some), and females usually (and males often) have faint orangish streaks in the middle of uph. The unh often has postmedian weak spots (more than *P. themistocles*). The male valva differs. The Colorado/Rocky Mts. ssp. ***rhena*** has oranger males than the darker eastern U.S. ssp. *origenes*.

Habitat open grassland/slopes with abundant *Andropogon gerardii*. Hostplants in Colorado Poaceae: usually *A. gerardii*, occasionally *Bouteloua curtipendula*, *Dichanthelium "Panicum" oligosanthes* var. *scribnerianum*. Eastward reported on *Schizachyrium* (*Andropogon*) *scoparius*, *Glyceria*, and *Tridens*. Uncommon, sometimes common.

Eggs greenish-cream, laid singly under hostplant leaves. Larvae eat leaves, and live in a silked-leaf tube aerial nest above ground on the host. Older larva brown, but many larvae pinkish-reddish-brown, several larvae brown-pink, a brownish heart-line, there may be very weak dorsolateral darker bands and weak browner & tan lateral bands, heart-line dark brown, A10 top blacker brown (no black bands or rim in Colo., although W. Va. ssp. *origenes* larva has black W pattern on A10), collar black (the neck is white in all *Polites*); head black. Pupa brown or blackish-brown, abdomen brown or reddish-brown with many various brownish marks, proboscis orange-brown where it extends 6-7mm beyond wings. 3rd- & 4th-stage larvae hibernate.

One flight M June-M July.

Adults visit flowers of all colors, including *Carduus nutans*, *Medicago sativa*, *Monarda fistulosa* (the favorite), *Verbena stricta*, sometimes mud, occasionally tree sap.

Males rait all day mostly in hillside swales among the host (sometimes in valley bottoms) to await females, as they rait ~50 cm up on vegetation there. In courtship, the female and male hover then land, when receptive females would presumably passively accept the male but most females vibrate or flutter their partly-or more-widely-open wings to repel males and the male sometimes flutters to transfer pheromone but usually just flies.

Polites mystic dacotah **Long Dash**

Identified by the broad yellow unh postmedian band of rather uniform width (unlike *P. peckius*), and the single small postbasal patch in several cells. The ups has much less orange than *Ochlodes sylvanoides*. The black male stigma and brown patch beyond it suggested the name "long dash", but other *Polites* etc. skippers also have that long dash. Colo.-Alta.-Ore. has the slightly-paler ssp. ***dacotah***. Occurs in the NE ¼ of Colo. Recent records from SW Colo. (Montezuma, La Plata, and Archuleta Cos.) and several counties in NE Ariz. may be errors.

Habitat moist grassy streamsides/valley bottoms on plains and foothills, a few sites in lower Canadian Zone. Hostplants in Colorado Poaceae: *Poa pratensis* (and ssp. *agassizensis*), sometimes *Agrostis gigantea*, *Calamagrostis canadensis, Poa compressa*. (Records of *Agropyron* [*Elymus, Elytrigia*] *repens*, *Echinochloa crus-galli*, *Phleum pratense*, and *Carex* are errors based on lab? *Polites themistocles*.) Mostly fairly common.

Eggs greenish-white or pale-yellowish-green, laid singly without glue so they fall into grass bases/litter near or on the host. Larvae eat leaves, and make silked-leaf-tube aerial nests (up to 70 cm above ground; also James & Nunnallee 2011 reported just aerial nests in Wash.). Older larva brown, a middorsal blackish-brown line, a faint slightly-darker brown band above spiracles, A10 unmarked brown, collar black behind whitish; head black. (Larvae in other states vary, slightly reddish-brown in Wash., sometimes brownish-green, a very-weakly-paler lateral ridge in Wash. photo; head sometimes reddish-brown.) Pupa very-dark-brown, blackish-brown on abdomen, a lateral blackish band on abdomen, proboscis red-brown where it extends 5mm beyond wings. 3rd- and sometimes 4th-stage larvae hibernate (James & Nunnallee 2011).

One flight M June-July (once Aug. 5 on the Squaw Mtn. Rd. 9400' in Clear Creek Co.).

Adults visit flowers of all colors including red, including *Apocynum cannabinum* (favorite), *Asclepias speciosa*, *Carduus nutans*, *Medicago sativa*, *Monarda fistulosa*, *Trifolium pratense*, and sometimes visit mud. Adults can shiver their closed wings to get warm.

Males rait all day in grassy swales or grassy streamsides in valley/gulch bottoms all day to await females, as they rait roughly ~94cm up on average (extremes 30-200cm representing a mixture of low-grass and tall-grass swales, N=9). In courtship, the male overtakes the female, both flutter/hover and then land, when receptive females would be quiescent and accept the male, but most females vibrate partly-spread or flutter more-widely-spread wings upon landing to reject the male, who sometimes flutters to transmit pheromone (or hovers near her) but usually just departs. Unreceptive females also drop into vegetation or fly. If a mating pair is disturbed, the female flies, the male dangling.

Polites sonora utahensis **Western Long Dash**

Like *P. mystic*, but lives only high in W U.S. mountains, and is smaller and the unh postmedian band is much narrower and more distinct. The subapical spot in unf cell M_1 is absent or nearly so, and the unh has a long white postbasal crescent. Ssp ***utahensis*** in the Rocky Mts. has greenish-brown unh.

Habitat Canadian-Subalpine Zone moist meadows. Hostplant in Colorado Poaceae: assoc. *Poa pratensis agassizensis*. Uncommon, sometimes common.

Eggs pale green or greenish-white, developing an orangish flush later, laid singly without glue so the eggs fall into the hostplant base/litter. Larvae eat leaves, and apparently live in a silked-tube nest in hostplant bases/litter (the only logical position on the turfgrass host), but James & Nunnallee (2011) found some made aerial nests in Wash. cages [the grass/cage base probably too tough to make a nest in]. Older larva light-reddish-brown on abdomen (Wash. larva dark-brown, more reddish-brown on abdomen), tan-gray on front and rear, heart-line darker, A10 top unmarked light-brown, collar black behind white, a ventral neck gland; head black. Pupa similar to *P. mystic*, bluish-black, rear of movable abdominal segments yellow-tan (reddish in Wash.), proboscis blackish-brown and extending 4-5mm beyond wings. Half-grown larvae hibernate (mostly 4th-stage in Wash., sometimes 3rd).

One flight mostly M July-M Aug.

Adults visit flowers of all colors including *Cirsium arvense* and *Aster*, but usually just visit the whitish ground-level *Cirsium scariosum* var. *acaulescens*; sometimes visit mud and manure. They fly very fast.

Males rait all day in low spots of gulches and meadows, as males sometimes rait in gulch bottoms on low rocks but usually rait in grassy meadows on low ~10cm plants next to flowers or on the zero-cm flowers (primarily the wide cream-flowered thistle *Cirsium scariosum* var. *acaulescens* that blooms at ground level in moist meadows—they feed and chase from those flowers, and males mostly trapline between those thistles--most adults can only be found on those flowers). In courtship, the male overtakes the female, they may hover then land, when the male may flutter with moderate ampltude to transfer pheromone and unreceptive females vibrate narrowly or flutter more widely to repel the male. If a mating pair is disturbed, the female flies, the male dangling.

Atalopedes campestris campestris **Sachem**

Males are easily recognized by the large gray-black upf patch next to the very-wide stigma. Females have a large transparent upf spot like some female *Hesperia* but have a large unh postmedian band of creamy or yellowish or tan spots, and the antenna has a more hooked tip. This species is not quite a regular migrant, and not quite a regular native; it is spreading northward.

Habitat valley bottoms in grassy areas, mostly in the lowlands but a record 9800' in the Wet Mts. Don Eff caught one in Boulder in 1954, and it was common in the Pueblo area in the 1960s, it is expanding northward and now is common in Denver and S Minn. and is now a resident in C Wash. It now occurs mostly on the E slope of Colo., with several records from the W slope in Grand and Archuleta Cos. Hostplants Poaceae: various grasses mostly lawn grasses elsewhere that are common in S U.S. It is assoc. with *Poa pratensis* and other grasses in Colo. It eats lawn grasses and survives mowers by living in a rolled-leaf nest in the turf base, so *Poa pratensis* is evidently the major host in Colo. An ovip. on *Buchloe dactyloides* in Neb. Fairly common esp. in late summer.

Eggs greenish-white, becoming white or sometimes slightly-pinkish cream, laid singly on or near the host. Larvae eat leaves, and live in nests of silked tied leaf tubes at the base of the grass/sod/soil (protected from mowers). Older larva dark green or brown, often more ochre-brown laterally, a dark brown middorsal line, sometimes a browner line near spiracles, collar black, neck whitish, ventral neck gland present; head black, with a weak to strong tan streak along coronal sulcus, usually a pale-brown adfrontal area, and frequently an orangish spot in front of eyes (head unmarked black in Wash. and often nearly-black in E U.S.). Pupa mostly light-brown when young, then head thorax wings become nearly black and abdomen becomes orange-brown and paler posteriorly (tan on front of otherwise-black segments and tan ventrally in Wash.), tan in movable area between A4-7, numerous brown-black dots esp. on abdomen, heart-band darker, proboscis extending 1-2mm beyond wings. Evidently no strong diapause and -0.6^{o}C is lethal to larvae, yet many 3rd-stage larvae can overwinter in Ore., where populations survived winters as low as -25^{o}C (Crozier 2004, James & Nunnallee 2011) perhaps in soil under snow.

Up to three flights May-E Nov., most common later in summer including L Aug.-Sept., suggesting that some mortality may occur during freezing winters.

Adults visit flowers of all colors (including reddish when adding the *Trifolium pratense* and *Monarda fistulosa* Ohio records of Iftner et al. 1992, and *Centranthus ruber* and violety-magenta-pink *Zinnia elegans*), including *Chrysothamnus* (*Ericameria*) *nauseosus*, *Heterotheca canescens*, *Medicago sativa*, *Tagetes ~erecta*, *Verbena hastata*, orange *Zinnia elegans*, *Echinacea purpurea*, *C. ruber*, and sometimes visit mud. Adults shiver to warm up. Many adults were seen roosting on cedar and other trees (P. & N. Rau 1916 Ann. Ent. Soc. Amer. 9:257).

Males rait all day mostly in grassy meadows and swales or benches on hillsides, as males rait ~0-200cm up (depending on the height of the grasses or flowers) there. In towns, they like great flowers near *Poa* lawns, where males rait on/beside flower patches, and sometimes flait about flowers to find females. Males investigate others and they fly ~7cm from each other laterally or around the area or vertically etc. before separating and landing again (males mostly prefer smaller butterflies somewhat similar, and seldom pursue large ones such as *Pieris rapae* or *Vanessa cardui*). In courtship, the male overtakes the female and they may flutter/hover and she lands, and he may hover around her to transfer pheromone, then a receptive landed female would be quiescent and accept a landing male. Most females are unreceptive, and after landing vibrate her wings several mm (wings spread usually ~10^{o} average [sometimes more 20-30-45^{o} especially if she basks a little while vibrating]) to discourage the nearby male (a landed male courted by another approaching male also vibrates his wings the same way to repel him), the male often flutters with wide amplitude about 2-3 cm away from a landed unreceptive female in irregular paths (rising up to nearly touch her, or lowering down near her repeatedly or going randomly around her), he often lands and she vibrates and he bends his abdomen to her causing her to fly to another flower and repeat many times the vibrating and male fluttering, until he departs (often chasing another). Males hover just 2-3 cm away from very fresh unreceptive females and attempt to join and rest nearby and pursue her for many minutes from flower to flower (evidently very young females' pheromone is stronger than older females' dissipated pheromone). Females mate just once, rarely twice (J. Burns).

Crozier, L. 2004. Warmer winters drive butterfly range expansion by increasing survivorship. Ecology 85:231-241.

Poanes hobomok **Hobomok Skipper**

Identified by the yellow unh patch like *Polites peckius*, but *P. hobomok* has only one tiny basal unh spot, and males lack a stigma. Ssp. ***wetona*** (Wet Mts. foothills in Colo., and Raton Mesa area along the New Mexico-S Colo. border, and presumably between those areas, also N N.M.) is paler than E U.S. ssp. *hobomok* and females are also pale like males. Ssp. ***hobomok*** occurs in Sedgwick Co. in NE tip of Colo. and in E N. Amer. incl. NE Wyo., and its females are much darker (sometimes all-brown in form *pocahontas* which is only common from N.H. to Penn., and is absent in Neb. and scarce in N.D.).

Habitat of *wetona* open oak-pine woods in foothills, evidently especially in valley bottoms. Hostplants Poaceae: evidently hay-grasses (like *P. taxiles*) (in E. U.S. *Panicum* [including *Dichanthelium*] spp. is preferred in W. Va., and *Schizachyrium "Andropogon" scoparius*, *Danthonia spicata*, and *Leersia oryzoides* are sometimes eaten [Allen 1997]; an ovip. on *Phleum pratense* in N.Y.). "*Poa*" is very dubious, evidently just a lab host. Ssp. *wetona* seems to be declining, as overgrowth of conifers in the Wet Mts. choke out its habitat. Uncommon.

Eggs pale green, becoming cream, laid singly on or near the host. Larvae eat leaves mostly at night, and live in silked-leaf nests. Older larva (ssp. *hobomok*, photo Allen et al 2005) reddish-brown with a whitish cast, or whitish tan, a dark heart-band, a very weak subdorsal darker spot near front of each A2-8 segment, two weak dark dorsolateral bands with a whiter line between them, collar whitish with narrow black rear; head uniform russet-brown; body and head covered with white hairs. Pupa reddish, with brown markings. 4th-stage (of 6) larvae hibernate (Wolfe et al. 2010).

One flight, most records for ssp.*wetona* M June-E July (rarely May 5-30 in early year at upper plains edge), so perhaps mostly end of May-June. Probably L May-E July in Sedgwick Co. Colo.

Adults visit all colors of flowers incl. *Geranium, Hedysarum, Lathyrus eucosmus,* pink *Symphoricarpos albus*, but seems to visit reddish flowers more than most butterflies (Scott, 2014a), and sometimes imbibe berries, mud, and bird dung. An adult in Ont. drowned in a *Cypripedium reginae* orchid.

Males rait all day 1-2m up on sunlit vegetation in small clearings in gulch bottoms or flat woods to await females. In courtship, the male overtakes the female, they flutter and land, and the male flutters his wings partly open to transfer pheromone and attempts to join. Unreceptive females flutter strongly to repel the male, and they fly. (I once saw a courtship of ssp. *hobomok* in the lion enclosure in the Minneapolis Zoo). Mating of ssp. *hobomok* lasts an average of 38 min. (J. Burns).

Poanes taxiles **Taxiles Skipper**

Adults are identified on unh, where males have large yellow areas with some brown rectangular areas and margin (the ups is mostly tawny with brown borders), and females are mostly brown on unh with bluish-gray lateral and posterior margins (the female ups is mostly brown with large orangish areas and subapical spots). There are slight differences between Colo. and Utah and Mex. adults, but those differences are not great (Nebraska and Black Hills SD. females have a stronger unh band, a weak ssp. *albimaculatus*).

Habitat gulch bottoms in lower mountains barely into the Canadian Zone, and Denver urban woodland. It is common in Denver. Hostplants in Colorado Poaceae hay grasses (mostly in fairly moist habitats in streamsides & gulch bottoms etc.) preferably shaded tall grasses with leaves about 3 mm or wider, usually growing in a single stalk [or few stalks] rather than a clump: commonly *Agrostis* *gigantea,* often *Agropyron* (*Elymus*) *canadensis, Bromus* (*Bromopsis*) *inermis, Agropyron* (*Elymus, Elytrigia*) *repens* (evidently a main host weed in Denver), *Agropyron* (*Elymus*) *trachycaulum, Dactylis glomerata, Agropyron* (*Leymus*) *ambiguus, Glyceria striata, Muhlenbergia racemosa, Phalaris* (*Phalaroides*) *arundinacea, sometimes Bromus* (*Bromopsis*) *lanatipes, Phleum pratense, Sorghastrum nutans,* seldom *Calamagrostis canadensis, Echinochloa crus-galli* var. *mitis, Agropyron cristatum desertorum, Glyceria grandis, Leersia oryzoides, Achnatherum* "*Stipa*" *scribneri, Bromus* (*Bromopsis*) *porteri, Agropyron* (*Pascopyrum*) *smithii var. molle, Agropyron* (*Thinopyrum*) *intermedium, Poa pratensis, Schedonorus (Festuca) arundinacea*. Wandering larvae ate the Cyperaceae sedge *Carex nebrascensis*. Fairly common consistently.

Eggs cream-white, laid singly on host leaf uns. Larvae eat leaves, and live in rolled-leaf silked nests. Older larva orangish-tan (sometimes greenish-ochre-tan), tan on the sides, a brown subdorsal band, a small subdorsal brown spot on front of each segment near middorsal band, two weak brownish dorsolateral bands, a narrow black collar (behind whiter area surely); head brownish-red or orange-brown, with weak pattern (a brown stripe edging coronal sulcus has a faint orangish band beside it, a light orange-brown band runs from just in front of eyes to top of head and contrasts with a brown streak extending up from eyes); head & body covered with short white hair. Pupa head, thorax, wings, & appendages dark-brown with a bluish-gray glaucous bloom, orangish-tan on abdomen (pale-tan on uns), many blackish dashes including transverse dashes & dots on abdomen, proboscis orange-brown where it extends 5mm beyond wings, eyes and cremaster red-brown. Pupates inside a silked-leaf nest, attached only by the cremaster. 4^{th}-5^{th}-(of 6) stage larvae evidently hibernate.

One flight M June-E Aug.

Adults visit flowers of all colors including red, especially purplish, including *Monarda fistulosa* (the favorite), *Cirsium arvense, Delphinium ajacis, Medicago sativa,* sometimes visit mud, and feed on bird dung using drops from the abdomen. They crawl completely inside the corolla tube of *Convolvulus* (*Calystegia*) *sepium* to feed. Adults shiver their closed wings to get warm. Adult females were seen roosting and camouflaged on the trunk and boughs of *Pinus edulis*.

Males rait all day in gulch and valley bottoms, especially in somewhat-shaded places, by raiting on vegetation averaging ~101cm up (5-200 cm, N=21). Males can rait in more shaded sites and in cloudier weather than *P. hobomok*. In courtship, the male overtakes the female, both usually hover (the male below) then land, (and now a receptive female would be quiescent and accept the male), but the unreceptive female flutters strongly to repel the male and the male flutters strongly behind to waft pheromone and tries to join, then they break up. Occasionally I saw a landed male move a bit sideways when the female stops fluttering and he flutters there, then she will flutter a bit and he will move the other way and flutter a bit. Males flutter at *Paratrytone snowi* females only ½ sec., evidently because the females produce the wrong pheromone.

Stinga morrisoni Arrowhead Skipper (Morrison's Silver Spike, Morrison's Skipper)

Resembles *Hesperia* on the ups, but easily identified by the silver unh streak from the base to the middle (forming an arrowhead along with the postmedian band).

Habitat foothills open pine woodland. It occurs mostly on the E slope, and just W of the continental divide on Monarch Pass and Summit Co. Eggs are laid on S- & E-facing slopes, none or almost none on N- & W-. Hostplants in Colorado large bunch-grass (evidently specializing on large clump size rather than plant chemistry) Poaceae: *Bouteloua curtipendula, Schizachyrium "Andropogon" scoparius, Achnatherum* "*Stipa*" *scribneri, Andropogon gerardii,* sometimes *Muhlenbergia montana,* occasionally *Bouteloua gracilis,* rarely *Festuca arizonica*. Uncommon.

Egg cream, oval in dorsal view and very rounded on bottom edges. Older larva tan, semi-translucent esp. on T3-A6 (tracheae are visible, and the two testes are visible inside A6 top of males), often slightly pinkish-tan on A7-9, heart-line darker, collar black; head amazingly highly-variable, from solid black (30% of larvae, and an Ariz. larva), or black with brown stripe near and parallel to coronal sulcus down the front (~36%) (an Ariz. larva same but stripe white), or mostly blackish-brown but coronal stripe and adfrontal areas and cheeks all orangish-brown (~27%), or dark-brown with orange-brown over most of the head (all except the solid-black heads have the blacker wedge on front of head along coronal sulcus and the blacker areas along adfrontal sulcus both colored orangish-brown). Larvae differ from *Hesperia* and *Atalopedes* by having straight long setae "hairs" on body and head (those two and *Polites-Poanes-Ochlodes-Paratrytone* have short hairs). Pupa black on head & thorax and wings, outer part of wings and appendages blackish-brown, proboscis reddish-brown where it extends ~6mm beyond wings, abdomen grayish-tan but rear light-brown, numerous blackish dots and dashes like *Hesperia* on abdomen. Mature fully-fed larvae hibernate, and usually refuse to pupate in lab.

One flight mostly L May-June (sometimes May-M June in mountains/plains edge of Wet Mts. in early years), L May-M July in higher Wet Mts. and San Luis Valley.

Adults visit evidently all colors of flowers, including *Oxytropis lambertii* and *Penstemon secundiflorus*, and often visit mud.

Males rait all day next to the top of hilltops/ridgetops to await females, usually not on the very top: males rait to await females mostly on the ground or low rocks (rarely on plants, an average of 16cm up [0-50cm, N=16]) in little clearings between shrubs or trees mostly on the periphery of the hilltop ~3-7m from the very top (once 30m) and mostly several m lower than the very top rather than on the very top, whereas hilltopping *Hesperia* males usually rait in more open sites on the very top. Adults have a slower flight than *Hesperia*.

Ochlodes sylvanoides napa **Woodland Skipper**

The unh is tawny with slightly-yellower large blocky postmedian spots and a central spot; the ups is mostly tawny (without white spots) with contrasting toothed borders. They fly later in summer. Males have an upf stigma, and females have a brown patch where the stigma would be. The abdomen tip is usually bright orangish. Ssp. ***napa*** in the southern Rockies incl. Colo. and E Utah is larger than ssp. *sylvanoides* from most of western U.S., but is otherwise identical so could be considered a synonym of it.

Habitat open woodland including gulches & N-facing slopes in foothills and sometimes into Canadian Zone (occasionally found at timberline such as Wolf Creek Pass and Loveland Pass), often occurring in mostly sagebrush westward. Hostplants in Colorado Poaceae hay grasses (wide-leaf tall grasses mostly in partial shade): *Leucopoa kingii*, *Agropyron* (*Elymus*) *trachycaulum*, *Agropyron* (*Leymus*) *ambiguus*, *Bromus* (*Bromopsis*) *inermis*, *Calamagrostis purpurascens*, *Agropyron* (*Elymus*, *Elytrigia*) *repens*, *Dactylis glomerata*, *Bromus* (*Bromopsis*) *lanatipes*, *Phalaris* (*Phalaroides*) *arundinacea*, *Phleum pratense*, *Agropyron* (*Elymus*) *canadensis*, *Agrostis gigantea*, *Bromus* (*Bromopsis*) *inermis pumpellianus*, *Muhlenbergia racemosa*. Common.

Eggs cream, laid singly preferably in partial shade (on N-facing nearly-always-wooded slopes or in shady areas near creeks) on the uns of dead leaves ~20-40 cm above ground on wide-leafed usually-tall hay grasses in patches of the hostplants. Larvae eat leaves (mostly at night when younger), and live in rolled tied leaf aerial nests. Older larva dull yellow-tan (often greener on front part of body due to food), a dark heart-band, a creamy dorsolateral band edged by darker lines (blending above the band to ground color), a weak grayish-tan line below that, a lateral cream band, a black collar; head white with black markings in early 5^{th} stage but later becoming red-brown or tan-brown with black markings (a blackish band extends all around rim of head, a wide black vertical stripe over coronal sulcus splits and extends narrowly downward beside adfrontal cleavage line, adfrontal areas and frontoclypeus mostly white but an inverted red-brown V on frontoclypeus has a vertical red-brown line in the middle), a paler band edges the vertical stripe due to fewer tiny red-brown dots, often a red-brown patch around eyes. Wash. larvae are variable, olive-green to cinnamon brown with the same stripes. Pupa pale yellow-tan with a slight grayish bloom (a few pupae have a slight pinkish tinge), wings &

head usually darker (light-brown) than abdomen, many blackish-brown dashes & dots on abdomen & top of thorax, proboscis light orangish-brown where it extends ~4-5 mm beyond wings; pupates in a silked-leaf nest of silk mesh like a screen, hanging dorsal side down by a silk girdle and by cremaster attached to the mesh. Wash. pupae are variable, whitish to cinnamon-brown. In the long hot summer of Calif. and dry lowland C Wash. mature larvae aestivate about a month before pupating (A. Shapiro; James & Nunnallee 2011; Wolfe et al. 2010 [perhaps Utah?]), but that evidently does not happen in shorter-growing-season Colorado. Unfed 1st-stage larvae hibernate.

One flight L July-E Sept. (perhaps mostly just July-Aug. in lowlands S of San Juan Mts.).

Adults visit all colors of flowers except pure red, including *Arctium minus, Aster foliaceus, A. lanceolatus hesperius* (a favorite), *A. laevis* var. *geyeri* (favorite), *A. porteri, Carduus nutans, Centaurea diffusa, Chrysothamnus* (*Ericameria*) *nauseosus, Cirsium arvense, Grindelia squarrosa, Heterotheca villosa, Liatris punctata, Medicago sativa, Solidago altissima* "*canadensis*", and often visit mud. An adult roosted 3m up on an *Ulmus pumila* tree branch. Adults strayed 4+ miles from the foothills to Lakewood.

Males rait all day mostly in gulch/valley bottoms (sometimes hillsides/ridges) to await females, by raiting an average of 85 cm up (15-150, N=20) mostly on vegetation. In courtship, the male overtakes the female, they flutter/hover with the male below/behind, they land and the female flutters with wings fairly widely spread (female fluttering is the female rejection dance) while the male flutters nearby with wings mostly spread and he tries to join but she moves away and flies (receptive females would be motionless after landing and the male would simply join). If a mating pair is disturbed, the female flies, the male dangling.

Ochlodes yuma yuma Giant-Reed Skipper (Yuma Skipper)

Identified by the spotless unh (yellow in males, tan-yellow in females), the orange ups blended into the narrow border, the large size, and the late-summer flight near Giant Reed. *Hesperia leonardus pawnee* and *H. ottoe* are similar but they occur only east of the continental divide in Colo. Colo. has ssp. ***yuma***; ssp. *scudderi* was named from Rio Blanco Co. CO but is a synonym of *yuma*, as are *lutea* and *sacramentorum*; ssp. *anasazi* from N New Mex. is a distinctive ssp. with darker somewhat banded unh.

Habitat lowland river edges and seeps where the hostplant Giant Reed *Phragmites australis* grows. Populations occur along major gentle rivers/creeks/canals incl. the Colorado R., and also occur at isolated colonies of *Phragmites* at springs. In 1986 I released adults from a Taos Co. NM colony of *O. yuma anasazi* onto the edge of the Arkansas River just W of Cotopaxi (Fremont Co. CO), but in 1990 none were seen there so the introduction evidently failed because there were not enough flowers or *Phragmites australis* there. Scott, O. Shields, and S. Ellis (1977 J. Lepid. Soc. 31:17-22) reported its distribution and biology. Since then it has been found at some very scattered sites in S and N Ida., Ore. and Wash. E of the Cascades, and N-C Wyo. Hostplant in Colorado and adjacent states Poaceae: *Phragmites australis*. (Recent floras list all Colorado *Phragmites* as this native species, not the introduced European *P. communis*, though W. Weber/R. Wittmann flora states that occasional populations are sterile and reproduce vegetatively and are *P. communis*, thus those might occur in Colo. somewhere.) Colonies may be possible on large grasses other than *Phragmites*: eggs were found on *Sorghum halepense* evidently in Utah (Wolfe et al. 2010), and adults were found with only *Agropyron* (*Leymus*) *triticoides* (a 50-120cm "hay" grass) in NW Nev. (Austin & Leary 2008), and there is a colony on only *Miscanthus sinensis* in Klickitat Co. Wash. Often locally common; if the population is just a colony at an isolated small site, collecting may damage the colony.

Eggs pale greenish-white, laid on or near host leaves, perhaps mostly under dead parts. Larvae eat leaves, and live in aerial rolled-leaf tube nests, feeding at night. Older larva whitish-green (a hint of yellowish on top, some larvae tan), a dark-green middorsal band, two subdorsal cream bands edged below by greenish, collar narrowly black; head cream or tan with numerous tiny brownish dots, with a black rim around side and top rim of head, attached to a vertical black bar down front of head over coronal sulcus that splits and narrowly extends halfway along adfrontal cleavage line, an inverted brown V on frontoclypeus encloses a vertical brown line. Pupa light brown, head and appendages dark-brown, wings brown, with two rows of dark-brown dots around each abdomen segment, proboscis extending ~3mm beyond wings. Unfed 1st-stage larvae hibernate.

One flight L July-Aug. (sometimes M July & E Sept.) (Aug. in N New Mex.).

Adults visit flowers of all colors except perhaps pure red, including *Chrysothamnus* (*Ericameria*) *nauseosus, Cirsium vulgare, arvense, Grindelia, Helianthus, Asclepias subverticillata, Pericome caudata*, *Chrysothamnus nauseosus*, etc.; they probably visit mud. Adults are local but can stray 1 km from an abundant colony.

Males rait all day in depressions near the host, especially in depressions between a river or gulch edge and the host, as they rait on large rocks or vegetation an average of ~2/3 m up (10-100cm, N=12—they may rait lower in weeds beside the host patch); at a large abundant colony males also fleek through the host reeds ~1m up to find females, and rait and chase others from flowers. Adults--especially males--can fly very fast. In courtship, the male overtakes the female, they flutter and land, when the female flutters with wide amplitude (an attempt to repel the male) in front of the male who flutters widely behind to transfer pheromone and tries to join, then the female flies (receptive females would be motionless and accept the male).

Paratrytone snowi snowi **Snow's Skipper (Rusty Gully Skipper)**

The rust-red unh and white fw spots (one hourglass-shaped spot in the discal cell) and male stigma characterize this distinctive skipper. The unh spots are creamy and blended into the background. Ssp. ***snowi*** evidently occurs in the U.S., because photos of *Paratrytone decepta* from E Mexico and *P. raspa* from S Mex. look to me like geographic ssp. of *P. snowi* which is mapped from northern Mexico.

Habitat upper foothills and Canadian Zone open coniferous woodland. Hostplant in Colorado Poaceae: *Muhlenbergia montana*; numerous ovipositions and found larvae prove it has just this one hostplant, which is unusual in Hesperiinae (*Blepharoneuron tricholepis* was a misidentification error, both grasses were in the same pressed newspaper). *M. montana* has fairly wide bluish-green leaves but they are thin (so dry out quickly when picked, thus cannot be used as lab food), and ranges south to central Mexico evidently along with *P. snowi*. Usually uncommon, sometimes common.

Eggs cream, developing a red ring and a red spot on top, laid singly on leaves of host clumps especially on ~20-cm wide lush host clumps without too many inflorescences. Ovipositing females hover ~20 cm above (and may fly back and forth before landing) the only host *Muhlenbergia montana* and oviposit on a leaf at the edge of the clump, gluing the egg onto a leaf uns. Most eggs are laid near valley bottoms and are scarce farther up. Larvae eat leaves, and usually rest head upward in a rolled-leaf nest made by silking ~10 of the thin leaves into a tube. There are six larval stages (most Hesperiinae have five). 1st-stage larva yellowish-cream (greener after eating), collar and head black or blackish-brown. Older larva gray-green, becoming tanish-gray-green, A10 light brown, a dark-gray heart line esp. on abdomen, a narrow brown collar; head light brown, a black median stripe down front of head (narrowest at top, completely enclosing frontoclypeus and adfrontal areas by the bottom (the stripe evenly tapered in females, wandering away from the sulci in male thus less wide in middle), lower rear of head blackish. Larvae pupate often on the host, in a loose silk tubelike nest of ~10-15 silked leaves, attached by cremaster hooks but not by a silk girdle, the exit above pupa has ~9 multistrand silk cords loosely closing exit, the nest powdered with the usual wax flakes. Pupa head blackish-brown and slightly pointed forward, appendages brownish-tan, thorax brownish or reddish-brown, abdomen tanish-cream with tan heart-band. Half-grown larvae hibernate (perhaps 4th-stage), based on the time of flight.

One flight mostly M July-E Aug. in S Colo., July in the Front Range (one wreck found Aug. 20), evidently flying later southward (M July-M Sept. in SE Ariz.).

Adults visit flowers of all colors, more often purplish ones, including *Astragalus hallii, Monarda fistulosa, Oxytropis lambertii, Penstemon virgatus asagrayi*, and occasionally visit mud. Scott (1974h) studied this species. When disturbed (by capture and marking etc.), adults often flew onto a tree or bush and rested for 5 min.; they probably roost there also. Adults averaged about a week lifespan in my mark-recapture study. When landing, adults face uphill, or into the wind, or along a twig, and if they can turn they face away from the sun to bask with fw ~45^{o} from vertical and hw ~70^{o}.

Males rait all day in the bottom of narrow gullies (sometimes valley bottom trails/dirt roads or even on boulders in creeks) to await females, as they rait on short vegetation, twigs, or rocks/boulders an average of 55cm up (5-150cm, N=28), and chase other small dark butterflies and other insects within a space of about 5m of the gully. Males also court females on flowers near the gully. Adults fly extremely fast (like the blazing speed of *Hesperia miriamae*), and can move 1.6 km or more. In courtship, the female flies past and the male approaches within a few cm, when a receptive virgin female lands and the male lands (he may flutter slightly before landing) and bends his abdomen laterally to mate (in the one completed mating seen, the female landed after the male approached, the male fluttered slightly, landed, and bent his abdomen laterally to mate). Unreceptive females flutter their wings to repel the male (virgins rarely flutter) and may hover about 3 cm above the ground; if the female hovers, the male hovers also and moves sideways behind and around the female and now and then moves forward touching her evidently to transfer pheromone (both sexes hover by beating their wings rapidly at wide amplitude); unreceptive females also crawl away or fly. Males have a pheromone in their stigma, and young females evidently also have a pheromone, as males remain behind virgin unreceptive females for an average of 15 min., but only 7.4 sec. on average near females found to be mated (females usually mate just once, often twice, seldom 3-5 times). Some females wait until their second day to mate.

Scott, J. 1974h ("1973"). Adult behavior and population biology of two skippers (Hesperiidae) mating in contrasting topographic sites. J. Res. Lepid. 12:181-196.

Anatrytone logan lagus **Delaware Skipper (Black-Vein Skipper)**

Identified by the black ups veins at least near the margin, the narrow upf borders, and the unspotted plain orangish-yellow unh. Adults are larger than *Thymelicus* which also has black ups veins. Females have wider ups borders and darker veins than males; females usually and males sometimes have a black dash at end of upf discal cell. Ssp. ***lagus*** from Colo. is paler with narrower borders and less black than E U.S. ssp. *logan* (the intergrade zone of the two ssp. extends from W Texas to S-C Neb.). The type locality=TL of *lagus* ("Oak Creek Can." in S Colorado, where there are two "Oak Creek Canyons" in Fremont Co. but none in Custer Co.) is in an area where the butterfly is currently absent, as the butterfly is now found in the Front Range/NE Colo. and in extreme SE Colo., so that TL is evidently an error.

Habitat grassy valley/gulch bottoms in plains and lower foothills. Hostplants Poaceae: always large or very large grasses (including hay grasses), associated with *Bromus* (*Bromopsis*) *inermis* in some places in the Front Range. {Proven hostplants for ssp. *logan* in E U.S. including many from Florida: *B.* (*B.*) *inermis* (my record in Minn.), *Panicum virgatum*, *hemitomon*, *Andropogon gerardii*, *virginicus*, *Sorghastrum nutans*, *secundum*, *Erianthus giganticus*, *alopecuroides=divaricatus*, *Arundinaria gigantea*, sometimes even Cyperaceae: *Carex aquatilis* in NY.} *A. logan lagus* is not common and females are scarce, and I spent many days trying to observe ovipositions or find larvae of this species, and I found a larva only for *A. logan logan* in Minnesota. Uncommon in Colo. (usually one or none seen/day).

Eggs yellowish-cream when laid, becoming pale-yellow with narrow and sharp red rings (one around top, the other around side), egg slightly oval in dorsal view, lower edge slightly rounded, laid singly on hay-grass leaf uns. Larvae eat leaves, and live in aerial silked-leaf tubes on host. Older larva pale bluish-green, heart darker blue-green, suranal plate creamy with two transverse black arcs all across it that resemble eyebrows, collar black (wider laterally) and whitish in front; head (Minn. & Mass.) cream with black vertical spear on front extending from mouthparts to rear rim (narrowly touching black rim), a black vertical spear beside it not touching black rim, and a black lateral band extending up and narrowing to form rear rim of top of head (in W.Va. these black marks are red-brown, and on lower frontoclypeus is an inverted red-brown V enclosing a red-brown vertical line), rear rim black. Pupa black, a narrow greenish-cream streak extends from above wing to underside of A4, the posterior movable parts of A4-7 greenish-cream (black rings all around anterior part of segments A4-7), some black dots are near the proboscis which extends 7mm beyond wings, cremaster narrow with unhooked crochets but an anteriorly-directed black spine hooks into nest wall, no silk girdle (pupa greenish-white in E U.S., the head and rear black). Half-grown larvae hibernate.

One flight L June-E Aug., but M June-M July in extreme SE Colo.

Adults seem to prefer purple flowers, sometimes yellow pink reddish etc., including *Monarda fistulosa*, and sometimes visit mud. Adults bask the usual Hesperiinae way, with hw spread more than fw.

Males rait all day in grassy swales in gulch/valley bottoms/roadside ditches (preferentially on a little grassy bench beside the lowest spot of a rocky/dirt gulch), as they rait an average of 66cm up (10-150cm, N=17). Courtship was not seen in this uncommon species.

Euphyes bimacula illinois **Two-Spotted Sedge Skipper**

Identified by the orange-brown unh with whitish veins, the white narrow abdominal margin of unh, and the unmarked brown uph. On upf, males have a long narrow stigma, females have several white spots. Ssp. ***illinois*** from Indiana westward to Colo. is much larger than ssp. *bimacula* in E N. Amer. and the fw spots on females are smaller. This skipper evidently expanded its range from Nebraska into Colorado, although it might have occurred originally in the NE corner and Yuma Co. While researching the history of the South Platte River for his ~dozen historic trail maps of most of Colorado (published by the U.S. Geological Survey), my father Glenn R. Scott learned that originally and in the late 1800s there was only ONE tree along that river between Julesburg and Denver, a cottonwood tree, because bison rubbed their backs against little trees and destroyed them. Irrigation along that river and people's disgusting extermination of plains bison produced a continuum of trees and good *Carex nebrascensis* sloughs, and let the butterfly spread to Fort Collins by the 1980s, and by 1983 it spread to just south of Boulder into an irrigation-ditch slough where I had often visited previously without seeing it. Frank Cross reported in 1937 that C. P. Gillette caught a single specimen in Dixon Can., Larimer Co. June 30, 1892, but that specimen might have been *E. vestris*, and I did not find that specimen in the C. P. Gillette Museum of Arthropod Diversity at CSU.

Habitat short coarse-sedge meadows in plains valley bottom sloughs & spring-fed lake edges. Hostplants in Colorado Cyperaceae sedges: usually *Carex nebrascensis*, sometimes *C. simulata*. Uncommon, sometimes common at large lush patches of the host.

Eggs greenish-cream when laid, soon developing a reddish ring near base (wider in E U.S. ssp. *bimacula*) and a small red ring around top, an acute angle at lower edges, laid singly on the host. The female lands on host sedge and backs down the sedge until she is only 2-5 cm above the mud, and oviposits on leaf uns, then she flies and her fw tips are gradually ripped off by the sharp edges of adjacent *Carex* leaves. Larvae eat leaves, and live in silked-leaf nests. Older larva light-green, a darker-green heart band has a pale green line through its middle on A1-8, a cream line along spiracles, suranal plate has long light-red-brown setae along posterior rim, underside greenish-tan, narrow collar black with narrow middorsal gap, whitish neck; head cream, with a black cyclops eye on forehead laterally clasped by white, frontoclypeus tan with inverted weak russet V, a long russet spike points upward beside that, and a russet (blackish in some individuals) band runs from side up to top where it narrows and meets same band from other side, sides near rear creamy-gray, a white patch just behind eyes (ssp. *bimacula* larva bluish-green, with a whiter lateral line, head creamy with same markings). Pupa blackish, appendages dark-green, abdomen light mottled green with orange-brown dorsal flush and dark-green heart band, cremaster blunt 2mm wide with two lateral spines on each side but no crochets. Half-grown larvae hibernate (my notes say evidently 4th- & 5th-stage of 6 stages, but flight period suggests 3rd-stage; others report 3rd-4th.

One flight L June-M July.

Adults frequently visit *Asclepias speciosa* and *A. syriaca* flowers.

Males rait all day near the host in moist/wet sedgy/grassy swales in valley bottoms/lake edges, as they rait on 1/3-2/3m stems. In courtship, the male overtakes the female, they flutter/hover then they land, when receptive females would be quiescent and accept the male while unreceptive females vibrate their wings partly open (the rejection dance) and the male behind rises and hovers near her then leaves. If a mating pair is startled, the female flies, the male dangling.

Euphyes vestris kiowah **Dun Sedge Skipper (Sedge Witch)**

Identified by the dark uniformly-brown wings and head, and mostly brown fringes (the palpi tips are a bit orangish, which is not very noticeable). Males have an upf stigma, and females have several paler fw spots and the lower one is slightly crescent-shaped (females rarely have faint unh spots). Females of similar *Polites* have many spines and two spurs (large spines) on the second long segment (tibia) of the middle legs, whereas *Euphyes* have two spurs but no spines. The ssp. in Colo. and the Rocky Mts. is apparently ssp. ***kiowah***, a weakly-defined ssp. distinguished by smaller tan female fw spots, compared to ssp. *vestris* from the Sierra Nevada of Calif. and ssp. *metacomet* from E U.S. with larger whiter spots, but coastal Calif. butterflies (ssp. "*osceola*") also have weaker female spots like *kiowah*, and the ssp. have been inadequately studied, and the mostly uniform brown coloration provides few traits to study. Ssp. *kiowah* also has almost no orangish flush around the male stigma and has almost no trace of an unh median band (ssp. *metacomet* in E N.A. incl. S.D. has a slightly orangish tinge and a slight unh median band; ssp. *vestris* in Calif. has a slight unh median band).

Habitat fairly open woodland etc. in the lower mountains. Hostplants in Colorado dry-land Cyperaceae sedges: in lower foothills usually *Carex inops* "*pensylvanica*" *heliophila* which grows on open slopes even S-facing, sometimes *C. pityophila=geophila*, in upper foothills *C. rossii* (those two *Carex* grow mostly in shade of conifers). *E. vestris* is common and widespread, because the dark-green turflike clumps of sedge hostplants are abundant on not-wet hillsides and flats.

Eggs slightly-greenish pale yellow, developing a wide red ring (wider than *E. bimacula*) and a red spot often with pale yellow center on top (a larger just-red spot in E U.S.), laid singly on host leaf uns. Larvae eat leaves, and live in rolled silked leaf tube nests. Older larva pale green with tiny whitish striations making it appear bluish-green, the front may be slightly tan, heart-band darker green with a narrow white line through it, a thin black collar behind whitish area, A10 creamy with black rim and a black dorsal crescent; head cream, with a black "cyclops eye"oval clasped by white on the forehead above a brown front (which has brown markings along frontoclypeus), from beside frontoclypeus a long brown spike aims upward beside black oval, a blackish-brown band runs around side and narrows as it crosses top (the lower front and spike and band are russet-brown in E U.S. ssp. *metacomet*), a blackish-brown band runs around rear rim of head. Pupa head & thorax blackish-brown, blending to greenish-brown on last half of thorax, wings blackish-brown (dark-brown outwardly), abdomen pale yellow-green but top of A5-8 brownish, the telescoping parts of abdominal segments brown-green, proboscis extends 3.5 mm beyond wings, cremaster wide with no hooked setae and pupa is held in place in silked nest by two black spines on each end of cremaster ridge, plus ventral setae on A8-10.

(Pupa in E U.S. yellow-green, hairy, the abdomen whitish-green, the head tan.) 3rd-stage (perhaps 4th sometimes) larvae hibernate.

One flight mostly M June-E Aug., but I have many M Aug. and some L Aug.-E Sept. records from the Front Range foothills which may represent a partial 2nd generation.

Adults visit flowers of all colors even reddish, mostly *Monarda fistulosa*, but also *Apocynum androsaemifolium, Asclepias, Carduus nutans, Geranium caespitosum, Heterotheca villosa, Medicago sativa, Verbena stricta*, sometimes visit mud and carrion, and also frequently recycle bird dung (drops from anus dissolve dung, long proboscis sucks it).

Males rait in gulch bottoms all day to await females, as males usually rait an average of 72cm up (30-100cm, N=14, but the average jumps to 107cm when two observations of 3m and 4m are included). In courtship, the male overtakes the female, and usually both hover, sometimes the male and female fly back and forth 6" from each other (in a successful courtship), or she hovers and the male hovers mostly beneath her several cm and sometimes rises up to touch her about once per second, the female lands and the male lands behind, then in successful courtship she is quiescent and the male bends abdomen and joins and turns to face opposite. Female fluttering is the rejection dance: unreceptive females flutter upon landing (sometimes she vibrates her moderately-spread wings) to repel the male who usually flutters behind her and bends his abdomen to try to join or may hover over her and go back and forth or hover beside or under her, but then he departs. If a mating pair is startled, the female flies, the male dangling. Females can mate several times.

Notamblyscirtes simius simius **Simius Skipper (Hilltop Little Skipper)**

Resembles *Amblyscirtes*, identified by the pale upf discal-cell spot (rarely absent in males), the whitish uncheckered fringes, orange in middle of unf, and gray unh with blended cream band & postbasal mark. Adults vary continously on ups from nearly black (**form nigra**) to quite orange (**form rufa**, esp. females). I named the genus *Notamblyscirtes*, because it differs spectacularly from *Amblyscirtes* in five genitalia traits of both sexes, in palpi length and positioning, mating time and location, hostplant shape, egg color, hibernation stage, larval nest location, lack of dracula fangs on larvae, other larval traits (collar color, head pattern, lack of waxy powder), and pupal cremaster position and crochets (Scott 1992 p. 147; Scott, in Scott et al. 2006 Papilio [New Series] #12:70). {Ssp. ***simius*** occurs in Colo. to N Ariz., and has paler unh and a differently-shaped fw chevron than the brown-unh S Ariz.-Mex. ssp. *durango*.}

Habitat shortgrass prairie or open pinyon-juniper woodland, on the plains/San Luis Valley and Arkansas Canyon. Scott (1973c) studied this species. Hostplant in Colorado Poaceae: *Bouteloua gracilis*. It is absent for about 50 miles in the higher-altitude Denver region, and is common southward (found 7 mi. NW of Elizabeth in Douglas Co.) and northward of this area (in N Weld and N Larimer Cos.). Several other Colorado butterflies show this range-gap pattern, including *Atrytonopsis hianna* and *Pontia chloridice beckerii* and *Apodemia mormo*, and a bigger gap is found in *Cercyonis meadii* which reappears northward in the center of Wyoming. Usually uncommon, but may be abundant on the Dry Union Formation (a silty grayish rock) in Arkansas Can.

Eggs slightly-yellowish-cream, developing a red ring around egg and a second small red ring around top, a small flange around base, laid singly on host leaf uns. Females usually land on bare ground, but when ovipositing they land on grass. 16 ovips. were seen on *Bouteloua gracilis* 09:03-14:44. An ovipositing female darts back and forth (30 cm each way) 30 cm above ground over the host *Bouteloua gracilis* and lands at the edge of a clump and lays an egg on leaf underside several cm up. Larvae eat leaves, and live in silked-leaf nests in host bases (the bottom of nest 5-10mm below soil level). Older larva light (slightly-yellowish) bluish-green, heart band dark-blue-green, collar green, the anal comb evidently shoots dung away; head has tan-brown stripe along coronal sulcus that is edged by a tan stripe that is edged by a tan-brown vertical band extending down to middle of adfrontal cleavage line, rest of head slightly paler tan-brown, tan on lower part of coronal sulcus and on adfrontal areas, dark-brown adfrontal sulcus and cleavage line, frontoclypeus tan with brownish vertical line, lower part of head tan, fangs absent, waxy powder evidently absent before pupation. Pupa tan-cream on head thorax & wings, abdomen cream turning slightly-yellowish cream, heart-band light-brown on abdomen, proboscis orange-brown where it extends 6-7mm beyond wings, cremaster aimed ventrally without crochets. Unfed 1st-stage larvae hibernate in base of grass clump, the tiny larvae amazingly endure most of the summer and fall and winter before they can eat.

One flight L May-June on the plains, M June-E July in Arkansas Canyon, evidently L June-July in San Luis Valley. (A male from prairie near Eagar in E-C Ariz. was dated mid Aug., perhaps showing influence from the S Ariz.-Mexico ssp. *durango* which mostly flies in July.)

Adults visit flowers of all colors, including *Oreocarya suffruticosa, Erigeron pumilus,* yellow *Opuntia macrorhiza,* yellow *O. polyacantha* (favorite), and *Penstemon secundiflorus* (favorite); I saw none on mud. They amazingly crawl among the little beetles and stamens of yellow-flowered *Opuntia* to get nectar, but do not visit purple-flowered *O. polyacantha*. Adults fly fast, like *Hesperia*, but adults are sedentary, seldom moving more than 200m. Adults average 5-7 days lifespan, maximum ~15 (hot weather reduces lifespan) (Scott 1973c). Adults bask with fw 90^o apart, hw 140^o as usual in Hesperiinae, and mostly turn to face away from the sun except when the sun is high. In hot weather they rest in the shade under a tree or bush, or occasionally the shade of a rock or up in a tree. Adults evidently roost on the ground, as several males were found in shade there at 17:06, and in a rain a male crawled into a grass clump.

Males rait from 07:40-~10:50 (sometimes 11:10--maximum raiting 08:30-09:30) on little hilltops & ridgetops to await females, as they rait mostly on bare ground. Virgin females fly to hilltops to mate, frequently early morning on the day after they emerge in early morning (the proportion of virgins was 21% on ridgetops, only 5% on hillsides). In courtship the male pursues her within 8 cm, then in four rapid matings the female merely landed with the male behind and they mated, while in five cases the female initiated a rapid “zigzag dance” just above the ground as she darted very rapidly up and down (3 cases) or back and forth (2 cases) about 15cm each way for 10-20 times, and the male followed her movements exactly, no more than 5-8cm below her, then they landed and joined. Virgins and mated females were noted to use this zigzag dance before mating, which might be a “test” of males (it is doubtfully a rejection dance). Unreceptive females fly a short distance when courted, and do not seem to flutter to reject the male. The male evidently transfers pheromone from his stigma during this dance, and females evidently have a short-distance pheromone, as several females who could not even fly were found to be mated with a spermatophore. About half the old females of *simius* had mated twice, rarely three times (n=215). If a mating pair is startled, the female flies, the male dangling.

Scott, J. A. 1973c. Convergence of population biology and adult behaviour in two sympatric butterflies, *Neominois ridingsii* (Papilionoidea: Nymphalidae) and *Amblyscirtes simius* (Hesperioidea: Hesperiidae). J. Anim. Ecol. 42:663-672.

Atrytonopsis hianna **Dusted Skipper**

Identified by the dark grayish-brown wings without orange, the gray uns margins, the few unh postmedian brown dots or white spots, the unspotted uph, and the few fw white spots (generally 3 together near costa, usually a tiny dot at end of discal cell, and often several postmedian spots). The male stigma is tiny and three-parted. The palpi are whitish, white occurs closely above the eye, and a small black patch is in front of the eye. Ssp. ***hianna*** in N Colo. usually has a band of brownish dots across unh and often some white unh dots, whereas ssp. ***turneri*** from Colorado Springs southward usually has no unh markings. *A. hianna* is absent in the Denver region (the foothills from Boulder nearly to Colorado Springs).

Habitat gulches/slopes in the foothills near the Colorado hostplant Poaceae: *Andropogon gerardii*. Usually uncommon, sometimes common on large lush swards of the host.

Eggs cream when laid, after 1-3 days turning frosty-light-red with cream narrow ridges/bumps, laid singly on host. Larvae eat leaves, and live in silked-leaf-tube nests, apparently low in the host near soil in Colo. because I could find no nests on the plants (in E. U.S. nests are higher on the plant than *Hesperia metea*). Older larva (in E U.S., photos Wagner 2005, Allen et al. 2005) reddish-brown, collar black behind tan, a whitish line along spiracles; head blackish; body and head covered with ~0.5mm short white hair. Also described in E U.S. as mostly reddish or pinkish-brown (lower sides of A1-7 sometimes pale gray), or larva pale green to brown, collar dark brown or black; head reddish-purple or dark brown. Pupa brown, wing cases light brown, abdomen light orange with pink overcast, in a nest of leaves. Mature larvae hibernate, in a silked-leaf tube the end of which is sealed with silk and leaf bits.

One flight mostly May-M June (sometimes L June).

Adults visit flowers of all colors, including *Erysimum asperum*, and visit mud.

Males rait all day to await females: in ssp. *turneri* in Colo. & N Texas they rait on or near the ground (0-10cm up) on 2-4m wide relatively flat usually-short-grass clearings of valley/gulch bottoms; in ssp. *hianna* they rait usually on 10 cm plants or rocks (occasionally on ½ m grass stalks) on concentrations of the host *Andropogon gerardii* on moist concave areas of hillsides or on sloping flats. (There is a report of males raiting on hilltops in Fall River Co. SD and the sand hills of N Neb., but I have not seen hilltopping in Colo.) In courtship, the male overtakes the female, she hovers and the male hovers usually below or behind her (reportedly he may loop over and under her a number of times), they land and he vibrates his wings or flutters strongly below/behind her and crawls beside her and bends his abdomen to try to join, but she flies (receptive females would remain stationary and motionless as the male joins) (unreceptive females probably flutter to reject males but this was not yet seen in my few observations). Mating of a receptive female (of *A. hianna loammi*=*quinteri*) was seen by J. Burns (2015 J. Lepid. Soc. 69:289): the female flew over a raiting male who pursued, she quickly landed with the male beside her and joined; another female was a bit less receptive and they fluttered about each other then they landed out of view and joined within 60 sec.

Atrytonopsis vierecki Viereck's Skipper

Similar to *A. hianna* with a gray unh, but has large white fw spots including an hourglass-shaped white spot in the fw discal cell, and the unf tornus has a white spot with a spray of white projecting distally from it.

Habitat shortgrass prairie and open pinyon/juniper woodland. Hostplant in Colorado Poaceae grass: *Bouteloua curtipendula* var. *cespitosa* (the large bushy var. of this grass) (an oviposition was on *Achnatherum* "*Oryzopsis*" *hymenoides* in SW Colo., which may not be a major host because it is a tough grass). Mature larvae hibernate. Uncommon to fairly common.

Eggs cream when laid, turning dirty-browner-cream. Older larva pale tan, but T3-A6 bluish-greenish-tan due to food, heart line darker, A10 brown, a narrow black collar behind whitish neck area; head brown, with a black triangle on front, the bottom of triangle widening to include eyes, a short brown line along coronal sulcus is within black triangle. Pupa unknown. Mature larvae hibernate.

One flight L May-start of July (May-June Archuleta Co.).

Adults evidently visit flowers of all colors, including yellow *Opuntia* and *Cirsium*.

Males rait all day in gulches to await females, especially in clearings between shrubs on a slope barely above gulch bottom, as they rait usually on 1m tall vegetation or sometimes on rocks.

Papilionidae Swallowtails

There are ~424 Papilionidae species worldwide, most of which have a long "swallowtail" on hindwing. Most Papilionidae are quite large in size, and many are strong fast fliers, but few migrate. They have six large legs, and the foreleg has a large projection (epiphysis) near the base of the tibia (present in Hesperiidae, absent in Pieridae/Nymphalidae/Lycaenidae) and there is usually only one A vein on the hindwing (two in other families including Hesperiidae). Adults (except *Parnassius*) continue to flutter when they visit flowers, an unusual trait but often necessary because their heavy weight might drag down the flowers. They bask dorsally, with wings spread. Larvae eat dicotyledon plants. The older larvae have an osmeterium, a forked orangish snake-tongue-like structure that pops out behind the head and stinks to repel ants and other insects and spiders and similar predators (K. Honda 1983, Physiol. Ent. pp. 173-179), using numerous chemicals (aliphatic acids, esters, monoterpene hydrocarbons, and sesquiterpenes in various Papilionidae) which in general repel worker ants and other arthropods rather than vertebrates. Osmeterium chemicals include isobutyric and 2-methylbutyric acid in Papilionini (*Papilio*) and Leptocircini (*Eurytides*) and Parnassiinae (*Parnassius*) and Baroniinae (*Baronia*), sesquiterpenes in Troidini (*Atrophaneura* & *Pachliopta*; Β-selinene & selin-11-en-4a-ol in *Battus*), monoterpenes in *Leudorfia* and *Sericinus* (both Parnassiinae); monoterpenes & sesquiterpenes in *Papilio demoleus*; aliphatic acid & ester in *Graphium* (Leptocircini); mostly three varieties of bisabolene in *Papilio thoas*. In most Papilionidae the osmeterium chemicals do not change with age, but in *Papilio machaon*, *xuthus* and other *Papilio*, young larvae produce different chemicals than older larvae (see Wikipedia). Larvae of Papilionidae evidently lack the ventral neck gland that is present in other butterflies (Hesperiidae, Pieridae, Nymphalidae) and produces a chemical to repel predators such as ants; the osmeterium evidently substitutes for the ventral neck gland. Oil droplets exuded from setae of very young larvae were reported in *Papilio zelicaon* (James & Nunnallee 2011), and may be more prevalent; in Pieridae and Nymphalidae those oil droplets evidently repel predators such as ants. Like Hesperiidae, the living eyes have no special spot-pattern reflections (Sibatani 1973), whereas Pieridae Nymphalidae Lycaenidae often have complicated eye patterns. Papilionidae can see all the colors from uv to red, for instance *Papilio aegeus* has optical receptors for Ultraviolet360, Violet390, Blue440, Green540, and Red610 (A. Kelber 1999 J. Exper. Biol. 202:2619-2630). The origin of Papilionidae is controversial, it evidently branched off of the butterfly family tree before Pieridae (although a computerized tree [Heikkila et al. 2011] involving just morphological traits placed Papilionidae and Pieridae on the same branch), then the epiphysis was lost and Pieridae split off the line leading to Nymphalidae/Lycaenidae.

Parnassiinae, Parnassiini Parnassians and relatives

Most Parnassiini are Eurasian, and Colorado has only one species. They lack tails, and their habits are unlike the other Papilionidae. Older larvae have osmeteria, but they are rarely or seldom used. Older larvae have a carpet of short hairs, unlike Papilioninae, and they can squeeze into small holes including loose soil, and they pupate in pebbly soil or under rocks etc., in a loose cocoon, attached by a silk girdle but not the cremaster. Larvae and adults are unpalatable to vertebrates, and larvae and adults have tough bodies that can resist a moderate bite by a predator. The white adults may be Müllerian mimics with various white species of Pieridae-Pierinae that eat Brassicaceae (Cruciferae) plants as larvae and contain mustard oils that make them unpalatable (birds pick up *Pieris* and drop them unharmed in disgust).

Parnassius corybas (or ***P. smintheus***) Smintheus Parnassian

Easily identified: it differs from other North American *Parnassius* by having red fw spots, and the antenna shaft is alternately ringed with black and white. Ssp. ***smintheus*** occurs in most of Colorado below timberline; it has mostly-white females (*sayi* is a synonym, one of 10 other synonyms in western U.S.—many people were too zealous in naming numerous synonyms of *smintheus* [but that's nothing compared to the incredible ridiculous farce of 200 synonyms of *Parnassius apollo* named in Eurasia]). Ssp. ***hermodur*** occurs in the alpine zone in most of the mountain ranges; adults are smaller, and have smaller spots and females are mostly blackish (they are genetically blacker than ssp. *smintheus*, and remained blackish when raised in my lab in lowland Lakewood). In the San Juan Mts. of SW Colorado mostly in the alpine zone, ssp. ***pseudorotgeri*** has males with a mostly-complete submarginal band of blackish marks on upf unlike the other ssp., and females are variable but are mostly rather blackish. C. Guppy (1986 Can. J. Zool. 64:956-962) found that adults throughout N.A. are blacker on the wing bases in colder places for thermoregulation (sunlight hits the black area and heats up the adjacent thorax), whereas the fw margin is blacker in some regions (which does not warm the thorax) because of genetically different subspecies (such as *hermodur* and *pseudorotgeri* and the very black Montana ssp. *maximus*). In Yukon and NW BC *P. corybas* occurs (previously known as *P. phoebus* before the name was changed in the Old Name Sewer) and *P. smintheus* and *P. corybas apricatus* are reported to occur near each other in Yukon so may be distinct species, though this decision is questionable as they apparently look very similar in some regions and mtDNA cannot be trusted, and the latest phenogram based on molecular and morphological data shows that the branch of *corybas/phoebus/bremeri/smintheus/behrii* has less genetic distance than within *P. apollo* so they may be conspecific (F. Condamine & F. Sperling 2018 News Lepid. Soc. 60:94-99). Adults apparently are Müllerian mimics with other white butterflies (Pierinae), and birds refuse to eat them because of their powerful odor/taste. Both sexes possess a powerful odor that humans can smell that repels predators such as birds; fluids from pinching the thorax--like a bird would do--irritate human nasal passages and cause sneezing; the female pheromone is evidently different from that odor, as it is limited to young females. Adults have a tough leathery body (like other poisonous butterflies such as *Danaus* and *Battus*) that survives a moderate pinch by bird or human.

Habitat open areas in the mountains with abundant *Sedum*/*Rhodiola*, from the base of the foothills (sometimes on South Table Mtn. just W of Denver) to alpine tundra. Scott (1973b) studied ssp. *smintheus* near Rosita, Custer Co. Colo. Hostplants in Colorado herb Crassulaceae: *Sedum lanceolatum* for ssp. *smintheus*, *Rhodiola* (*rosea*) *integrifolia* and *S. lanceolatum* for ssp. *hermodur*, and *R. integrifolia* and *R. rhodantha* for ssp. *pseudorotgeri*. The hostplants are *Sedum lanceolatum* usually from the foothills to tundra, and also *R. integrifolia* in some tundra colonies in the Front Range (though *hermodur* was not seen at an *R. integrifolia* patch on Pikes Peak), and *R. integrifolia* is the usual host for San Juan Mts. *pseudorotgeri* (and for Alaskan *P. corybas apricatus*); *pseudorotgeri* also occurs mostly in moist cirques as does *apricatus* thus shows a link to that butterfly. Common, sometimes abundant where the host is abundant).

Eggs white, laid indiscriminately/randomly on grass or other plants or plant litter or soil near the hostplants (an average of 17 cm away from the hostplants). Egg micropyle varies individually too much to use as a taxonomic character (B. Schmidt & S. Matter 2011 J. Lepid. Soc. 65:223-226). Older larva black with two rows of yellow (sometimes orange or whitish) spots (each segment has one spot near top, three moderate to tiny subdorsal spots in Colo. (a large anterior and a small posterior yellowish spots in a subdorsal row in Wash. and the same two in Utah, in N Calif. just one subdorsal spot and all spots are larger and orangish). Larvae have a short yellow osmeterium, which is evidently usable and produces a bad smell, though they do not use it much and often just curl up when disturbed. Normally the older larvae rest on the ground to display their yellow-spotted warning coloration to deter predators, but to pupate, the larva amazingly worms itself backward into litter or loose pebbly soil like a charmed cobra (David Bruce even saw them wiggle through a small-mesh screen), or they may pupate under rocks or grass clumps or among leaves silked together, where in those places the larva makes a loose cocoon nest with ~hexagonal mesh openings for pupation inside. To emerge from soil/"cocoon" the new adult of *Parnassius* spp. has two hooks on the forewing base (on the base of vein R and on the radial plate, see fig. 61 in Scott 1986a), which evidently tear the silk mesh of the loose cocoon and pull the adult upward out of the pebbly soil when the adult flaps its wings while they are as yet unexpanded, then it emerges and crawls to a plant or rock etc. to hang and spread and expand and harden its wings. Pupa reddish-brown or yellow-brown, the wings browner, cylindrical, without cremaster hooks. Eggs hibernate, the larva fully developed inside. They are probably biennial in the Alpine Zone tundra, where pupae may also hibernate.

One flight end of May-June in lower foothills, mostly L June-July in higher mountains, L July-Aug. for ssp. *hermodur* above timberline.

Adults prefer yellow and white flowers, sometimes visit orange, and seldom visit blue-purple flowers, including *Erigeron pumilus, Sedum lanceolatum* (favorite), *Senecio* (*Packera*) spp. including *S. canus* & *S. fendleri*, and sometimes visit mud. Ssp. *hermodur* often visits *Arnica rydbergii, Heterotheca pumila, Sedum lanceolatum,* and *Senecio* spp. Adults evidently pollinate yellow Asteraceae such as *Senecio* and *Heterotheca* and the underside becomes covered with yellow pollen. Adults generally move less than 1km (up to 1.7km in BC, Guppy 1986), but can sometimes fly many km; I found one adult at Westcliffe Colo. which is up to 8 km from a probable colony. Adults in my study of a large open Colo. population moved an average of several hundred meters, up to 671m. Males live an average of 6 days, up to 16 in my study (34 days in BC). Adults bask with wings spread, but roost on top of grass clumps or *Penstemon virens* etc. with wings closed. Males mainly fleek about the hostplant colony, and fly against the wind; females make short and straight flights then quickly land. Adults land facing into the wind. When frightened, adults fly with a zigzag flight downwind; startled females fly 30m or even 100m+ downwind, much faster and straighter than males--females seem to disperse farther than males and are sometimes seen crossing whole valley bottoms of talus/poor tundra. Males can fly at body temperature of 18-20^{o}C because they flap the wings slowly (versus 28-30^{o} for *Colias* males and 35^{o} for *Colias* females [and 28^{o} for *Pieris virginiensis*] which flap the wings much faster, and only 10^{o}C minimum for *Danaus plexippus* at its Mexican overwintering site which flap very slowly) (Guppy 1986).

Males fleek all day about 20-30 cm above ground (~15cm in alpine ssp. *hermodur*), ~2m/sec., to locate females in open grassland/tundra areas where the hostplant is abundant. Sometimes they glide for a few seconds with wings spread 140^{o}. Males spend ~60% of their time flying, female only ~10%. The male finds virgin females by flying low and detecting females by color and often by her scent, and he sometimes finds females while both are in flight, when he pursues and the female lands with wings partly/mostly spread and he lands on top of her with his wings mostly spread and flicks his wings several times then crawls over her down and back and rotates his abdomen to make venter-to-venter contact and he joins. If the female flops over when she lands or lands on the other side of a grass stem than the male, he crawls and joins without the bother of landing on her top. The male often finds a quiescent landed female, and he captures her by dropping onto her and crawling over her (often fluttering slightly), until he finds the proper venter-to-venter grip (occasionally he just lands beside her and bends his abdomen as she leans sideways to help join). In one instance the male landed between her wings and after grappling both sexes simply rotated their abdomens to join. Adults land usually on bare ground and spread the wings flat to bask, usually regardless of the sun's position although in cool periods some face away from the sun, so the fleeking male often visually detects resting females whose wings are spread, seldom when raised; mated females were observed to close their wings if a male flies over, to prevent harassment by the male. (Flying unreceptive females try to escape males by flying erratically or zooming downward. And a mated female was observed to flutter her wings to possibly discourage the male beside her, who flew.). A female kept in lab for several days was released and actively sought a mating by pursuing several males for 10m each time and then caught up to one and mated with him. Fleeking males often find females by detecting the female pheromone, as a male can even detect a newly-emerged female with unexpanded wings hidden in a plant clump by using her scent (then she expands her wings during the mating). I observed males finding seven females (several with unexpanded wings) hidden in grass by using this pheromone (in contrast, flying males approach near other males and detect their scent [or the absence of a female scent] then quickly turn away). That female pheromone lasts ~3 days, after which females are less attractive to males and may not mate (S. Matter et al. 2012, J. Lepid. Soc. 66:111-113). {*Parnassius clodius* also has a female pheromone (Shapiro 2007).} Males approach white objects including males and mated females within 10-20 cm, then break off the pursuit, while they try to mate with young females (they also try to mate with freshly-mated young females that still have the pheromone, but after grappling for a minute or so and encountering only her sphragis they fly away). So "primitive" is mating in *P. phoebus* that I got five matings between males and virgins inside the darkness of a coffee can containing dozens of other adults during a mark-recapture study, where the males found the virgins using only tactile and olfactory cues, and the virgin's pheromone got onto some males in the can so in four instances two of the males released from the can grappled just as males grapple with virgins. During mating he deposits a huge solid translucent whitish sphragis onto her abdomen tip during a long mating of 2hr. 40 min to 3hr. 33 min. (once >24 hr.), which prevents her from remating. The sphragis may plug the female's pheromone glands, as happens in some African *Acraea* (Nymphalidae) studied by H. Eltringham. The male everts a giant gland from his abdomen that secretes the sphragis. Once I saw a male land and grapple with a mated female and bent his valvae maybe to try to scrape off her sphragis. Some females do not mate until their second day. Neither sex was observed to fly when the copulating pair was startled, though the female may crawl and drag the male a short distance, and when thrown into the air the female can fly, the male dangling (females of European *P. apollo* pairs were observed to fly).

Guppy, C. 1986. The adaptive significance of alpine melanism in the butterfly *Parnassius phoebus* F. (Lepid.: Papilionidae). Oecologia 70:205-213.

Scott, J. A. 1973b. Population biology and adult behavior of the circumpolar butterfly, *Parnassius phoebus* F. (Papilionidae). Entomologica Scandinavica 4:161-168.

Papilionidae, Papilioninae Swallowtails

Papiloninae has ~352 species worldwide, including the large butterflies we popularly call Swallowtails. They all have a small inconspicuous CuP vein at the forewing base (most butterflies just have the two large CuA veins). Adults flap their wings slowly, but can fly quite fast. At flowers, they generally continue to flutter while they sip nectar, which keeps the flower from sagging under their weight. Older larvae have a stinky forked reddish or yellowish osmeterium that pops out just behind the head to scare away predators. Larvae of the European *Iphiclides podalirius* have been reported to place a volatile trail marker along with their silk thread, and they prefer to follow that olfactory trail (R. Weyh & U. Maschwitz 1982, Oecologia 52:415-416). Pupae usually have two short head horns and a prong on the thorax, and are attached by the cremaster and a silk girdle around the middle. Pupae in many species may be yellow/green or brown, depending on where they pupate, for camouflage. Adults are claimed to have optical structures on their genitalia, used by males to position the valvae etc. during mating, used by females to position eggs (Science News May 28, 2016, p. 23).

Papilionidae, Papilioninae, Troidini Aristolochia Swallowtails

Most Troidini species are tropical, including the Birdwing butterflies of the East Indies, and the only Colorado species *Battus philenor* is just a stray to the state. Most species feed on *Aristolochia* plants which make them taste of aristolochic acids thus are unpalatable to birds and some other predators. Adults of some tropical *Battus* and *Parides* have scent glands at red or yellow abdominal spots, which produce an acrid odor if the butterfly is pinched (H. Tyler). Many including *Battus* have long filaments on the larva. Pupae have flaring ridges on the side of the abdomen, plus the two short head horns and the prong on the thorax.

Battus philenor philenor Pipevine Swallowtail

Adults are easily identified by the single row of large orange spots on unh (positioned on the postmedian area). Females have less uph blue and larger pale uph spots than males. A rare stray migrant from southward; dozens have been caught in Colorado (I have found only several they are so rare), mostly L June-L Aug. Adults rarely wander as far north as Maine and Michigan. Adults are poisonous to birds due to aristolochic acid chemicals in their hostplants that become sequestered in eggs, larvae, and adults (adults have tough leathery bodies that can resist a moderate pinch by birds who taste it or a pinch by humans--the pale lateral spots on the adult abdomen reportedly emit an acrid odor when pinched) (but *Anolis* lizards eat them, F. Odendaal et al. 1987 J. Lepid. Soc. 41:141-144). As a result, adults are the models for the Batesian (palatable) mimics *Papilio polyxenes* females, *Papilio glaucus glaucus* black females, female *Argynnis diana*, *Papilio troilus* both sexes, and *Limenitis arthemis astyanax* both sexes. Those mimics occur where *B. philenor* is common in eastern U.S.; only *P. polyxenes* is common in Colo. where the mimicry fails to work.

Habitat open areas mostly in S & SE U.S. southward, a stray in Colo., evidently commoner just S in N.M. Hostplant in Colorado vine Aristolochiaceae: *Aristolochia durior* (cultivated Pipevine); many other vine and herb *Aristolochia* are used elsewhere (some filamentous). Common southward.

Eggs reddish-brown/orange, laid in clusters of 1-25 (up to 25 in Calif., <10 averaging 2 in Tex.), often in rows on leaves or leaf stems on new growth of various *Aristolochia*; females do not oviposit if they see another egg already on a plant (M. Rauscher 1979 Anim. Behav. 27:1034-1040). If the host has narrow leaves, females learn to search for those, or learn to search for flower buds (D. Papaj, 1986 Evolution 40:518-530, & 1986 Behav. Ecol. Sociobiol. 19:31-39). Young larvae are gregarious on leaf uns. Larvae eat leaves, stems, and seed capsules, without nests. Older larva usually dark-purplish-brown with subdorsal, dorsolateral, and lateral filaments, two filaments on T1 very long like horns, those on side and rear much shorter, many dorsolateral and subdorsal filaments are very short and on middle of body (sometimes most of body) are orange; larva mostly reddish in S Ariz. and often in Tex. & Mex., and development in full hot sun causes Calif. larvae to become nearly- or all red (temperatures above 30°C reportedly produce reddish larvae); head reddish-brown; osmeterium yellow. Pupa brown on most rough surfaces, green on smooth, with numerous tiny dark specks; thorax has a middorsal projection and A5-7 have subdorsal spatulate projections, wings project convexly downward, and there are yellow or gold patches on top of head and saddle of green pupae, which patches may be yellowish or brown on brown pupae; two short head horns. Pupae are found on bushes/tree trunks/cliffs and other exposed surfaces well off the ground. Pupae hibernate (for an irregular length of time in California); brown pupae are more likely to diapause in Calif.

Adults visit flowers of most colors (often pink, purple, or orange, even red tubular flowers of *Epilobium canum* in Calif., all colors in Ohio and the Great Lakes region), including *Asclepias, Apocynum, Cirsium* and *Carduus*, and visit urine, carrion, dung, and mud. When visiting flowers, adults flutter their wings, like *Papilio*, but may be motionless on mud. Adults often roost communally (often 2-21, up to 40) and conspicuously on a deciduous tree, often 4m up. Adults regularly live for a month in Calif., up to 44 days.

Males flait all day on hilltops (in ssp. *philenor* in Colo., Ariz., Texas, Penn.) (records 10:50-16:35), and fleek more widely in the habitat in gulches and hillsides. In Colo. I saw three males flait around three hilltops up to 2m above ground while being chased by *Papilio eurymedon* and sometimes *P. zelicaon*. M. Fisher noted that Colo. males flait on hilltops, and K. Davenport saw hilltopping on the continental divide 12500’ in Clear Creek Co. J. Merritt (1952, Lepid. News 6:101) frequently found males flaiting about the top of a 7500’ hilltop above Raton New Mex. (just S of Colo.). Thus at low density such as in Colorado, where this is just a stray from the south and is rarely seen, males seem to prefer to flait on hilltops. R. Rutowski & J. Alcock & M. Carey (1989, Ethology 82:244-254) noted hilltopping in *B. philenor* in Ariz., where males flait on hilltops and stay only a few seconds to more than 2 hours (mean 44 min., seldom appearing the next day). They evidently fleek at abundant colonies. In Calif. ssp. *hirsuta*, I saw some males flaiting about hilltops, and also found an abundant colony where males mainly fleeked about the host vines on a hillside, as they flew only ~1/2m up. In flat areas of S Mich.-Ohio (Douglas & Douglas 2005), males fleek in a zigzag pattern close to the ground to seek females. In courtship of released virgins (R.Rutowski, J. Alcock, & M. Carey 1989 Ethology 82:244-254) the male approaches behind and just under her and flies up in front of her to place the trailing edges of his hw within a few cm of her head (to transfer pheromone to her antennae--

males have scent scales along the uph abdominal margin to seduce the female into landing and accepting him—males have a sweet flowery odor while females reportedly smell disagreeable like acetic acid, Clark 1926), then he may drop back and repeat that pheromone transfer, the receptive female lands and remains quiescent while the male lands beside and in back of her a bit and bends his abdomen to join. Some landed females were approached by the male, who buffeted her with his wings, then he landed and joined. Mating can also occur when the female is on a twig and the male lands below and hangs from the twig and both face the same direction (D. West 1983, J. Lepid. Soc. 37:90). R.Rutowski & P. Rajyaguru (2013, J. Insect Behavior 26:200-211) found that females mate only with a male possessing the usual male-only bluish uph iridescence, while males do not use that iridescence to determine that another individual is a male. Courtship lasts <30 sec. when the female is receptive. Rejection behavior by mated females has not been studied. Mating lasts 99min. (49-194). Females usually mate only once, sometimes twice when older; males can mate up to 4 times. If a mating pair is startled, the female flies, the male dangling.

Papilionidae, Papilioninae, Papilionini Fluted Swallowtails

Papilionini include most of the large Swallowtails, except *Battus*. The hind margin of the male hindwing is bent downward "fluted." Larvae lack tubercles, and many species resemble bird droppings as both young and old larvae, others just as young larvae. Older larvae often resemble snakes, with large eyes and even a reddish forked "snake tongue" osmeterium that pops out when the larva is disturbed, to scare away bird or lizard predators. Adults of *Papilio troilus*, and females of *Papilio polyxenes asterias*, are palatable Batesian mimics of unpalatable *Battus philenor* adults.

Papilio cresphontes (includes *rumiko*) Giant Swallowtail

A rare stray to Colo. Easily identified: the unh is mostly yellow, the upf has the yellow spots forming a large V, and the hw tail usually contains a yellow spot. The unh of *P. cresphontes* (and *P. thoas*) has only two red postmedian spots. The male has a space between his valvae in dorsal view, a strange trait. Colorado has two subspecies. Ssp. ***cresphontes*** occurs in SE U.S. to La. and strays rarely to E Colorado; it is identified by the narrow yellow marks on top of head and thorax each usually consisting of two yellow dots and a long dash, and the postmedian unh dark area varies from very narrow to moderately wide on different adults, and the upper and lower uncas prongs (there are two on each side, below the less-dark rounded superuncus [which covers the uncus when not mating]) are all mostly pointed posteriorly (in lateral view). A confirmed photo with the two yellow dots and a dash was taken near the South Platte north of Fort Morgan in Morgan Co., evidently a stray from Nebraska or Kansas. A stray from vicinity of Sheridan in northern Wyoming (map fig. 18 of Shiraiwa et al. 2014) is ssp. *cresphontes*, confirming it will stray into NE Colo. sometimes. *P. cresphontes* of undetermined ssp. has been found in nearly all of the Colo. plains counties, and the abundant records in Kansas and Neb. suggest that ssp. *cresphontes* is much more likely to stray into E Colorado than *rumiko*, so most of those records awaiting identification are probably ssp. *cresphontes*). Ssp. ***rumiko*** (named and detailed by Shiraiwa, Cong, & Grishin 2014) occurs in W & S Texas-Arizona-S Calif.-Mexico-Panama and rarely E Colorado; it usually has smaller yellow ups spots on the wings and has a narrow continuous yellow line from top rear of head to neck and to the yellow tegulae on top of thorax, and the unh postmedian dark area is mostly moderate to very wide in different adults, and the upper uncus prongs are mostly pointed at an angle upward while the lower are pointed nearly posteriorly (in lateral view). They are 3% different in mtDNA yet the two ssp. intergrade in C Texas where there are intermediate characters and atypical character combinations (their Fig. 11E & p. 104 & 109) so are here treated as ssp. because of that intergradation and the very small differences in coloration; the most conspicuous variation within *P. cresphontes* involves the unh median band of ssp. *cresphontes* which varies from very narrow to more than twice as wide, even in single areas such as Maryland. Two known strays to NE Colo. (from Sterling, Logan Co., July 10, 1970 D. L. Munger,in O.D., and Denver, Aug. 15, 1965 M. Fisher) are ssp. *rumiko*, and one was found at Lamar in Prowers Co. Aug. 14, 2018 J. Thompson, so many or perhaps most Colo. strays are probably that ssp.

Habitat open woodland and open areas in E U.S. and SW U.S. and Mexico-Panama. Hostplant in Colorado Rutaceae: the herb *Dictamnus albus* in a garden, the only Colorado record; the tree *Ptelea trifoliata angustifolia* could be eaten in SE Colorado; elsewhere *Citrus* spp. and *Zanthoxylum* spp. trees are the most frequent hostplants in SE U.S. for ssp. *cresphontes* (esp. *Z. clava-herculis* in Tex., and *Ptelea trifoliata, Ruta graveolens, Casimiroa edulis, Amyris elemifera*, and *Choisya dumosa* are also used). Ssp. *rumiko* hosts in Texas are *Zanthoxylum fagara, Ptelea trifoliata, Amyris texana, Casimiroa greggii, Ruta graveolens, Geijera parviflora, Citrus*; and *Citrus sinensis, limon* and *Ptelea crenulata* are eaten in Calif.; and *Choisya arizonica* and *Ptelea trifoliata* are eaten in Ariz., where sour orange *Citrus aurantium* is a main host in Phoenix. As a pest on *Citrus* in Fla. and Calif. the larvae are known as "Orange Dogs". Common southward.

Eggs pale yellow when laid, changing to dull orange-brown, laid on young leaves and shoots (*rumiko* eggs a bit smaller). Larvae (young and old) resemble a bird dropping. Young larvae rest on leaves, while older *rumiko* larvae rest on stems. Older larvae brown (dark areas of the bird-dung pattern brown in *rumiko*, dark-brown in *cresphontes*), T2-A1 much wider than rest of body, whitish on side of T1-2 (weakly so and running upward like wisps of smoke on T3) and dark-brown on top of T1-2, but ~T-3-A1 are paler brown with brown streaks across top (there may be cream crescents along a brown streak over T3), all making the front of body roughly resemble the wide head and eyes of a viper snake, while rearward A2-4 and A7-9 (rear) are mostly white to resemble the white portions of a bird dropping, A3-6 prolegs have cream crescent. When an older larva is disturbed it lifts its head and inflates the thorax, revealing the "eyespots" on T3, then if disturbed further it inflates T2-A1 and everts the two narrow lobes of the bright-red or orange osmeterium (yellowish in the first stage larva). Pupa variable in both ssp., mottled pale to grayish light-brown, varying to dark brown (the paler pupae formed on paler surfaces), a darker dorsal area on thorax and most of wing cases, appendages darker, sometimes a small middorsal pale area on ~A3-4, a rugged point on top of thorax and two rugged "bat ears" on head, wings bulge downward a little; pupa resembles a broken tree branch it usually attaches to with cremaster and silk girdle. Pupates usually near ground usually on sticks or brown stems. Pupae hibernate.

A rare stray to Colorado L June to L Aug. (multiple flights farther south). It is spreading northward slowly in N.Y.

Adults visit various flowers of all colors (one of my sightings in Colo. was on a *Clematis jackmanii* flower), and mud, dung/manure, & carrion. They continue to flutter while they feed on flowers, like all *Papilio*. They bask dorsally, and reportedly *P. cresphontes* and relatives (*P. aristodemus, andraemon* etc.) adults "never" close their wings (but if true, how would the male join the female, by landing on her wings? or spreading them just a little?).

Males fleek about the habitat along trails and near the hosts all day to seek females, as they fly fast ~2m above ground over grass fields, and often fly high in the trees evidently fleeking.

Shiraiwa, K., Q. Cong, N. Grishin. 2014. A new *Heraclides* swallowtail (Lepidoptera, Papilionidae) from North America is recognized by the pattern on its neck. Zookeys 468:85-135.

Papilio thoas autocles **Thoas Swallowtail**

This species has been recorded several times from Colorado, but there is no proven-authentic record. The unh of *P. thoas* (and *P. cresphontes*) has only two red postmedian spots. It differs from *P. cresphontes* by lacking the space between male valvae on the end of the abdomen (that space is visible from above in *cresphontes*), and the yellow upf postmedian spots next to the discal cell of *thoas* are inclined similar-size rectangles in a neat row (they are irregular or oval in *cresphontes*, and one spot is smaller), and there are usually four yellow submarginal spots from vein M_2 to the rear in *thoas*, three in *cresphontes*. It is a subtropical/tropical species. The hostplant is mostly Piperaceae: a dozen+ sp. of mostly-woody-climbing *Piper* in Latin America. Scott (1986a) details the early stages. Egg cream, turning orange, laid singly on ups of host leaves. Older larva olive-green mottled with brown, with blue points, yellow rings on thorax, white on top of rear, a brownish-white irregular lateral band; slightly resembling a snake head. Pupa gray-brown, or dark-brown with gray or greenish shading, with rows of tiny dorsal bumps. It flies all year in Mexico, and supposedly rarely strays to Kansas and Colorado. In Brazil, *P. thoas brasiliensis* usually flaits about good hilltops not far above ground (evidently ~1m perhaps) evidently all day and seldom raits there to find females; sometimes a male will grab another male evidently in an attempt to mate (C. Pinheiro 1990, J. Res. Lepid. 29:134-142).

Papilio multicaudata multicaudata **Two-Tailed Tiger Swallowtail**

Identified by the several tails on each hw, and the narrow black bands. Adults vary greatly in size and markings. The early (spring) adults tend to be **form pusillus** which is smaller with a narrower black postmedian-marginal hw area, while late-summer lowland adults are **form multicaudata** which is larger (56-69mm fw length) with a wider black hw area (up to 18mm on uph) and sometimes has a more concave fw margin. In the lower foothills **form minimulticaudata** occurs rarely (from M April to E July), and is tiny (fw only 42-49mm) with narrow black hw area (as small as 6mm on uph), and develops from larvae that starved on old tough *Prunus virginiana* var. *melanocarpa* leaves the previous L Sept.-Oct. so were forced to pupate at small size. I have never seen a hybrid between *P. multicaudata* and *P. glaucus* or *P. eurymedon*.

Habitat mountain canyons from foothills to Canadian Zone, and the suburbs/small towns. Hostplants in Colorado mainly shrub Rosaceae: *Prunus virginiana* var. *melanocarpa* and less often *P. americana* in the mountains, and tree Oleaceae: *Fraxinus pennsylvanica* trees in towns (*Fraxinus* also used in Mexico City), (one oviposition on *Syringa vulgaris* bush in my yard, but young larva ate almost none of it compared to *Fraxinus*) (Colo. females refuse to oviposit on *Prunus pensylvanica, Populus*, and *Ceanothus*). The beautiful green Emerald Ash Borer beetle spread to northern Colo. by 2016 and may soon destroy most of the major town/city hostplant *Fraxinus pennsylvanica* trees, and the butterfly may become scarce there. *Ptelea trifoliata* (Rutaceae) is a usual host in Texas, and *P. t. angustifolia* occurs in S-C Colo. where the butterfly may survive if that beetle extirpates the *Fraxinus*. Common.

Eggs greenish-yellow with reddish patches, laid by females after 2-3 days, placed singly on host leaves (mostly on upperside as females land on the leaf and continue to flutter while they lay). There are five larval stages (G. Pronin 1955 details how to get eggs and rear larvae/pupae, Lepid. News 9:137-140). Larvae eat leaves, without nests, but silk the leaf top so their crochets can gain a good grip on the leaf. Young larvae resemble bird droppings. Older larvae rest on a leaftop and silk the top so it is a little concave. Older larva similar to *P. glaucus rutulus*, green with a white-edged black transverse band between segments A1-2, the large dorsolateral eyespot on T3 usually yellow and consisting of the eye with black-rimmed blue pupil (then a yellow then blue then yellow spot above that eye), three rows (subdorsal, dorsolateral, and supralateral) of black-rimmed bluish spots on abdomen, T1 front and A9 rear have a pale transverse rim; head reddish-brown. The larva turns dark orangish and pupates. Pupa mottled greenish-brown to yellowish-brown, with a brown lateral stripe, a light-brown band on top of abdomen, light-brown or brown wings, and brown horns and bumps, shaped like *glaucus* & *eurymedon*. Pupae hibernate.

Several generations L Apr.-E June and M June-M Aug. (some Sept.) on the plains-foothills edge in SE Colorado and in lowland W Colorado (Mesa, Montrose, Delta Cos. and SW Colo.). Just one main generation M June-July on the NE Colo. plains (including Denver) plus partial emergences (April-M June and Aug.-E Sept.). In the mountains mostly just that M June-E Aug. generation.

Adults visit flowers of all colors including red, but seldom visit yellow flowers, including *Asclepias, Carduus nutans, Cirsium, Delphinium ajacis, Echinacea purpurea, Hesperis matronalis,* *Penstemon*, *Philadelphus lemoinei*, and often visit mud. It pollinates cultivated *Hemerocallis ~fulva* lilies in Colo. (and visits *Lilium pardalinum* in Calif. and probably pollinates it too). Adults bask with wings mostly spread. They roost on *Pinus Quercus Acer* etc. trees even 3-7m up.

Males fleek all day, in gulch bottoms in mountainous terrain, along trees in woods lanes on flat land such as suburbs, as males fleek ~2.5-3 m (sometimes 4-5m) up; when males reach the top of a gulch, they often fly rapidly over the ridge and down another gulch. In courtship, males spot resting or flying females, the female hovers (with her body more vertical like adults on flowers) and the male hovers (with full strokes like the female) 5cm to mostly 10cm below and slightly to the side and bumps up into her repeatedly (often 10x or as often as 15-30x), when receptive females would land and remain quiescent while the male joins. Unreceptive females keep flying (and the male leaves), and may reject males by flying vertically 5-12m then rapidly down to 3m. Young virgin females position themselves ~2.5m up on prominent trees and spread their wings to attract fleeking males.

***Papilio glaucus* (ssp. *rutulus* Western Tiger Swallowtail; ssp. *glaucus* Eastern Tiger Swallowtail)**

P. g. rutulus is distinguished from *P. multicaudata* by having just one tail, and by the wider black stripes. There are two ssp. in Colorado. Nearly all are the usual Colorado *P. glaucus* ssp. ***rutulus*** which has a narrow solid yellow band on the unf margin, and has no or little orange in the unh submarginal spots (the apical spot may have some orange). In contrast, *P. g.* ssp. ***glaucus*** has a row of yellow distinct spots (not a band) on the unf margin, and the unh submarginal spots are all mostly orange, and ssp. *glaucus* is usually found only near Nebraska or Kansas). These traits are inherited quantitatively. The male and female genitalia differ also (the dorsal prong on male valva has 1 major hook in *rutulus*, 2 in *glaucus*; the female lamella flap is like a wide cottonwood tree leaf in *rutulus*, a narrower serrated blade in *glaucus*). Ssp. *glaucus* females are sometimes the **black form nigra**, which is common in SE U.S. but rare and only near the Kansas border in Colo.; those nigra resemble female *P. polyxenes*, but the upf marginal cream spots are very small, and remnants of the black stripes of yellow females usually remain on the black form. (Each female is the yellow or black color of her mother.) Early spring *P. glaucus* are smaller than later generations. Ssp. *rutulus* and *glaucus* are very often considered distinct species nowadays, but careful study of *P. glaucus* including its Mexican ssp. *alexiares* and *garcia* and the northern ssp. *appalachiensis* and *canadensis* and Alaskan *arcticus* proves that they and *rutulus* are all ssp. of *P. glaucus*. The Mexican ssp. *alexiares/garcia* are universally considered to be conspecific with ssp. *glaucus* (and their mtDNA is like ssp. *glaucus* and the northernmost Mexican populations even have black form nigra females) even though the unf marginal band and genitalia resemble *rutulus*. Ssp. *canadensis* and *glaucus* intergrade where they meet in NE U.S.-SE Canada, *canadensis* and *rutulus* interbreed in SE BC (J. Scott & J. Shepard 1976, Pan-Pacific Entom. 52:23-28), *glaucus* and *rutulus* intergrade in the Black Hills (L. Brower 1959 Evolution 13:40-63 analyzed 70 specimens and demonstrated intergrades with *rutulus*; the commonest phenotype has the yellow unf marginal band and less unh orange than Canadian *canadensis*, and *glaucus* is occasional and *rutulus* rare [the male uns *canadensis* photo in Marrone 2002 is *glaucus*X*rutulus*]), and there is little infertility in lab hybridization studies. And in Wisconsin several traits of ssp. *canadensis* and *glaucus* traveled north in the intergrade zone at different rates during recent global warming (real species are able to retain their genes). *P. g. appalachiensis* (S Penn. Tenn.-N.C.) is just a hybrid population intermediate between ssp. *canadensis* and *glaucus* which persists only because it flies between two generations of ssp. *glaucus*, and a population like *appalachiensis* has recently formed anew from hybridization in the Battenkill Valley of E N.Y.-Vermont (studied by R. Mercader & J. Scriber 2007 Entomologia Experimentalis et Applicata 117:1-13). Ssp. *arcticus* from Alaska is like *canadensis* but has few or no red unh submarginal spots like *rutulus*. I discussed this situation thoroughly with numerous references in Papilio (New Series) #19:(pages 31, 66, 75, 89, 95, 109-110, 119-120) (2008).

Ssp. *glaucus* occurs in "pure" form in Colorado only along the South Platte River next to Nebraska (Julesburg) and along creeks next to Kansas, where M. Fisher collected a ssp. *glaucus* form nigra black female E of Bonny Res. in Yuma Co. (the black female form nigra—common in SE U.S.--is a Batesian mimic of *Battus philenor*, and is produced by a gene on the female's W (Y) chromosome, so each female is the color of her mother). But individuals identical to ssp. *glaucus* also occur rarely in the Front Range foothills and in Denver (I found three pure *glaucus* males, on a hilltop in Jarre Canyon in Douglas Co. 30iv81, at a hilltop near Tinytown 2vii91, and in my yard in Lakewood 24vii15 (both Jefferson Co.), plus I found a male near *glaucus* flaiting just below a hilltop on Mt. Zion 19vi95 in Jeff. Co., plus I found various intermediates *glaucus*X*rutulus* in Wheatridge and the foothills). Those pure adults probably come in as pupae/larvae on nursery stock, because they seem to be too rare to be a viable separate-species population (numerous tree species are grown in Denver that could produce a pure *P. glaucus glaucus* population if it were really a distinct species, although a favorite hostplant of ssp. *glaucus Liriodendron* is not present), and the ssp. *glaucus* adults evidently interbreed and are absorbed into the much larger *rutulus* population, producing the result that *P. glaucus rutulus* remains the predominant phenotype in Denver and *glaucus* traits are rare.

Habitat mountains (from foothills through Canadian Zone), suburbs, and plains streamsides with deciduous trees. Hostplants for *rutulus* in Colorado Salicaceae: *Populus tremula tremuloides, P. angustifolia, Salix exigua, S. eriocephala var. ligulifolia*, and in towns *S. babylonica*; in Wyo. *S. lemmonii*. Ssp. *rutulus* elsewhere often feeds on *Prunus*, *Populus, Salix*, *Alnus*, *Platanus*, and many others (Scott 1986a). Ssp. *glaucus* in E U.S. eats numerous trees and shrubs esp. *Betula, Alnus, Prunus*, *Fraxinus*, etc., and *Liriodendron* is a favorite (the ability to eat *Liriodendron* is a dominant trait; ssp. *rutulus* cannot eat it), and *Magnolia* is eaten in Fla.; in Neb. it usually eats *Prunus americana,* sometimes *P. virginiana* and *Fraxinus pennsylvanica* (S. Spomer). In Texas it eats *Fraxinus* esp. *F. velutina*. Ssp. *canadensis* in northern N. America is intermediate in hostplant choice (often eating *Populus, Salix*, *Prunus*, etc. to which it is genetically adapted) as well as in wing pattern (it has red unh submarginal spots, but a yellow unf marginal band). Ssp. *rutulus* (and ssp. *canadensis*) can eat Salicaceae, which ssp. *glaucus* mostly cannot eat, because they have intestinal esterases that can detoxify salicortin and tremulacin etc. compounds that Salicaceae contain to repel herbivores (R. Lindroth 1989 Oecologia 81:219-224; K. Lee & M. Berenbaum 1992 Biochem. System. & Ecol. 20:197-207). Fairly common in the mts., but uncommon in Denver and other towns along the Front Range (where *multicaudata* is common).

Eggs green, soon becoming greenish-yellow speckled with reddish-brown, laid singly on ups of host leaves near the tip, mostly on sunlit branch tips and mostly less than 3m above ground but I observed apparent oviposition high in a tree. Larvae eat leaves, and rest on a silk mat on top of a leaf, which usually makes the leaf ups somewhat concave. Older larva (similar to *P. multicaudata* and P. *eurymedon*) green (blending to pale-green on underside), and all have a "snake head" eyespot on the thorax consisting of a large black-rimmed yellow subdorsal eyespot with black-rimmed blue center on T3 (a yellow, then blue, then yellow spot above it) (larval eyespots of ssp. *rutulus*, *P. eurymedon*, and *P. multicaudata* have those three spots above the main spot, the lower yellow spot attached to the eyespot [although *rutulus* may have yellow or somewhat orangish spots, and J. Emmel notes that *rutulus* and *P. multicaudata* and *P. eurymedon* in Calif. are somewhat variable in the full number of spots], while ssp. *glaucus* & *alexiares* lack the upper spot or *glaucus* may have the extra blue spot—crosses suggest that the eyespot types are inherited quantitatively [C. Clarke & P. Sheppard 1957 Lepid. News 11:201-205]), a black transverse dorsal stripe (edged in front with yellow) between A1 and A2, two subdorsal and one lateral rows of small black-rimmed blue or yellow spots all along abdomen, T1 front and A9 rear have a creamy transverse rim; head reddish-brown. The larva turns brown before pupating. The osmeterium is orange. Pupa light brown, often with green patches and black markings, a brown or black lateral stripe on abdomen runs nearly to the middorsal thorax peak, outer wing margin darker, a wide light- or dark-brown dorsal band, dorsal edge of wings and side of head (the two head horns) sometimes blackish, a peak on top of thorax, and a bump at base of the wing, wings not bulging. Pupae are often attached to objects in ground litter, sometimes to fences or tree trunks. Pupae hibernate.

One flight L May-E Aug. (mostly L May-M July at the lowest altitude, M June-July in Canadian Zone). An adult *rutulus* lived 39 days in nature.

Adults visit flowers of all colors including red, including *Apocynum androsaemifolium*, *Cirsium*, *Asclepias speciosa*, *Carduus nutans*, *Verbena hastata*, *Philadelphus lemoinei* (Iftner et al. 1992, Butterflies of Ohio, give many flowers visited by ssp. *glaucus*), often visit mud, and other ssp. sometimes visit urine, dung, carrion, rotten fish, and dead butterflies. The butterflies pollinate large lily and similar flowers. Ssp. *rutulus* (and *P. multicaudata* and *P. eurymedon*) are incredibly attracted to *Lilium pardalinum* (G. Pronin 1955 Lepid. News 9:139) which they surely pollinate. Ssp. *rutulus* adults often carry pollen of *Ipomopsis aggregata* (N. Waser 1982 Oecologia 55:251-257). {In the S Appalachians, ssp. *glaucus* adults flutter while they visit the orange flowers of Flame Azalea [*Rhododendron calendulaceum* ssp.] and long sticky pollen from the anthers sticks to the fw, then is deposited on the longer stigma of another flower to pollinate it.} Ssp. *glaucus* has been seen to imbibe salt from beside a swimming pool by imbibing fluid it had dropped from the abdomen for ~20 min. (W. Reinthal 1963 J. Lepid. Soc 17:35). Adults flutter while flower-feeding like all *Papilio*, though they sometimes just hang from *Asclepias* while they imbibe. Males often glide with wings spread ~110°. They bask dorsally. Papilionidae are seldom reported to warm up by shivering their wings and are not reported to do it with wings vertically (*P. glaucus* reportedly shivers with wings to the side).

Males fleek all day, as males fly ~3-5m up along little creeks and streams, around trees in towns, and fleek on N-facing slopes near *Populus tremula tremuloides*, and also fleek on hilltops/ridgetops where males fly ~3m up in woods lanes and glades and along a row of trees growing on or next to the hilltop (the row of trees is due N or E or W of the hilltop, but not S of the top because S-facing slopes are drier in the foothills thus few trees grow there). Their hilltopping in woods lanes on/near hilltops looks similar to the flaiting of *P. eurymedon*, but *rutulus* males do not stay long and after a few minutes they return to the N-facing slope to fleek. I observed this hilltop fleeking on several dozen hilltops in Colorado, and also in Napa Co. Calif. *rutulus* (and also in pure or nearly pure *P. glaucus glaucus* males I found at Jarre Can. and Tinytown and Mt. Zion in the foothills in Jefferson Co. Colo. and in ssp. *glaucus* in Nebraska and Iowa—and J. Turner [1990 J. Lepid. Soc. 44:174-179] noted male ssp. *glaucus* fleek >3m up on hilltops in Tennessee). (In flat land in South Dakota I observed ssp. *glaucus* fleek 3-5m up along trees.) Males rarely rest on the trees (a hilltopping male rested briefly ½m up on *Juniperus*). R. Krebs (1988 J. Lepid. Soc. 26:27-31) studied courtship of *P. glaucus glaucus*. The male finds a flying female or one on vegetation, or sometimes a very receptive female pursues the male (sometimes pursues even a resting male), then the female flies up and away from the male who pursues 5-15 cm below/behind and sometimes contacts her (transmitting pheromone), she lands usually with closed wings then he usually hovers over her for a second or two then lands beside her, or if she lands with open wings (7 of 31) he always hovers over her then lands when she closes her wings, then he bends his abdomen to join. Mating lasts 45-60 min. Most matings were high up, few as low as 3m. Unreceptive females close their wings if a male flies nearby, or depress the abdomen to the substrate so he cannot join, or suddenly land, drop into vegetation, fly near the ground until he leaves, fly through thick brush, or simply do not fly when he comes near. If a mating pair is disturbed, the female flies, the male dangling. In courtship of ssp. *rutulus* that I saw, the male overtakes the female, she hovers with body vertical so her wings--especially the forewings--move from side to side from the human viewpoint, the male hovers ~10 cm away to the side and mostly beneath and contacts her every few seconds (up to 10x or more) while he may change positions, then receptive females would land and accept the male but most females are unreceptive and the male departs sooner or later. I found a mating pair on an apple tree with the female's wings still "wet"; evidently they mated before she could fly well. The male pheromone smells sweet and flowery like that of related species and male *Papilio* *machaon*-group species, while females have a disagreeable odor of "rubber cement or creosote" (Clark 1926, ?after mating). Adults are evidently not attracted to ultraviolet-reflecting butterflies, because *P. eurymedon* adults reflect uv whereas *P. glaucus* yellow and black forms absorb uv (the blue areas reflect uv slightly). Females most often mate just once, often twice, sometimes thrice.

Papilio eurymedon **Pallid Tiger Swallowtail**

Easily identified by the whitish ground color (which reflects uv), and the thick black stripes; females are slightly yellower-white than the whiter males. I have never seen a hybrid with *P. glaucus rutulus* or with *P. multicaudata*.

Habitat open woods in the lower mountains mostly below 8000' barely into the Canadian Zone. Hostplants in Colorado bush Rhamnaceae: *Ceanothus fendleri*, (surely eats *Ceanothus velutinus* in W Colo. [a host in Nev., Austin & Leary 2008]) and doubtfully shrub Rosaceae: *Crataegus rivularis* (just one ovip., probably a female mistake as no eggs could be found on other *Crataegus*). *Ribes inerme* [Grossulariaceae] was evidently another mistake as eggs could not be found on it (L. Brower 1958 Lepid. News 12:103-114). Numerous shrubs and small trees are eaten elsewhere, especially *Prunus*, sometimes *Holodiscus dumosus*, etc. Uncommon, sometimes common.

Eggs yellowish-green, with reddish-brown blotches, laid singly on host leaves. Larval and pupal habits like *P. glaucus*. Young larvae resemble bird droppings. Older larva resembles *P. glaucus rutulus*, although the large black-rimmed yellow eyespot with bluish black-rimmed center is sometimes a little narrower, and above that is a yellowish, blue, and yellowish spot (those four spots are connected and the yellow ones are often orangish), three subdorsal, dorsolateral, and lateral black-rimmed bluish spots on abdomen segments, T1 front and A9 rear have a pale transverse rim; head reddish-brown. Prepupal larva turns orangish-brown. Pupa resembles *P. glaucus*, light brown, with brown lateral band, the front and top half mottled dark-brown or blackish-brown; or pupa (photo in Wolfe et al. 2010, evidently Utah, and Neill 2007) bright-green with chocolate-brown wide lateral (running to head projection) and wide middorsal (running to thorax projection) bands (both bands narrowly edged by cream), the thorax peak and small subdorsal abdominal bumps cream in the Neill photo. Pupae hibernate.

One flight L May-M July (mostly June-E July).

Adults visit flowers of all colors including red, including *Apocynum androsaemifolium*, *Jamesia americana*, *Penstemon virens*, and often visit mud. Adults pollinate large lily flowers such as *Lilium philadelphicum*, *L. washingtonianum*, etc. as their forewings transport the orange pollen.

Adults bask with the wings more or less fully spread, and they can shiver with the wings spread to the side to get warm. Sometimes adults especially males fly down gulches to seek mud, and a male was seen chasing a *P. glaucus rutulus* in a gulch. Adults roost on trees such as a Ponderosa Pine 4m up. A male strayed 7 miles from foothills to Lakewood. Adults can fly several km.

Males flait all day on hilltops/ridgetops to await females, where they fly rather lazily around small clearings in open lanes in the woods on the hilltop/ridgetop, flaiting an average of ~1.7m up (122-200cm, N=6), and occasionally rest (rait) there. These lanes can be ~3-5m wide and up to 10m long etc., any small lane where they can fly back and forth; if a big hill mostly lacks trees, they find the nearest "clearing" near the top which at some localities is a little flaiting lane formed between the steep hillside and a row of trees such as Douglasfir. Males can rarely fly around a treeless hilltop for a few minutes but they never stay there (they search for a suitable ridgetop clearing among trees). Sometimes they glide for a few meters with wings spread apart ~90°-110°. In courtship, the female hovers with her body vertical (which can be as low as 15cm or 50-100 cm above ground) for several minutes while the male hovers around her or below and above her and he contacts her now and then to transfer pheromone (then receptive females presumably land and accept the male). If a mating pair is disturbed, the female flies, the male dangling.

Papilio troilus troilus **Spicebush Swallowtail**

Easily identified by the smudge over much of uph (greenish-blue in males and bluish in females), the lack of ups postmedian stripes, and the unh resembles *P. polyxenes* but the postmedian orange spot is missing in cell M_3 and is replaced by a "streaking comet" mark (sometimes followed by a tiny baby comet). Adults are Batesian (palatable) mimics of *Battus philenor*. A rare stray in Colorado, so far recorded from Boulder (twice), Larimer, Prowers, and Baca counties.

Hostplants in E U.S. are usually Lauraceae trees: *Sassafras albidum* var. *molle*, *Lindera benzoin*. Neither of these occur naturally in Colorado, so artificial transport may be responsible for Colo. records. Common in E U.S.

Eggs greenish-white, laid singly on host leaf uns. Larvae eat leaves. 1st-2nd-stage larvae live in a silked bent-over flap of leaf, while older larvae live in a tube made by silking the top of a leaf to make it concave and silking the top edges together. Young larvae resemble bird droppings. Larvae feed mostly at night. Older larva green with a yellow lateral band (blended dorsally), two subdorsal and one sublateral rows of black-rimmed blue spots on abdomen, a black-rimmed orangish eyespot with blue-above-black center on T3 and another black-rimmed orangish eyespot with blue center on A1, a transverse rim of cream then black on top of T1, underside orangish-brown; larva turns yellow or orange-yellow just before pupation. When disturbed, the body is reportedly "enlarged" and the yellow osmeterium is everted, making the front resemble the head of a green snake or tree frog to scare a bird? away. Pupa yellowish-green or pale-green to reddish-brown, with some black dorsal dots or enlarged into dorsolateral and subdorsal rows of small blue abdominal spots (Allen 1997 photo), a brown (or red-brown anteriorly) or grayish lateral ridge edged beneath with white (which ridge may separate the yellower [or bright green] top from whiter bottom of pupa if those differ in color) and that ridge may become brown then blackish on the lateral point on head, often a red-brown middorsal band on abdomen, the wings bulging downward considerably; attached near the ground on slender stems. Short photoperiod produces brown diapausing pupae, while pupae can be brown or green with long photoperiod, partly depending on the background color. Pupae hibernate.

Several flights May-Sept. in E U.S. where the Colorado strays originated.

Adults visit various flowers of all colors (Iftner et al. 1992) mud, rotten fish, and urine.

Males fleek low all day in margins and pathways of wooded areas with the hostplant to seek females. Males have a strong-smelling pheromone.

Papilio indra **Cliff Swallowtail (Indra Swallowtail)**

Identified by the black ups with pale creamy median bands, and the mostly-black abdomen which has just a short cream-colored lateral dash near the rear. The tegulae are slightly yellow. There are two main ssp. in Colo. plus intergrades: the Front Range ssp. ***indra*** has a wider median band and very short tails, while ssp. ***minori*** in far western Colo. has the band very narrow and long tails. Ssp. *minori*X*kaibabensis* occurs in La Plata and Montezuma Cos. (ssp. *kaibabensis* has almost no median band in the Grand Canyon area incl. N Rim, though the S Rim has near-*minori*). Adults in NW Colo. (in Dinosaur Nat. Mon. and adjacent Utah) are *indra*X*minori*, the median band wide to narrow and tails longer.

Habitat open rocky areas in the foothills of the northern Front Range for ssp. *indra* (it occurs south only to the South Platte Canyon area in northern Douglas, Jefferson, and NE Park Cos.), and the juniper/pinyon pine canyonlands of W Colorado (Mesa and Delta and Gunnison Cos.) for ssp. *minori* and ssp. *minori*X*kaibabensis* in La Plata and Montezuma Cos. Hostplants in Colorado bushy odorous herb Apiaceae growing among rocks: *Harbouria trachypleura* and sometimes *Aletes acaulis* for ssp. *indra*; *Aletes* "*Lomatium" eastwoodiae* and *Cymopterus* "*Pteryxia" hendersoni* and probably *Lomatium grayi* for ssp. *minori*. Ssp. *indra*X*minori* assoc. with *Lomatium grayi* on the Yampa River. Uncommon, seldom common.

Eggs greenish-cream, developing a brownish ring and top within 2 days, laid singly on underside of host leaves. Larvae eat just leaves, and rest at the base of the plant, without nests, feeding day and night. Young larvae stages 1-3 resemble a bird dropping. Older larva mostly black (some larvae at least in W Utah are solid black with a few yellow/orangish spots, resembling *Parnassius*), the areas between the black bands pinkish-cream in ssp. *indra* (just cream in Ore. *indra*, photo Neill 2007), pinkish (and variable sometimes enlarged) in ssp. *minori*, the spots between the bands yellowish (creamy in Ore. & Colo. *indra*, orange in *minori*), underside black, with a pale spot above each leg/proleg; head black, an inverted orangish V on front, and an orangish spike extending way up from a black dash near eyes; head with black and yellowish pattern in ssp.*indra*. (Ariz. ssp. *kaibabensis* larva is identical to *minori*.) Pupa tan, blackish, grayish, reddish, or greenish-brown in various areas in W U.S., tending to resemble the background rocks at each locality (*minori* pupa grayish-tan with olive-tan wings) (*kaibabensis* pupa light tan-pink); pupa shorter with smaller projections than other *machaon*-group pupae. Pupae hibernate.

One flight mostly M May-M July in the Front Range; one main generation May-E June and a partial generation in July for ssp. *minori*.

Adults visit flowers of all colors including red, including *Apocynum androsaemifolium, Jamesia americana, Penstemon, Solidago ~altissima* "*canadensis*", and often visit mud. Ssp. *minori* often visits *Amelanchier alnifolia*. Adults bask with wings mostly spread. Adults dispersed 1 km east to Green Mtn. in Jefferson Co. to temporarily populate it 1977-1980.

Males rait all day on little <u>clifflike rocky outcrops</u> (several to many meters tall) just below/off a hilltop (away from the very top just a few meters to as much as 35m or rarely 50m), as males rait on the rock face or on talus just below the cliff or on prominent rocky places. If no rocky clifflike spots are available at the hilltop, males rait on the ground in clearings near the hilltop. Sometimes males fly about (flaiting) before landing again. In mesa country in Delta and Mesa Counties (ssp. *minori*) males rait the same way in the same clifflike places near the top of hilltops, and also flait just below and along the clifflike edge of the flat mesa to seek females. Downstream in the canyonlands along the Colorado River, there are places where the mesa top drops in long cliffs 100m high, and males perhaps rait on talus just below the cliff or flait along the cliff some, but we know they do come to the top of the cliffs some to rait, as occasional males are found on *Cirsium* on top of the cliffs. The common name Cliff Swallowtail refers to the preferred mate-locating sites, just OFF the hilltop, not on top. In courtship, the female arrives at the clifflike spot and flutters slowly, the male overtakes her, both fluttered close together in midair ~2/3-1m up for 5 sec., the female landed on a rock with wings spread and fluttering and the male landed closely behind and bent his abdomen and joined. Males (of ssp. *minori* in particular) have been reported to be ferocious in "attacking" other males and damaging each other's wings, esp. in a fanciful article by Don Eff in J. Lepid. Soc., but I found three males raiting/flaiting slowly near each other on a hilltop in Mesa Co. without bothering each other, actually sharing the hilltop, and the only "attacks" I have seen were in the Front Range foothills in Jefferson Co.: a young male flew over, and a raiting male darted after him and fluttered beside him and seemed to grab him and they fluttered-hovered down to ground (1m below) and the male fluttered and bent his abdomen to the motionless young male then separated (this seemed to be a desire for sex rather than an attack--most inexperienced people misinterpret raiting behavior as aggression or territoriality, when the truth is that it is just efficient mate-location); at the same site two males encountered each other at a rocky spot when one flew over, they whirled close about each other and slowly landed and grappled awhile, then one flew off the other behind—an attempt to mate?; at the same site 2 males grappled together before separating; I did not see any wing pieces coming off; those are the only grappling observations I have seen in 55 years. I conclude that *P. indra* is a normal butterfly with ordinary mate-locating behavior, it is not "ferocious" (the *Papilio polyxenes* observation below shows that grappling can be a precursor to mating). If a mating pair is startled, the female flies (seldom the male), the male dangling.

Papilio machaon Machaon Swallowtail (Baird's Swallowtail)

P. machaon generally has yellow tegulae (two comma-like structures on top of the thorax at the base of each forewing), the black eyespot on uph tornus is usually connected to the wing margin, and the unh postmedian band usually has just a few orange spots in the middle of the wing, and adults fly most often in July. Colorado has several forms and ssp., which look mostly black or mostly yellow. William H. Edwards and David Bruce reared yellow and black forms from each other in Glenwood Canyon in 1893. The **black form bairdii** has the unh base black (and fw discal cell has 0-1 yellow bars), whereas the **yellow form brucei** has the unh base yellow (this is the best spot to define those major forms, because the other wing areas are more variable in color) (fw discal cell usually has two yellow bars). There are three ssp. in Colorado: ssp. ***brucei*** north of 40^{o} latitude, ssp. ***bairdii*** southward, and ssp. ***brucei*X*oregonia*** in extreme NW Colorado in Moffat Co. Forms brucei and bairdii intergrade clinally from Wyo. to N.M. Form brucei is >50% north of roughly 40^{o} latitude (=Baseline Avenue in Boulder Co. CO), and has a yellow unh base and two yellow bars in upf discal cell, plus a very yellow abdomen (a broad yellow stripe on the side, a yellow line below that, and a yellow midventral line), therefore that area has **ssp. *brucei***=*dodi*. Form brucei is >50% on the NE Colorado plains and is nearly absent in NM. Form bairdii is >50% southward of that 40^{o} line, and has a black unh base and 0-1 yellow bars in upf discal cell, plus the abdomen is black with ~2 ½ rows of yellow dots, therefore the range of **ssp. *bairdii*** is south of 40^{o}. Form bairdii is basically absent in Wyoming but occurs throughout Colorado, and grows more common southward. The forms bairdii and brucei vary in the width of the postmedian ups bands, but not quite as much as *P. polyxenes* (some black form *bairdii* have the uph postmedian band nearly gone like form ampliata in *P. polyxenes* so can be called **form ampliata**, and some yellow form *brucei* have the uph postmedian band only ~8mm wide, called **form comstocki**); on these and all others the color of the unh base is important to determine the name of the form. **Form hollandii** is the same as the black form bairdii and varies similarly in width of the yellow postmedian band (from wide to narrow), except the side of the abdomen is mostly yellow (these are mostly males, because very few if any females have the abdomen mostly yellow, the female abdomen gets only partly suffused with yellow with several rows of prominent yellow dots); yellow-abdomen form hollandii is also known from Ariz. and Neb. as well as Colo. (See Scott [1986a] table 2 pp. 165-166 for identifying features of all the forms and subspecies and species in the *P. machaon*-group of species—*P. machaon, P. zelicaon, P. polyxenes, P. indra*). In extreme NW Colorado, the population represents ssp. ***bruceiXoregonia*** (*oregonia* differs by having the unf discal cell base yellow, versus black in both *bruce*i and *bairdii*, and the eyespot blends more). Adults of *P. machaon* are rare in the Front Range foothills (some form brucei, some form bairdii, and few near form hollandii, mostly flying in July but some in June and one in early Aug.), and they are uncommon on the northern plains also. Some specimens in the Front Range foothills appear to be hybridized with *P. zelicaon* or *P. polyxenes*. Identification of this butterfly is complicated by individual variation, the presence of distinctive forms, and the occasional hybridization that occurs in nature between *P. machaon, P. zelicaon*, and *P. polyxenes*. *P. machaon* also has a lot of geographic variation elsewhere: ssp. *oregonia* and *pikei* link our *brucei* with the N Canadian *hudsonianus* and Yukon-Alaska *aliaska*, which latter resembles the Palaearctic ssp. *machaon*. Also, *P. m. joanae* from Missouri-Arkansas and *P. m. brevicauda* from E Canada are subspecies of *P. machaon* and have *hudsonianus* mtDNA: they are sympatric with *P. polyxenes* without interbreeding, and they hybridize and backcross readily with other *P. machaon* ssp. when hand-paired in the lab (J. R. Heitzman, C. Remington). In central northern Alberta *P. machaon hudsonianus* and *P. zelicaon* have hybridized and formed a mixed population. *P. polyxenes kahli* in SW Man. has interbred with *hudsonianus* somewhat and has its mtDNA also. C. Clarke, P. Sheppard, S. Ae, and C. Remington studied the inheritance of the traits of the *P. machaon* group. Dominant traits (versus recessive) are the black form (unh base black) versus yellow form (unh base yellow), long tails versus short, red or orange spots in the black transverse stripes of older larvae (versus yellow spots). Traits that seem to be quantitatively inherited are the eyespot pattern, amount of orange or yellow in the unh submarginal (and evidently median) spots, amount of yellow or black on the legs, amount of yellow on the unf discal cell base, amount of yellow between the apical unf spots. Modifier genes affect the width of the yellow ups median bands, the sexual difference in the ups median-band width of black forms (females have the median band much narrower than males in *P. machaon bairdii* and *P. m. joanae* and *P. polyxenes*, not narrower in *P. machaon brevicauda* and *P. indra*—other taxa are intermediate to those in width), and the number of flights (the single flight of most *P. machaon* ssp. incl. *brevicauda* and *aliaska* and Colo. *P. machaon* ssp., plus *P. zelicaon*). The abdominal pattern seems regulated by modifier genes, although yellow dots on the side of abdomen seem dominant to yellow stripes, and black forms usually have spotted abdomens while yellow forms usually have striped abdomens. {Missouri-Arkansas ssp. *joanae* is confused with *P. polyxenes* and is evidently growing scarce. Good identification features are these: Adults fly mostly in forest [open areas in *polyxenes*]. The uph eyespot has black pupil usually [50% or 80%] connected to margin [rarely connected in *polyxenes*]. Unf & unh postmedian spots are strongly orange [less so in spring and in *polyxenes* esp. on unf]. Ups median yellow band averages narrower. Uph blue spots are larger on males [usually all present], more rounded [convex] distally on both sexes [*polyxenes* usually has concave blue spots].}

Habitat the lower mountains all over the state (seldom into the Canadian Zone), and the NE (one record SE) Colo. plains. Hostplant in Colorado herb Asteraceae: *Artemisia dracunculus*. This plant contains anisic aldehyde oil that attracts *P. machaon*-group butterflies; Apiaceae herbs are sometimes eaten elsewhere because they also have anisic aldehyde oil, but Apiaceae are not known to be used so far in nature in Colo. (in Utah it sometimes eats *Cymopterus duchesnensis* and *Lomatium grayi* and rarely *Foeniculum vulgare*) (lab larvae eat Apiaceae well, including *Daucus carota, F. vulgare, Pastinaca sativa*). Uncommon (rare near Denver), occasionally very common in S Colo.

Eggs cream or greenish-yellow, developing a reddish ring and top, laid singly on host leaves. Young larvae eat leaves, but older larvae prefer the inflorescence at least elsewhere where larvae sometimes eat Apiaceae. Young larvae (stages L1-3) resemble a bird dropping (black with central white patch), and have numerous scoli (spiny tubercles) which may have orangish-yellow bases on L1-2 (yellow bases on L3). Older *P. machaon*-group larvae have transverse green and black stripes with orange or yellow spots and are reportedly Müllerian mimics with *Danaus plexippus* and *Pontia sisymbrii* (which has mustard oils to deter predators), because their skin repels birds who let them go (C. Wiklund & T. Jarvi [1982 Evolution 36:998-1002] and T. Jarvi & B. Sillen-Tullberg & C. Wiklund [1981 Oikos 36:267-272] and C. Wiklund & B. Sillen-Tullberg [1985 Evolution 39:1155-1158]; also, A. Leslie & M. Berenbaum [1990 J. Lepid. Soc. 44:245-251] found that nearly all larvae of *P. machaon* survived being seized then dropped by a disgusted bird; the whitish stripes of *P. polyxenes* older larvae have uric acid, which might deter birds [M. Berenbaum 1999 J. Lepid. Soc. 53:104-107]). However the older-larva color pattern is also due to older larvae of Apiaceae-feeders being camouflaged on the pedicels of the umbels of the hostplants. Larvae also use their osmeteria to deter predators, as they are effective against arthropods but weakly effective against birds (the T. Jarvi et al. reference above). Older larva green to pale grayish-green or bluish-green (in *oregonia* whitish-green becoming green), with the black transverse bands across the body enlarged in some larvae which appear mostly black (black bands narrower in Ore. *oregonia*, photo Neill 2007); spots in notches of the black transverse bands orange or red in Colo. (yellow and rarely orange in Ore.-BC *oregonia*, mostly yellow in Canada); head like that of *P. zelicaon*. {Ssp. *joanae* from Missouri has been greatly confused with *P. polyxenes* [including in my 1986a book], so I list its larval traits here, based on J.R. Heitzman & S. Spomer: Young larvae have slightly yellower saddle [cream in *polyxenes*], older larva ground color more uniform dorsally/ventrally [*polyxenes* gets paler beneath], and ground color green or light-bluish [usually green in *polyxenes*], black markings often small [the black bands reduced to spots], the black dorsal dash on older larvae A10 is broken into two spots [usually unbroken in

Missouri *polyxenes*].} Pupa grayish-brown to lighter brown or brown with a tan pattern and lateral abdominal and middorsal bands like those of *P. polyxenes*; or pupa yellowish-green or green, unbanded; pupa has two short horns on the head, a point on top of thorax, and bumps at the wing bases. Pupae hibernate.

Mostly one flight, most common from L June to M Aug. (there are a few M June and L Aug. records). May records seem to be scarce, in strong contrast with *P. polyxenes* which has 2-3 gen.; and *P. zelicaon* flies earlier, mostly May-June.

Adults visit flowers of all colors, especially purplish, including *Cirsium vulgare* etc., *Asclepias speciosa,* and *Medicago sativa* (favorite), and seldom visit mud. In southern Colo. adults are abundant in occasional years (maybe 5% or less), when they fleek across flats and can be abundant on alfalfa flowers (I have seen 5 at one time in a small alfalfa field, where they are conspicuous because all *Papilio* flutter their wings widely while feeding) and fewer males are on hilltops. Adults bask dorsally. Adults can live several weeks in nature.

Males rait all day on hilltops, and flait there nearly as often, as they rait ~1/5-½ m up and flait ~1/5-1m up to find females; on flat land they fleek to find females; ssp. *bairdii* and *brucei* and European ssp. *machaon* mate-locate the same way (I found the latter on the Acropolis hilltop in Greece and on hilltop in Italy) (my notebooks have ~1000 usages of the words "perch" and "patrol" for the *Papilio machaon*/*polyxenes*/*zelicaon* taxa, and the word patrol is used nearly as often as the word perch; of course the human observer often disturbs raiting males, and then one could record flaiting "patrolling" as long as humans disturb them and don't allow them to rest; but these butterflies do seem to flait naturally (without disturbance) quite often. Adults can fly several km to reach hilltops and ridgetops for mate-locating. Complete courtships were not seen but are like that of *P. polyxenes*. In Europe and N.A., if a mating pair is disturbed, the female flies, the male dangling.

{In Missouri (J. Richard Heitzman, pers. comm.), male ssp. *joanae* rait in small clearings in forest (sometimes under large forest trees) at least 09:30-18:30 (matings were found 13:30-17:00), where a female flies, he pursues and flutters just above [probably below] her (a few feet above ground) to transfer his pheromone, she lands on plants/bushes 1-4 feet above ground with him behind and they join; unreceptive females fly high up to 75-100 feet as the male flutters near, then the male resumes raiting & she resumes flying. Other males may pursue a mating couple and once a male tried to mate and knocked the pair off its resting spot. Ssp. *joanae* matings last 25-39 min. averaging 31. Female *joanae* evidently mate several times as old females were also mating.}

Papilio polyxenes "*asterias*" Black Swallowtail

Nearly all adults are the black form (with unh base black, and 0-1 yellow bars in fw discal cell), which has black tegulae, the unh postmedian (and submarginal) band has most spots orange (other species usually have just a few orange spots in middle of the postmedian band), the hw eyespot has the black center generally not touching the black border, and the abdomen has 2 ½ rows of yellow spots. These traits vary somewhat, and in the foothills near Denver some adults seem to intergrade between *P. zelicaon*, and even *P. machaon*. The yellow **form pseudoamericus** is very rare in the U.S. so people never expect to find it (it is common at Veracruz in Mex., but rare in Colo., Illinois, S.D., Arizona, etc. throughout the range of ssp. *asterias*). All yellow forms have unh basal area yellow, and have 0-2 yellow bars in upf discal cell, and form pseudoamericus has the abdomen mostly yellow like *P. machaon* form brucei, but unlike brucei the unh postmedian band has a complete set of mostly-orange spots and the hw eyespot is not connected to the margin (Gary Marrone's 2002 book Butterflies of South Dakota illustrates a beautiful rare female pseudoamericus, misidentified as *P. machaon* form hollandii). The black forms vary also in the width of postmedian bands (0-7mm on uph), and the extreme black form **male form ampliata** has the yellow postmedian uph band nearly absent (I have found ampliata only in the Front Range foothills, where it is rare). Black form females are usually very black, averaging less yellow on ups, because they are Batesian mimics of *Battus philenor* which is poisonous to birds; the yellow postmedian band varies from absent on uph (the **female equivalent of male form ampliata**) to much wider but averaging much narrower than males. {The width of yellow postmedian bands varies greatly in *P. machaon*, *polyxenes*, and *zelicaon*--Table 2 of Scott (1986a) is the best reference to identify all of the forms and species.} {The name *asterias* may be just a synonym of *polyxenes,* because recent Cuban specimens are identical to mainland U.S. specimens and are thought to be temporary imports. A hypothesis is that the original ssp. *polixenes* was a common native in Cuba where Gundlach reported it abundant in 1881 in La Habana (its range there is claimed to be "especially near Habana" evidently copying Gundlach), and supposedly females had wider postmedian bands (because they did not mimic *Battus philenor* there) but then ssp. *polixenes* went extinct there. But this hypothesis is questionable because Rothschild & Jordan saw only two Cuban females (and 4 males) and photos of an old Cuban male resembles a Florida male, and variation exists in band width, so maybe Cuban *polyxenes* never differed significantly from *asterias* and maybe there never was a Cuban native, maybe they were just imports to the city of Havana, making *asterias* a synonym.}

Habitat the plains and lower mountains up to the middle of the Canadian Zone. Hostplants in Colorado herb Apiaceae: *Harbouria trachypleura, Anethum graveolens* (dill—a pseudoamericus was reared from that), *Daucus carota* (carrot), *Conium maculatum*, *Berula erecta*, *Angelica ampla, Cicuta douglasii, Foeniculum vulgare, Petroselinum crispum* (parsley), *Pastinaca sativa* (parsnips), *Heracleum maximum* ="*lanatum*"=*sphondylium montanum*. Larvae are attracted to various oils present in Apiaceae including methyl chavicol, anethole, anisic aldehyde, anisic acid, carvone, coriandrol, and sedanolid, and to the Rutaceae oil methyl-nonyl-ketone (V. Dethier). Lab larvae will eat *Cosmos* and *Solidago* (Asteraceae) which contain similar oils, and females rarely oviposit on *Cosmos* in Penn. and larvae were reared on it. Apiaceae plants produce linear furanocoumarins (psoralins) that they successfully use to repel most insects, but *P. polyxenes* is attracted to them and larvae detoxify them (a single gene Cytochrome P450S in *Papilio* metabolizes those furanocoumarins and larvae grow faster eating them [M. Berenbaum et al. 1996 The American Naturalist 148:S139-S155]), while angular furanocoumarins reduce larval growth and some Apiaceae now produce those to try to repel *P. polyxenes*. Larvae refuse *Artemisia*. Common.

Eggs cream, developing a reddish-brown ring and top, laid singly on leaves and inflorescences of the host. A female can lay up to 435 in her lifetime in lab, about 36-53 per day, starting about 2-4 days of age. Larvae eat leaves and the inflorescence, and older larvae often prefer the inflorescence. They do not make nests. Young larva stages L1-3 resembles a bird dropping, black with a cream saddle. Older larva stages L4-5 green, yellow-green, bluish-green, or whitish-green, with black lines between segments, and notched black transverse bands with yellow (sometimes orange or red) spots in the notches; the black notches and bands variable in thickness, and some larvae are mostly black; head like that of *zelicaon*. Larvae are distasteful to birds (M. Berenbaum 1990 Ann. Review of Entomology 35:319-343), while the orange osmeterium repels most arthropod predators such as ants and mantids (M. Berenbaum, B. Moreno, E. Green 1992, J. Insect Behav. 5:597-554). Pupa light brown with a brown-to-black lateral band and a light-brown-to-black middorsal band, wing case margins brown; or pupa green (often with yellow near-middorsal stripe). Pupae are found on thick or thin stems, rocks, etc., within a meter above ground. Pupae are brown with short photoperiod and when attached to rough surfaces, or green with long photoperiod and smooth surfaces or green or yellow surfaces; that ensures that overwintering pupae are camouflaged brown, and growing-season pupae are camouflaged in green vegetation. Pupae hibernate (diapause produced by short photoperiod).

Several generations: adults fly continuously from L April until early Oct. and the records are difficult to divide into generations, but there may be roughly three flights on the plains, May-M June, M July-M Aug., Sept-Oct., and about two flights higher in the mountains with peaks M-L June and in L July-Aug. (M June-Aug. in higher mts., evidently not just one flight). At any rate *P. polyxenes* is common—perhaps commonest--May-M June, unlike *P. machaon* which is scarce then.

Adults visit flowers of all colors, including red, and very often purplish, including *Carduus nutans, Cirsium arvense, Cirsium, Dipsacus fullonum, Echinacea purpurea, Erysimum capitatum, Liatris punctata, Trifolium pratense*; and imbibe mud. Like all *Papilio*, adults continue to flutter while they feed on flowers. Adults are dorsal baskers, spreading their wings. I saw an adult roosting 5m up in a pine tree, but J. Rawlins & R. Lederhouse (1978, J. Lepid. Soc. 32:145-159) found they generally roost on apices or stems of usually grasses (73%), herbs (*Tragopogon, Solidago, Potentilla, Linaria*) or rarely the shrub *Lonicera*; they found that when sunlight dims adults suddenly fly to find a roosting site and prefer sturdy spots (not sagging or blown by wind) that let them bask dorsally for a while, until they close their wings and move the forewings back into the hindwings for the night. In flight, swallowtails fly fairly rapidly, with regular wingbeats rather than gliding.

Males mate-locate all day, as they rait (and flait nearly as often) on hilltops to await females, and on flat land they fleek to find them; they rait and fleek ~15cm-1m up. They find even small rises in mostly-flat land and prefer to rait/flait there. Males change sites frequently (only half of marked males were there the next day in one study, though some males stayed at one spot for five days or more). If multiple males are on a good hilltop, they tend to cooperate so that a few are on/near the top and others rait/flait in spots below the top, to minimize time-wasting chases if every male were to try to rait/flait on the very top. On flat land/valley bottoms males fleek 1/3m to 1m above ground (or ~1.5m over a *Conium maculatum* patch) and dip down among vegetation to seek females. In very hot weather they fly slower. In courtship, the female arrives on the hilltop and flies slowly around, the male overtakes the female who hovers and the male hovers mostly just below and in front of her 10 cm away and he flies upward and backs into her and sometimes above her 5cm to transfer his pheromone to her antennae, and this may be repeated up to ~20X if she does not land but receptive females land after an average of 20m and remain quiescent while the male lands behind and crawls alongside and joins. Males hover over flower-feeding females to transfer pheromone (the strong sweet odor of males), and successful courtship may follow. Sometimes mating happens fast, as I observed a female *polyxenes* and male *zelicaon* flying and they quickly flew around each other, mated, and landed on a bush (it appeared that they mated in midair, but they must have joined the instant they landed, otherwise I would have noticed one hanging from the other as mated pairs always travel) (note that this quick coupling seems to be why I saw several *Papilio indra* grapple in midair). Unreceptive females fly high in the air (like the encounters between two males) then fly rapidly downward to reject and evade the courting male, or females often just fly away, or refuse to land so the male gives up and flies away. Mating lasts an average of 45 min. (4 hours if the male mated twice in one day), and females may mate two or sometimes three times (1.9 average for old females, R. Lederhouse 1981, J. Lepid. Soc. 35:266-277). If a mating pair is disturbed, the female flies, the male dangling.

Papilio zelicaon **Anise Swallowtail**

P. zelicaon normally has yellow wings (unh basal areas yellow, two yellow bars in upf discal cell), and is identified by a single yellow stripe on the side of the black abdomen, tegulae mostly-yellow, usually just a few orange spots on the postmedian unh band (usually only at apex and center of the band), and the black spot in hw eyespot is not connected to the margin. Most adults are the **yellow form** (unh basal areas yellow, two yellow bars in upf discal cell), which vary in width of the yellow postmedian bands, from usually wide to less than 1cm wide on uph (**form comstocki**). **Form nitra** is the black form (unh wing base black; and 0-1 yellow bars in upf discal cell), which is identified by the single row of yellow dots along side of black abdomen (sometimes a partial row of dots above it toward the rear) plus the unh postmedian band which usually has just a few orange spots that are present in the middle of that band, and by the black to slightly yellow tegulae. Form nitra has the yellow postmedian uph band varying from fairly wide 7mm to very narrow (0-2mm in the rare **form ampliatanitra**); they are usually narrower in females than in males. Form *nitra* represents ~5% of the population in the Front Range foothills from Douglas Co. northward, but becomes rarer southward and is quite rare along and south of the Arkansas River, and in the higher mts. and western Colorado it is basically absent; northward, it seems to be rather common (~20% or seldom more in western Nebraska and N & S Dakota and Montana), and continues northward into Alberta where it is uncommon again (very rare nitra have been found in N New Mex., N Ariz., N Utah, and Ida.). {Some very rare black forms are known from near Los Angeles, but those are some other kind of genetic form as the abdomen of those has just one *zelicaon*-type yellow stripe.} Form nitra and ordinary *zelicaon* can be reared from a single female (the black form is mostly dominant to yellow). The black form *nitra* may have originated from introgression with *P. polyxenes*, but most typical *nitra* adults found in nature now are NOT just current hybridization (*P. polyxenes* is absent in Alberta where nitra & *zelicaon* fly, for instance, and nitra also mostly occurs farther west than *P. polyxenes* in Montana), although current hybridization may produce some of the odd hybridlike adults that are found (the Front Range foothills has many adults that look like they are various kinds of hybrids between *P. zelicaon*, *P. polyxenes*, and *P. machaon bairdii* & *brucei*). In the Front Range *nitra* occurs on all the big hilltops in the foothills, and it seems that male *nitra* are more likely to be found on the highest point of the hilltop compared to yellow *zelicaon*, and less likely to be found on lower points away from the top where the extra males rait and flait who cannot all fit on the very top without wasting everyone's time (these lower males may get lucky and be the first to spot a female flying up from below to mate—at low density a female could fly to the top and mate without meeting a male on the way, while at high density the female would surely meet a male lower down before she got to the top). Scott (1983a) reported that in 42 observations in 1979-1981 in the Front Range foothills, *nitra* males were found on the highest point of the hilltop at a locality, and in only 13 cases was *nitra* found lower down on a sloping ridge or adjacent hill; whereas *zelicaon* forms distributed themselves all over the top middle and ends of ridges. At one locality 48 different form *zelicaon* were all over the ridge system, while the three male *nitra* were on the topmost two adjacent points. *P. polyxenes* raits on top points and ridges and shelves nearby etc. like *zelicaon*. That tendency of *nitra* to rait on the very top may be responsible for its persistence in the foothills where there are more suitable hilltops, whereas the higher mountains have fewer suitable hilltops and the forest is often dense which ruins a hilltop for these butterflies' mate-location system, and nitra is scarce there. Additionally, form nitra may survive better at low altitude (possibly helped by linked genes introgressed from *polyxenes*), form zelicaon better at high altitude. *P. zelicaon* has sometimes been lumped as a subspecies of *P. polyxenes*, and they do seem to hybridize some in the Front Range of Colorado, but no more than they do with *P. machaon*, and *P. polyxenes coloro* overlaps the range of *P. zelicaon* somewhat in the mountains of southern California, so I keep them as separate species. Basically they remain separate species only because the mountains favor just one generation, the plains favor several. The *P. machaon* group is a stenchospecies (superspecies). *P. zelicaon* flies early in the year overlapping the early generation of *P. polyxenes*, while *P. machaon* mostly flies later peaking July. The name *gothica* (named from Colo.) is a syn. of *zelicaon*.

Habitat the lower mountains up to timberline, and rarely straying to the top of peaks above timberline, several times straying 3-7 miles east to my house at Lakewood. Hostplants in Colorado herb Apiaceae: *Conium maculatum*, *Harbouria trachypleura*, *Aletes acaulis*, *Cicuta douglasii*, *Lomatium grayi* on the E slope, *Ligusticum porteri, Angelica ampla, Conioselinum scopulorum, Cymopterus lemmonii*="*Pseudocymopterus montanus*" (also the probable host at Florissant on E slope), *Lomatium parryi, Heracleum maximum=sphondylium montanum*, *Ligusticum porteri, Cymopterus montanus*, and *Pteryxia hendersoni* on the W slope. There are ~100 species of hostplants throughout the range (Wayne Wehling recorded 69 species in 39 genera, many in Washington, and together with J. Thompson found that oviposition preference is the same everywhere), the hosts elsewhere are mostly Apiaceae, and a few Rutaceae such as *Ruta graveolens*. The hostplants contain essential oils such as anisic aldehyde and anethole. In California *P. zelicaon* moved into the lowlands and Central Valley when *Foeniculum vulgare* was introduced before 1850, and then became common on *Citrus* in S Calif. (and one small area in Butte Co. in N end of Central Valley, Graves & Shapiro 2003), which has a similar oil methyl chavicol. These oils stimulate the larvae to eat. Common.

Eggs cream, developing a reddish-brown ring and top, laid singly on leaves and inflorescences. Larvae eat leaves, but older larvae prefer inflorescences, without nests. Young larvae (stages1-3) resemble a bird dropping, black with a cream saddle on the middle of body, and many scoli (most black, but many L2 and esp. L3 have red around base of the scoli). Older larva (stages 4-5) green or bluish-green (rarely blacker), with notches in the black transverse bands (the spots in notches usually yellow, sometimes orange), black lines between segments, and as in *P. machaon*-*P. polyxenes* two black spots occur above each proleg; head greenish, with a black spot in front and another among the eyes, the black vertical bands in front of eyes and on each side are joined or nearly joined at the top. The orange osmeterium of older larvae dispenses butyric acid, a strong smell that repels predators. Pupa yellowish-gray, or light-brown to blackish-brown, with brown lateral band and brown middorsal band; or pupa yellowish-green and unbanded or a dark-green lateral band. Pupae hibernate (because of short photoperiod/low temperature detected by 3rd-stage larvae) for up to five years (mostly just one year in Colo.).

One flight M April-E Aug., mostly L April-E July in foothills, L June-E Aug. at high altitude.

Adults visit flowers of all colors, even red, including *Erysimum capitatum, Penstemon, Senecio*, and sometimes visit mud. Adults continue to flutter while they flower-feed. They bask dorsally with wings mostly spread.

Males rait on hilltops, and flait there nearly as often, all day to await females, as males rait an average of ~57cm up (0-150cm, N=9) (they flait similarly ~2/3m up). Males distribute themselves over the top of a hill/ridge so they don't have to waste too much time meeting other males. In courtship (Scott 1986a, Shields 1967) the female flies slowly onto then around the hilltop, the male sees her and overtakes her then she flutters and he flutters near her in a bobbing flight as he rises up next to her repeatedly to transfer pheromone, then receptive females land (usually just below the summit) with the male behind and parallel to her or just below her and he moves alongside and curves his abdomen to join. Males develop a strong pheromone after a few days that smells perfumey and similar to related species and *P. glaucus*-group species, but maybe a bit stronger. Females evidently have a pheromone that allows males to recognize them and land and try to mate, whereas males fly away from males that land and remain quiescent (the male pheromone evidently serves only to make the female willing to mate with him). If a mating pair is startled, the female flies, with the male dangling. Mating lasts ~36 min., or up to 30 hours if the male mated just prior (Shields 1967). After mating, the female flies rapidly downhill. Shields found some males lived up to 29 days in nature in Calif., and preferred the hill they were captured on, and sometimes returned to it from up to 5km away.

Pieridae Whites and Sulfurs

Pieridae are ~1026 species worldwide, usually medium-sized butterflies—some are large and a few are small—that are usually white or yellow or orange due to pterine pigments. Adults-especially males—often reflect ultraviolet, and the reflection is due to pterine pigments in Pierinae *Pieris*/*Pontia* etc. but is due to structural lamellate wing scales in Coliadinae *Colias*/*Eurema* etc. & probably *Phoebis*. Adults are often common, and may be fast flyers and many are somewhat migratory. Seasonal forms occur very often, the spring butterflies being redder or darker on the underside. Adults have six large legs, and the claws on the leg tips are forked. Adults usually rest with wings closed, and Coliadinae bask laterally (with wings closed), but most Pierinae bask dorsally with wings open, except *Euchloe* bask dorsally or laterally. Adults have not been reported to shiver to get warm. If a mating pair is disturbed, the male usually flies with the female dangling, whereas in most other butterflies the female flies, with the male dangling. Pieridae have a special mate-refusal posture, in which the female spreads her wings flat and raises her abdomen nearly straight up to expose complicated glands that waft pheromone chemicals—transferred from male to female during mating--that repel the male (see

Pieris rapae writeup). Larvae are cylindrical without filaments or horns, though they may have short tails. Larvae of some species have a ventral neck gland (*Neophasia, Nathalis*—absent on *Pieris, Pontia, Euchloe, Anthocharis*) that produces chemicals that evidently repel predators such as ants (James et al. 2012) (the gland is bilobed in Pieridae, single-lobed in Hesperiidae and Nymphalidae). Young Pieridae larvae (always the first stage, and usually stages 1-4, sometimes on mature stage 5 larvae) have droplets of an oily substance emitted from the widened tips of the tiny hairs (setae) on the body, which has mayolene chemicals that repel predators such as ants (see *Pieris rapae*, below); these seta-tip droplets have been noticed in few other butterflies, notably *Argynnis* and *Boloria* in Heliconiini, Nymphalinae), but are probably widespread. Older larvae are rather simple with no scoli or projections, and the crochets are in a semicircle on the inside of the prolegs. Pupae are attached by the cremaster and by a silk girdle around the middle. The pupal head is often prolonged into a cone, and in some species the wing cases bulge downward (the bulge contains the gigantic proboscis of *Phoebis sennae* etc.). Adults of Pieridae (including Coliadinae and Pierinae) can see all colors from ultraviolet to red, and have Red610 rhodopsin detectors that let them see red (G. Bernard 1978 Science 203:1125-1127). Male Pieridae usually fly after joining, and males of mated pairs generally fly when disturbed (in *Eurema*, *Pieris*, etc.).

Pieridae, Dismorphiinae

Colorado has no species in this mostly-tropical family of ~57 species, but the courtship is interesting for comparison, so the courtship of European *Leptidea sinapis* is given here (C. Wiklund 1977. Courtship behaviour in relation to female monogamy in *Leptidea sinapis*. Oikos 29:275-283.): The fleeking male pursues a flying female (or he spots a landed female who flutters a bit until he lands or she flies and he pursues), and she lands and he lands facing her, he extends his proboscis and bends both antennae down and sways his head left and right ~once/sec., and the female bends her antennae backward to avoid being hit, after 10-90 sec. she curves her abdomen forward and upward closer to him, then the male flutters a little and bends his abdomen to join hers (obviously the male would have to rotate to get closer and join). Unreceptive females usually land and remain unresponsive except for bending her antennae backward farther than virgin females, and she ignores the fluttering/swaying male, or she flies vertically with the male behind then descends ½-1m above ground to try to be rid of the male. The female has a pheromone, because when males are placed on a leaf under which a female is hiding, the male does the head/proboscis/antennae swaying courtship without actually seeing her. (The male probably has a pheromone also, transmitted by his fluttering, and females may recognize the color of his antennae which differ in each *Leptidea* species.) Females mate only once, the mating lasting 25-55 min.

Pieridae, Coliadinae Sulfurs

Coliadinae are mostly yellow or orange, ~191 species worldwide. Many species are migratory. The larvae mostly eat Fabaceae plants (legumes); they are mostly simple in coloration, but some are multicolored. Pupae are mostly simple, but some have the head elongated into a cone and the wing cases may be expanded downward in some species that have a giant proboscis. Adults bask laterally.

Nathalis iole Dainty Sulfur

A unique tiny butterfly, which has a black bar on rear of upf and a black bar on front of uph. The unh is yellow in summer, but cool temperatures or short photoperiod produces the early spring and fall **form viridis**, which has the unh greenish rather than yellow: individuals vary from slightly or mostly green (a mixture of yellow and black scales that appears green to our eyes/brain). The uph is a bit orangish in some females. The male has an oval androconial stigma on the uph costa near the base of the black stripe, which is red but fades to yellow after several months in museums.

Habitat open areas, mostly in valley bottoms in weedy places or lake/stream margins (many hostplants are weeds), though it occurs all over Colo. including mountains with a dozen+ records above timberline up to 13,000' at least. This tiny butterfly apparently migrates into Colo. from the south every year, flying gradually northward in spring and summer and becoming most common in summer until frost. The exact amount of frost hardiness is uncertain. The records of sightings/collections seem to confidently prove that it strays northward to Colo., and as far north as Idaho and New York and C Manitoba, although unidirectional migrants flying northward in May (typical of the migrants *Vanessa cardui* and *Euptoieta claudia*) are seldom seen (though I once saw a migrating? female flying over a roof in October), so one has to wonder whether they migrate high in the air like *V. cardui*, and are they aided by strong spring winds from the southwest? Hostplants in Colorado small herb Asteraceae: *Dyssodia papposa*, *Bidens frondosa*, *Bahia dissecta*, *Coreopsis verticillata* (in gardens), (*Tagetes* is eaten southward) (in Nev. even more Asteraceae are used: *Centaurea repens*, *Pectis papposa*, *Thymophylla pentachaeta*, Austin & Leary 2008). Even more Asteraceae are eaten elsewhere incl. *Helenium* in SD, and *Mollugo verticillata* (Molluginaceae) is also eaten, which has been introduced into Colo. so could be eaten here. The hostplants generally contain photosensitizing compounds, which become noxious when exposed to light. Uncommon, sometimes common in late summer.

Eggs lemon-yellow or orange-yellow, laid singly on leaves (rarely sepals) of hostplant seedlings. Larvae eat leaves and flowers, without nests (they rest on stems or leaf ribs near the top of plants), and feed mainly at night. Young larvae chew the leaf surface down to a "windowpaned" cuticle, while older larvae eat entire leaves and petals. Older larva {Allen et al. (2005) and James & Nunnallee (2011) have photos}whitish-green to dark green, covered with tiny hairs, without markings, or with a yellow or white narrow lateral stripe which is often edged above by a broad stripe (which varies from weakly purplish to dark-red to chocolate) and a similar broad middorsal band (which varies with the same colors often purple/dark-red) edged narrowly by whitish (both whitish stripes may be narrowly edged below by darker-green line), the rear projects a little where the two broad stripes meet, and all larvae have two small subdorsal reddish tubercles projecting forward on T1 of unknown function (dispenses predator-repellent chemical?), prolegs can be reddish-brown on striped larvae; a bilobed ventral neck gland; head green. Older larvae have setae that emit chemicals that evidently deter ants etc. There are only 4 larval stages. Pupa green or yellow-green, with at least a lateral whitish dashed line, yellow-white dots, mottled with light and dark green, lacking a head projection. Probably no hibernating stage, as they overwinter in S New Mex. and S Tex. etc.

Several yearly flights M May-E Dec.

Adults prefer yellow flowers, often whitish, sometimes purple/violet/blue flowers, especially Asteraceae, including *Bidens frondosa, Coreopsis verticillata, Heterotheca canescens*. They enjoy the tiny 1.5mm pink *Thymus vulgaris* (Labiatae) flowers that grow in low mats. They often visit mud. They fly just above the ground. Adults are lateral baskers; form viridis helps them get warm in cool early spring or fall by absorbing more sunlight. Adults roost on low weeds or grass, and tend to creep down to a sheltered twig near ground.

Males fleek all day throughout the habitat but prefer low spots such as gulch/valley bottoms & roadside ditches etc., as they fly ~5cm up (seldom 10cm) in gulches and on trails and through weeds etc. to find females. In courtship (Rutowski 1982), the male finds a flying or resting female (rarely a receptive female will chase a male), she lands and the male sometimes flutters above her briefly before landing, and both have wings closed as the female lowers her abdomen and he bends his abdomen to mate. In one courtship that I saw they fluttered and landed with wings closed and she hung from a stem as he was on top of stem and bent abdomen down to join. Unreceptive females spread their wings and raise the abdomen to reject the male with repellent pheromone (like all Pieridae), and males may hover over her, but if the female briefly does this the male can move in front of her and face away and spread his wings and move his fw forward to expose his uph scent patch to waft pheromone, and then he tries again to join. Unreceptive females may fly high in the air to discourage the male. If a mating pair is disturbed, the male flies, the female dangling. The male has an orange stigma at the base of uph cell $Sc+R_1$ that has pheromone glands in the wing membrane to seduce the female (the scales above this patch may be evolving to disappear, because the orange color and pheromone glands are in the wing membrane so the scales are not essential and some males emerge from pupae without the scales).

Rutowski, R. "1981" (1982). Courtship behavior of the dainty sulfur butterfly, *Nathalis iole*, with a description of a new, facultative display (Pieridae). J. Res. Lepid. 20:161-169.

Eurema lisa lisa Little Yellow

A small yellow butterfly, distinguished by a black dash at the end of the upf discal cell, the 1-2 tiny black dots on unh base (seldom absent), and a black border on uph as well as upf. Some females are white (**form alba**), and fall adults have redder unh (**form rosa**). Males reflect ultraviolet all over the ups. A rare stray in Colorado from farther south, with 9 county records on the eastern plains, once found on Mt. Evans >13,000'.

Habitat open areas in SE U.S. Hostplants southward herb Fabaceae: esp. *Cassia* (*Senna*), often *Mimosa*.

Eggs deposited singly on leaf ups, often on rachis or midrib (on ups near the growing tip of young *Mimosa* leaves, then the leaf closes about the egg). Scott (1986a) describes early stages, and Allen et al. (2005) and Wagner (2005) have photos of older larva, which is green or bluish-green with yellow or white lateral band/spots, edged below by darker green, plus weak or strong darker-green middorsal and dorsolateral bands. Pupa green, a lateral cream line (stronger on hind margin of wing) and short white head cone. It overwinters only southward, and there may be no diapause stage, although Bright & Ogard (2010, who show photos of larva and pupa) report that adults hibernate, so it probably overwinters as diapausing adults in SE U.S. Common in SE U.S.

Many flights most of the year in SE U.S. and Mexico. It seems to migrate north in spring in small numbers but south in fall in large numbers, as proved by Florida malaise traps (T. Walker 1991 Ecol. Ent. 16:241-252). Migrating swarms are sometimes seen in the Caribbean and Atlantic. It is much more common in E U.S. than westward.

Adults feed on flowers including *Medicago sativa*, in E U.S. preferring small flowers such as Asteraceae including *Aster* and *Solidago*. They also sip mud and urine. *Eurema* usually land with wings closed.

Males fleek all day ~30 cm up to seek females. Males reflect uv on ups, so males ignore butterflies that reflect uv (resting *E. lisa* males flutter the wings several times to display their uv to repel an approaching male). Males also do not court butterflies with a black upf wing bar of *Nathalis* and *Eurema daira*, or butterflies that have grayish undersides like Florida *E. daira*. In rapid courtship (Rutowski, 1978), the male pursues a flying female or nears a landed female, she lands if she was flying, he contacts her with fluttering wings (to display his uv) and sometimes contacts her with his legs, causing the female to usually flutter (females did not flutter in ~1/3 of successful courtships) {the fluttering of males and females occurs in short bursts of ~75-80 milliseconds with ~1/2 second between bursts, for a short time or nearly a minute}, then when she detects his pheromone (from a patch of scales and scent glands mostly in cell CuA_2 on the male's unf-base, at the rear of the discal cell to the front of cell 1A+2A—some people can smell the pheromone) she spreads her antennae and lowers her abdomen from beneath her closed wings, the male lands on her with partly-open wings and crawls, flapping his wings, onto the side of her thorax and bends his abdomen and joins. Unreceptive females flutter strongly & continuously or fly straight up in the air to reject the male (a resting male also flutters to reject an approaching male), or very rarely adopt the Pieridae rejection posture (wings spread, abdomen raised) to repel him. Mating lasts ~30-60 min. Females usually mate once, often twice, rarely three times. If a mating pair is disturbed, the male flies, the female dangling. Male and female have different sex pheromones (T. Takanashi et al. 2001. Entomologica Experimentalis et Applicata 101:89-92.) {*Eurema daira* courtship is very interesting (R. Rutowski 1983 Anim. Behav. 31:985-989): the male hovers until she lands, he lands and moves one fw out from covering the hw, and then he flaps only that fw ~20X in each 5-sec. bout so the fw hind margin (next to the pheromone patch) rubs against her antenna, and meanwhile she flicks her wings, then she stops and lowers abdomen and he joins.}

Rutowski, R. 1978. The courtship behaviour of the small sulphur butterfly, *Eurema lisa* (Lepidoptera: Pieridae). Animal Behavior 26:892-903; and two more Rutowski et al. 1977 papers on same subject at J. Comparative Physiol. 115:61-74 and 115:75-85.

Eurema nise nelphe **Mimosa Yellow**

A very rare stray from far southward (I caught one 1.6 mi. SW Goodpasture SW Pueblo Aug. 1, 1972, and there is a record from Yuma Co.). Resembles *E. lisa*, but lacks the black upf dash at the end of the discal cell, and the unh base lacks the tiny black dot(s) of most *lisa*. Sometimes there is a slight black border on uph as well as upf, but the black borders are narrower than *E. lisa*. Females are yellow. There are seasonal forms, presumably **form rosa**. Habitat subtropical areas. Habitat woods and scrub in S Tex. Hostplants southward ~8 herb/tree Fabaceae incl. *Mimosa pudica*. Eggs white becoming yellowish. Scott (1986a) describes immatures, and Allen et al. (2005) has a photo of larva that is similar to *E. lisa*, green, heart-line darker, a lateral white line edged below by a dark-green band. Pupa yellowish-green (occasionally much darker) mottled with greenish-white and brownish specks. Many yearly flights in Mexico, where there may be no special overwintering stage (adult? as in other *Eurema*). Adults feed on flowers including *Hymenopappus filifolius*. Males evidently fleek on trails and along the margins of hammocks.

Eurema mexicana mexicana **Wolf-Face Yellow (Mexican Yellow)**

The upf has a "wolf face". There is a short tail. The uns is yellowish while the ups ground color is mostly white except the front of uph, so most can be identified in flight. The orange on uph of males reflects ultraviolet. Adults migrate as far north as Sask., Minn., Mich., and Ont. and often into Colo. with records all over the state, rarely even above timberline, most in late summer; they are usually absent or rare, but occasionally can be moderately common locally (in 1955, and I found them common in 1974 at Tinytown near Denver, and M. Fisher found them common in 1990 and 2010, and they were common and bred once in El Paso Co. at 8500'), thus they occasionally temporarily breed in Colo. The fall **form rosa** has a reddish unh.

Habitat open areas. Hostplants farther south tree Fabaceae: *Acacia*, *Robinia neomexicana* (a female seen investigating this in Fremont Co.). Common southward.

Allen et al. (2005) has a photo of larva, which is dark-green with dark-green-edged lateral stripe (which is cream with reddish tinge at bottom) and a narrow whitish line beside heart. Overwintering stage unknown, they evidently do not overwinter in Colo.

Most of my Colorado sightings were from L June-July, but some have been caught in L May and Aug.-Sept.; it has multiple flights farther south.

Adults feed on many flowers, especially Asteraceae, and mud. *Eurema* usually land with wings closed, and they evidently bask laterally.

Males fleek all day to seek females, especially in valley bottoms, flying slower than *E. nicippe*, roughly ~1/2m up. If a mating pair is disturbed, the male flies, the female dangling.

Eurema nicippe Erratic Orange

Identified by the orange wings with broad black uph borders. Adults migrate from the south, so are scarce in Colorado, where multiple adults rarely can be seen in a day. It flies so far, that after first discovery in Hawaii Dec. 2013 in Oahu, by the end of 2014 it had spread to all the big Hawaiian Is. Adults fly fairly fast and erratically, so the former common name "Sleepy Orange" is misleading. The fall **form rosa** has redder unh. A yellow **form flava** is very rare.

Habitat open areas or open woodland, in warmer regions, mostly at low altitude but rarely migrates as high as the Alpine Zone 12,500'. Hostplants herb Fabaceae: seen ovipositing on *Astragalus* in Arapahoe Co. Colo. by Mike Fisher, but southward the host is nearly always *Cassia* (*Senna*) spp. incl. *C. marilandica* in Neb. Common southward.

Eggs pale greenish-yellow, turning reddish later, laid singly under host leaves or sometimes on flower buds. Larvae eat flower buds/young fruits, also leaves (the tips first). Allen et al. (2005) and Wagner (2005) have photos of older larva, which is light-green or grayish-green with a lateral cream band (blended above to whitish-green and edged below by a dark-green band) (the band sometimes contains orange spots or rarely contains an orange line). Pupa whitish-green (sometimes black) sometimes with a few small irregular russet patches here and there, sometimes several white spots on T2, a darker middorsal line, lateral whiter band extends from cremaster to ridge along top edge of wings to the long green or brown head cone, wings bulging down greatly (sometimes with a midventral brown band on the wing bulge extending to cremaster). Pupae in Tex. and Ariz. vary from black to green with brown blotches, to just green, apparently genetically (W. Evans 1958 Lepid. News 12:95-96). Overwinters as an adult far southward.

Multiple yearly flights occur farther south. Colorado adults were mostly found June-July, some Aug. and Sept. Opler & Krizek (1984) note that there are many generations May-Oct. in Miss., but probably just one winter adult-overwintering generation there Oct.-April (*Eurema daira* overwinters as adults and may live 110 days then, so there is suspicion that other *Eurema* have adult diapause also during the dry/winter period).

Adults feed on various yellow, whitish, and purplish flowers at least (often on Asteraceae), and mud, sometimes aphid honeydew. Adults bask laterally, and cannot warm up by shivering the wing muscles. *Eurema* usually land with wings closed.

Males fleek all day ~30 cm up mostly in gulches and flats to seek females. In courtship, the male buffets the female with his wings to transfer pheromone from his unf base (an orange stigma that becomes white, at the base of cell CuA_2) to the flying or landed female, the female lands with the male nearby, and a receptive female accepts the male. If a mating pair is disturbed, the male flies, the female dangling.

Kricogonia lyside Lyside Sulfur

A rare stray to Colo., with records all over E Colo. The yellow upf basal patch reflects uv on males, weakly on females; some females lack that yellow patch (**form anorbus**), and may be pure yellow (**form unicolor**) to pure white. The wing pattern is simple, as the only black markings are at wing apices (S Arizona males usually have an apical black bar on hw, **form terissa**, which is uncommon in S Texas, and the female upf margin may be tipped with black, **form fantasia**). The female traits vary independently. The unh is light green, sometimes yellowish. It is a common tropical species of open areas. Migrations were seen E to W in NE Mex. Oct. 23 (W. Howe 1964 J. Lepid. Soc. 18:26), and WSW to E on June 11, & NNW to SE July 9, & to E June 9 10000! per 10m of road flying 0-8m up, then later a few to W (Yucatan, E. Welling 1964 J. Lepid. Soc. 18:229, 1973 J. Lepid. Soc. 27:154-5), and NW to SE in Tamaulipas July 11 (G. Byers 1971 J. Lepid. Soc. 25:124-125); these directions suggest that the butterfly has no organized N-S migration system, just random movements. Hostplants tree and shrub Zygophyllaceae in Latin America (*Porlieria*, *Guaiacum* including *coulteri* in S Ariz.); found in *Medicago sativa* fields in Kansas. Scott (1986a) describes early stages, and Allen et al. (2005) has photos of larva. Egg cream. Larva dark-green, a middorsal white band edged by dark-green, some silvery subdorsal dusting, a russet band edged on top by whitish and bordered below by white band; head green. Or larva solid unmarked green with lateral paler area mimicing a pale leaf edge. Larva feeds at night, and hides in daytime. Pupa bluish-gray with whitish bloom. Flies all year in S Tex., migrating northward rarely to Neb. Adults often land upside down under leaves. Adults roost on trees.

Colias meadii meadii Mead's Sulfur (Alpine Sulfur)

C. meadii is deep-orange on ups similar to the orangest *C. eurytheme*, but the unh is greenish without submarginal brown dots. The male has a round stigma on the uph base (normally hidden beneath the fw base). White females (**form alba**) are very rare in Colo., slightly commoner in Wind River Mts., Wyo. and vicinity (I have never found one in Colo., except for a whitish large alba from Loveland Pass that might be a hybrid with *C. scudderii* because it has larger pale spots in the black border than other *meadii* and looks rather intermediate; V. Nabokov found one alba near Longs Peak Colo., whereas at Togwotee Pass Wyo. he found ~3 alba and ~9 orange females [1953, Lepid. News 7:50]; I found one in the Wind River Mts. Wyo.)

Habitat Subalpine and Alpine Zone open areas and tundra; adults can fly at colder temperatures than other *Colias*. Hostplants in Colorado herb Fabaceae: *Trifolium dasyphyllum, parryi, nanum, Astragalus alpinus, Vicia americana, Oxytropis deflexa*. Common.

Eggs yellow-green, later turning crimson, laid singly on leaves. Larvae eat leaves, without nests. Older larva dark yellow-green, with black points, heart-band darker, a pale-yellow subdorsal stripe with black spots on its lower edge, and a narrow white lateral line; head darker-green, with black points. {*C. meadii* is related to arctic and Siberian *Colias*. Larva of the arctic Canada ssp. *johanseni* is the same, except the black spots on lower edge of subdorsal stripe are larger black dashes. And ssp. *rankinensis*--widespread W of Hudson Bay in Canada--is conspecific with *johanseni* but lacks the stigma of *meadii* & *johanseni*. In mtDNA *johanseni* and *rankinensis* are very similar while *meadii* differs somewhat.} Pupa yellow-green, with a middorsal dark line and cream subdorsal and lateral bands, all but the wings dotted with whitish; head projection cream. *C. meadii* is surely biennial in Colorado, because all Alpine/Arctic Zone butterflies seem to be biennial or multiannual, and probably hibernates as ~2nd and ~4th stages in the two winters. Colo. larvae hibernate also 4th –stage (W. Edwards 1889 Can. Ent. 21:41), 3rd-4th-(rarely 5th)-stage (W. Edwards 1892, Can.Ent. 24:49). {Ssp. *johanseni* hibernates at fully-grown 3rd-stage, J. Harry}. In Alberta it is biennial and 1st-stage larvae hibernate "almost certainly" the first winter, nearly-mature larvae the second, according to T. Bean (1890, Can. Ent. 22:94-99), who is probably correct. Jack Harry (2009) worked out definite hibernation stages of N Alaskan *Colias*, and found that annual species hibernate generally in 3rd stage, biennial arctic species as 2nd the first winter (sometimes 1st or 3rd) and 4th stage the second (rarely 3rd) (except mature fed 5th stage hibernate in *C. tyche canadensis* and *C. t. thula*). I conclude Colo. *C. meadii* is surely biennial and hibernates mostly as ~2nd and ~4th stages the two winters.

One flight L June-E Sept. (mostly M July-Aug.).

Adults visit yellow flowers, sometimes blue/purple, including *Arnica* spp., *Erigeron* spp., *Heterotheca*, *Senecio* spp., and *Solidago* spp., and sometimes suck mud. Adults live an average of about a week in nature based on mark-recapture studies, which found that adults move an average of 0.5 km males and 0.7 km females in their lives (one moved 1.7 km), but populations can exist in only 8 hectares, or in a population 1.9 km wide; adults tend to drift downward later in the flight period; their swift flight suggests they can fly far. Adults can fly at ~4ºC lower temperatures than *C. philodice*; if there is wind the temperature must be higher for butterflies to fly, and the green unh and more-furry body helps lateral-basking adults get warm (the scale "fur" is 1.5 mm thick, whereas in *C. philodice* it is ~.95mm at 1700m altitude, ~1.1mm at 2700m, J. Kingsolver & W. Watt 1984 Ecology 65:1835-1839).

Males fleek all day over alpine tundra and subalpine open areas to seek females, as they fleek usually only 10-20 cm up (once 50cm, mean 20cm, N=7); when windy they fly lower. In courtship, the female and male flutter/hover, and the male may hover over a landed female (evidently to transfer pheromone from his stigma patch on the uph base in cell $Sc+R_1$), and then receptive females presumably land and remain quiescent and accept the male; unreceptive females can flutter her wings, crawl under a leaf, or often fly vertically up to 15m to reject the male.

Harry, J. 2009. Natural life histories of Alaska *Colias* (Lepid., Pieridae). TheTaxonomic Report of the Int. Lepid. Survey. 7(2):1-20.

Colias alexandra Queen Alexandra's Sulfur

C. alexandra is yellow, the unh usually-greenish gray (often slightly yellowish), the unh central spot usually lacks a reddish ring or the ring is weak (and a reddish satellite spot beside the central spot is rare), the uph central spot is yellow (=actually missing) or sometimes orangish, and the unh seldom has strong submarginal dots. Males reflect ultraviolet next to the ups black border (narrowly on upf, wider on uph), and very rare Colorado males are conspicuously orangish [reflecting uv strongly] on outer part of uph (males from W of Denver, the Rampart Range, Grand Co., and a male from Gunnison Co. with upf as well as uph orangish). Females are yellow, seldom white (**form alba**, rare ~1% on E slope, commoner as much as 10% on the W slope). Ssp. ***alexandra*** (=*karina* [named from Laramie Mts. Wyo.] =*brigitta* =*natalia* =*julia* =*katrina*--all have Colorado TLs, but they cannot be distinguished so are synonyms) occurs only in the mountains.

Habitat open grassland areas and open forest in the mountains from the foothills to the Canadian Zone. Hostplants in Colorado (ssp. *alexandra*) herb Fabaceae: *Thermopsis rhombifolia* var. *divaricarpa* (main host in the Front Range) and var. *montana* (Sangre de Cristo Mts.), *Astragalus laxmannii* (=*adsurgens*) var. *robustior*, *alpinus* (a common host at higher altitude), *miser* var. *oblongifolius*, *bisulcatus* var. *haydenianus*, *Lathyrus lanszwertii* var. *leucanthus* (main host Gunnison Co.), *Hedysarum boreale*, *Trifolium pratense*, rarely *Lupinus argenteus* in Colo. (a main host in Wyo. in the higher Laramie Range), *Oxytropis lambertii*, *Vicia americana*. And *Astragalus canadensis* is another host in the Laramie Mts. Wyo. Usually uncommon, occasionally common in the mtns.

Eggs pale yellow/cream, later turning crimson, laid singly on host leaves, mostly on ups, sometimes on uns (all *Colias* oviposit mostly on leaf ups). Females do not seem to recognize other eggs laid on plants, and may lay up to 5 eggs per shoot (J. Hayes 1985 Oecologia 66:495-498). Females can lay up to 600 eggs. Larvae eat leaves, without nests, and prefer to rest on the midrib/stem with head toward the base. Older larva green or yellowish-green with tiny black points (setae), a slightly darker heart-band, and a white lateral band (with orange dashes running through it), the underside darker-green; head yellow-green, with small black setae. Pupa yellow-green (darker dorsally) with a reddish-brown near-midventral line on abdomen, a yellowish lateral stripe that is edged beneath with a little red-brown on abdomen. Unfed 3rd-stage larvae hibernate. The time in the field from egg laying to adult eclosion is 65 days in W Colo., plus the duration of hibernation of older 3rd-stage larvae (Hayes, 1980) (2nd-, 3rd-, sometimes 4th-stages hibernate elsewhere in *C. alexandra*-group butterflies).

One flight for ssp. *alexandra*, end of May-Aug. but mostly L June-E Aug. Males marked in nature live 6-12 days on average in nature, but some lived 26 days. Marked-released adults in Colo. averaged only 0.6 km movement in a lifetime; dispersing adults averaged 1.2 km, the longest dispersal being 5.7 (in one day), and 8 km (W. Watt et al. 1977, Oecologia 27:1). The population size of the next generation near Gothic, Gunnison Co. Colo. is proportional to the number of eggs laid on the local host *Lathyrus lanszwertii* var. *leucanthus*, which in turn depends on weather (bad weather that prevents oviposition decreases the population size of the next generation) (J. Hayes 1981 Oecologia 49:188-200, & 1984 J. Res. Lepid. 23:113-124).

Adults visit yellow, blue/purple, sometimes white or reddish flowers, including *Cirsium*, *Astragalus*, *Gaillardia aristata*, *Trifolium pratense* (*Erysimum asperum* and *Liatris punctata* for *altiplano*) and sometimes visit mud. Adult flight is rather fast and erratic (notably fast in *altiplano* discussed below), as they can abruptly change direction (*C. eurytheme* and *C. philodice* have a more direct flight).

Males fleek all day throughout the habitat, ~1/2-1m up, to seek females. In courtship, the female and the male flutter/hover near each other; unreceptive females may fly 5m up and away to escape the male, or do the Pierid rejection posture. If a mating pair is startled, the male usually flies, the female dangling. Males are more attracted to yellow than white females in Colo., where white females are rare, unlike *C. scudderi* (S. Graham, W. Watt, L. Gall 1980 Proc. National Academy Sci. 77:3615-3619).

Hayes, J. 1980. Some aspects of the biology of the developmental stages of *Colias alexandra* (Pieridae). J. Lepid. Soc. 34:345-352.

Colias alexandra (doubtfully *C. edwardsii*) *edwardsii* Henry Edwards' Sulfur

The butterflies identified here as *altiplano* & *edwardsii* have yellow ups like *C. alexandra* and unh is greenish gray; *altiplano* (*edwardsii* is similar) is distinguished by usually having a narrower fw border (sometimes very narrow), the fw margin [between M_2 and 1A+2A] more often concave than convex— in ssp. *alexandra* more often convex than concave), pinker unf fringes esp. on uns, the unf central areas are slightly-oranger yellow (seldom orangish in *C. alexandra*), the unh reddish marks are more extensive (the unh central spot usually has a weak reddish ring often with a reddish satellite dot, the uph central spot is yellow [missing] or orangish, and the unh seldom has strong submarginal dots), and it averages smaller. Also, the unh is slightly lighter esp. in the 2nd generation (the unh is darker greenish-gray in spring, a little paler greenish-gray in the 2nd gen.). Males also reflect ultraviolet next to the ups black border (more widely uv-reflective on uph, narrowly on upf), and very rare Colorado males are a bit orangish on outer part of uph where the uv reflects. Females are nearly-always yellow in Colo. Ssp. ***altiplano*** occurs on the plains from the Black Forest area northward into E Wyoming and W Nebraska-SE Mont.-W S.D., and ranges to Green Mtn. and S Table Mtn. right at the base of the Front Range, and several strays or variants that look like *altiplano* have been caught on top of the lower foothills just above the plains (at Guy Hill). Ssp. *altiplano* is clearly conspecific with *C. edwardsii*, which is usually considered to be a ssp. of *C. alexandra* and ranges to E Nevada-SW Mont.-C Wash. and possibly S BC. Ssp. **near-*edwardsii*** occurs in the NW tip of Colorado, has somewhat narrow black borders, and more often has a ring around the unh central spot, and also has two generations (it is dubiously reported to be a blend of the synonyms [actually seasonal forms] *melanoverna* [spring form] and *emilia* [summer form] by Hammond & McCorkle 2017). **Form alba** (white females) is quite rare.

C. alexandra and *C. edwardsii* are involved in a taxonomic mess, as part of stenchospecies *C. occidentalis* (containing *C. occidentalis*, *C. christina*, *C. pseudocolumbiensis*, *C. alexandra*, and *C. edwardsii* which all have been considered to be different "species"). Recently Hammond and McCorkle (2017) named 20 new ssp. of those butterflies, most of them synonyms, and attempted to work out relationships (that paper has a lot of problems, with the colors described strangely, seasonal forms called ssp., etc.). My lumped summary: *C. occidentalis* from SW BC to Ore.-Calif. & Idaho-Utah (its ssp. are yellow from BC to Calif. but turn orangish in mid Ore. and become mostly orange in Idaho *resplendens* then turn mostly yellow southward into Utah as ssp. *wasatchia*) is a separate species from the yellowish-unh *C. alexandra* (or *C.christina*) *pseudocolumbiensis* in S BC, which also occurs in N Wash.-NW Mont.-Ida. (many adult *pseudcolumbiensis* look like variants of *edwardsii*, so those two may be conspecific). The partially- or mostly orange *C. alexandra* (or *C.christina*) *sacajawea* is in W Mont., the mostly- orange *C. alexandra* (or *C.christina*) *christina* occurs from Alta. to N BC, Yukon has *C. alexandra* (or *C.christina*) *kluanensis*, and the Black Hills has *C. alexandra* (or *C.christina*) *krauthii*. Mature larvae of the orange-adult taxa *C. occidentalis resplendens* (E Ida.)=*pseudochristina* (N. Utah) and both *C. alexandra* (or *christina*) ssp. *kluanensis* and *krauthii* (both related to *christina*) usually have an extra subdorsal red-in-white or orange band, unlike larvae of ssp. *alexandra* and *edwardsii* and the photos of *occidentalis* in Allen et al (2005) and Neill (2007), suggesting they may be related to each other (but that subdorsal band occurs occasionally in *C. philodice* and *C. eurytheme* larvae). {Preliminary mtDNA results suggest that *C. occidentalis* is a distinct species (its ssp. have a usually-different black dash at end of fw discal cell), while the others are a big mess as if they are all just ecotypes of *C. alexandra*; but *C. o. resplendens* has probably not been sequenced so if its DNA is intermediate to *sacajawea* then *C. occidentalis* may include all the five ssp. in the stenchospecies listed above.} *C. alexandra edwardsii* ranges from C Wash.-SW Mont. to Calif and NW Colo. and the Great Plains, and based on overall appearance may be conspecific with the grayish-unh *C. alexandra* from the Southern Rocky Mts. S to New Mex. *C. a. edwardsii* mostly has concave rather than convex fw while the others mostly have convex rather than concave fw, and the Colo. plains concave *altiplano* remains distinct from mts. convex *alexandra*, so it is difficult to decide whether Colo. *edwardsii* and *altiplano* and the concave *astraea* from Wyoming should be in the convex-fw *C. alexandra* (based on similarity of unh), or should be in a separate species *C. edwardsii* (the concave/convex character isn't a great character, as the Ariz.-Utah ssp. *apache* has concave fw so may be in *C. edwardsii*, but in about every other way they are like ssp. *alexandra*, making it easier to lump *C. edwardsii* ssp. into *C. alexandra*). Anyway these taxa are a giant mess, and there may be just two species, *C. occidentalis* and *C. alexandra*.

Habitat of *altiplano* open shortgrass prairie areas (often with scattered pines) and sagebrush on the higher plains; habitat of *edwardsii* sagebrush in NW Colo. Ssp. *altiplano* hostplant in Colo. *Thermopsis rhombifolia* var. *divaricarpa*, and probably *Astragalus* (assoc. with *A. laxmannii*) (in Neb. recorded also on *Lathyrus*). *C.* (*alexandra*) *edwardsii* ssp. generally feed on *Astragalus* (in Nev. 8 sp. of *Astragalus* and one of *Lupinus*, Austin & Leary 2008). In SW Wyo. & NW Colo., Hammond & McCorkle (2017) state without exact localities that the primary hostplants are *A. miser*, *bisulcatus* (both evidently Wyo.), *racemosus*, and females ovip. on *Hedysarum occidentale*, and the *A. racemosus* and *Hedysarum* records may have been gotten in Colo. *C. alexandra astraea*=*parvoverna* (like *edwardsii* but unh bluish-green with tiny central spot) in the arid basin W of the Laramie Mts. in S-C Wyo. (where adults fly L May-E or L June—plus a 2nd gen.?) has host stated to be *A. bisulcatus*, and in the nearby foothills it ovip. on *A. miser* & *crassicarpus*. Usually uncommon.

Eggs pale cream, turning crimson, laid singly on host leaves, mostly on ups, sometimes on uns (all *Colias* oviposit mostly on leaf ups). Larvae eat leaves, without nests. Ssp. *edwardsii* older larva (Tooele Co. Utah, Nicky Davis, photos at butterfliesofamerica.com) green, heart-band darker, a broad lateral white band contains very weak or strong red-orange diffuse patches at segment junctions, dorsolateral band absent. Pupa light-green, heart-band slightly darker, wing veins paler, a lateral (on abdomen and edge of wing) white-below-dark-green band with orange tinge in the center, small reddish-brown supraventral dashes on A4-6.

Ssp. *altiplano* has two flights on the plains (and Green Mtn. and S & N Table Mtn. just W Denver) E May-L June and L July-Aug. (rarely to L Sept.). Ssp. *edwardsii* has two flights also in NW Colo., the second at least during wet years.

Adults visit various flowers, and so far have not been seen on mud. They fly quite fast.

Males fleek all day throughout the habitat (mostly below ridges in rolling hills and ravine systems) ~1/2-1m up, to seek females.

Hammond, P., & D. McCorkle. 2017. Taxonomy, ecology, and evolutionary theory of the genus *Colias* (Lepid., Pieridae; Coliadinae). The Franklin Press, Ore. (published by authors). 268 p.

Colias eurytheme Orange Sulfur (Alfalfa Butterfly)

C. eurytheme has the same unh markings as *C. philodice* (a central unh silver spot with reddish double-ring around it and reddish satellite spot, and submarginal reddish-brown dots) but adults are generally orange on ups (versus yellow), except for white females (**form alba**, which include ~16-20% of the females, which are difficult to distinguish from white females of *C. philodice,* but the upf black border averages wider and size averages larger in *eurytheme*). (Very rare whitish males are known in *C. eurytheme* and *C. philodice*, due to a recessive gene [C. Remington 1953, Lepid. News 7:139-145].) Males reflect ultraviolet all over the ups (very rare males are yellow but still reflect uv); *C. philodice* does not reflect uv. Most of the differences between *eurytheme* and *philodice* are due to genes on the X (now Z) chromosome (specifically the genes controlling female mate choice, male pheromones, male ultraviolet reflection [determined by a recessive gene], orange or yellow color, width of the black fw border, size, and developmental rate, which all form a "supergene" [J. Grula & R. Taylor]) so these species are basically chromosome polymorphs and even hybrids can sort themselves out into the two species. The orange versus yellow color and the wide versus narrow black upf borders are controlled by one or two pairs of genes without dominance, but those genes are also on the X (now Z) chromosome. Adults vary greatly seasonally. Early spring and mid-fall adults (**form ariadne**) are small, the unh (and the uph of females) is darker, the orange is restricted to the uph and the central and rear area of upf, the upf borders are narrower, and the body scales "fur" is thicker; ariadne is produced by short photoperiod acting on the 3rd-4th-stage larva [S. Ae & S. Hoffman 1957 J. Lepid. Soc. 11:207-214; S. Ae 1957 Lepid. News 11:207-214; etc.]; cold temperatures during the pupal stage can also produce ariadne adults. Most adults in later generations have considerable orange, then in Sept.-E Oct. many adults are large and magnificently fully orange with wide black borders. Many females of all broods are whitish (form alba), which in *Colias* species results from a dominant gene; these alba females produce more fat, faster development, and larger eggs, by using the nitrogen that would have gone into manufacturing orange pigment to produce eggs instead (yet males of *Colias* generally prefer normally-colored females for mating); alba is more common in cold–climate *Colias*.

Habitat open areas everywhere, even straying above timberline sometimes. Hostplants in Colorado herb Fabaceae: *Astragalus flexuosus, agrestis, bisulcatus, crassicarpus, drummondii, spatulatus, parryi, racemosus, miser, Lathyrus lanszwertii* var. *leucanthus, Vicia americana, Trifolium repens, nanum, fragiferum, hybridum, longipes=rusbyi, Glycyrrhiza lepidota, Medicago sativa, lupulina, Melilotus officinalis, alba, Sphaerophysa salsula, Lupinus argenteus* (including white-flowered var. *ingratus*), *Thermopsis rhombifolia vars. divaricarpa, montana*. *Vicia* and *Trifolium* are favorites in Gunnison Co. (M. Stanton 1982 Ecology 63:839-853). *C. eurytheme* evidently spread eastward/northward into NE U.S. (Jean Boisduval recorded it in N.Y. before 1840, but it did not become common in New England and D. C. until 1929-1933), it spread in E. U.S. following widespread cultivation of alfalfa (to Ohio by 1874 but became common ~1930, to Pennsylvania by 1869 but became common there and in Delaware Valley ~1930 when it became established in S NY by 1929-1933, in Washington DC-Md. it was rare in 1904 and became common only in 1925), so its diapause mechanism is evidently poorly tuned for northern latitudes and it has fatal emergences in warm periods in late fall in northern areas of N.Y. and Penn., and I found a female Dec. 9 in Colo. One could think that it originally may have occurred only in Mexico/SW U.S. But in 1871 T. Mead collected a number of *eurytheme* in Colo. and saw one in Cheyenne Wyo. (Scott 2016a), and Herman Nash collected butterflies near Pueblo Colo. from 1894-1901 and sent W. H. Edwards eggs of both orange *eurytheme* and yellow *eriphyle*, so *eurytheme* evidently occurred in Colo. before the state became extensively agriculturally developed. Maybe the origin of *eurytheme* should be reassessed, because there are old records everywhere even E U.S. Common.

Eggs cream, turning crimson in a day or two, laid singly on host leaves (mostly on ups). Females tend to fly upwind when they oviposit. Lab females can lay 715 eggs on average (max. 1172), and can live up to 39 days. Form alba females lay more eggs (they divert pteridine color pigments [erythropterin is red, sepiapterin darker-yellow, xanthopterin yellow, leucopterin white] to making more eggs), but are less attractive to males. Older larva green, heart-band green, a white lateral band with a rosy line through it (this band sometimes has dark dashes beneath it; short photoperiod can produce black patches on the spiracular line on mature larvae [S. Ae 1957 Lepid. News 11:207-214]); sometimes a subdorsal whitish band which also may contain weak reddish dashes, the underside darker-green. Larvae prefer body temperature 23^{o}-29^{o}C, versus *C. philodice* which prefer 20^{o}-26^{o}C (adults of both prefer 35-39^{o}C) (P. Sherman & W. Watt 1973 J. Comp. Physiol. 83:25). Pupa green, a cream or yellow lateral band (sometimes with reddish dashes inside it) extends to cremaster and the short head cone, sometimes a subdorsal cream or yellow band on abdomen, an irregular maroon supraventral band on abdomen. Larvae are claimed not to have a true diapause and claimed to be merely torpid during winter. But J. Harry proved that they can survive Utah winters well in litter under a hostplant, and adults do survive fall freezing nights in Denver as low as 15^{o}F. Some reports claim that 3^{rd}-4^{th}-stage larvae hibernate. *C. eurytheme* can survive winters in Indiana (Belth 2013). Pupae can also hibernate in R. I. (H. Pavulaan). D. Schweitzer (2006, J. Lepid. Soc. 60:51-60) reports that in southern N.J. it does not “diapause” like hardier butterflies but larvae and pupae and even adults have a supercooling ability to survive freezing N.J. winters (adults survive even a night in a -15^{o}C freezer) and larvae even feed during the winter, mostly on alien Fabaceae (*Vicia villosa, grandiflora, Trifolium*) so they overwinter every year in N.J. The theory that *C. eurytheme* may have originated from Mexico or from California, and then spread to occupy the Pacific Northwest and the plains and NE U.S., where its overwintering mechanism was poorly adapted to the latitude of N.Y. and Penn. until alien hostplants provided winter food, is questionable because they can survive freezing.

Three or four flights L Apr.-Oct. at low altitude (oviposition to adult takes only 30 days in warm weather), perhaps just two or one at high altitude mostly M June-Sept. Much has been written about *C. eurytheme* being a migratory species (in Kansas, Washington, etc.), but in Colorado adults are seldom seen migrating (I saw some flying ~NNW in L April-E May, some evidently migrating N even over houses in E June 2019, and a few flying ~SSE in L-Sept.-E Oct., but mostly adults behave like *C. philodice* and rarely show the unidirectional flights that true migrants perform). But maybe it is becoming more migratory through Denver, as my observations above are mostly recent. The species mostly seems to be just “dispersive”, not very migratory. And unlike migrants, adults are frost-hardy in fall when I often saw adults flying around after outdoor temperatures dropped to 24^{o}F (once 15^{o} in Dec. and once 5^{o}F in Nov.); thus *C. eurytheme* is basically a native to Colorado like *C. philodice*.

Adults visit yellow or purplish, sometimes reddish or white or blue flowers, including *Aster lanceolatus hesperius, Carduus nutans, Centaurea diffusa, Chrysothamnus* (*Ericameria*) *nauseosus* (favorite), *Helianthus, Heterotheca villosa, Liatris punctata, Machaeranthera* spp., *Medicago sativa* (favorite), *Trifolium pratense*, and often visit mud. Adults roost on low ~15 cm green plants within dry grass or as much as 4-7m up on tree branches, etc., and sometimes roost in groups of ~5 basking adults, and often roost on yellow leaves/objects for camouflage. All *Colias* are lateral baskers (below body temp. 34-35^{o}C); *eurytheme* does not warm up by rapidly vibrating the wings at small amplitude. All *Colias* fly at body temperature of 30-40^{o}C (extremes 28-42^{o}, optimally 35-39^{o}) and do not fly at all outside the extremes; above 40^{o} they orient parallel to the sun to avoid overheating (Watt 1968 Evol. 22:437-458; J. Kingsolver & W. Watt 1983 American Naturalist 121:32-55). The darker unh on spring/fall form ariadne helps warm them during basking.

Males fleek all day throughout the habitat to seek females, as they fleek ~1/2-1m up. In courtship (Silberglied & Taylor, 1978), fleeking males approach females (they prefer normal females rather than form alba), both may hover, he buffets her with his wings to display his uv and transfer pheromone from his uph basal androconial patch as he dips down to one side of her (when the color/uv pattern becomes visible), she lands if flying, he may hover and buffet her with his wings, he lands beside or on her, she moves her abdomen downward from between the wings, and he joins. Males are attracted to the greenish-yellow unh of females and their lack of uv, while females require a uv-reflective male and do not care if he is orange or yellow on ups (the spring ariadne form of *C. eurytheme* has very little orange, often just a patch toward rear of upf). His pheromone (13-methylheptacosane, plus several straight-chain hydrocarbons also found in females and in *C. philodice*) causes her to lower her abdomen so they can mate. Unreceptive females do the Pierid rejection posture (wings fully spread, abdomen sticking up), and sometimes fly high in the air until he leaves or fly slowly away and down to elude the male, or flutter or flap their wings, or roll the body upward and away from the male, or drop into vegetation and crawl away, or fly away. If a resting male sees another male flying over, he opens his wings to display his uv to repel the approaching male. If a copulating male is approached by another male, he spreads his hindwings only, or flies away with her. If a mating pair is startled, the male usually flies, the female dangling. Mating lasts ~30-60 min. Females can mate multiple times. Scott (1986a) has more information about *C. eurytheme* and *C. philodice* mating and genetics. The *eurytheme* X *philodice* female hybrids preferably mate with a male of their father's species, and female Lepidoptera have one X (now called the Z) chromosome from the father and one Y (now called the W) from the mother (males have two Z's, one from the father and one from the mother), so the Z chromosomes stay in the proper species and do not end up in the other species like other chromosomes may; thus even the hybrids sort into the two species according to the source of their Z chromosomes, so the two species remain distinct, and this situation of two "species" is essentially just a case of chromosome polymorphism. Yet we still consider them to be separate species, because they do not hybridize very often, at least not randomly.

Silberglied, R., O. Taylor. 1978. Ultraviolet reflection and its behavioral role in the courtship of the sulfur butterflies *Colias eurytheme* and *C. philodice* (Lepid.: Pieridae). Behavioral Ecology & Sociobiology 3:203-243.

Colias philodice eriphyle **Clouded Sulfur**

Identified by the yellow ups, and by the same unh markings as *C. eurytheme*, specifically the silver spot in the center with two red rings around it and usually a satellite spot, and the reddish-brown submarginal dots. Also, adults are a little smaller than *eurytheme*, in females the black upf border averages slightly narrower with smaller cream spots, the male ups does not reflect ultraviolet, and the range of *philodice* extends farther north than *eurytheme*, as *philodice* has a true larval diapause whereas *eurytheme* reportedly does not. Some yellow-orange hybrids occur with *eurytheme*, and white females of the two species (**form alba**, ~12% of the population) sometimes cannot be distinguished (smaller size and narrower black border are about the only clues to try to identify some *philodice* form alba). Colorado has mostly ssp. ***eriphyle***, which occurs in W North America and on average has slightly more of an orangish tint on unf (this tint noticeable to absent) and sometimes a partly-very-weakly-orangish ups. Perhaps adults near Kansas may be more like ssp. ***philodice*** which occupies E North America, but the ranges have not been determined adequately in the Great Plains because ssp. *eriphyle* differs very little from ssp. *philodice* from the eastern deciduous woodland, thus there is an identification problem. Some people consider *eriphyle* a separate species from eastern ssp. *philodice*, which is difficult to believe because few specimens can be identified; the difficulty of identifying these taxa makes conclusions about ranges and species status dubious (and mtDNA has failed to help elucidate the phylogeny of *Colias*). *C. philodice* and *eriphyle* hybridize with *C. eurytheme* often (about 10% in Arizona ssp. *eriphyle* and Virginia/DC ssp. *philodice,* ~20% in ssp. *philodice* alfalfa populations in Wis. and Mich.), but A. Shapiro and his students found that many of the adults that look like hybrids in W U.S. (they studied Sierra Co. Calif. in particular) are just slightly-oranger *eriphyle*: Shapiro's group (Dwyer et al. 2015) showed that there is significant hybridization between *C. eurytheme* and *C. philodice eriphyle*, but most of the slightly-orangish adults that are commonly found (at least in the E Sierra Nevada of Calif.) are not *C. eurytheme*X*philodice eriphyle* hybrids, they are just variants of *eriphyle*. This makes it even more difficult to distinguish yellower *eurytheme* from *C.*

philodice--evidently only the variants that are larger in size & upf border width when those differ between the two sympatric species can be somewhat confidently considered to be hybrids, or one could use the abundance of pure specimens of *C. philodice* or *C. eurytheme* at your site as a clue, etc. {Most yellow-orange adults found in areas of sympatry with *C. eurytheme* are uv-absorbing (R. Silberglied & O. Taylor 1973 Nature 241:406-408) thus could be considered to be mostly *C. philodice*, but all F1 hybrid *eurytheme*X*philodice* are non-uv-reflective, so they could just be hybrids.} Ssp. *eriphyle* evidently got some of its DNA from past introgression with *eurytheme*, and lowland Calif. *C. eurytheme* DNA differs a little from *eurytheme* elsewhere because *C. philodice* does not occur in lowland Calif. so there was no interbreeding there. The two species do hybridize sometimes but not randomly. The cross of *philodice* males X *eurytheme* females usually produces sterile and inviable female offspring, whereas the cross *eurytheme* males X *philodice* females produces very fertile and viable offspring, suggesting how orangish *eurytheme* genes were introduced into the *philodice* population to produce *eriphyle*. The logical hypothesis is that eastern U.S. *philodice* differ from *eriphyle* a little (by having less orangish) merely because *eurytheme* has spread there more recently (*eurytheme* became common in New England and D.C. in 1929-1933) and there has been less time for interbreeding there than in western U.S. The spring **form vernalis** differs by having narrower black borders and smaller size and slightly darker somewhat-sooty-green unh. It occurs in spring and M Oct.-Nov. at low altitude, and is 100% of the first generation in June at high altitude, while the second generation at high altitude may have both spring and some summer forms. Most male adults (and all *C. eurytheme*) have an orange central spot on uph, but it is absent in some *philodice* males (just a ghostlike version of the unh central spot); orange is dominant in inheritance to a yellow spot in males, and dominant to a pale-orange spot in females (the spot is never yellow in females [C. Remington 1954 Lepid. News 8:163-166]).

Habitat open areas everywhere, even wandering to the alpine zone sometimes. Hostplants in Colorado herb Fabaceae: *Trifolium* (favorites) *repens, fragiferum, longipes*=*rusbyi* (a favorite in Gunnison Co.), *hybridum, Medicago sativa, lupulina, Vicia americana* (a favorite in Gunnison Co. Colo.), *Astragalus flexuosus, miser* "*decumbens*", *laxmannii* (=*adsurgens*) var. *robustior, bisulcatus, agrestis, Lathyrus lanszwertii* var. *leucanthus, Sphaerophysa salsula, Melilotus albus,* (ovip. *M. officinalis* in Wyo.), *Thermopsis rhombifolia* var. *divaricarpa, Hedysarum boreale,* seldom *Lupinus* (M. Stanton 1982 Ecology 63:839-853, & Stanton & R. Cook 1984 Oecologia 61:265-270 studied hosts in W Colo.). In E U.S. it may prefer *Trifolium* to *Medicago sativa* (alfalfa), but in Colo.-Nev.-Ariz.-Calif. it swarms in alfalfa fields just like *C. eurytheme*. It expanded its range in the mid 1900s W through S Arizona to SE Calif. in alfalfa fields. {It is odd that *philodice* is reported from Lake Chapala in S Mex., higher-altitude Chiapas, Mex., and 3 sites in Guatemala; the latter are reported to reflect uv so may be another taxon.}

Eggs cream, turning crimson in a day or two, laid singly on host leaves (mostly on leaf ups). Females start to oviposit 2-4 days after emergence. They do not inspect the plant for eggs and if eggs are present will lay more. Females have up to 726 growing eggs in the abdomen, but start ovipositing at age 2 days and may only be able to oviposit for 2-5 hours/day so cannot lay very many in nature, where mark-recapture studies suggest they live only an average of 5 days. Larvae eat leaves, without nests. Older larva green, heart-band slightly-darker green, sometimes with a subdorsal cream line, always a white lateral band with a narrow rosy line through it, and beneath that band is a darker-green area or even black dashes. Larvae prefer temperatures 3^{o}C cooler than *C. eurytheme*, enabling the species to occur in cooler regions. Rare blue-green or yellow-green larvae are recessive to normal green larvae, and yellow-green is recessive to blue-green (C. Remington). Pupa green, with a yellow or cream lateral band (which extends along the wing case edge like other *Colias*), and a supraventral reddish-brown band on abdomen; head pointed. 3rd- (sometimes 4th)-stage larvae hibernate.

Usually three sometimes four flights at low altitude L Apr.-Oct., two flights at higher altitude mostly June-E July and L July-E Sept. Adults can live 31 days in nature in Colo., though average lifespan may be short only 5 days.

Adults visit blue/purple and yellow flowers, often whitish, sometimes pinkish/reddish etc., including *Aster ericoides, Aster lanceolatus hesperius, Chrysothamnus* (*Ericameria*) *nauseosus, Grindelia squarrosa, Heterotheca villosa, Machaeranthera* spp. (favorite), *Medicago sativa* (favorite), *Trifolium pratense*, and often visit mud, sometimes urine. Adults bask laterally to get warm. They roost on *Erigeron* leaves and on weeds etc., and on grasses [in cold nights they may creep lower down into the grass to stay warmer].

Males fleek all day throughout the habitat to seek females, as they fleek ½-1m up. In courtship (similar to *C. eurytheme*, Silberglied & Taylor 1978), the female and male flutter in midair, when he often flies in front of her and slightly lower than her (they can fly that way ½ m up as far as 30m), she lands then he lands alongside as he flutters beside her (spreading his wings 70 to 120^o apart) for a second (or she was landed already and he spotted her and flutters down and lands beside her), if receptive she keeps her wings closed and lowers her abdomen a bit under her hindwings so he can join with curved abdomen after only 1.5 or 2 sec. on ground, then he faces opposite. Males may hover over landed females, and the female may flutter some. If a female needs to find a mate, she approaches males. Males mostly do not reflect uv, and females do not require a uv male, but they need the male pheromone (three esters n-hexyl myristate, n-hexyl palmitate, and n-hexyl stearate, along with several straight-chain hydrocarbons also found in females and in *C. eurytheme*—this pheromone differs from that of *C. eurytheme*, and smells like "sweet bay") to accept a male, and the female must be contacted by his wings during courtship (he buffets her with his wings, evidently while his forewings are drawn forward to uncover his uph scent patch at the base of cell $Sc+R_1$) to make her lower her abdomen to allow him to join. Unreceptive females can spread wings wide and raise abdomen in the Pierid rejection posture, but unreceptive females refuse to lower her abdomen from between her closed wings (even if a male lands on top of her spread wings and flutters with his wings spread 45^o) (receptive females of *Colias* lower the abdomen) and often fly vertically up to 10m then quickly down to escape the male. (See Watanabe & Irie 2011 for references to mating). Males must mature several days before they can mate. If a mated pair is startled, the male generally flies, the female dangling.

Dwyer, H. E., M. Jasieniuk, M. Okada, & A. Shapiro. 2015. Molecular evidence for hybridization in *Colias* (Lepidoptera: Pieridae): are *Colias* hybrids really hybrids? Ecology and Evolution 2015, p. 1-14.

Colias scudderi scudderi Scudder's Sulfur

Identified by the greenish unh, the unh central white spot with red rim and often a satellite spot but <u>no</u> submarginal brown dots, and the pinkish fringe. Some *C. alexandra* are similar, but have a weaker unh spot. The uph spot is usually yellow, except in females. The ups blackish wing borders are often absent or weak on females, or show only traces of wide blackish borders. Males are yellow on ups; most females are white **form alba** in Colorado ssp. ***scudderi***, but roughly 5-10% are yellow (in contrast, females are mostly yellow northward, in ssp. *harroweri* in the Wind River Mts. of C Wyo. and ssp. *gigantea* over much of Canada).

Habitat mostly Subalpine and lower Alpine Zone valley bottom *Salix*-shrub carrs and *Vaccinium cespitosum* swales. Hostplants in Colorado herb Ericaceae: *Vaccinium cespitosum, scoparium*; Salicaceae: *Salix planifolia, reticulata var. nana=nivalis*; Polygonaceae: *Polygonum* (*Bistorta*) *viviparum*. Larvae are somewhat polyphagous (high-altitude "bog" butterflies tend to be rather polyphagous), but lab larvae refuse Fabaceae (*Trifolium repens*) plants. Uncommon, sometimes common.

Eggs cream, turning orange-red after a day like all *Colias*, laid singly on host seedlings ~2-5 cm high, especially down-slope from shrub *Salix* where the bushes form a cul-de-sac that slows the ovipositing female. Larvae eat leaves, without nests. Older larva green, with a lateral cream band with a ventral yellow-orange margin (or band yellow), a faint subdorsal yellow-green line, underside and head grayer-green. Pupa green (yellowish-green on abdomen), a lateral yellowish band (consisting of cream color with orangish-yellow ventral half), a wide sublateral purplish-red dash on each of A4-7. Half-grown larvae (2nd-3rd-4th stages) hibernate. In N Alaska, the biennial ssp. *inupiat* hibernates as 2nd then 4th-stage larvae (J. Harry 2009), and perhaps the timberline *scudderi* does that also.

One flight mostly M July-Aug.

Adults visit mostly yellow flowers, seldom white/pinkish/blue-purple, including *Arnica* spp., *Erigeron ursinus, Senecio* spp., and sometimes suck mud. Marked adults in a willow carr only 200m long don't disperse much, whereas those along creeks can move farther such as 0.8 km average between capures, up to 1.3 km or more in a population 4.8 km long (W. Watt et al. 1977 Oecologia 27:1). They fly fairly fast like most *Colias*.

Males fleek all day ~1/2m up in valley bottoms/streamsides that are open or have sparse trees, in shrub willow carrs and *Vaccinium* valley bottoms. In courtship, female and male flutter/hover near each other, and then land and both may flutter with mostly-wide amplitude (female fluttering serves to repel the male--receptive females would remain quiescent and accept the male). Colo. males are attracted to white nearly as much as they are to yellow females, because most females are white.

Zerene cesonia **Dogface**

A rare migrant from the south. Both sexes have a "dog face" with black eye on upf; rare females lack the dog face (**form immaculsecunda**). The outer half of the dog face reflects ultraviolet. Females are usually yellow, rarely paler (whitish on upf, pale yellow on uph at least, evidently some kind of weak version of **form alba**). The fall and early-spring **form rosa** has red on unh.

Habitat open areas southward. Hostplants southward herb Fabaceae such as *Amorpha* & *Dalea* & sometimes *Medicago sativa* & *Trifolium* etc.; unknown in Colo., but at Wheatland in Platte Co. Wyo. several were found in a *M. sativa* field, suggesting they bred on it there (DeFoliart 1956). Common southward.

Eggs cream, turning crimson, laid singly on terminal new growth host leaves. Larvae eat leaves, without nests. Older larvae show great individual variation: light or dark yellow-green, or bluish-gray, with many tiny black points; some larvae have a lateral band of cream (the lower edge has orange or red streaks), several black spots just above this cream band on T2-3 or T2-A9, collar may have black beadlike line; most larvae have running over body between each segment a long transverse cream band containing a red line (red line may be missing) and attached to the rear of this band is a shorter or irregular black transverse stripe, and just below the end of that transverse cream band may be a gray patch in front of a black ovoid spot just above the lateral cream band; other larvae are striped lengthwise with yellow and black; head yellow-green or green with black points (photos in Bright & Ogard 2010, Allen et al. 2005). Pupa bluish-green (sometimes yellow-green) with whitish streaks, black subdorsal dots, and a lateral gray line (white on abdomen), abdomen yellow-green beneath; wings darker green with yellow veins; short green head horn; as the adult develops inside the pupa, the black border of fw may appear reddish. Evidently no diapause, but adults may survive mild southern winters (adults reportedly overwinter in Houston Texas, and diapause in the Costa Rica dry season).

Multiple flights in S New Mexico, most records May-Aug. in Colorado. Occasional migrations are seen (from SE to NE Tex., C. Bordelon Jr. 1998 News Lepid. Soc. 40[5]:121). I found it common and fresh July 1973 in Hardscrabble Can. in the Wet Mts., so sometimes it can breed in Colo. and produce several generations.

Adults visit flowers probably of all colors, occasionally mud and aphid honeydew. Adults fly rapidly, mostly along valley bottoms. Adults bask laterally. They cannot get warm by vibrating the wings at small amplitude.

Males fleek all day, especially in valley bottoms and on flats, ~2m up to seek females (Douglas & Douglas 2005 state 3-6m up). In courtship, the male buffets her with his wings to transfer pheromone (from the small reddish stigma on his uph base) to her, she lands and lowers abdomen & closes wings as he continues fluttering, and they mate for 60-90 min. In morning, males fly low and sometimes land on pupae and mate there. Females use the Pierid rejection posture. (B. Counterman 2021 J. Lepid. Soc. 75:220-223). If a mating pair is startled, the male flies, the female dangling.

Anteos clorinde **Ghost Brimstone (White Angled Sulfur)**

Adults are giant, white in both sexes, and males and some females have a large orange upf spot (some are the **spotless female form**), which reflects ultraviolet only on males. A rare stray to E Colorado, recorded for seven counties around Denver, including Weldona in Morgan Co. in 1928 (H. Rollin) and in Denver July 15, 1935 on a *Delphinium* flower, and Adams Co. Aug. 29, 1960. Hostplants Fabaceae such as shrub *Cassia* & *Pithecellobium* in Latin Amer., where it flies most of the year. It migrates in Yucatan, Mex., also. Females may be in reproductive diapause in the Costa Rica dry season. Scott (1986a) describes the immatures, and Allen et al. (2005) has photo; older larva green with yellowish or cream lateral band, spiracles black, some larvae have black vertical dashes just above the pale lateral band; some larvae eating flowers are reportedly yellowish. Pupa green or yellow or cream, with red-brown middorsal & lateral lines, the wing cases bulging ventrally. Adults fly high and fast. They prefer red flowers, and roost in trees.

Phoebis sennae marcellina **Cloudless Sulfur**

This rare migrant has the unf postmedian line jagged. Females differ from other *Phoebus* by having the upf postmedian line faint; the upf border is a series of spots, not a line as in *P. statira* which is very doubtfully recorded from Colorado. Males are yellow; females are orangish-yellow on ups, or pinkish-cream to cream (**form alba**). J. Brown noted that females are usually orangish-yellow in winter, creamier in summer, which may be true in ssp. ***marcellina*** (other ssp. reportedly differ in the % of form alba); evidently form alba is not fully genetic as it is in *Colias*. The winter **form rosa** of both sexes has more unh spots. Recorded almost everywhere in Colo., but very rare everywhere except in extreme SE Colorado, where it is sometimes common when it evidently breeds.

Habitat open areas everywhere far south of Colorado. Hostplants herb and shrub Fabaceae: mostly *Cassia* (*Senna*) southward. Common southward.

Eggs cream, turning reddish, laid singly on new hostplant growth mostly on stems of flower buds, sometimes leaves. Larvae eat leaves but prefer flowers/young fruits, without nests. Young larvae of *Phoebis* (*sennae* and *agarithe*) may be eaten by ants attracted to the nectar glands on *Cassia* leaf petioles. Allen et al. (2005) and Wagner (2005) have photos of older larvae; body and head green, or yellow (underside greenish) (older larvae are yellow on the yellow flowers of *Cassia hebecarpa*, green on leaves and some flowers [J. Calhoun 1991 J. Res. Lepid. 28:123-128]), with numerous black dots, often with cream or yellow or yellowish lateral stripe with bluish-black spots (or a few black dots) below it and patches of bluish-black vertical streaks above it (those black streaks sometimes start with red-brown and run over body to other side in the middle of each segment on some yellow larvae), there may be bluish tint on the side of greenish larvae, the setae may be pale-tipped, underside green on green larvae and brownish-green on yellow larvae. The green or pink (both forms in SE U.S. and Calif.--form rosa pupae are pale pink) pupa has a lateral whitish stripe (edged above by darker green) and the wings and proboscis are hugely expanded downward into a rounded lobe (mainly to grow the gigantic long proboscis on adult butterflies) with the costa rim edged by white; wing veins paler, head extended into a long cone. No diapause in *Phoebis*.

Colorado records June to Sept. (flies all year in Mex.).

Adults visit flowers of all colors, using their very long proboscis, but clearly prefer red and orange flowers (often long tubular red ones--see the hundred visited flower species listed by Scott [2014] from SE U.S. and latin america) (adults are attracted to red objects they think are flowers), often visit yellow ones, less often white and pink, and least often purple/blue/violet, including *Cirsium, Eupatorium coelestinum, Hibiscus, Ipomoea spp., Lantana camara, Lobelia cardinalis, Pentas lanceolata, Phlox paniculata, Plumbago auriculata*, *Salvia* spp., *Saponaria officinalis*, *Zinnia elegans*. They can imbibe even 35-40% sucrose with greater suction (P. May 1985, Oecologia 66:381-386). Adults often visit mud, and sometimes visit garbage, carrion, dung. They fly rather high up; in Colo. I saw one flying 5m up among trees and another 3-5m up, which were probably migrants (Indiana migrants fly northward high above ground, Belth 2013). The regular migrants fly unidirectionally ~2-3m above trees or the ground, ~3 km/hour, though another report stated that migrants flew within a few cm of the water and on land flew close to the vegetation: in SE U.S. adults migrate NW in spring, SE in Aug.-Nov. (to the S-SE in Sept.-E Nov. in N Fla., peaking about Oct. 1, in malaise traps run by T. Walker, A. Riordan). Although sometimes they fly NE in ~Sept. on the South Carolina coast. Adults may roost in groups of ~a dozen, 2m up, esp. near yellow leaves. They bask laterally.

Males fleek all day, often on flat land, as they fly 1 or 2m up or even much higher. In courtship (tethered virgins studied by R. Rutowski 1983, J. Res. Lepid. 22:249-253), the male nears the female and flutters over her while she lands, he hovers and touches his wings or legs to her wings, she nearly always opens and closes her wings briefly, and then he lands beside her and joins. Unreceptive females do the Pierid rejection posture; if she assumes that mate-refusal posture, he sometimes lands on her wings, then if she closes her wings he lands and mates. Successful courtships averaged only 5-7 sec. In courtships with flying females, the male hovers over her and then she lands. A second or two after joining, the male flies with her dangling; and if a mating pair is disturbed, the male flies, the female dangling. Some people can smell the male pheromone.

Phoebis agarithe agarithe **Large Orange Sulfur**

Identified by the straight postmedian unf brown line (and the straight upf postmedian line of females). Males are orange on ups; females are cream to usually a little pinkish-cream (**form alba**, usual in Tex.-Mex. ssp. ***agarithe***), or sometimes orange (usual in Fla. ssp. *maxima*). A rare migrant to Colorado with records all over populated eastern Colo. (8 counties on the plains), and it will be found in W Colo. Males reflect ultraviolet only on upf even though both upf and uph are orange. Common southward.

Hostplants shrub/tree Fabaceae southward: *Lysiloma microphylla* in Ariz., *Calliandra inaequilatera* in Calif., *Pithecellobium, Cassia* (*Senna*), etc. Scott (1986a) describes early stages, and Allen et al. (2005) has a photo of larva. Eggs laid on new growth. Older larva green (eating leaves) often with tiny black dots, an orangish-yellow lateral stripe edged below by whitish and above sometimes by a blue band; larvae eating *Cassia* flowers become yellow; prolegs may be orangish; head green or brownish-green. Pupa green with purplish mottling, a purplish heart-line, yellowish lateral line, and whitish irregular spots on abdomen.

Colorado records were often in September. Many flights all year farther south.

Adults visit flowers of many colors (*Liatris punctata* in Colo.), sometimes mud.

Males have a pheromone detectable by people as sweet.

Phoebis philea philea **Orange-Barred Sulfur**

Adults are very large. Males and most females are yellow but have a large upf orange bar (which reflects ultraviolet on males) and an orange uph margin. Females vary: some **form alamacho** have an orange uph margin like males (and rarely have a bit of orange in outer part of upf discal cell), but other females are uniformly cream (**form crema**) with large upf postmedian spots, or are rarely white (**form**

alba). Reportedly adult females are yellow if larvae ate *Cassia* flowers, white if they ate leaves (B. Seefeldt, in Butterflies of the Florida Keys). The winter form has more unh spots (**form rosa**). A very rare stray to Colorado with three records scattered over E Colo. (Boulder, Costilla, and Prowers Cos.) mostly in July-Aug. One was found at Trinchera Ranch, Costilla Co. July 27 by Bernard Rotger.

Habitat subtropical open areas. Hostplants southward shrub & tree Fabaceae: *Cassia* and *Pithecellobium*. Eggs yellow, laid singly on new growth, such as under leaves. Larvae prefer to eat flowers, but often eat young, then old leaves. Early stages are described by Scott (1986a), and Allen et al. (2005) have a photo of older larva, which has many tiny black bumps, a green band beside darker green heart-band, a broad cream or yellow lateral band of yellow crescents edged above by very dark green row containing black vertical dashes, below that yellow band is a dark-green sublateral band with more black dots on/next to it, underside cream or yellowish and prolegs/leg bases yellowish; head green or greenish-tan. Larvae become yellow on yellow *Cassia* flowers and green on foliage. Pupa greenish with darker heart-line and yellowish lateral line, a brownish head projection, some pupae purplish-rose marbled with white and yellow, a yellow lateral band and wing veins; pupae vary in color also. Sometimes common southward.

Adults fly high above ground. It flies most of the year in Mex. It sometimes migrates, as far N as Wis. and Nova Scotia.

Adults visit the same flowers as *P. sennae*, mostly red or yellow, and sometimes visit mud. They reportedly fly even higher than *P. sennae*. In courtship, a male on a flower may pursue a passing female, bump into her to transfer pheromone, they land and quickly mate.

Pieridae, Pierinae Whites

Pierinae number ~ 1026 species worldwide. Adults are mostly white. The humeral vein is long on the hw base. The larvae of most feed on Brassicaceae and relatives (Capparidaceae, Tropaeolaceae, Resedaceae) which usually contain mustard oils (isothiocyanates) (which produce that powerful horseradish taste), to which larvae and ovipositing females are attracted, though a few Colo. species eat other plants (*Neophasia* eats *Pinus* leaves). Those chemicals make some adults less palatable to predators such as birds: Two chemicals occur in different cells in the plants (glucosinolates=mustard oil glycosides in some cells, the enzyme myrosinase in other cells), and when eaten by butterfly caterpillars or humans the cells are crushed by mandibles/jaws and the chemicals mix and the poison, mustard oil (isothiocyanate) is produced that tastes horseradish/radish “hot”. The butterflies can detoxify those chemicals, and adults now use the mustard oil glycosides (also called glucosinolates, one of them sinigrin=allyl glucosinolate) to find them (except glucosinolates with sulfur on a side chain are unpopular), and the mustard oils stimulate larvae to continue feeding. Therefore many Pierinae are rejected by predatory birds, and may be Müllerian mimics, along with *Parnassius* butterflies. Some Brassicaceae make bad hostplants, in particular *Thlaspi arvense* (which may kill *Pieris marginalis* and *Pontia callidice*), *Lesquerella* which is generally refused, and *Erysimum* which has odd chemicals accepted by few Pierinae. Research by A. Shapiro suggests that *Euchloe* and *Pontia* etc. females detect orange-colored older eggs and refuse to lay more. The European *Anthocharis cardamines* females also tend to avoid ovipositing on plants that already have eggs, and J. Dempster (1992, Ecol. Ent. 17:83-85) wrote that females detect some water-soluble chemical on the eggs to avoid laying eggs there, rather than the orange color. Further research showed that *Pieris rapae* and European *P. brassicae* have an oviposition-deterring egg pheromone (made of cinnamic acid derivatives) (J.Renwick & F. Chew 1994 Annual Review Entomology 49:377-400 and references cited there). So evidently all the Pierinae species with orangish-reddish eggs may have that egg pheromone which—along with the reddish egg color--keeps females from laying more eggs on that plant. Pierinae adults generally bask dorsally (with wings spread), except *Euchloe* bask dorsally or laterally. Perhaps Pierinae evolved from Coliadinae.

Pieridae, Pierinae, Anthocharini Orange Tips and Marbles

Anthocharini includes *Anthocharis* and *Euchloe*, which have Brassicaceae and relatives as hostplants. The older larvae of *Euchloe ausonides* and *E. olympia* resemble *Pontia protodice* and *P. callidice* which belong to tribe Pierini, which is interesting, and supposedly resulted from camouflage on Brassicaceae siliques (long pods) to minimize predation; or one could speculate about some kind of virus transmission of genes?

Anthocharis julia (within stenchospecies *A. sara*) Julia Orangetip

Anthocharis julia is identified by the quite-offset position of the black bar at base of the upf orange patch (the black bar at end of discal cell is usually much more basal than the black stripe going to the lower corner [tornus] of the wing), the rather weak uph marginal dots, the weaker unh mottling, and the partly-yellowish females on the E slope (half-yellow on uph, slightly yellow on upf), and the mostly Canadian-Zone habitat. Ssp. ***julia*** has yellow-gray unh and often yellowish-tinged female ups. It occurs on the E slope of Colo.: in the Front Range it extends from Wyo. southward and down to the edge of Boulder because of the high peaks there (Eldorado Mtn. and Green Mtn.), but in that range it stops at the NW corner of Jefferson Co., whereas near the continental divide ssp. *julia* extends south to the Sawatch Range and the E end of the San Juan Mts. and also the Sangre de Cristo Mts. (near Coaldale). Ssp. ***prestonorum*** occurs on the W slope in the Colorado River drainage and SW Colo.; it has grayish unh mottling and white female ups. S of the San Juan Mts. in La Plata and Archuleta Cos. Stout (2018) found ssp. near-*prestonorum* (adults somewhat intermediate to *julia*, as females mostly whitish, unh yellow-gray, the mottling mostly absent on unf margin and usually a little paler on unh margin compared to *A. sara colorado*) occurs within 9 miles of *A. sara colorado* near Mancos in Montezuma Co. (*prestonorum* E at Target Tree Rec. Area, *colorado* NW at Summit Res.), and occurs within 3.6 miles of *A. s. colorado* near Durango in La Plata Co. (*prestonorum* W at Wildcat Can., *colorado* SSE at Carbon Jct. Can.). But many adults from SW Colo. & Rio Arriba Co. NM look like possible intergrades between *A. j.* near-*prestonorum* and *A. s. colorado* (the two *Anthocharis* "species" belong to one stenchospecies *A. sara*) though larvae and pupae differ. T. Stout (2018) reviewed *A. sara* & *A. sara thoosa* and their ssp. (<u>their ssp. are never sympatric with each other</u>) and *A. julia* and reported some small areas in W U.S. where *A. julia* overlaps the others and occasionally interbreeds with them (even in Utah--where *A. julia browningi* is maximally different from *A. sara thoosa*--they interbreed a little, Stout 2010). These *Anthocharis* are a mess, because adult characters show a different pattern of variation than larval traits (*A. j. flora* and *A. j. alaskensis* adults from Ore.-Alaska resemble *A. sara* but larvae/pupae resemble *A. julia*), and there is considerable variation in most traits. The larval pattern of *A. julia* may be a consistent trait, but it occurs during just a very short time on the larva so is not a very useful character.

Habitat wooded areas (pines and often Douglasfir etc.) mostly from the upper foothills (down to the lower foothills at Boulder) to Canadian Zone. Hostplants in Colorado herb Brassicaceae: Ssp. *prestonorum* hosts *Descurainia pinnata*, *D. californica*, *Arabis* (*Boechera*) *retrofracta*, and *A.* (*B.*) sp. (reported as "*sparsiflora*" from near Durango in error by Stout 2018 because *sparsiflora* does not occur in Colo.), and *Noccaea fendleri*=*Thlaspi montanum*. Ssp. *julia* hosts *Arabis* (*Boechera*) *fendleri* at least. In Utah *ssp. julia* eats four other spp. of *Arabis* and evidently also *Streptanthella longirostris* (Wolfe et al. 2010). Usually uncommon; rare in the central Front Range.

Eggs cream, turning orange-red in a few hours, laid singly on pedicels of host inflorescences near top of plant. Larvae eat buds, flowers and fruits, but after those are eaten they eat leaves, without nests. Larva green (darker-green beneath), lighter green than *A. sara* (including *thoosa*), with a cream lateral stripe (edged below by a dark-green band) which blends dorsally into the green body color (a rather bad trait, as the whitish blending is most noticeable on abdomen and only 48-54 hours after molting to 5th stage and does not blend 72-80 hours after--it does not blend in *A. sara* ssp., though Stout's 2018 fig. 3 photos show "*thoosa*"-ssp. blending slightly above the cream lateral stripe), the stripe extending onto the green head. *Anthocharis* larvae develop into pupae in just ~15 days. Pupa usually green, sometimes light brown, with a green or brown middorsal line, a white lateral band edged above by an irregular dark band (brown or green, that dark band commonly stronger along head cone and middle and along rear), the wings expanded downward to a point, with a long conelike head with the tip usually curving backward a little (whereas the cone is generally straight in *A. sara* ssp. except it is sometimes curved backward a little in Calif.). Pupae hibernate, usually just for one winter (seldom two); some green and brown pupae from throughout the range of *A. julia* ssp. darken to blackish (retaining the lateral cream stripe) as they hibernate.

One flight, May-E June at low altitude and L May-June at higher altitude for ssp. *julia*, M Apr.-May (E April-E May at lowest altitude in SW Colo.) for ssp. *prestonorum*.

Adults visit flowers (often yellowish or whitish ones) such as *Taraxacum officinale* and *Viola*.

Males fleek all day ~1/2m up, as they fleek fairly slowly mostly in fairly-open woods in gulch/valley bottoms along trails and adjacent swales etc. Unreceptive females do the Pierid rejection posture (wings spread, abdomen high) as the male hovers overhead. Males of both *Anthocharis* species reflect uv from the orange upf patch, which is surely used in sex-recognition.

{Courtship of U.S. *Anthocharis* has been studied poorly, but is known for *Anthocharis cardamines* in Europe (C. Wiklund & J. Forsberg 1986 Anim. Behavior 34:328-332): the fleeking male pursues the female, after 7-183 sec. (when his fluttering near her evidently wafts his pheromone to her) she lands (or sometimes the male spots a resting female) and remains quiescent while he lands alongside and joins; unreceptive mated females do the Pierid rejection posture (elevated abdomen, spread wings) and her abdomen tip repels males with a pheromone chemical transferred from the male during mating (virgin females evidently have an attractive pheromone as males remain behind them for a long time).}

Stout, T. 2010. Observations on *Anthocharis julia browningi* and *A. thoosa thoosa* including tension zones near Nephi, Juab Co., Utah. TheTaxonomic Report of the Int. Lepid. Survey. 7(4):1-12.
Stout, T. 2018. A review of three species-level taxa of the *Anthocharis sara* complex (Lep.: Pieridae). Insecta Mundi 0615: 1-39.

Anthocharis sara **(includes *thoosa*) Sara Orangetip**

Anthocharis sara occurs in Colorado only on the W slope, and is identified by the lower-altitude habitat (often open pinyon-juniper woodland, with *Quercus gambelii* sometimes) compared to *A. julia* (except S of the San Juan Mts. where *A. julia* can fly lower also) the upf black bar at end of discal cell is more connected to the black stripe that goes to the lower corner of wing, the orangish patch supposedly averages redder (not on my specimens), the black uph marginal spots are stronger, and the unh and unf-apex mottling averages stronger/blacker, and females are mostly whiter. The ssp. of *A. sara* (& *A. julia*) were reviewed and named by Scott & M. Fisher (2008, Papilio [New Series] #18:1-14). Ssp. ***colorado*** (the Colorado River basin south to Montezuma & La Plata Cos.) has the black markings on upf a little less than Utah ssp. *thoosa* and a little thicker than ssp. *coriande*, females whitish (these ssp. and ssp. *thoosa* are ssp. of *A. sara*, as they intergrade in Nev. [where *pseudothoosa* is intermediate *sara* X *thoosa*] and in the Providence Mts. of Calif., and *A. sara gunderi* on Santa Catalina I. Calif. resembles *thoosa*). Ssp. ***coriande*** (N New Mex. including Rio Arriba/Taos/Santa Fe Cos. and the Sandia and Manzano Mts.) has the black markings on upf less strong and connected than *colorado*, but females are still only slightly yellow on uph (some whitish). Stout (1918) thought SW Colo. has only ssp. *colorado* and *A. j.* near *prestonorum* but not *coriande*; however M. Fisher's book photos of male and female from W of Sandoval Mesa in Archuleta Co. look like *coriande* with considerable unh and unf distal mottling and are evidently not near-*prestonorum* which has the mottling paler esp. on distal part of unf/unh--Stout's (2018) 26 photos of *A. j.* near-*prestonorum* from SW Colo. all show the unh mottling distally paler and unf apex mottling nearly absent, and the female is slightly yellow (Stout's near-*prestonorum* females are usually whitish)--so ssp. *coriande* may occur in Archuleta Co. Colo. Adults of the two "species" are often similar to each other in SW Colo., so there may be some hybridization there. *A. sara* (with ssp. *thoosa*, *colorado*, *coriande*, etc.) is sympatric with *A. julia* in various places in W N.A. (and they apparently hybridize in some places incl. Utah between the very different *A. s. thoosa* and *A. j. browningi*), but *A. sara* is never sympatric with the *thoosa*-type ssp. (Stout 2018), also suggesting that the *thoosa* ssp. (including ssp. *colorado* and *coriande*) belong to *A. sara*. T. Stout found that if a female hybridizes with the other species, her offspring have adult and larval etc. traits of her rather than him. The mtDNA suggests that there are three kinds of mtDNA: one type in desert areas with *thoosa*-type ssp., one in Mediterranean climates with *sara*-type ssp., and one in boreal climates in *A. julia*. Pupal color and shape and lengthy diapause also are similar in the *sara* and *thoosa*-kinds, which seem to be conspecific.

Habitat lowland open woods, mostly juniper or pinyon-juniper (often *Quercus*) woodland. Hostplant in Colorado herb Brassicaceae: *Arabis* (*Turritis*) *glabra* in Montezuma Co. & *Descurainia pinnata* near Durango. Utah *A. sara thoosa* also eats several other species of *Arabis*. Fairly common.

Eggs cream, turning orange-red in a few hours, laid singly, mainly on petioles near top of hostplant, less often on buds, flowers, or uns of host leaves (often on leaf uns etc. on young *Descurainia*). Females that see or smell an orangish egg already present do not lay another. Larvae grow into pupae in just a few weeks. Larvae eat buds, flowers and fruits, but after those are eaten they eat leaves, without nests. Older larva green (darker-green beneath) slightly darker green than *A. julia* (figs. 3-4 in Stout 2018 show the green middorsal & ventral ground color of *sara* and *thoosa* ssp. very similar and *A. julia* ssp. also very similar), with a cream lateral stripe (edged below by a dark-green band) which does <u>not</u> (or only slightly such as on ssp. *thoosa* & *colorado* & *coriande* larvae on fig. 3 of Stout 2018) blend dorsally into the green body color (it blends somewhat above the stripe in *A. julia* ssp. 48-54 hours after molting to 5th stage, but does not blend 72-80 hours after, then the larva pupates after 4 days), the stripe extending onto the green head. Pupa light brown, with brown spots, a minority of pupae green, with a brown or green middorsal line, a white lateral band edged above by an irregular dark band (brown or green, that dark band commonly stronger along head cone and middle and along rear), the wings expanded downward to a point, with a long usually-straight conelike head (whereas the cone bends backward a little in *A. julia* and in many Calif. *A. sara*). Pupae hibernate, averaging nearly 3 years (nearly 4 in one Montezuma Co. sample) in desert habitats (mostly 1-2 years in Calif. *A. sara* ssp.); they do not turn blackish as they hibernate.

One flight L Mar.-L May (mostly M Apr.-M May) ssp. *colorado*, M Apr.-E May ssp. *coriande*.

Adults visit flowers (especially yellow or white ones, often of the hostplants) and sometimes visit mud.

Males fleek all day to seek females, as they fleek fairly slowly ~1/2m up especially in valley bottoms but also on hillsides, preferably among trees or brush. The orange fw patch reflects ultraviolet in males, but not in females, so is presumably involved in mate-locating and mating as they can identify the sex by the color of the patch. Females fly in semi-shaded valley bottoms and hillsides.

Euchloe hyantis **Pearly Marble**

Identified by the pearly-white unh with green mottling, by the solid black upf bar at the end of the discal cell which has no white scales (or up to 8 scales), and the fw veins R_4 and R_5 which are very short. Ssp. ***lotta*** occurs in the Colorado River & Gunnison River Valleys (the black upf spot usually square) then ranges W to C Nev. Ssp. ***belioides*** occurs in Moffat Co. northward (upf spot a narrow rectangle). The Four-Corners area and N New Mex. has populations that can be called near-*belioides* with mostly a narrow spot, sometimes a square spot (it occurs in N.M.-Ariz. and Wyo.-Mont.-Wash.-Ore.).

Habitat low-altitude Pinyon/Juniper woodland and sagebrush. Hostplants in Colorado for ssp. *lotta* herb Brassicaceae: *Arabis* (*Boechera*) *retrofracta*, *Descurainia pinnata, D. californica*. Common.

Eggs bluish-white, turning orange the first day, laid singly on flower buds in most ssp. (mostly on hostplant leaves in Calif. ssp. *hyantis*). Larvae prefer to eat flowers and fruits, without nests. Older larva light-green or green, with a wide white lateral band bordered above by a purplish band, underside dark-green; head light-green or green. Larva turns reddish-purple before pupating. Pupa light gray with yellower lateral band, and indistinct darker middorsal, lateral, and sublateral lines, after several weeks turning dark brown often with a lateral cream line on abdomen; head lengthened into a cone, the wings expanded downward to a blunt point 2/3 out on the costal margin. Pupae hibernate, often for multiple years.

Adults visit flowers often of yellow and white colors. They bask dorsally and laterally.

One flight, M Apr.-May (mostly L Apr.-M May) for ssp. *lotta*, M May-M June for ssp. *belioides* in Moffat Co.

Males fleek all day with a faster flight than *Anthocharis*, as they fleek ~1/2m up (fairly slowly often just 15cm up in Calif. ssp. *hyantis*). Males fleek usually on hilltops, but sometimes in valley bottoms including roadside ditches in Delta Co. Colo. If a mating pair is disturbed, the male flies, the female dangling.

Euchloe ausonides coloradensis **Large Marble**

Differs from *E. hyantis* by having a narrow black bar at end of upf discal cell with many (20-120) white scales in the bar (0-8--usually none--in *E. hyantis*), the unh background is not pearly like *hyantis*, the wing ups have a creamy-yellowish tint compared to *hyantis*, fw veins R_4 and R_5 are longer (as long as their stem), and the male juxta is V shaped (Y-shaped in other *Euchloe*). There is a row of orangish scales behind the compound eyes. Colo. has ssp. ***coloradensis***. Some Colo. females have slightly yellowish uph, which is strongly yellow and very common in female form flavidalis in lowland Calif. ssp. *ausonides*. {*E. ausonides* seems to be a different species than European *E. ausonia* (other European species such as *E. simplonia* are more similar) which I found fleeking on hilltops in Greece (including the Parthenon) and Italy.} The mostly-green-unh Siberia-Alaska-Yukon *E. naina* (sometimes lumped into *E. ausonia* for reasons I do not know) *jakutia* has blackish ups and mostly-green unh, which in the arctic occurs with *E. ausonides ogilvia* (similar to *coloradensis* but with longer black uph smudge). Rare adults from the Subalpine Zone in Colorado have the unh mostly green approaching that of *jakutia* (I have several from Clear Creek and Summit Cos. that have strong green unh mottling and one from Clear Creek Co. [near Berthoud Pass] with very strong mottling); these are evidently variants of *coloradensis*.

Habitat open areas and woodland in foothills and Canadian Zone (sometimes lower Subalpine Zone). Hostplants in Colorado herb Brassicaceae: *Arabis* (*Turritis*) *glabra*, *Arabis* (*Arabis*) *pycnocarpa=hirsuta*, *Arabis* (*Boechera*) *stricta=drummondii*, *fendleri*, *Barbarea orthoceras*, *Lepidium campestre*, *virginicum*, *Sisymbrium altissimum*, *officinale*, *Draba nemorosa*, *Descurainia californica*, *Berteroa incana*, rarely *Erysimum capitatum* (but larvae may die on *Erysimum*). Common.

Eggs bluish-cream, turning orange after about a day. Scott (1975b) studied this species, mostly in California for ssp. *ausonides*. Eggs are laid singly in the middle of unopened flower buds of Brassicaceae (Cruciferae) plants; females generally lay only one egg per plant (if the female spots an orange egg on a plant, she frequently leaves without ovipositing another) and then fly >3m before laying another, but other females are not deterred by eggs—especially bluish-green eggs--already present (in Calif. where I studied *E. ausonides*, many *Brassica nigra* plants had several eggs and one had ten). Larvae eat flower buds and flowers and growing fruits, rarely leaves, without nests. Older larva dark bluish-gray, with many minute black points (seta bases), a yellow subdorsal band (sometimes orangish-yellow or slightly greenish-yellow), and a white lateral band edged beneath by a yellow band (this band more continuous than the interrupted yellow of *E. olympia*—evidently the best trait to separate the two species), the uns green with black seta bases; head greenish-gray. When about to pupate the larva turns purplish or pinkish-brown or brown and wanders to pupate. Pupa whitish-gray to tan, with a brown lateral line and a narrow brown dorsal line, the head elongated into a cone and the middle of the wing costa expanded downward (the silk girdle keeps the pupa secure at that point, and the cremaster attaches the rear). Pupae hibernate, sometimes more than one year.

One flight, M Apr.-E June (sometimes to L June) in lower foothills, L May-M July at highest altitude.

Adults prefer yellow, often white, flowers esp. those of Brassicaceae hostplants, but sometimes orange or purple or blue or red-purple flowers, including *Arabis*, *Barbarea orthoceras*, *Cerastium arvense strictum*, *Erysimum capitatum*, and seldom visit mud. In Calif. they often visit *Brassica nigra*, *Plantago lanceolata, and Raphanus sativus*. Adults can glide downhill 5m with wings mostly spread. Many Brassicaceae hostplants are weedy plants, encouraging adult dispersal; adults fly fairly far, averaging nearly 400m for my marked recaptured adults in California (females a little farther than males), and one male moved 1460m in one day. Adults bask by spreading the wings to the sides (dorsal basking), or with the wings closed and orienting those wing surfaces nearly perpendicular to the sun's rays (lateral basking). Adults roost on *Plantago lanceolata* or grass or a blackberry (*Rubus*) leaf etc.

Males fleek all day to seek females for mating, most often in hollows and valley bottoms, often on hillsides, and seldom on ridgetops/hilltops, as males fly rapidly several m/sec. about 1m above ground. They often fly 100m or more without stopping. Mating occurs all day usually when a flying male encounters a flying female, when they hover near each other with the male behind, then the female lands and the male lands behind her and bends his abdomen to join. One female mated after she flew 5m up in the air and she and the male flew around each other for a while, then they landed and joined. Occasionally a flying male finds a resting female and the male hovers, or lands and joins. Males are attracted to the whitish color of females and even to the whitish *Coenonympha tullia california*. Males approach other males an average of 5 seconds, *C. t. california* only 2 sec., female *ausonides* much longer (up to 20 min. over a young newly-mated female giving the Pierid rejection posture) evidently due to a female pheromone. Unreceptive females reject males by resting and doing the Pieridae rejection posture: spreading the wings flat and raising the abdomen almost vertically, while she opens and closes her terminal abdominal flaps to expose an elaborate apparatus of six membranous lobes that disseminate a repellent pheromone to try to repel the hovering male. Males often repeatedly land on a female that is landed and seems unreceptive or does the Pierid rejection posture, or he may buffet her with his wings, in an apparent attempt to get her to fly or accept the male. Occasionally an unreceptive female will fly vertically up to 7m to try to repel the male (like the vertical encounter done by two males of most butterflies). Females usually mate just once, but some mate twice, rarely thrice. Mating lasts ~30 min.

Scott, J. A. 1975b. Movements of *Euchloe ausonides* (Pieridae). J. Lepid. Soc. 29:24-31.

Euchloe olympia **Rosy Marble (Olympia Marble)**

Identification: the unh has few greenish bands--<u>none</u> on unh tornus--and sometimes has a rosy tinge esp. anteriorly, and the antenna is pure white. A photo shows orange scales behind the eye.

Habitat foothills chaparral/open woods, and Great Plains prairie especially with some trees. Hostplants in Colorado herb Brassicaceae: *Descurainia sophia, pinnata, incana=richardsonii*, *Arabis* (*Turritis*) *glabra*, *Lepidium campestre, virginicum*, *Sisymbrium altissimum*. Common.

Eggs faint bluish-white when laid, turning cream, then turning orange after a day, laid singly on unopened hostplant flower buds (sometimes on nearby leaves). Young larvae eat flowers and fruits, older larvae may have to eat leaves and stems. No larval nests. Larva light-bluish-gray (lighter than *E. ausonides* because of paler mottling), with many black seta bases (the seta bases seem smaller than *ausonides* in Colo. as the dorsal pinaculi are half as wide on average, and there are more long setae), a pale blue middorsal line on thorax, front rim of T1 yellow dorsally, a green (yellow-centered) subdorsal band contains a greenish-yellow anterior area on each segment (the band uninterrupted yellow in some W.Va. larvae and in *E. ausonides*), and a white lateral band edged below with yellow (at segment joints the band is mostly replaced by yellow), underside bluish-gray; head pale blue-gray, with the lateral whitish band running onto side of head. Pupa gray-brown to tan, with a brown lateral band, the wings projecting downward a little, the front projecting into a long cone as in other *Euchloe* and *Anthocharis*. Pupae hibernate.

One flight, mostly M Apr.-E June (rarely to July).

Adults prefer yellow and white flowers esp. Brassicaceae, but also visit blue, purple, pink, and orange, including *Allium textile, Cerastium arvense strictum* (favorite), *Erysimum, Lesquerella montana*; I have not seen them on mud. Adults bask dorsally or laterally, and cannot warm up by shivering the wing muscles.

Males fleek all day on hilltops/ridgetops, as they fly ~1/2m up to seek females. In courtship, the male overtakes the female and both hover, or he hovers over a landed female whose wings are widely spread. (Females surely reject males by spreading wings and raising abdomen.) Completed courtships were not seen. If a mating pair is disturbed, the male flies, the female dangling.

Pieridae, Pierinae, Pierini Whites

Pierini in Colorado include the common *Pieris* and *Pontia* that have Brassicaceae hostplants, the odd *Neophasia menapia* that eats pines, and some tropical strays. If a female spots orange eggs on the Brassicaceae hosts, she usually does not oviposit. Larvae of the Brassicaceae feeders are evidently unpalatable to birds, evidently because of mustard oil-related chemicals in their skin. C. Wiklund & T. Jarvi (1982, Evolution 36:998-1002) found that nearly all larvae of *Pieris brassicae* survived being seized then dropped by a disgusted bird. But Mueller, C., N. Agerbirk, & C. Olsen 2003 (Lack of sequestration of hostplant glucosilolates in *Pieris rapae* and *P. brassicae*. Chemoecology 13:47-54), and A. Shapiro states agrees (2021, News Lepid. Soc. 64:9), so maybe the seta-tip chemicals repel birds.

Appias drusilla tenuis Tropical White (Florida White)

Adults lack distinct spots, upf wing bases are pearly, the upf costa is darker on the basal third, the unh costal margin has a 1mm thick orange edge near the body, and the fw outer margin is very concave. Males are white, whereas females have blacker fw outer margins and a yellow unf base; some females are slightly yellowish-white on uph with a narrow dark upf border, while others are yellow on uph with a broader upf border (**form amarilla**). A very rare stray to Colo., recorded in Larimer, Park, and El Paso Counties from L June-E Aug. (it flies all year in Fla.). It rarely strays to Neb. and N.Y. The hostplants in Fla.-latin america are tree Capparidaceae (*Capparis*) and Euphorbiaceae (*Drypetes*) which do not grow in Colo. (garden capers *Capparis spinosa* might suffice, but they are seldom grown in Colo.; perhaps *Cleome* would be acceptable to a stray female). (Details of this species including hostplants and early stages are given in Scott, 1986a). Eggs white, turning yellow, laid singly (sometimes in small clusters) on young leaves; a female can lay 1000 eggs. Larvae eat leaves at night. Older larvae (photo in Allen et al. 2005) dark green, with a lateral white line, and numerous tiny black points and orange points, two short tails. Disturbed older larvae spit acrid green liquid when disturbed (perhaps from a ventral neck gland?) (C. Jordan Ph.D. thesis 1981 Univ. Texas Austin). Pupa grayish- or yellowish-green with white middorsal line and sometimes a yellow lateral line, above each wing is a dorsolateral spine that is red-brown margined with white. Eggs/larva/pupae take only 22 days in lab, where adults can live 22 days. Reportedly adults do not visit mud. Males fleek erratically and fast to find females.

Neophasia menapia menapia Pine White

Easily identified by the distinctive black unh veins and black submarginal unh line, and the whitish upf discal cell, which has a black bar curving from costa across the end of the cell. The Colo. ssp. ***menapia*** is sometimes called *magnamenapia* (TL Lincoln Co. Nev.), because of slightly larger size, but I consider the latter a synonym because it is very similar to the smaller Calif. *menapia*.

Habitat pine forest, from the foothills into the Canadian Zone; it is evidently not common in the lowest foothills or in the highest forests, but is frequent in the Black Forest and the South Platte watershed. In general it is not common in Colorado, where massive outbreaks are rare such as those that sometimes occur in Idaho-Washington-Oregon; the only reported outbreak was reported by R. Young who saw brief 3-day population explosions on *P. edulis* just E of Basalt in Eagle Co. Aug. 13-15 1983 & Aug. 3-5 1984. Hostplants in Colorado tree Pinaceae: *Pinus ponderosa* var. *scopulorum*, *P. edulis*; the following are hosts elsewhere probably also used in Colo.: *Pinus contorta* var. *latifolia*, *Pseudotsuga menziesii* var. *glauca*. Usually uncommon in Colo.

Eggs bluish-green to emerald-green with a narrow whitish crown of beads on the top, each egg angled ~45^{o} and glued together in a row of 3-25 (mostly less than a dozen) onto a pine needle mostly near the top of the tree, or "even 40 in a group" as egg masses of several females may be joined together (Shapiro 2007). Young larvae feed gregariously in clusters typically 4-6 circling the needle, heads mostly facing outward, perhaps to stop the resin flow as they mine the needle. Disturbed young larvae may drop, suspended by silk; older larvae can regurgitate food and wave their heads around. Older larvae feed alone, and consume entire needles; larvae prefer older needles. No nests. Older larva dark-green, reported sometimes with a purplish tinge, a broad white lateral band, a narrower white subdorsal band, two very short tails, a bilobed ventral neck gland; head green. Larvae pupate on bark or twigs, or lower themselves by a silk thread to ground vegetation (young larvae do this when disturbed). Pupa yellowish-green (male) or dark-brown (female) with yellowish-white bands (one on wing, one lateral band also running along top of wing, one subdorsal band, one middorsal), the cremaster brown, a brown conical projection on head. Eggs hibernate.

One flight, mostly L July-Aug. (sometimes M July and E Sept.).

Adults visit whitish, yellow, blue/purple/violet, and sometimes reddish flowers, including *Aster laevis*, *Centaurea diffusa*, *Cirsium arvense*, *Heterotheca villosa*, and *Rudbeckia laciniata* flowers; I have not seen them on mud. They evidently come down to feed on flowers more often early and late in the day or in cloudy periods.

Males fleek all day to find females, as they lazily circle around the canopy of hostplant *Pinus ponderosa* and *P. edulis* trees, ~4-10+m up depending on the size of the tree. One must wait a long time before a male comes down to the lower part of a tree, although females often seem to rest between ovipositions 2-3m up on the *Pinus*, and adults fly low to visit flowers.

Pieris "*marginalis*" (*mcdunnoughi*) Forest White

Adults vary, but are usually identified by the whitish coloration, the darker unh veins, and the lack of a black central upf spot present on *P. rapae*. Some summer adults in lowland W Colorado are mostly spotless and can be confused with weakly-patterned *P. rapae* (but *rapae* nearly always has its characteristic fw pattern and fw spot), the male androconial scales are much broader without the narrow neck of *rapae*, the male juxta is narrower, and the plate on the female bursa is triangular and tailed in *marginalis* (rounded in *rapae*). Males absorb ultraviolet, while many Rocky Mts. females reflect it strongly. Spring adults in W Colo. have darker markings. In Calif., diapausing pupae produce the darker spring form, while non-diapausing pupae produce the spring form only when chilled (A. Shapiro 1977, Ecol. Ent. 2:217). The subspecies of this and related "species" in North America are controversial, because adults vary greatly and immatures offer few character traits, and mtDNA offers its usual poor performance in distinguishing similar butterflies, so the species and subspecies are now uncertain. The former common name "Margined White" makes no sense as Mike

Fisher noted, so Forest White is the best common name. The San Juan Mts. has ssp. ***mcdunnoughi*** (because the TL is Silverton in San Juan Co.), and those butterflies usually have darker unh veins and seldom have weak veins, evidently more similar to the Ariz.-New Mex. ssp. *mogollon* which generally has dark unh veins (*mcdunnoughi* is the correct spelling because it is the "prevailing" spelling as defined by the ICZN Code, which obviously happened because James McDunnough spelled his name that way). {If San Juan Mts. adults are similar to Mogollon Rim NM butterflies as seems likely based on a half-dozen adults from the White Mts. AZ, *mcdunoughi* would be a synonym of the older name *mogollon*.} Most of the rest of Colorado has ssp. "**near-*mcdunnoughi***" (a cumbersome name forced by the Silverton TL, but appropriate considering the variable darker-to-paler adults in most of Colorado) which has strong to weak unh veins; this variation has been reported from Glenwood Canyon in W Colo. and actually occurs everywhere in ssp. near-*mcdunnoughi* in Colo., even along the continental divide in Clear Creek and Grand Cos. etc. Ssp. ***pallidissima*** (W Colo.-Utah-SW Wyo.) occurs at low altitude in the Colorado River basin in W Colo. (Mesa, Delta, even lower Gunnison Co. and Eagle Co.) and has the unh veins weakly marked or unmarked (these weak veins are evidently partly genetic but may also be due to higher temperatures experienced by larvae/pupae). The species versus ssp. status has been argued for European taxa also, where the ssp. or species *bryoniae* hybridizes with *P. napi* in the southern Alps but not in the northern Alps. The genetics of wing pattern forms of those and other taxa have been studied in Europe (summarized by Scott 1986a). S. Bowden (1988, J. Res. Lepid. 26:82-88) suggested that in Colorado forms sulphurea (inherited with two recessive genes), & flava occur in ssp. *mcdunnoughi*, but based on their whitish-ups wing phenotypes it appears that Colorado populations are all fixed for the dominant gene W producing form subtalba that has a whitish unh in males, a light-yellow unh in females (the recessive gene w produces the greenish-yellow unh form subflava in some Swiss and Alaska ssp.). (Yellow coloration in these butterflies is due to the chemical sepiapterin.) However Chew & Watt (2006) updated this and stated that the alleles governing the amount of pterin wing color (sepiapterin) in N. Amer. ssp. are these, in decreasing order of dominance: in the sulphurea gene, **subtalba allele S** is entirely white in ground color and only occurs in N. Amer. in *Pieris virginiensis* eastward; the **European Wild Type s^+ allele** with yellow unf apex and unh; the **pale-yellow s^p allele** with unf apex and unh deep yellow (remaining areas pale-yellow); and **sulphurea s allele** is a rare polymorph with ground color deep yellow. Ssp. *mcdunnoughi* (and *oleracea* and "*angelika*") is polymorphic for s^+ and s^p, while *marginalis* has just s^p. Two other gene loci: In vein melanization, Colorado butterflies are the dominant **form acuta** with narrow unh veins (compared to eastern N.A. *P. virginiensis*) but some are "British wild-type" with veins on unh bases like form diffusa grading to acuta at wing edges (*marginalis* has form **diffusa** with broad melanic band along unh veins with pronounced central light streak; *venosa* and *oleracea* have form acuta; "*angelika*" has diffusa and British wild type). In upf central black spot, Colorado adults are the recessive **form restricta** with absent spot (which is present in *P. rapae*, and in a few P. *marginalis venosa* in Calif.). B. Warren found male androconial scale differences between these taxa, but they are somewhat environmentally variable (see Chew & Watt 2006). Chew & Watt (2006) analyzed DNA of three *marginalis* from Wash.-BC and one *mcdunnoughi* from Gunnison Co. Colo., and other taxa, and found that *mcdunnoughi* is close to *marginalis* but is closest to *P. virginiensis*, while *marginalis* grouped with *venosa*, and arctic "*angelika*" grouped with *oleracea*. So the species name for Colo. butterflies is rather dubious; they belong to stenchospecies *P. napi*. These butterflies are a mess taxonomically because the characters are few and are variable and change due to photoperiod/temperature, and mtDNA is very often or usually useless for delimiting butterfly species/ssp.

Habitat moist wooded valley bottoms from the upper foothills and mostly the Canadian and Subalpine Zones; they prefer moist semishaded places in slight clearings or lanes in the forest or the open-forested edges of willow carrs. Hostplants in Colorado herb Brassicaceae: *Cardamine cordifolia* (favorite), *Rorippa palustris* "*islandica*", *Descurainia incana=richardsonii, Draba aurea, Arabis*

(*Boechera*) *stricta=drummondii*, *Noccaea fendleri=Thlaspi montanum, Thlaspi arvense* (lethal to larvae, see F. Chew 1977 Evolution 31:568-579); ssp. *pallidissima* eats *Nasturtium officinale*. Females oviposit on *Barbarea vulgaris* and *Thlaspi arvense* but larvae refuse to eat them or die if they do. Some adults move more than 2km, up to 5km, though marked adults moved an average of 350m. Common.

Eggs cream, becoming yellowish-cream (they do NOT turn orange), laid singly on hostplant leaves (usually on uns), seldom on stems. Lab females lay fewer eggs than *P. protodice*/*P. callidice* (mostly 108-167 versus 284-330, A. Shapiro). Females oviposit starting several days old and oviposit for several weeks and can produce ~300 lifetime eggs. Larvae eat leaves and other parts, without nests. Young larvae bore into leaves but older larvae eat the margins. No nests. Older larva (Wash., James & Nunnallee 2011) green, with a weak line of sinuous whitish dashes between two rows of darker-green on side (similar N.A. "species" have a yellowish or whitish lateral stripe); a *P. "marginalis" venosa* larva from Calif. (Allen et al. 2005) is light-green with very weak whitish subdorsal line and weak near-lateral creamy line with weak darker bits atop it, and traces of a few sinuous whitish marks along side. Pupa green or yellowish or sometimes tan in Wash. (other "species" green or tan or light bluish-gray), with whitish-yellow middorsal crest all along pupa (which has projections on T2 and A3) and lateral yellowish-cream band (the latter running on a lateral abdominal ridge then extending just above wing where it has two brown bumps), the point on crest on top of T2 & A2 and the bumps above tornus of wing and the projection on front of head all tipped by brown. Pupae hibernate.

One generation mostly L June-E Aug. (seldom L May or M Aug.). Ssp. *pallidissima* in low-altitude canyons has several generations approx. May, L July, and L Aug.-E Sept. (3m near Minturn in Eagle Co. Sept. 3 may be *pallidissima*) In some dry years the first generation of *pallidissima* in Delta/Gunnison Counties is reported to be weak or absent.

Adults visit flowers of all colors except red, including *Arnica cordifolia, Erigeron ursinus*, *Geranium*, and *Senecio* spp.; I have not seen them on mud. Adults are body baskers, and adjust the angle of their somewhat-spread wings so that sunlight reflects off the white ups and onto the blacker thorax areas to maximally warm it. Adults cannot get warm by vibrating the wings slightly. Some adults roost 3m up in spruce trees, etc.; sometimes they roost in small groups. Adults at Gothic CO disperse several hundred to ~750m average in mark-recapture studies.

Males fleek all day about shady wooded valley bottoms, especially in moist areas, to find females, as they fleek fairly slowly ~1/2m up. In courtship of a Japanese close relative *Pieris* "*napi*" (Y. Suzuki 1977), the male lands beside a resting female, or if she is flying he zigzags up-and-down just below her to in front of her until she lands with him behind, she usually opens her wings quickly and closes them after a while, he flutters his wings, he catches her closed forewings with his legs, then joins while opening his wings which causes her to lean somewhat. Then he usually flies with the female dangling beneath. In Colorado the male often hovers over the female. Unreceptive females do the Pierid rejection posture (wings spread, abdomen up), or may crawl away or drop into vegetation. European virgins may also do the Pierid rejection posture, but soon close their wings and accept the male; females can mate up to 5X, an average of 2.65X; males generally start mating on their 2nd day. In European *P. napi*, the male manufactures and transfers an anti-aphrodisiac pheromone to the female during mating (which lasts 50 min. to 3 hrs.), which she uses to repel males during that Pierid rejection posture (Andersson et al. 2000). *P. napi* virgins emit a sex-pheromone attractive to males, different chemicals than they emit after mating (Andersson et al. 2000; and 2003 J. Chem. Ecol. 29:1489-1499). This species and *P. rapae* have unique male pheromones, that some people can smell. *P. napi* male pheromone is citral (1:1 mixture of geranial and neral), and the anti-aphrodisiac pheromone manufactured by males and transferred to females is methyl salicylate (larvae and adults can manufacture these pheromones from L-phenylalanine and from flower-fragrance chemicals) (Murtazina 2014).

Pieris rapae rapae Cabbage White

Identified by the yellowish or greenish-gray unmarked unh. The male has one black fw spot beyond the discal cell, females have two; fw and hw have apical black tips. Yellow adults are extremely rare. Early spring adults (**form metra**, and spotless males **form immaculata**) are smaller with fewer smaller black markings and yellower & grayer unh, making them more similar to *P. marginalis*; this spring form is produced from cold temperatures acting on 24-34-hour-old hibernating or non-diapausing pupae (J. Kolyer 1970 J. Lepid. Soc. 24:133). In fall the unh becomes grayer again while the ups retains the larger summer spots. *P. rapae* was introduced from Europe into Quebec about 1860, entered Colorado about 1890, and it now ranges from the plains even to the Subalpine Zone at the Eisenhower Tunnel.

Habitat towns and moist valley bottoms statewide from the plains to Canadian Zone, sometimes the Subalpine Zone. I found 3+ adults near timberline along I-70 where they evidently bred, and notably W. Krivda found 3 pupae surviving the winter at The Pas Manitoba (not far from the Polar Bears at Churchill) (1968 J. Lepid. Soc. 22:191). Hostplants in Colorado herb Brassicaceae: *Barbarea orthoceras, vulgaris, Arabis* (*Turritis*) *glabra, Sisymbrium altissimum, officinale, Brassica oleracea* (vars. *acephala, capitata, botrytis, gemifera*), *carinata*, *juncea* var. *rugosa*, *campestris=rapa, Lunaria annua, Lepidium campestre, latifolium, pubescens, chalepensis, Rorippa* teres*, sinuata, palustris=hispida, Nasturtium officinale, Thlaspi arvense, Raphanus sativus, Hesperis matronalis, Aurantia* (*Alyssum*) *saxatile*; Capparidaceae: *Cleome serrulata*. It is often claimed to be an agricultural pest, but I have not seen vast swarms, although the adults seemed to perpetually hang around my cabbages when I tried to raise them (Colorado is a bad place for a garden due to high altitude and short growing season and tornadoes and bad hail and clay soil and little rainfall etc., and my cabbages were puny). But Mike Fisher once saw a swarm of hundreds over a plot of cabbages near Longmont in Sept. 1972. Common.

Eggs yellowish-cream, turning yellow-orange after a day or two, laid singly on host leaf uns. Larvae eat tender leaves mostly at night, without nests, and can bore into cabbages. Females in lab can live up to 3 weeks, and oviposition peaks at 3-6 days of age, with up to 800 eggs per female lifetime. Older larva green or bluish-green, with a weak yellowish middorsal line, and a lateral row of deep-yellow or yellow dashes/spots. Pupa green to brownish-gray to brown, tending to match the brown or green background (summer pupae usually green, autumn pupae brown, the color resulting from photoperiod, temperature, and substrate color and transparency, R. Bernath), with middorsal cream band containing black dots, a long head projection often tipped with brown & black, the lateral white line on abdomen joins flared subdorsal ridge on edge of wings, where two protruding subdorsal points on that wing edge and a large point on top of T2 are orange-brown or reddish on green pupae and brown on green pupae. The head projection and the other protruding points are sharper points than *P. marginalis.* All the larval stages have dorsal setae (hairs) that secrete oil droplets (containing mayolenes [with major components palmitic acid and stearic acid]) that deter ants; ironically some parasitoid wasps *Cotesia glomerata* use those acids to find the *P. rapae* larvae and lay eggs in the larvae, producing more wasps rather than butterflies (Takabayashi et al. 2000; Smedley et al. 2002; Shiojiri & Takabayashi 2005). Pupae hibernate, due to long nights (short photoperiod causes pupal diapause, high temperature prevents diapause).

Adults have three or perhaps sometimes four flights at low altitude April-M Oct. Adults average about 5 days lifespan, but can live at least 39 days in nature, and can move up to 12 km. Yet when I grew cabbages, adults hung around them seemingly most of the time. Adults reportedly migrate over the Pyrenee Mts. in Europe (S in fall, N in spring, N. Gilbert & D. Raworth 2005 J. Lepid. Soc. 59:10-18), and in Florida adults migrate northward commonly in spring, but few migrate in fall (T. Walker 1991 Ecol. Ent. 16:241-252); I have not seen obvious migrating adults in Colo. In Australia dyed adults moved ~700m per day and ended up ~250-600m from where they started, and a 16-day-old female would move ~2km total (R. Jones et al. 1980 J. Animal Ecol. 49:629-642).

Adults visit flowers of all colors, most often on yellow and whitish, and not often on red, and prefer small Lamiaceae esp. *Nepeta*, but seldom visit *Asclepias* and large-headed Asteraceae such as *Cirsium, Carduus, and Gaillardia*. Flowers visited include *Apocynum cannabinum, Arctium minus, Aster lanceolatus hesperius, Chrysothamnus* (*Ericameria*) *nauseosus, Cirsium arvense* (favorite), *Hesperis matronalis, Marrubium vulgare, Medicago sativa* (favorite), *Nasturtium officinale, Nepeta cataria, N.* X*faassenii, Taraxacum officinale*; it seldom visits mud. Adults preferentially pollinate the yellow-flowered form of *Raphanus raphanistrum* (Q. Kay 1976 Nature 261:230-232). Adults extend the proboscis before landing on the flower. Adults are body baskers, and cannot get warm by vibrating the wings slightly. Adults roost mainly on low 10cm-2m plants of all kinds (*Paeonia lactiflora*, *Rubus ursinus*, *Zea*, *Syringa vulgaris*, *Phaseolus*, *Cucurbita*, *Iris*, *Lycopersicon*, *Echinacea*, grass, rarely 20' up on a fir tree [they may creep down into the grass to stay warmer in cold nights], etc.); they often roost in small groups.

Males fleek all day (Shull [1987] saw an incredible 406 mating pairs in Indiana, from 09:30-18:30) near hostplants, especially among riparian vegetation in native habitats and on flat land in cultivated areas. They fleek fairly slowly and have a more up-and-down somewhat hopping flight compared to the straighter flight of *Pontia protodice*. Yet adults sometimes glide as far as 50cm in between fluttering. In Japan ssp. *crucivora* females reflect uv while males absorb it and males are attracted to uv reflective females, but this does not happen in America where males and females both absorb ultraviolet. In courtship, the male flutters near or over the hovering female (sometimes zigzaging up and down below and in front of her until she lands—sometimes it appears she zigzags to try to escape and he just follows her zigzags) and she lands and may vibrate her wings a little as the male may flutter over her before he lands beside her, he flutters a little after he lands and then (according to Y. Suzuki et al. [1977] in Japan) catches her closed forewings with his front legs and a middle leg and mates while opening his wings to 120-170^o (which causes her to lean) and inserting his abdomen tip between her hindwings to join. After joining the male may fly, with the female dangling, especially if they are startled; the female rarely flies. A female desiring to mate flies to a male and zigzags in front of him to attract his attention. Courtship may last as little as 7 sec. Unreceptive females may fly vertically to evade the male, or may drop to the ground, or do the Pierid rejection posture (wings spread fully, abdomen up vertically to waft a repellent pheromone from the scent gland lobes on her abdomen tip), or close wings and lean toward an unwanted approaching male. The male of a mating pair flutters his wings to repel approaching males, evidently to discourage the interloper. During mating the female's scent-gland lobes are within the grasp of his valvae. The male has an aphrodisiac pheromone consisting of ferrulactone, hexahydrofarnesylacetone, and phytol; the female anti-aphrodisiac pheromone is methyl salicylate and indole (Murtazina 2014). {*Pieris brassicae* male pheromone is brassicalactone and hexahydrofarnesylacetone and phytol, the anti-aphrodisiac pheromone is benzyl cyanide; S. Schulz et al. 2011. J. Chemical Ecol. 37:360-363.} Females mate multiple times, up to 3-4X for older females. Mating lasts ~82 min. (Y. Obara).

Shiojiri, K., J. Takabayashi 2005. Effects of oil droplets by *Pieris* caterpillars against generalist and specialist carnivores. Ecol. Res. 20:695-700.

Smedley, S., F. Schroeder, D. Weibel, J. Meinwald, K. Lafleur, J. Renwick, R. Rutowski, and T. Eisner. 2002. Mayolenes: labile defensive lipids from the glandular hairs of a caterpillar (*Pieris rapae*). Proc. Nat. Acad. Sci. USA 99:6822-6827.

Takabayashi, J., Y. Sato, S. Yano, & N. Ohsaki. 2000. Appl. Entomol. Zool. 35:115-118.

Pontia chloridice beckerii Great Basin White (Becker's White)

Identified on unh by the broad green edging on the veins, the white postmedian space beyond the discal cell, and the median and postmedian green patches on the costa which wander off the vein straight into the front of the wing. **Form pseudochloridice** occurs in early spring and has stronger green unh veins. *P. chloridice* is common in SE Colorado but is absent around Denver, then reappears uncommonly in N Boulder Co. and Larimer Co.; it is widespread and common in W Colo. lowlands. North American *beckerii* has usually been considered a separate species, but adults larvae and pupae are nearly identical to Eurasian *P. chloridice*: a mistaken paper by Coutsis & Tolman (1996, Linn. Belg. 15:271-272) reporting that *chloridice* larvae are very different from *beckerii* was based on misidentified immatures, then a paper by J. Coutsis {2014. *Pontia beckerii* from Balkhash Lake, Kazakhstan, new to the Palaearctic, and misidentified larva and pupa of *Pieris krueperi* from the Tarbagatai Range, Kazakhstan (Lepid.: Pieridae). Phegea 42:39-41} corrected that and reported that real *chloridice* from Kazakhstan actually has *beckerii*-like larva and pupa; so they are conspecific.

Habitat mainly arid Upper Sonoran Zone deserts, gulchy grasslands, and foothills. Often found on soft clayey/shale/gypsiferous soils. Hostplants in Colorado numerous herb Brassicaceae: *Stanleya pinnata, Arabis* (*Boechera*) *lignifera, Sisymbrium altissimum*; Capparidaceae: *Cleome serrulata*. Common where found.

Egg lemon-yellow, in a day or two turning orange, laid singly most often on flower buds/ inflorescence, sometimes on leaves. Larvae eat all parts but young larvae prefer flowers. No nests. Older larva yellowish-green or greenish-white with large black seta bases, mottled with bright purplish esp. subdorsally, widely orangish-yellow or orange at joints between segments, with cream or whitish middorsal line and cream or whitish lateral band. Pupa resembles a bird dropping, mottled dark-brown & cream and sometimes brownish-green, with a pale middorsal line, wings cream, first two abdomen segments gray-white, some cream blotches on abdomen including a creamy vague lateral band, a whitish blotch on side of thorax, a brownish sublateral band on abdomen, a middorsal crest on T2, A2-3 bulge upward, a point on front of head; attached by silk girdle over A1 and cremaster. Pupae hibernate.

About three flights on the plains M Apr.-E May, June-M July, and end July-E Oct., the last two flights rather coalesced and may overlap in E Aug., and similar flights occur in the Arkansas Canyon. About three flights in W Colo. L Apr.-May, June-M July, and Aug.-E Oct.

Adults visit flowers of all colors except perhaps pure red, including *Eriogonum lonchophyllum*.

Males fleek all day preferably up and down usually-dry gulch bottoms and valley bottom trails/roadside ditches, sometimes on hillsides, as they fleek rather fast ~1/2m up to seek females. Adults may identify their species by the strong ultraviolet pattern on unh (white reflects uv, green absorbs it). If a mating pair is disturbed, the male flies, the female dangling.

Pontia protodice Checkered White

P. protodice differs from *P. callidice* by having the rear postmedian black fw spot usually larger (esp. on unf, as it is sometimes small on upf) because that black spot is ~3mm in summer *protodice* (1-3mm in spring), versus small in *callidice* (~1.5mm in males, but up to 2.5 mm in females). Also, the fw apical marks are usually smaller, summer form males usually have the unh mostly white, summer form females usually have brownish rather than black ups markings, and the unh veins on the spring form vernalis are generally yellowish-brown or grayish-brown rather than green (the *P. callidice* spring form calyce has thick greenish unh veins, while the *callidice* summer form has yellowish-brown unh veins in both sexes). More technical ways to separate *protodice* from *callidice*: fw vein M_2 is usually the second vein to split off from the vein at upper edge of fw discal cell in *protodice*, usually the third vein in *callidice*; the male saccus is usually <0.7mm in *protodice*, usually >0.8mm in *callidice*; the aedeagus is smaller in *protodice*; and the signum bursa on the female bursa copulatrix is usually <0.85mm in *protodice*, usually longer in *callidice* (that trait works well). The spring/fall **form**

vernalis is smaller, the unh veins are yellowish-brown, and the apical upf spots are smaller; it is produced by short photoperiod (long nights) acting on older larvae regardless of temperature, and cold temperature causes pupae raised in even long-day conditions to become vernalis. The butterfly is still common in western U.S. (in spring but not late 2019), but is more irregular in occurrence in E U.S. where it reportedly became scarce when *Pieris rapae* became common. David Wagner reported it common in New England south to the Carolinas in the late 1900s, where it since then declined greatly (perhaps due to introduced parasitoids?, and perhaps it was scarce there before Europeans arrived), and it has declined around the Great Lakes.

Habitat open areas everywhere, most common at low altitudes but often found at middle altitudes and occasional individuals wander onto Alpine Zone peaks all over Colo. Hostplants in Colorado herb Brassicaceae: *Arabis* (*Boechera*) *stricta=drummondii, Sisymbrium altissimum, Descurainia sophia, pinnata, incisa, Thelypodium wrightii oklahomensis, Lepidium chalepensis, draba, pubescens, latifolium, campestre, Berteroa incana, Rorippa teres, sinuata, Chorispora tenella, Barbarea orthoceras, Nasturtium officinale, Thlaspi arvense, Aurinia* "*Alyssum*" *saxatile, Hesperis matronalis*; Capparidaceae: *Cleome serrulata*. It evidently seldom eats cabbage varieties (*Brassica oleracea*) in Colorado. Common, sometimes abundant.

Eggs cream, soon turning red-orange, laid singly on hostplant flower buds/inflorescence, sometimes on leaves. If the female spots or smells eggs on a plant, she seldom lays more. Larvae prefer flower buds, flowers, and fruits, sometimes eat leaves; on cabbage the larva eats only outer leaves, whereas *P. rapae* can burrow into the interior. No nests. Older larva pale blue-green to bluish-gray (not much paler than *P. callidice* in photo of Wagner 2005), with small and large black seta bases, the body has bright yellow subdorsal and lateral stripes (there are orangish-tinged and whiter places in these stripes). Larvae of *P. protodice*/*P. callidice* resemble those of *Euchloe ausonides*/*E. olympia* (presumably camouflage on the siliques=long seed pods, although the larvae may taste mustardy and unpalatable to birds). Pupa light bluish-gray to tan (sometimes green), often with yellowish or white middorsal and lateral-ridge stripes, the small head projection and point on top of thorax and two projections on the lateral stripe above tornus of wing case are all reddish-tipped (all those projections are smaller than *P. rapae*), a small red spot at wing base, there may be some small orangish patches next to lateral white stripe on abdomen. Pupae hibernate.

Up to three flights April-Oct. on the plains (similar in San Luis Valley), while most records from high altitude are M June-M Sept. probably in part because people don't observe there earlier and later in the season, and in part because adults take some time to migrate into Colo. Adults are somewhat migratory, as they are usually seen flying N through Denver in some numbers every year ~May-E June (whereas *P. callidice* is not migratory), so adults evidently populate high-altitude areas by migration also. I seldom see *P. protodice* flying south in fall, so maybe they fly high in the air southward then?

Adults visit flowers of all colors except perhaps pure red, including *Aster ericoides, Chrysothamnus* (*Ericameria*) *nauseosus, Cirsium, Heterotheca villosa, Medicago sativa* (favorite); they rarely visit catkins and mud. Adults usually bask by spreading their wings somewhat "body basking" ~20-60^{o}, seldom do wider-dorsal or lateral basking, and evidently cannot warm up by shivering their wings at small amplitude. Adults roost on low plants such as *Phaseolus vulgaris* or *Paeonia lactiflora*, and greatly prefer white ones such as the fluffy white seed masses of *Eupatorium ageroides* (dozens of adults), and sometimes the white flowers of *Aster* and *Melilotus albus* (P. & R. Rau 1916 Ann. Ent. Soc. Amer. 9:251-252, a study not in Colo.). Adults live about a week on average, longer in cool weather.

Males fleek all day ~1/2m up everywhere in the habitat, preferably on hilltops if available, where they don't stay long as they fly fairly fast to cover considerable territory. *P. protodice* (and *P. callidice occidentalis*) lack androconial scales present in other *Pontia*, and instead the males prefer the moderately-ultraviolet-reflective females, while females prefer the non-uv-reflecting males. Females will approach males for mating if no male has approached them first. In courtship (R. Rutowski 1979

J. Lepid. Soc. 33:42-49), the male flutters beneath the fluttering female (below and in front of her facing the same way as her to transmit pheromone back to her antennae) (sometimes he flutters beside or over her), and after she lands the male usually continues to flutter over her and contacts her with wings and legs for several seconds, then he lands (usually onto her side, or beside her [beside her in my observations]) and crawls a bit and bends his abdomen and mates if she is receptive, or if she is somewhat unreceptive and flutters moderately he leans and flutters beside her with moderate amplitude and tries to creep under her wings and tries to join (receptive females would flutter little and be quiescent and accept the male). Unreceptive females flutter fairly widely after landing and raise her abdomen so he cannot join, fly away or fly vertically to try to escape, and do the Pierid rejection posture (wings spread, abdomen raised vertically); the male may flutter futilely beside the landed female or hover overhead. At high density (local swarms of 10,000 or more reported to reach up to 6 adults per m^2), the males courted the females so often that the females dispersed from the area (A. Shapiro 1970 Amer. Nat. 104:367-372). The female may have an attraction pheromone, as a mating pair was found in which the female could not fly because all 4 wings were deformed into linear lobes and her hw was caught on a *Cenchrus longispinus* hooked grass seed, and females with unexpanded wings are quickly found and mated (C. Ferris 1969 J. Lepid. Soc. 23:271). If a mated pair is startled or sometimes voluntarily flies, usually the male flies, the female dangling. Mating lasts an average of ~27-35 min., or 3-4 hours if the male mated very recently. The male spermatophore transferred to the female is ~7-8% of his body weight, and females can mate multiple times; they remate after they digest the last male's spermatophore which takes 5-7 days (R. Rutowski 1984 Psyche 91:141-152).

Pontia callidice occidentalis **Western Peak White**

The American ssp. ***occidentalis*** is evidently the same species as Eurasian *P. callidice*, and is reportedly nearly identical to *P.callidice* from Tibet (crossing experiments had very small sample size). *P. callidice* differs from *P. protodice* by darker unh veins (the *callidice* spring form calyce has thick greenish unh veins, while the *callidice* summer form has yellowish-brown unh veins in both sexes), the black markings on the fw apex are larger and usually blacker, and the black spot near fw tornus is smaller especially in summer. The spring **form calyce** has much greener unh veins, more upf apical spots, and blacker unf tornus spot than *protodice*; it is produced by short photoperiod and cold temperatures, as in *P. protodice* form vernalis.

Habitat open areas everywhere, from the upper plains to tundra. *P. callidice* occurs over the NE Colorado plains surely eastward as far as Limon, but I did not find it on the plains in the Pueblo area so it doubtfully occurs on the SE Colo. plains. I studied *occidentalis* and *P. protodice* at Barr Lake NE of Denver, where they fly sympatrically and remain distinct. Hostplants in Colorado herb Brassicaceae: *Descurainia incana=richardsonii, sophia, Rorippa teres, sinuata, Arabis* (*Turritis*) *glabra, Arabis* (*Boechera*) *stricta=drummondii, Lepidium densiflorum, Chorispora tenella, Barbarea vulgaris, Noccaea fendleri=Thlaspi montanum=Thlaspi alpestre*, (they occasionally oviposit on *Thlaspi arvense* which is lethal to larvae) (F. Chew 1977 Evolution 31:568-579) (Also, high altitude pops. are assoc. with Brassicaceae: *Smelowskia calycina*.); Capparidaceae: *Cleome serrulata*. Usually uncommon on E slope (common a few times at Barr Lake), often common on W slope.

Eggs cream, turning orange-red after a day, laid singly on the hostplant inflorescence (usually) or leaves or stems. If the female spots or smells eggs on a plant, she seldom lays more. Larvae prefer flower buds-fruits, sometimes eat leaves. No nests. Older larva dark-bluish-gray (most somewhat darker than *P. protodice* in Colo.), with black seta bases, a wide subdorsal stripe and a lateral stripe are white in just the middle of segments and orange-yellow in most of segments (see photo in Guppy & Shepard 2001); head lighter-bluish-gray with orangish-yellow patch on side. Pupa usually light bluish-gray or gray, sometimes bluish-tan or bluish-cream (averaging slightly darker than *P. protodice*), with many tiny black dots on wing veins and body, a middorsal creamy crest with orange-brown tints on thorax top crest (cream on weaker abdomen crest), a weak subdorsal cream line esp. on abdomen, a lateral band of whitish and orange-brown on abdomen extends to the red-brown projections on A2 & A3 above tornus of wing, the projection of head creamy or orange-brown, a yellowish bump just above antenna base and an orangish-tan bump on wing base. Pupae hibernate.

About three flights M Apr.-Oct. on upper plains/foothills (Green Mtn. records M May-M June, July 16, M Aug.-E Oct.), mostly one gen. L June-M Aug. at high altitudes (some L May-E Sept. there). Form calyce has wide green unh veins, and occurs in April-May and Sept.-Oct. on the upper plains, and predominates in the high mts. including the Alpine Zone where most are form calyce even in summer.

Adults visit yellow and white and violet/blue/purplish flowers, rarely pinkish, including *Medicago sativa*, and rarely visit catkins. Adults are body baskers (wings spread ~20-60º), occasionally bask laterally), and cannot warm up by shivering their wings. Adults can fly far, often ½ km and 1 km from Green Mtn. to near my house, and A. Shapiro found one that evidently flew 60 mi. to Sacramento CA.

Males fleek all day, on hilltops/ridgetops if present, or on hillsides or flat land near the host, as they fleek ~1/2 m up (extremes 15, 20, 80 cm up) and can chase others up to four in a row, but they don't stay long on hilltops as they speed onward to the rest of the habitat. (Males of ssp. *callidice* also fleek on hilltops in France [Aice Choko 1954 Lepid. News 8: 143-145.].) In courtship, the male finds a female and both flutter and land, then he flutters some at fairly wide amplitude near her, and joins. Receptive females are evidently usually quiescent while he joins, while less receptive females may flutter some after landing, and completely-unreceptive females can do the Pierid rejection posture (wings spread, abdomen raised way up). If a mated pair is startled, he flies, the female dangling.

Pontia sisymbrii elivata **Spring White**

This species is smaller than *P. callidice*, with the uns veins edged by blackish-brown (not greenish or tan) and the black bar at the end of the fw discal cell is a narrower single bar constricted in the middle (not the doubled spot with white in middle as in other *Pontia* species). Colo. has ssp. ***elivata*** (E of Sierra Nevada in Calif.-Nev. and most of the range incl. Rocky Mts. & Neb.), while ssp. *sisymbrii* occurs in lowland Calif. (weaker unh & ups markings) (intermediate to *elivata* in San Diego Co. CA), ssp. *transversa* from S Ariz.-S New Mex. is similar with weaker unh markings and is probably a synonym of *sisymbrii*, whereas ssp. *nigravenosa* from S and E-C Nevada is a good ssp. with larger black markings including a larger black spot at end of fw discal cell (ssp. *flavitincta* from Alta.-BC is also more heavily marked). Many females are yellowish in ssp. *elivata* and *sisymbrii* (**form flava**).

Habitat the desert hills and foothills up to the middle Canadian Zone. Hostplants in Colorado herb Brassicaceae: *Arabis* (*Turritis*) *glabra, Arabis* (*Boechera*) *fendleri, stricta=drummondii, Arabis* (*Arabis*) *pycnocarpa=hirsuta*, *Descurainia incana=richardsonii*. Common.

Eggs bluish-green or yellowish-green, turning yellow then orange after a day, laid singly mostly on leaf uns or stem ½ or 2/3 of the way up the plant, sometimes on flowers. Larvae usually feed on leaves but when older they sometimes (or may prefer to) eat flower buds and green fruits. Females lay fewer eggs on plants that already have orange eggs. Older larva (photo Allen et al. 2005) has light-yellow (orangish in S Calif.) on each intersegmental area on most of top of body, edged broadly by black transverse stripes on each segment that form the sides of each rectangular box and the end of the box is a black sublateral stripe just above the white underside, a subdorsal white spot is in the yellow rectangle where the rectangle is constricted and there are thin transverse black and yellow lines within the rectangle, the middle of each segment is white, black tongues extend downward from each rectangle to legs and prolegs; head black, with white dots, white on frontoclypeus, and an inverted white V on face. Older larvae resemble *Danaus plexippus* and *Papilio machaon*-group larvae, evidently a case of Müllerian mimicry, because they possess chemicals that are evidently distasteful to birds who taste then drop them (evidently mustard oil glycosides in *P. sisymbrii* gotten from the hostplants). Pupa dark brown, the head tan, with many darker spots, varying to black with tiny white dots, the pupal prominences very small compared to other *Pontia* and *Pieris*. Pupae hibernate, sometimes for up to four years.

One flight M Apr.-E June (some records E April & rarely L June), May-M June at highest altitude.

Adults visit mostly whitish flowers, sometimes other colors, including *Thlaspi arvense*, and rarely visit mud.

Males fleek all day, throughout the habitat but preferably on hilltops (but they fleek more away from hilltops than *Euchloe olympia*), as they fleek ~1/2m up with a slower more fluttery flight than *Euchloe ausonides*. Courtship was not seen. If a mating pair is disturbed, the male flies, the female dangling.

Ascia monuste monuste Great Southern White

A very rare stray to Colo., found in El Paso Co. in 1957 by F. M. Brown, and Boulder Co. on ~Aug. 6 1978 by Paul R. Ehrlich. The antenna club tips are turqoise! in color, and the upf and often unf borders are jagged black. Dark-gray females (**form nigra**) are produced from long photoperiod. Hostplants southward are mostly herb Brassicaceae and evidently also Capparaceae, and various other odd plant families, so it could breed in Colo. Common in S Tex. and Mexico. Eggs laid singly or in clusters up to 50, preferably on new leaves, sometimes old. Photos of larvae are in Allen et al. (2005) and Wagner (2005) and Bright & Ogard (2010). Older larva similar to *Pontia protodice*, dark-grayish-green or green with numerous tiny and some medium black dots, with a yellow middorsal line, a dorsolateral white band often edged below by darker ground color, a lateral orange line often edged above by a darker line; head orangish gray or orangish with tiny black dots. Pupa green, gray, white, or black, with olive-black markings on head and thorax and around top of wing, and often with orange-yellow middorsal and lateral bands on abdomen, a spine on each side of A3. It flies all year in Mexico and S Tex. Some migrations are known in SE U.S. Migrations are described in Scott (1986a). Migration in Fla. occurs as a result of crowding, and adults tend to fly N in summer and S in winter and early spring. Adults can use landmarks during migration, and use polarized light from blue sky. Males evidently fleek near the hostplant to find females. Females usually mate just once, sometimes twice, rarely thrice.

Nymphalidae Brush-footed Butterflies

Nymphalidae is a large family of ~5997 species worldwide that are very diverse in color and size of adults, larvae, and pupae. They are called "Brush-footed" because the forelegs of both sexes are very small in size (except in Libytheinae the female forelegs are 2/3 of normal, while the male forelegs are smaller than female forelegs) and are covered with "hair", vaguely resembling a brush, and adults walk with just the four hind legs. Females use the forelegs to detect their hostplants, by "drumming" the forelegs on plants which enables spinelike olfactory setae on the foreleg tips to sample the chemicals in the plant to determine its suitability; the male forelegs have the tarsal segments fused together and their forelegs are apparently mostly useless. Larvae of Nymphalidae are incredibly variable. All of them evidently have a ventral neck gland on the larva (known in Libytheinae, Danainae, Satyrinae [*Erebia*], Morphinae, Nymphalinae [*Euptoieta, Argynnis, Boloria, Dione, Historis*, *Chlosyne*, *Phyciodes, Smyrna, Polygonia, Nymphalis, Aglais, Vanessa, Junonia, Adelpha*, Acraeini, etc.]) that produces a noxious smell that evidently repels predators such as ants (James et al. 2012), in *Dione* and *Acraeini* mostly using carboxylic acids (acetic, linoleic, oleic acids) and terpenes (alpha farnesene) (Osborn & Jaffe 1998). Many species (notably *Euptoieta*, *Argynnis* and *Boloria*, detailed by James & Nunnallee 2011) have oil droplets exuded from setae of very young larvae; those oil droplets evidently repel predators such as ants (see the *Pieris rapae* writeup above); other Nymphalidae evidently have those oil droplets also. On older larvae, a Mexican butterfly *Dynamine dyonis* has sticky blobs on the scoli; and the scolus tips of neotropical *Siproeta stelenes* reportedly produce a rash when rubbed on the skin, evidently for defense; and larvae of neotropical *Hamadryas* *amphinome* exude a foul odor. Pupae lack a silk girdle, and generally hang upside down from the cremaster. Adults of many groups can shiver to get warm (reported in Danainae, Brassolini, Charaxinae, Nymphalinae). Most Nymphalidae rest and bask with wings spread open. Most Nymphalidae bask dorsally, except most Satyrinae bask laterally. Some Nymphalidae cannot see red, such as *Vanessa cardui* which has optical receptors peaking at Ultraviolet360nm, Blue470nm, and Green530, and *V. atalanta* cannot see 590-640nm. However *Heliconius erato* has similar receptors and has filtering pigments at the rhabdom at Orange590, Red620, Red640 that see orange and red, and *Anartia* and *Polygonia* have Red610 rhodopsin detectors that let them see red (G. Bernard 1978 Science 203:1125-1127), and they have other receptors from ultraviolet to green.

Nymphalidae, Libytheinae Snout Butterflies

There is only one species of Libytheinae in Colorado, notable for its elongated labial palpi, misnamed a "snout" (palpi actually sense odors). Only about 8 species occur worldwide, in warmer areas on most continents. Males have small forelegs without claws, while females have two-thirds-normal-size forelegs with claws. Larvae and pupae are rather simple, without conspicuous adornments.

Libythea (*Libytheana*) *carinenta larvata* (occasionally *L. c. bachmanni*) Snout Butterfly

The "snout" consists of two elongated labial palpi (olfactory organs) that project forward from the head. Adults land on a twig with antennae positioned along the palpi to camouflage themselves: the wings resemble a leaf and the antennae/palpi resemble the leaf petiole (however, adults don't press the antennae-palpi against the twig to perfect the camouflage, perhaps? because it would take too much energy to lean forward to do that). But reportedly they usually rest with heads facing downward, on trunks or hanging leaves. I have seen ~20 *Libythea* caught in Colorado, and most were ssp. ***larvata*** which has two separate white postmedian spots on the fw costa, except five were ssp. ***bachmanni*** which has those two spots merged into one large spot. The Denver adults were three *bachmanni* (the other two were from Elbert and Kit Carson Cos.) which were likely brought into Colorado on *Celtis occidentalis* nursery saplings from eastern U.S., rather than migrating westward (although a population explosion eastward might result in adults flying westward to Colo.?). Two forms occur in all ssp.: the dry season form has unh pale tan with brown dashes and brown median and submarginal bands; the wet-weather **form kirtlandi** has the unh nearly uniform violet-gray.

Habitat for *larvata* Lower Sonoran Zone woodland and thorn forest, migrating northward. A rare stray in Colo. Hostplants in other states tree Cannabaceae: many *Celtis* species (mostly *C. pallida* for *L. c. larvata* in Mexico-Ariz.-S Texas, and other *Celtis* spp. for ssp. *bachmanii*) including two Colorado species *reticulata* (native) and *occidentalis* (cultivated). Migrants to Colorado would eat *C. reticulata* in the Front Range foothills and SE Colo. and far SW Colo., and eat *C. occidentalis* in towns.

Eggs pale green to yellowish, laid singly on uns of young terminal hostplant leaves, usually on the petiole, sometimes on leaf underside. Larvae prefer to eat young leaves, without nests. Half-grown larvae chew the leaf down to the midrib and rest far out on the midrib in Brazilian ssp. *carinenta*. Older larva of ssp. *bachmanii* (photos Allen et al. 2005, Wagner 2005) green with numerous short cream points, a pale cream heart-line, sometimes a cream subdorsal line, a lateral wider pale-yellowish area (sometimes absent) above a cream lateral stripe just above spiracles, a tiny black subdorsal slight-cone on T2 ringed with cream (just a minute black dot on photo of Minno et al. [2005], a larger black "eye" spot on photo of Bright & Ogard [2010]) (some people describe all the cream markings as yellowish, the color is variable); head green, the eyes black or brown (several middle eyes have narrow cream base). Wagner notes that greener larvae somewhat resemble partly-opened leaves. The two larvae of Tveten & Tveten (1996, probably ssp. *bachmanii*, although they seem to lack the T2 subdorsal cone) are "dark-green" (due to mixture of blackish and yellow) with pale-yellowish stripes, with yellowish heart-band, a wide dark-green area, a pale-yellowish dorsolateral line, a narrower greenish stripe, a pale-yellowish wide area, a lateral cream band with a wide very-dark stripe below it, and a pale-yellowish stripe above prolegs, a small or large blackish dorsolateral spot on A8. Ssp. *bachmanii* larvae are variable: some have the lateral line replaced by a wide yellowish band above a narrow cream line, and some have a brown or black dorsolateral spot on A8, some larvae have T3-A2 partially black (due to bacteria?), and some lack all lines and pattern except the yellowish heart band and the yellower underside. Darker larvae may be more prevalent at high density or possibly in high humidity. Older larva of ssp. *larvata* (and *carinenta*) similar, dark-green or yellow-white, yellowish-green or greenish-brown beneath, with many yellowish points and with a yellowish lateral line (which may be just faint yellow and only on abdomen), and with NO subdorsal cone on T2, some have black middorsal band and wide black area above lateral band, legs black, a black dorsolateral spot on T2 about cone position and a similar spot ~A8. Larvae often rest with front of body hunched upward, only the prolegs and head touching the hostplant. Pupa somewhat camouflaged like a leaf, deep green or bluish-green or yellowish-green, abdomen sprinkled with yellowish dots, a slight whitish or yellowish lateral line on abdomen, a cream or yellowish line starts middorsally on ~A4 to A1 then runs from the point on top of abdomen diagonally across the wing bases to the end point of head, wing veins green sometimes edged with white points; pupae have two points on the head and a crest on the abdomen. Pupae hang from the ventrally-aimed cremaster. Adults overwinter, but only far southward of Colorado in S U.S. and Mexico, migrating northward.

Many flights all year in S Texas and S Fla., ~two flights in Kansas, but rare in Colo. Adults migrate individually and sometimes in huge swarms; single individuals of *larvata* rarely stray into Colorado, mostly in summer (seldom May, most July to Oct.), and rarely migrate as far as N.D. and Ont. I once saw 200 adults on one tree during a local swarm in S Texas. R. Heitzman (1962 J. Lepid.Soc. 16:249) saw a small migration March 21 in NE Mexico to the S (where the next day a huge *Danaus plexippus* migration went NE), and H. Clench saw them migrate N July 4-5 and S July 10 in Tex. (1965 J. Lepid. Soc. 19:223-224). R. Neck (1983 J. Lepid. Soc. 37:122-123, and 1984 J. Lepid. Soc. 38:319-322) reported a large migration to NNE in L Aug. 1971 (evidently leading to a migration NNE in Kansas in Sept.-E Oct. 1971), but he reports they usually fly to the SE, and a 1978 migration was to the SE from an area of high rainfall generating swarms in S-C Texas. Evidently *L. carinenta larvata* does not have an organized system of N-S migration, it just has the randomly-oriented swarm kind of migration, dispersing from areas of overpopulation, as Tveten & Tveten (1996) also note. R. Neck suggests a population explosion can follow heavy rains.

Adults usually visit white flowers, often yellow, occasionally pink or purple, and rarely orange or blue or red or greenish (Scott [2014] lists more than 50 flowers visited). *Trifolium repens, Cirsium, and Solidago* are often visited, as is mud/wet sand, and sometimes rotting fruit, bird droppings, dead wood, aphid honeydew, and perspiration. While flying, adults somewhat resemble a small *Argynnis*, fluttering not very strongly about a meter above ground, though they can be swift and erratic. Adults bask dorsally (by spreading the wings up to 180^o or even 210^o apart). They rest and roost with the wings closed. They often rest with head downward, on trunks or hanging leaves.

Males in high-density population "swarms" in Ariz. evidently mainly fleek by flying an erratic zigzag path up and down through host *Celtis pallida* trees to seek females (one mating was with a female with still-floppy wings who could not fly, suggesting males are attracted to her pheromone), but at [comparatively] low density ~34% of males rest an average of 1.9m above ground which would seem to constitute occasional raiting (Rutowski et al. 1997--he evidently observed only in morning and failed to state the time of day when they mate-locate--I saw raiting in Arizona at 13:35 and they evidently mate-locate all day). In Texas, males mostly rait to await females (T. Friedlander, in Scott 1986a), and Friedlander notes (pers. comm.) "Mate locating behavior in snouts is routinely more perching than anything else though they don't commonly return to individual perches." In the Great Lakes area, Douglas & Douglas (2005) noted that "Rapidly flying males patrol near host plants during the day, looking for mates." Evidently males usually rait at low density, and fleek at high density. In a swarm of millions of adults in S Texas I saw many courtships 09:00-16:00 and found 10 mating pairs all day including 07:36 and 17:14, but mostly in morning (maybe the virgins were mostly mated by afternoon); Richard Heitzman saw four mating pairs at uv light from 22:05-23:45, so those evidently joined late in the day. Rutowski et al. (1997) note that successful courtship is simple, as the male overtakes a flying female and she lands with him behind, or he approaches a resting female, and the female keeps her wings closed as the male moves alongside and bends his abdomen to mate. Unreceptive females keep flying or suddenly drop downward and land to evade him, or land and flutter their wings to repel the male, or spread their wings and elevate the abdomen, or fly. In my few observations, males flutter behind landed unreceptive females by fluttering his partly-open wings closed ~3x/sec. for ~5sec. (evidently to transfer pheromone), and the female may be motionless but usually flutters her wings or vibrates her 70°-spread wings to reject him. (Males reportedly inspected other males an average of 14.6 sec., other species almost as long 12.7 sec.) Females usually mate once or often twice (average 1.3x, up to 4). Mating lasts ~88 min (45-140). If the mated pair is startled the female flies, the male dangling.

Rutowski, R., B. Terkanian, O. Eitan. 1997. Male mate-locating behavior and yearly population cycles in the Snout Butterfly, *Libythea bachmanii* (Libytheidae). J. Lepid. Soc. 51:197-207.

Nymphalidae, Danainae, Danaini Milkweed Butterflies

~475 Danainae species occur worldwide, mostly tropical, and most of those are Ithomiini, so only ~150 are Danaini. Only three occur in Colo., all of them migrants and two of them rarely straying here. The forelegs are very small, and the tarsi of males are fused while females have four tarsal segments. The adult male has a hair pencil on the abdomen used to waft a pheromone to seduce the female. Larvae eat Apocynaceae plants (mostly *Asclepias*) which contain poisons that make the larvae pupae and adults unpalatable to birds etc. Larvae have fleshy filaments on top of the body (1st-stage larvae have just bumps there) and lack branching spines (scoli). Pupae are stout. After mating, the male flies in a "postnuptial flight", the female dangling; mating pairs of other butterflies generally fly only when disturbed.

Danaus plexippus plexippus Monarch

A migrant to Colorado, but uncommon here, breeding mostly eastward at lower altitude and wetter climate. Easily identified by the coloration and large size and pointed forewings. *Limenitis archippus* (adults) is a Müllerian Mimic of it, but differs by having a black uph postmedian line. The basis of the Müllerian mimicry is poisonous compounds that the larvae ingest from their *Asclepias* (milkweed) hostplants. Some *Asclepias* species contain those cardiac glycoside heart poisons (mainly calactin, calotropin, and calotoxin) in large amounts, but others have less. L. Brower, M Rothschild, and others found that females have more glycosides than males, NE U.S. adults are more poisonous than southern U.S. and Calif. adults (90% in Mass. are noxious, 71% in Mex., 53% in Calif.), and the wings and abdomen are more poisonous than the rest of the body. Birds still eat some Monarchs: At the California coast overwintering sites, Rufous-sided Towhees eat 13% of the butterflies (~22/day/bird). And millions are eaten in the Mexican overwintering sites by Black-Headed Grosbeaks that eat the whole butterfly and are immune to the poison, and Monarchs are their main winter food, while orioles and jays eat only the thoracic muscles and abdominal contents and discard the wings (warblers and chickadees refuse all Monarchs). Mice eat many. And some Mex. ranchers used to lead their cattle to the Monarchs and whack the branches to knock them down and the cattle grew fat eating the butterflies. Monarchs become less poisonous during their stay in Mexico, and Monarchs have become less poisonous historically because *Asclepias syriaca* was the host for most overwintering Mexican Monarchs and has less heart poisons, and *A. syriaca* has increased in abundance in the summer range.

Still, many Monarchs are protected from predation by being poisonous, and birds such as jays vomit if they do eat them, and adults have tough leathery bodies that can resist a moderate bite so teach birds not to eat Monarchs. Some adults (10-20%) in Hawaii are whitish (**form alba**, due to an autosomal recessive allele), but none have been found in Colo. (they are very rare in E U.S.).

Habitat open areas, mostly at low altitude. Uncommon now.

Adults are strongly migratory. In fall they migrate from Ontario and E U.S.-Great Plains down to central Mexico to the high-altitude (3000-3400m) Oyamel-Fir forests in the states of Michoacan and Mexico where they overwinter and color the trees dark-red with up to hundreds of millions of hanging adults. They migrate to ~30 sites there (on ~12 mountains, most in just 5 colonies ~110 km W of Mexico City) because it is cold enough there to minimize burning their fat stores yet not so cold that they would freeze to death (some do freeze if a major storm wets them then gets cold and freezes esp. the tops of the trees and next to the ground—most roost midway down dense forest Oyamel trees ~10-15m above ground where the temperature is safest), and they choose places near water for drinking and with sun for basking so they can get warm enough to fly to drink. Small aggregations have been found westward in Jalisco and Colima, and southeastward in the Sierra de Juarez in eastern Oaxaca. The E North American migration southward to S-C Mexico is conducted by one generation of adults: many are seen migrating near ground level, and they migrate southward as low as ~1-3m over small lakes, but helicopter pilots report that adults fly an average of ~300m up in the air (a glider pilot saw them at 12,000 feet), and can ride thermals of warm air up to over 1000m and then glide toward S-C Mexico (W. Calvert 2001 J. Lepid. Soc. 55:162-168; D. Gibo & M. Pallett 1977 Canad. J. Zool 57:1393-1401; D. Gibo 1981 Can J. Zool 59:571-572). Douglas & Douglas (2005) wrote that around the Great Lakes the migration to SSW begins in M Aug., peaks E Sept., and concludes as late as M Oct. In central Tex. they fly an average of 239^{o} (to the SSW). In Mexico many follow the Sierra Madre Oriental southward (175^{o}) (W. Calvert 2001 J. Lepid. Soc. 55:162-168); however they must eventually fly westward to the major overwintering sites in the states of Mexico and Michoacan, and winds from the E may help them go westward. Some adults go too far, to Oaxaca and Guerrero. Adults in SE U.S. at least west of peninsular Florida evidently often fly across the Gulf of Mexico, because they reportedly congregate in 3 layers on oil platforms 150 mi. S of La. ~Oct. 17-18 every year (B. Mather 1990 News Lepid. Soc. #4:59), while flying to Michoacan and Chiapas and Guatemala. Adults along the Atlantic coast of U.S. less often fly to S Mex., and some overwinter in S Fla., and some adults fly through Fla. to Cuba and Yucatan where roosts are known. C. Dockx (2012 Linn. Soc. Biol. J. 106:717-736) studied migration through Florida to Cuba and the Caribbean, and found that most stopped migrating and started breeding in S Fla.; and Minno et al. (2005) notes that in C and S Fla. they breed all year. S and W Florida adults have less-elongated fw (Puerto Rico & Costa Rica adults have the smallest roundest fw, ssp. *megalippe*), suggesting that there is not much migration northward from Florida (S. Altizer & A. Davis 2010 Evolution 64:1018-1028). Wing-damaged monarchs migrate slower. When they arrive at the wintering sites in S Mex. (arriving M Oct.-Nov.-E Dec.) they congregate on ridges and may soar into spirals up to 300m high near forming colonies, then they consolidate in moist valleys <200m from the windy ridgetops. The Mexican $19^{o}20'$-$19^{o}45'$ latitude overwintering sites are cool enough (<20^{o}C) with daylength short enough (less than 11-12 hours) to prevent egg development in females, and to minimize metabolism of the fat reserves the butterflies need to get through the winter. In contrast, the migration northward in L Feb.-March in Mexico (the sun is perpendicular to the average $25^{o}22'$ slope of the colonies for maximum sunlight and heating on ~March 1) proceeds at an average rate of 24km/day (versus 45 or ~72 km/day for the whole fall migration southward by the generation to Mexico, and 35 km/day reported from Wash.-Ore. area to Calif.) and usually takes an extra generation to reach Ontario. Nearly all females at the Mex. overwintering sites are virgins, so after overwintering in S Mexico and occasionally sipping mud there, they mate there during a short time in Feb. then fly leisurely northward and lay eggs along the way, and only ~10-25% of adults fly all the way to the Great Lakes area while most do not make it that far and their offspring grow up mostly in the midwest U.S. then fly the rest of the way back into NE N.A. as far as Minnesota, Ontario, and New York. {I found one unexplained adult in Boulder in N Colo. on April 13.}

In S Tex., adults are normally seen only in fall and early spring, but in warmer years they occur in winter months, and in cooler-spring 1966 they were found in June-July (R. Neck 1976 J. Lepid. Soc. 30:137). Perhaps they will overwinter there and in NE Mex. in the future as a result of global warming.

Great Basin-Pacific Northwest populations mainly migrate in August-October ~40-50km/day to the Pacific coast of central Calif. (usually S of San Francisco including Pacific Grove, but in some years also to Bolinas in Marin Co.) southward to the coast of N Baja Calif. near Ensenada (one overwintering site is on Santa Cruz Is. [at Central Valley on Bishop Pine]). 9 tagged SE Wash.-W Ore. adults flew to the Calif. Coast, and one flew to Brigham City Utah (D. James et al. 2018 J. Lepid. Soc. 72:127-144); and 5 tagged in SW Ore. flew S to those Calif. coast overwintering sites except one female few S to Santa Barbara and oviposited on *Asclepias curassavica* for a week, as they sometimes now breed in the winter from L. A. to Santa Barbara and even San Francisco (D. James 2018 J. Lepid. Soc. 72:244-246). 1/3 of females had mated before they arrived at the coast, then they spend L Oct.-L Feb. overwintering usually on *Eucalyptus* trees or seldom on *Pinus radiata* trees on the coast, they mate during a short period in L Jan-E Mar., then migrate northeastward into Calif. and W Nevada etc. (one flew from N Calif. to Twin Falls Ida.). Great Basin adults evidently fly westward over the Sierra Nevada mostly in Sept.-Oct. and are frequent even at 9000-10000’ (K. Davenport). 40% of adults from the Calif. coast overwintering sites had stable isotype ratios indicating they came from E Wash.-E Ore.-Ida. (L. Yang et al. 2015 Ecography 38:1-10), but a few from Idaho may migrate S to Mexico.

But migration of Colorado monarchs has been poorly studied, partly because they are uncommon in Colorado and in the western U.S. intermountain area including Washington; in Denver now one may see only half a dozen adults per year. The Great Plains butterflies evidently often or mostly overwinter in S Mex., and many of the W Colo. adults may overwinter in S Mex. also. An Alberta adult migrated to Mexico. California and eastern U.S. butterflies seem to show no genetic differences so far (Lyons et al. 2012), and Dingle et al. (2005, who mostly studied just collection records) suggested that butterflies flying from the California coast from Santa Barbara northward fly ~195º [clockwise from south] to populate Ore. Wash. S BC W Ida. and Nev., then reverse that path to hibernate on the coast, just as the S Mexican butterflies fly ~195º to eastern North America then back, whereas Montana and other Idaho Monarchs may fly though Utah to Arizona and then often to Mexico. But in southern Arizona some may overwinter based on anecdotes by R. Pyle etc. R. Funk found them breeding (54 larvae/pupae) at Yuma in SW Ariz. all winter 1965-1966 (1968 J. Lepid. Soc. 22:63-64). Some fall S Ariz. adults use prevailing winds to fly to the California coast or use winds to fly to southern Mexico (Morris et al. 2015). Some of several dozen adults released in fall in SE Ariz. on the same day flew to California coast and some flew to S Mexico (of total releases, 32 flew to the California coast and 11 flew to S Mex. while Sept. releases were most likely to fly to Calif. and L Oct. releases were more likely to fly to S Mex.) (J. Billings 2019 J. Lepid. Soc. 73:257-267). Some Wyo. adults flew to Mexico. So maybe butterflies in western Colorado and eastern Utah might fly to Mexico also, which would be a rough trip over the San Juan Mountains and the canyonlands, but Mike Fisher (2005) “noted individuals in the high southwestern [Colo.] mountains on their way south in late October.”

California studies recently (C. Schultz & E. Crone 2021, News of Lepid. Soc. 63:34-35) found that very few adults now hibernate on the Calif. coast (only 1914 counted) and instead are common and hibernate inland in urban gardens N of Santa Barbara to San Francisco and Berkeley, and larvae feed on the introduced tropical milkweed *Asclepias curassavica.*

Monarchs are sophisticated migrants: their eyes use sunlight and polarized light to migrate (they have ultraviolet-sensitive and polarization-sensitive receptors in the dorsal rim of the compound eye), as they start and end their migrations at particular angles of the midday sun to the ground (they start at 57-56º and end migration at 47º), and their antennae have a molecular clock used for sun compass orientation, that allows their brain to compensate for movement of the sun east to west each day and make them fly at the same compass direction all day long, and they may even use a magnetic compass with cryptochrome pigments in their eyes to maintain the proper direction (Reppert et al. 2016). Migrating adults align with the magnetic field (PBS TV show "Butterfly Blueprints" Jan. 2022). Stationary summer adults have high levels of juvenile hormone, while migratory fall butterflies have little.

D. plexippus has spread throughout much of the world, including Bermuda, the Bahamas and Antilles, Hawaii, NW South America south to Peru and Argentina, the Azores and Canary Is., S Europe incl. Spain/Portugal, Sri Lanka, India, some East Indian islands such as Philippines, Sulawesi, Moluccas, the Solomons, New Caledonia, New Guinea, Australia (1870), New Zealand (1840). It probably colonized California in the early 1900s. Monarchs are evidently non-migratory in most of Latin America, although they migrate to mountain peaks in the Costa Rica dry season March-April (W. Haber). In Costa Rica they are similar to N.A. ssp. ***plexippus*** adults but have the fw margin less indented, while in the Caribbean and South American ssp. *megalippe* the fw is less pointed and the fw apex and ups margins are blacker. In Australia they lack strong adult diapause and instead have a flexible weaker adult diapause, and reportedly migrate up to 380 km in late summer & fall to more than 33 sites in SE Australia near the S or SE coast if the weather is cool <18ºC and overcast (D. James & T. James 2019 J. Lepid. Soc. 20:177-190); these sites usually contain milkweed (*Gomphocarpus fruticosus*). {In Taiwan 10-15 million of four species of *Euploea* [Milkweed Butterflies, Danainae] migrate in L Sept.-M Nov. near the W and E coasts south 400km to 12-15 warm vallies in the Dawu Mtn. range, then go back north in March, both migrations mostly aided by winds [lonelyplanet.com].}

Danaus plexippus is seriously decreasing in abundance in North America. The Pacific Coastal roosts may be doomed, as 192,668 were counted in the 2017-8 winter, only 28,428 in the 2018-9 winter, an 86% drop in one year and a 99% drop since the 1980s (S. Black, National Wildlife [magazine] Apr.-May 2019 p. 25).

The flyway from E N. Amer. to Mexico is greatly decreasing also. Several decades ago a billion flew to S Mexico, but in the winter of 2013-2014 only 25 million arrived there. There is worry that the strong migratory population from Mexico may become extinct, for several reasons: 1) The federally-mandated but environmentally-unsound ethanol production program (ethanol currently makes sense environmentally and financially only when produced from sugar cane) has caused large areas of federally-subsidized fallow lands to be taken out of protection in E U.S. and plowed up again and planted in corn to produce ethanol, reducing the population of *Asclepias*. 2) Weeds such as the horrible rhizomatous *Bromus* (*Bromopsis*) *inermis* grass grow into thick monocultures over much of E N.A. and choke out other plants and reduce the population of *Asclepias* and many butterflies. 3) Farmers are relentlessly using herbicide glyphosate etc. to spray weeds such as *Asclepias* because modern genetically-engineered pesticide-resistant soybeans and Bt corn etc. survive increased amounts of glyphosate etc. 4) The Mexican government has failed to prevent greedy peasants from cutting down the Oyamel trees at the overwintering sites (for example in 2015 criminals logged 25 acres within the best Sierra Chincua site). Those peasants use or sell the wood for lumber, and they plant avocado trees in the cleared spots in order to make money from the lucrative sale of avocado fruits (the price of avocados is good because of great demand for guacamole in the U.S.). 5) Intruders to the colonies may breathe on the monarchs and otherwise disturb them, causing thousands to fall to the ground and evidently some are harmed. 6) An invasive weed "Tropical Milkweed" *Asclepias curassavica* does not die back in warm winter areas of Mex. etc., and breeding year-round exposes larvae to a protozoan "OE parasite" *Ophryocystis elektroscirrha* from the leaves; news reports claim that female Monarchs with that disease preferably lay eggs on a species of *Asclepias* that has chemicals toxic to that parasite.

Non-hibernating populations may be at greater risk of dieoff in spring, because *Asclepias* populations are mostly least common then.

Hostplants in Colorado are herb Apocynaceae (includes Asclepiadaceae): *Asclepias speciosa, incarnata, subverticillata* (*A. halli* is evidently not chosen). {In contrast, most of the fall migrants from E N.A. to Mexico ate *A. syriaca*, while most of the 2nd generation NE U.S. migrants northward had eaten *A. viridis* or *A. humistrata* in Texas etc. on their way northward} The ~70 milkweed hostplant species contain toxic mostly-bitter cardiac glycosides=cardenolides (heart poisons, mostly calactin, calotropin, and calotoxin—some hosts have large amounts, some have little) that are eaten by larvae and become incorporated into the Monarch larvae pupae and adults, and cause vertebrate predators such as birds incl. blue jays to vomit, so birds learn to avoid them. The wings and abdomen contain high concentrations of cardiac glycosides, so birds may find even grabbing the wings distasteful.

Eggs greenish-white or cream, laid singly under host leaves, stems, and inflorescences. Egg-laying lifespan is ~23-29 days after 4-5 days with immature oocytes, and a female can lay 715 eggs. Sometimes more eggs are laid on large plants, and larval survival is greater there, but females also oviposit readily on seedlings. Larvae eat leaves and flowers, without nests. Older larvae chew the midvein (sometimes the petiole) at the base of a leaf to stop the flow of poisonous sap before they eat. Older larva black, with transverse rows of white across the body that are laterally connected to similar transverse rows of yellow, the black areas expanded on some larvae, the underside black with a whitish area on each proleg, with two pairs of black filaments on T2 and A8; head with black & yellow rings. Older larvae are involved in mimicry: *D. plexippus* and *D. gilippus* and *D. eresimus* are Müllerian mimics with very similar larvae, while larvae of the *Papilio machaon* group (*machaon, zelicaon, polyxenes*) and *Pontia sisymbrii* and evidently even *Pontia chloridice beckerii* and *Anthocharis cethura* are Müllerian mimics, and the larva of the moth *Schinia gaurae* (Noctuidae, hostplant *Gaura*) is very similar evidently a Batesian mimic. {It's interesting that the Ithomiini butterfly *Tithorea pinthias* has a larva that resembles *D. plexippus*, probably a Müllerian mimic.} In cooler weather, older larvae spend 2/3 of their time in direct sun to get warm, because predators are not likely to eat them. There may be 6 larval stages. Pupa stout, green, with a thin gold-edged black transverse band behind A3, and with many gold spots esp. on thorax, a few black spots below the black cremaster. A PBS TV show nicely shows how the pupal cremaster pulls dorsally out of the larval skin and moves posteriorly and probes around to attach it to the silk pad (a ligament from anus holds the pupa up while the cremaster pops out). Pupae mostly occur on dry grass or wire fence, seldom on wooden posts or green plants (L. Smith 1986 J. Lepid. Soc. 40:67). Adults hibernate by roosting in trees at overwintering sites especially along the California coast and in Mexico, and to a lesser extent in SW Ariz. and Fla., and scattered adults along the Gulf Coast in SE U.S., with a few in Cuba and Yucatan etc.

One to three generations May-Oct. in Colo., depending on time of arrival, most common Aug.-Oct.

Adults visit flowers of all colors, rarely even red, including *Asclepias* (the favorite), *Buddleja davidii, Chrysothamnus* (*Ericameria*) *nauseosus* (favorite), *Cirsium, Medicago sativa, Trifolium pratense*, often visit mud esp. at the Mex. overwintering sites, and imbibe morning dew near the Calif. overwintering sites, and sometimes imbibe human sweat. *D. plexippus* eyes can see all the colors from ultraviolet to red, using opsins UV340nm, Blue435nm, Yellow545nm, and they see orange and red using a long-wavelength color receptor and filtering dark-orange pigments in the eye (D. Blackiston et al. 2011 J. Experimental Biol. 214:509-520). They pollinate some *Asclepias*, and milkweed pollinia are often found hanging from their legs. Adults often glide in a widely-spread V. They can fly in light rain. Adults bask dorsally with wings spread rather fully, and can warm up at 13-17^{o}C ambient temperature by shivering the wing muscles & wings 5-10^{o} at various wing positions (to allow them to fly above the freezing ground), and they can fly at ~18-42^{o}C thorax temperature (A. Kammer 1970 Zeitschrift Vergl. Physiol. 68:334-344). They rest and roost with wings closed. Adults in the U.S. roost high up in trees (maple, spruce, elm, *Salix*, *Eleagnus*, *Juniperus*, etc.), in Minn. in Sept. dozens may roost together on tree branches ~2-6m up and fly onward southward the next day. In S Mex. they roost all over the tall Oyamel fir (*Abies religiosa*) trees. The trees are important because temperatures at the ground in clearings at the Mexican overwintering sites can freeze and kill adults (freezes in Jan. 1981 killed 2.5 million adults, and a Jan. 2002 freeze killed 80% of adults). Even in the summer adults in U.S. roost on plants or trees 2m or more up. Summer-population adults can live 14-20 days, and adults can disperse 16km.

Males fleek ~1-2m up to seek females (normally flying <3m up, though males may chase females up to 15m), mainly in valley bottoms and other moist places such as moist weedy fields where the hosts grow, all day but <u>mostly from 14:00 to dusk</u>. Adults fly slowly but strongly, often soaring or gliding between wing flaps. Most of my mate-locating records are in afternoon, and males usually fleek in the afternoon, and my 32 mating pairs were found 12:13-18:50, mostly after 14:00, and at the Mexican overwintering sites mated pairs are most common in afternoon (T. Van Hook, p.50-60 in Malcolm & Zalucki 1993). However, males apparently sometimes mate-locate in the morning, and I have records of males chasing/mate-locating as early as 06:30, 07:10, 09:10, 09:44, 10:00 in the morning. Shull (1987) found 66 mating pairs 09:45-18:45 (most 14:00-16:30 and usually after 11:00). Lincoln Brower evidently found some matings in morning at Calif. overwintering sites (as noted by Scott 1976a). Opler & Krizek (1984) report mating pairs from 07:25-18:30 (though most pairs were 14:00-16:30). At the Calif. overwintering sites males mate-locate and evidently frequently mate in early morning when they visit adjacent meadows and drink dew on grass (D. Frey, R. Roman, L. Messett 2002 J. Lepid. Soc. 56:90-97; D. Frey, K. Leong, E. Peffer 1998 J. Lepid. Soc. 52:84-97). Males occasionally rait, and my 10:00 observation was a male resting (raiting) that flew after a *Limenitis archippus* female which landed and the male landed onto or just beside her and fluttered with wings spread to 40^{o} for a second then flew. Thus <u>they mate-locate mostly 14:00 to dusk</u>. They chase the reddish *Anaea andria* and *Vanessa cardui* butterflies also but leave after coming close to them. Sometimes males will remain flying over a nice big *Asclepias* patch for awhile (flaiting behavior). Once I saw a fleeking male bump a *Papilio polyxenes* off an *Asclepias incarnata* flower, causing it to fly away. Thus males contact females after fleeking, flaiting at monarch aggregations, and seldom raiting there. “Courtship” has disappeared in this species because the dense concentration of adults in the Mexican (and Calif.) overwintering sites renders traditional courtship inefficient: males just capture females instead (hibernating Monarchs mate in late winter at the Mexico overwintering sites, and some females are mated before they arrive in fall). Courtship is the same at the overwintering sites as it is in Minnesota in July where I observed it, and everywhere else (T. Pliske 1974 Ann. Ent. Soc. Amer. 68:143): the male nudges the female if she is landed, he flies after her (and occasionally hairpencils her) and grabs her with his legs, they fall to the ground where he touches her with his antennae, and they mate (with wings always closed in male and female), (sometimes males just fly along and see and drop onto landed females and mate), then the male always flies away (up to 50m in Minn.) with her dangling. An unreceptive female tries to fly or crawls through foliage or she keeps her abdomen away from the male by placing it between her wings or lowering it beneath her and grasping it with her legs. *D. plexippus* lacks the danaidone pheromone used by *D. gilippus*, his hair pencils are small and he does not run them through his uph gland as *D. gilippus* males do, and only rarely does he expose his hair pencils before grappling with a female. Yet Monarch antennae still respond to the *gilippus* pheromone and Monarchs are attracted to plants (such as *Heliotropium* and an *Epidendrum paniculatum* orchid—W. Wagner Jr. [1973 J. Lepid. Soc. 27:192-194] [both sexes attracted to the latter for some reason]) that are sources of danaidone, as evolution has not had enough time to completely erase the regular courtship system of *D. gilippus* from the *D. plexippus* genome. In the lab, males can mate 19 times, females 12!, and wild females have up to 10 spermatophores. Mated pairs can remain coupled overnight (this is probably merely due to the multiple matings reported per male--males mating for the first time would stay coupled just a short time because they do not need extra time to replenish their spermatophore fluids).

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Danaus gilippus thersippus **Queen**

Identified by the brownish color, and the white postmedian spots in upf cells M_3, CuA_1, and CuA_2 (the latter sometimes absent). It is a stray to Colorado sometimes in spring but mostly in summer (June, mostly July-Sept.); there are records from most Colo. counties, all over the state. In far SE U.S. and Mexico brown ssp. of *Limenitis archippus* (ssp. *floridensis*, *watsoni*, and *obsoleta*) are Müllerian mimics with the brown *D. gilippus*, not with the orangish *D. plexippus*, because *D. gilippus* is more common than *D. plexippus* most of the year there.

Habitat open areas straying to Colo., recorded from lowlands to Canadian Zone. Adults are modestly migratory. Migration has been proven in Florida (north in spring, south in Aug. or Sept.-Oct.), and southward flight of numerous adults has been seen in Mex. in L Oct., so it presumably has north-in-spring & south-in-fall migration in SW U.S./Mexico also, but at very low numbers in Colo. Adults fly sparsely north to Colorado where they are rare but sometimes become common enough to breed a few dozen offspring, such as at Wheatridge in Denver one year. It rarely flies as far N as N.D. Hostplants in Colorado herb Apocynaceae (includes Asclepiadaceae): *Asclepias speciosa*, *incarnata*. Larvae eat leaves, flowers, and stems. Adults are poisonous to predators such as birds, and are involved in Müllerian mimicry with *L. archippus*. A rare stray to Colo.

Eggs cream, laid singly on leaves, stems, and flower buds of the host. Larvae eat leaves, flowers, and stems, without nests. Older larva white, with narrow to wide transverse bands of black (each band containing a yellowish subdorsal oval (the yellow ovals are obscured on T3-A2 in females [G. Pronin 1954 Lepid. News 8:123-124]) connected to the black underside, with transverse yellowish lines across top of body connected below to lateral groups of yellowish teardrops, with six pairs of black dorsal filaments (sometimes with red bases); head whitish with black stripes and black triangles on the face. Larvae are similar to *D. plexippus*, but older larvae have six black filaments, not four (on T2, A8, the extra pair on A2). Pupa like *D. plexippus*, green (rarely pale pink) with ~3 gold spots on thorax and a black transverse band edged with gold on rim along front of A4, apparently no black spots below cremaster. Overwinters only in the south, presumably as adults.

Many flights far southward, straying northward and found most often July-Sept. in Colo.

Adults visit flowers of all colors, including *Asclepias* and elsewhere on *Baccharis*, *Solidago*, *Aster*, and sometimes visit mud, once reported sucking something from grass inflorescence. They may suck the milky juice of *Asclepias curassavica* leaves also evidently to get cardiac glycosides. Adults bask dorsally, and can warm up by shivering the wing muscles. Adults often roost in groups, and they overwinter in mountains during the Costa Rica dry season. Adults often glide with wings spread widely in a V.

Males fleek ~1-1.5m up mostly in valley bottoms to seek females, evidently mainly in afternoon {my 3 copulating pairs were found 16:00-18:03, and Lincoln Brower et al. (1965, Zoologica 50:1) note that mating occurs mostly in afternoon—and *D. plexippus* mates primarily in afternoon, so mating time is probably about the same as *D. plexippus*} throughout the habitat to seek females. In courtship, the male overtakes the female, exposes his hair pencils near her antennae and may nudge her, she lands, he hovers near her with hair pencils exposed, she closes her wings (if she flutters he drops repeatedly onto her to make her fly and courtship is repeated), then he lands on her side and palpates her with his antennae while they join; then he always flies away with her dangling. Unreceptive females spread her wings or try to escape. The male produces a pheromone "danaidone" in his uph black wing-pocket gland, which he transfers to his abdomen-tip hairpencils by running them alternately through each gland, and an extra glue "diol" from the gland helps the pheromone-laden particles stick to her antennae, as both are required to induce her to land. The males visit plants containing the alkaloid lycopsamine (chemically 1,2-dihydropyrrolizidine alkaloid) and suck these plants (including *Heliotropium, Eupatorium, Chromolaena, Crotalaria, Tournefortia, Ageratum, Packera, Senecio*--plus *Parsonsia* which contains both cardiac glycoside and lycopsamine so may have been the ancestral hostplant used by the progenitor of Danaini/Ithomiini—butterflies in both of these butterfly tribes visit rotten Heliotrope plants [crushed and set out as bait by lepidopterists] to suck those chemicals to maufacture their pheromones), and then the males biochemically convert the lycopsamine to make the wing pocket danaidone (=2,3-dihydro-7-methyl-1H-pyrrolizin-1-one). Interestingly, the African *Danaus chrysippus* has the same pheromone, so perhaps it could interbreed well with *D. gilippus* (photo of *gilippus* mating with *chrysippus* in butterfly greenhouse, P. Schappert 1998 News Lepid. Soc. 40:46). Thin-walled olfactory pegs on the female antennae detect the male pheromone and also respond to honey odor for feeding; in contrast, the larval foodplant detectors are on the tips (tarsi) of all six legs. The female may also have a pheromone that attracts males, because males whose antennae are painted mate less often (J. Myers & L. Brower 1969, J. Insect Physiol. 15:2117-2130). Mating lasts ~100 min., or up to 12 hours (presumably because the male mated recently and needed time to regenerate his mating fluids) (J. Burns). Females can mate up to 15 times! If a mating pair is disturbed, the male flies, the female dangling.

Danaus eresimus montezuma **Soldier**

A very rare stray to Colorado (one found in Las Animas County near Lake Dorothy, June 30, 2001). Similar to *D. gilippus*, but it lacks the postmedian white spots on the rear of upf, and the unh has a weak brown postmedian band, the ups is darker on the basal half, and the upf veins are blacker. It is migratory, but less so than *D. gilippus*. Hostplants include several tropical genera of Apocynaceae (Asclepiadaceae), so adults are presumably involved in Müllerian mimicry with *Danaus gilippus* and *Limenitis archippus*. Early stages are described by Scott (1986a). Egg yellowish or orange. The older larva has six filaments like *D. gilippus*, and is quite variable (photos in Allen et al. 2005 and Minno et al. 2005), some are similar to *D. plexippus* in pattern with yellow or tan subdorsal spots, yellowish lateral spots, but in others (the Minno et al. Fla. photo) most of that body pattern is converted into dark-gray while there is a wide lateral band of white; head similar to *D. plexippus* and *D. gilippus*. It flies most of the year in Mexico, and is resident there and in S Fla.

Nymphalidae, Satyrinae Satyrs

Many Satyrinae occur in Colorado (~2636++ occur worldwide). Larvae eat monocotyledons (mostly grasses or sedges), making them palatable to birds etc. Being palatable, adults tend to be camouflaged in various shades of brown, or sometimes blackish to yellow to orange (thousands of species occur in the tropics, where some lowland rain forest species are extravagantly colored bluish or transparent or red etc.). Adults generally have swollen veins on the forewing base, containing hearing organs (*Mestra* of the Nymphalinae also have those swollen veins). Flying adults usually "hop" in peculiar fashion with slow wingbeats, as they drift downward during the upstroke and then rise during the downstroke. But some species such as the arctic *Oeneis alpina* can fly quite fast. Adults generally are local in occurrence and do not migrate. Most adults bask laterally, with wings closed and oriented with one side facing the sun, but some genera such as *Oeneis* often and *Cercyonis* sometimes bask dorsally (with wings spread), and *Neominois* basks dorsally. Adults rest and roost with wings closed. Some species frequently visit sap, and some rarely visit flowers. Larvae are usually camouflaged green or brown with contrasting lines that simulate grass/sedge edges, and often have two short tails that make their rear end blend into the grass, and may have small conical head horns. Pupae are also similarly cryptic, and usually have a humped thorax and two head horns. Most pupae hang upside down from the cremaster, except in some mostly grassland/tundra species (*Erebia*, *Neominois, Oeneis*) that are simple in shape; these three also lack cremaster hooks and *Neominois* and *Oeneis* have nearly lost the entire cremaster, and they pupate in loosely-silked nests among grass or litter or under rocks. Satyrinae often have androconial scales, but the pheromones they produce are mostly not strong enough to be detectable by humans. The male pheromone in *Bicyclus anynana* is (Z)-9-tetradecen-1-ol, hexadecanal, and 6,10,14-trimethylpentadecan-2-ol (T. Geister et al. 2008. J. Exp. Biol. 211:1587-1593). In most Satyrinae the females flutter strongly to repel courting males, like most butterflies, but in *Neominois* and *Oeneis* and perhaps Elymniini (*Lethe*) females do not flutter.

Nymphalidae, Satyrinae, Elymniini Pearly-Eyes

Pearly-Eyes also occur in SE Asia, where some have bamboo hostplants, similar to the *Arundinacea* hostplants used by some *Lethe* in SE U.S. Only one species is in Colo.

Lethe ("*Satyrodes*") *eurydice fumosus* Eyed Brown

Easily identified in Colo. by the numerous ocelli. Ssp. ***fumosus*** from the Great Plains (reportedly east to NW Indiana) averages darker than ssp. *eurydice* elsewhere in NE North Amer., but adults vary considerably from pale to dark brown in color so this is a rather weak ssp. Colorado is the southwestern limit of this ssp., as it has been found in Kit Carson, Philips, and Yuma Cos. all near Kansas, and there are doubtfully one or more tiny colonies still present in Larimer Co. Adults are a little larger in Colo. than elsewhere (fw length averaging 25.8mm males, 27.9mm females, versus 24.6 & 26.4 in Minn.). Adults can fly under trees and through brush, and several of the colonies in Larimer Co. Colo. were in a sedge/grass place among cottonwood etc. trees [this colony would have survived if someone cut down at least half the trees], while another was in a fenced sedge pasture. The butterfly occurred in Loveland (surely along the creek) from 1881-1897 collected by David Bruce and Herman Strecker, last collected there July 29, 1942 by Arthur H. Moeck, but has not been located there since. I introduced ~3m13f from a colony with trees in Larimer Co. to a suburb of Denver (Wheatridge, along Clear Creek just SE Bass Lake) on July 12, 1988, and the colony slowly expanded by 1992 to 1.2 miles along Clear Creek (just N Kullerstrand School to just SW Prospect Park) and lasted at least 16 years (flying July 3-Aug. 10) through 2003 when it was still common, but when I checked on it in 2008 and 2016 I saw none there (apparently extirpated) evidently because cattails overran most of the *Carex emoryi* hostplant area and *Lythrum salicaria* and *Diplacus sylvestris* overran other areas, though some *C. emoryi* area still remains (the town might have sprayed for mosquitoes?). {In general, butterfly introductions throughout the world are successful only if there are large areas with good adjacent habitat that allow repopulation of any local extirpations (a metapopulation), so if anyone is planning an introduction a large diverse suitable area with guaranteed protection must first be found.} Global warming is expected to exterminate all or most of the current N-C Colorado colonies if they are still present. Luckily there are thousands of colonies in the northeastern Great Plains, in open tall-sedge (mostly *Carex stricta*/*C. aquatilis*) areas in wet places in valley bottoms and pond margins and roadside ditches, where it is too wet to plow (in Freeborn Co. in S-C Minnesota, the wet marshy places are about the only natural places left because corn soybeans oats were planted nearly everywhere else that is flat enough to plow and tile).

Habitat plains valley bottoms along rivers, pond margins, meadows, & roadside ditches with the hostplants. Hostplants in Colorado Poaceae (grasses) at a native Larimer Co. location: usually *Agrostis gigantea*, sometimes *Dactylis glomerata*, *Poa pratensis*. Hostplants Cyperaceae sedges (probably *Carex aquatilis*) at another native Larimer Co. meadowy pasture (butterflies gone at later visit), and tall Cyperaceae at the introduced Wheatridge population (now gone): definitely *Carex emoryi*, & probably *C. pellita=lanuginosa*. I found ovipositions on these plants, and reared them on grasses. In Minn. the host is *Carex stricta* (which is identical to *C. aquatilis* except for possible rhizomes, both are 2/3-1m narrow-leaf sedges like *C. emoryi*). Ray Stanford found a female in a pure stand of the grass *Phalaris* (*Phalaroides*) *arundinacea* in Laramie Co. Wyo. In NE N.A., *L. eurydice* mostly feeds on sedges such as *Carex stricta* & *lacustris* etc. and sometimes *Cyperus* & *Scirpus*, but A. Shapiro (1974, Wasmann J. Biology 32:173-185) found one population at Ithaca NY that eats grasses and sedges. Common locally, but N-C Colo. colonies are quite small or extirpated and should not be collected (overgrowth of trees exterminated the best Larimer Co. sites).

Eggs pale cream or greenish-white, spherical, fragile; laid in clusters of 2 or 3 or just singly (average 2.0 eggs) on green plants (usually a leaf uns or side of the host, but often on nearby non-hosts including dicotyledons). Eggs must be on non-shrinkable substrates because when a picked leaf with egg dessicates & shrinks in lab the egg deforms and dies. Older larva green with numerous pale-yellowish and green lines, including a darker-green heart-band (edged by whitish line) and broader pale-yellow subdorsal and lateral bands and two weaker lines between them, two long sharp pinkish-tipped tails; head green with a subdorsal pale-yellow band running onto two long sharp reddish-brown horns, and a red stripe from each horn extending to the eyes. All *Lethe* have green and brown forms, and Allen et al. (2005) also show a tan larva with brown and tan lines and two wide subdorsal and lateral tan bands and tan tails & horns, but my Colo. larvae were all green (maybe the brown forms were just hibernating?). Larvae spin a silk resting mat. Pupa green, with pale-yellowish lines (subdorsal, lateral, and two faint dorsal ones, the lateral line extending along top edge of wing case), a large point on top of thorax and two points on the head. 3rd- (and 4th?) stage larvae turn straw-yellow and hibernate.

One flight L June-M July in Larimer Co. CO and S Minn., July-E Aug. for the introduced-now-absent Jefferson Co. colony.

Adults seldom visit flowers, but seem to prefer pink *Asclepias*, and sometimes visit dung and mud, and in E U.S. visit sap, rotten fruit, decaying fungi, and bird droppings. Adults have a rather bouncing flight. Adults bask by spreading the wings partly (body basking) or mostly (dorsal basking), and sometimes laterally (lateral basking); they cannot warm up by shivering the wing muscles; in hot weather adults turn their closed wings parallel to the sun. Adults sometimes roost in lower leaves of *Populus deltoides monilifera=sargenti* and *Ulmus pumila* etc. trees.

Males mate-locate all day. Males rest ~80% of the time, and in the active 20% of their time they fleek slowly about the canopy of their 2/3-m *Carex* hosts for up to 3-30m in a hopping weaving manner before resting, and they often chase others from rest also (raiting behavior) (my notebooks contain 109 mentions of the word patrol and 52 of the word perch, though many of the males I saw just resting may be waiting for passing objects thus could be raiting and would not be written as perching in my notebooks, so evidently males fleek roughly up to ~60% of the time and rait ~40% or more of the time that they devote to mate-locating). (Females mainly rest near or among the host sedges and seldom fly.) Males fleek and rait mostly ~2/3m above ground (20cm-rarely 2-3m up on branches of trees), but in a few habitats they occur where trees are encroaching and mate-locate ~50cm-3m up and often land on the tree branches. Males chase others, and often two males will fly in a 15-cm circle "ball" a few times in their zeal to find a female. They don't travel very far, and one male stayed in the same sedge spot in a roadside ditch in Minn. for 4 days, evidently mostly raiting and some flaiting. In a successful courtship, a male pursued a female 20m (she pursued him for 10 cm at one point), she landed with wings spread 25º as he landed behind and vibrated his 0-25º–spread wings regularly or in bursts behind and to the side of her then bent his abdomen and joined. In several unsuccessful courtships, the male chased a flying female, she landed and closed wings and remained motionless, the male fluttered below her with fairly wide wing strokes (wings spread 90-180º, sometimes 0-90º) ~3-7x/sec. and usually butted her with his head while fluttering wings and bending his abdomen to try to mate. Unreceptive females can swing upside down on a twig so he cannot join. Mating lasts ~80-100 minutes. If a mating pair is disturbed, the female flies, the male dangling.

Nymphalidae, Satyrinae, Satyrini (most Satyrs)

There are a half-dozen or more tribes of Satyrinae, but most of our species are in Satyrini.

Coenonympha tullia ochracea Common Ringlet

Easily identified by the small size, orange coloration, large unf eyespot, and smaller unh eyespots. Colorado has ssp. ***ochracea*** mostly, though in the NW part of the state the unh averages slightly more ocelli, so those can be called **near-*ochracea*** partly intergrading with ssp. *pseudobrenda* which has numerous unh ocelli (range Utah and Nevada). And the butterflies in the Wind River Mts. of Wyo. and in Rio Arriba Co. of N New Mex. have more ocelli also thus are intergraded with *pseudobrenda* even more, so one may expect that the butterflies near Wyo. and near New Mex. may have slightly more ocelli on average also {this variation is discussed some by Scott, N. Kondla, R. Gray 2014, Papilio (New Series) #22:8-16.} {In the Black Hills of S.D., males of ssp. *benjamini* are browner, while female *benjamini* are paler like *ochracea*, leading to mistaken opinions that two species are present [the intergrades *benjamini*X*ochracea* in Black Hills mentioned by Marrone 2002 may be mostly just those males and paler females, and some intergradation may be present with *ochracea* phenotypes commonest in Fall River Co. in extreme SW S.D.].}

Habitat open grassy areas in the mountains, from foothills to Canadian Zone, seldom in Subalpine Zone. In the Front Range lower foothills they prefer swards of *Poa pratensis agassizensis* which grow on gentle valley bottoms with slightly moister soil. Hostplants in Colorado Poaceae: *Poa pratensis* ssp. *agassizensis* (the "native" ssp.) usually is the most common host, less common hosts are *Hesperostipa* "*Stipa*" *comata*, *Bouteloua gracilis, Festuca idahoensis, arizonica, saximontana, Bromus* (*Anisantha*) *tectorum,* {probable hosts are *Agropyron* (*Pascopyrum*) *smithii, Bromus japonicus or Poa compressa*}; host Cyperaceae: *Carex inops "pensylvanica" heliophila*. Assoc. with *Poa fendleriana* in Gunnison Co. Common.

Egg yellowish-cream, developing hundreds of orange-brown dots and sometimes a red-brown ring around egg, laid singly on dead mostly-grass blades ~3-6cm above ground. Larvae eat leaves, without nests. Older larva green, middorsal heart-band darker green edged by whitish, a dorsolateral pale line below a darker line, and weaker pale line below that, a wide pale-yellowish lateral band below a darker-green band, two short orange-brown tails laterally edged by a stronger part of the dorsolateral pale line; head green. Pupa evidently green with two black stripes on the wings and two on antenna/legs, wing veins a bit darker, a white line along the black stripe on inner margin of wing. (In Calif. Ore. and E Wash. where summers get very dry, in addition to green there are brown larval and tan pupal forms, which evidently do not occur eastward or in Colo., although Wagner [2005] mentions some tan or brown esp. overwintering larvae perhaps? from E U.S.) Half-grown larvae hibernate strongly in Colo. (~3rd stage of perhaps 5 stages). {*C. tullia* throughout its range has 4-5 stages, perhaps 4 when larvae do not diapause [resulting in multiple yearly generations in Calif. where they diapause as L3 etc.—some Wash.-Calif. ssp. have several generations], 5 when they do [as happens in European *Coenonympha pamphilus*]. L1 and sometimes L2 hibernate N of Lake Ontario, and in biennial European populations young larvae hibernate and older larvae then hibernate the next winter.} Diapausing larvae build loose silked shelters, evidently in litter.

One flight mostly end of May-June in Front Range foothills and lower altitudes, mostly L May-E July in the lower Wet Mts. foothills, L May-July at middle altitudes, and mostly M June- E Aug. at highest altitudes. (Adults aestivate for months in warm dry Calif. summers, but not in Colo.). (Ssp. *benjamini* in SD flies June-E July and a partial gen. Aug.)

Adults generally visit yellow or sometimes white flowers, rarely pink or orange etc., including *Antennaria parvifolia*, *Cerastium arvense strictum*, *Sedum lanceolatum*, and *Senecio* (*Packera*) *fendleri*, and sometimes visit mud. Adults typically fly in a slow hopping/bouncy manner only roughly ~10m before stopping, but when flying downslope they rarely can glide multiple times with wings spread only ~100^o for a second to save energy. Adults bask laterally. Adults roost on bushes etc. A male flew 4-7 miles to my backyard in Denver.

Males fleek all day ~1/3m up in grassy areas regardless of topography, as they very often just fly a short distance ~10m then rest for ~5 sec. then repeat this. In courtship, the male finds the female, she hovers and the male hovers around her and bumps her from below or side ~10x (or she may hover while the male just hovers below her 5cm and slightly downwind for ~30 sec.--and in several observations she hovered above him for a minute and fluttered in a circle {plane of circle parallel to ground} while he fluttered in a circle below her {all circles ~4cm}), then when she lands with the male behind, unreceptive females flutter with wide amplitude while the male nearly-continuously flutters faster full-stroke (or he may perform 0^o to 50-100^o wings-spread bursts of maybe 5-10 flaps per burst of ~½-1 second, with 1-2 sec. between each of ~3-20 bursts) behind and may butt her half the time, as he bends his abdomen to try to join (receptive females presumably are motionless after landing and allow the male to quickly join; receptive *C. pamphilus* in Britain reportedly join after landing without any fluttering of the male [Vere Temple 1953 Entomologists' Gazette 4:149]). Unreceptive females also crawl and fly away and may fly near the ground to try to escape. If a copulating pair is disturbed, the female usually flies, the male sometimes flies, the partner dangling below.

Cyllopsis pertepida dorothea Canyonland Satyr (Arroyo Satyr)

The unh is very distinctive: the unh postmedian line curves toward the outer margin above the black spots, then usually disappears (the line goes straight to the forward margin in *C. pyracmon* which occurs only in C NM-Ariz. southward), and the outer part of unh has a black patch with several black-dotted diamondy "gems".

Habitat lower altitude juniper/pine/*Quercus* brushy gulches/canyons, mostly in narrow dry semi-shaded gulch bottoms. *C. pertepida* ranges north to Garfield Co. on the W slope and Larimer Co. on the E slope. It is usually widespread but uncommon in southern Colorado, whereas in the Front Range north of Colorado Springs it is present in all the canyons north to Jefferson and Boulder Cos. but is rare (multiple adults can be seen per day only at one known site), so I have not been able to determine any hostplants even after going to the uncommon locality many times to watch them. Hostplants in Colorado probably hay-grasses (tall skinny grasses) because lab larvae hang onto grasses rather strongly (whereas clump-feeding Satyrinae such as *Oeneis* and *Erebia* drop off with a slight touch so have to hide in clumps). Uncommon, rare northward.

Egg round, cream, duration about 7 days in lab. There is only one generation in the Front Range, yet larvae there retain two very different forms (the **straw-colored form** and the **green form**), both of which evidently occur in nature only southward and in SW Colo. where there are several generations. I reared both forms from Jefferson Co. Colo. females, despite just one generation occuring there. Green larvae take 23 days for males, 23-24 females in lab, green pupae 9 days males, 10-11 females. Straw-colored larvae/pupae take 109-139 days males, 160 days female. Thus the straw-colored larvae must endure the late-spring/early-summer drought southward in Ariz./N.M. where there are two yearly generations and brown drought grasses, while the green larvae evidently live through the winter, and both forms are retained in most of Colo. DNA even though one form (presumably the tan form) is not needed. 1st-stage larva cream turning light-green, heart dark-green, a weak subdorsal creamy line, lateral ridge creamy, 2 short tails; head black with 2 large conelike horns. Older green larva striped bright-yellow-green with dark-green heart band and many yellow-cream lines and yellow-green areas; head yellowish-green with two russet-tipped horns, brown stripes and cream areas running onto horn. Older tan larva is straw-colored, with brown & cream bands/lines; head straw with brown bands. Green pupa light-green with some white and cream lines etc. Straw pupa has white and cream lines. {J. Scott [2006a, Papilio (New Series) #14:8-9] describes immatures in detail}. Half-grown larvae hibernate, evidently 3rd-stage of 4 stages (perhaps there are 5 stages when 3rd diapauses?).

One flight mostly L June-M Aug. (sometimes E Sept.) in Wet Mts. foothills, mostly July-E Aug. at higher/more northern areas. Two generations in SW Colo. (Mesa Co. southward) L May-June, then M Aug.-E Sept.

Adults rarely visit flowers, but occasionally visit sap, manure, and mud. Adults bask laterally.

Males fleek all day ~1m up usually in mostly-shaded narrow dry ravine/gulch bottoms but sometimes on hillsides, and sometimes rait (chase from resting spots) there. They may fly only a few m then rest in the shade of the gulch bottom (on ground or rock or branches), but one marked male moved 124m along a gulch in 48 minutes. When frightened they may dart up the hillside. They hop during flight; the hops are about twice those of *Cercyonis pegala*/*C.oetus*. Females usually rest and seldom fly. Courtship was not seen. If the mating pair is disturbed, the female flies, the male dangling.

Megisto cymela cymela **Little Wood Satyr**

Easily identified by the ~4 eyespots (two on each wing), and those on uns have two white dots in each eyespot.

Habitat valley bottoms in partial shade of cottonwood trees, near Kansas. Common in E U.S., in Colo. occurs from Sedgwick to Kit Carson Cos. Hostplants various grasses in E U.S. incl. *Dactylis glomerata* and *Andropogon*/*Schizachyrium*.

Eggs pale yellowish-green, laid haphazardly near or on grasses (usually on dead parts). Larvae eat leaves, without nests, and feed at night. Older larva pale-brown or yellow-brown with ruglike protruding hair, often tinged with green, with a darker middorsal stripe often edged by brown patches, a tan wavy subdorsal line, a large brown or tan oblique supralateral dash on each segment, a lateral cream or tan line, two slightly-pinkish-tipped tails with a cream line on the side of each tail; head yellow-brown or brown, with small bumplike horns. Larvae grow slowly in lab. Pupa yellowish-brown or brown, with fine brown streaks, dark-brown spots on margins of the wing cases, wing veins whitish, midddorsal white line also runs along thorax, white lines around lower and lateral edges of head, two brown ventral stripes on abdomen, brown lateral dots, and two low ridges on abdomen. 3rd–4th-stage larvae hibernate eastward, ½” long (2nd-stage once reported), probably mostly 3rd in Colo.

One flight M June-July; there is just one distinct flight in Colo. (and S.D. & Iowa). In E U.S. there are often two maxima of records (E June & E July in Ohio and Monroe Co. Ind.; L May & L June in Penn.; M May-June & L June-Aug. in R. I.; L May-E June & L June-M July [extremes L Apr.-M Aug.] in W.Va.). Farther south, May-E June and L July-M Aug. in Mo. perhaps two gen.; two gen. near Dallas TX, and 3+ in Fla. but just one in ssp. *viola*. C. Oliver (1982 J. Lepid. Soc. 36:153) thought the two close maxima northward may represent different species, but little or no differences have been found between those butterflies, including some Ron Gatrelle sent me. Evidently there are differences in growth rate or perhaps (the simplest idea) some just hibernate as 3rd stage and some in 4th leading to two adult-emergence peaks, and there are several generations southward. In N Fla. the spring ssp. *viola* evidently intergrades with the longer-flight ssp. *cymela* (J. Calhoun April 1996 Lepid. News season summary p. 52).}

Adults in eastern U.S. feed mostly on tree sap, also decaying fruit, dung, aphid honeydew, decaying mushrooms, urine, and mud, and rarely visit flowers including *Asclepias, Melilotus albus*, and *Rhus typhina* (Douglas & Douglas [2005] note adults prefer small white/pale flowers such as *Trifolium repens*, plus *Rhus*). Adults bask dorsally with spread wings (often body basking) or laterally, but cannot warm up by vibrating the wing muscles.

Males fleek all day (mating pairs 08:10-16:10, P. Opler & E. Shull books), mainly in shady woods, with a bouncing flight ~1/3m up among the grasses/bushes etc. It generally flies close to the ground, but P. Opler notes that sometimes males "patrol" the crowns of trees along forest edges and occasionally over the tops of tall trees, for unknown reasons. If a mating pair is disturbed, the female flies, the male dangling.

Cercyonis pegala nephele Common Wood Nymph

Somewhat similar to *C. sthenele*, but larger (fw length 26mm males, 30mm females), the male stigma only occurs in upf cells CuA_1, CuA_2, and 1A+2A, and the posterior fw eyespot is generally bigger than the anterior eyespot (sometimes the same size in males). Most Colo. adults are ssp. ***nephele*** with solid brown wings, but on the plains some adults have a slight yellowish upf patch, and the frequency of that increases as one goes toward the SE corner of the state, where those individuals are starting to **intergrade with ssp. *texana*** which occurs in E New Mex.-S Kansas-C Texas-evidently S Mo. and has a yellowish upf patch around the eyespots and broader brown & whitish unh striations. Lowland adults in W Colorado (Delta Co. and vicinity) seem to be slightly smaller and average a stronger median unh band, but this **W Slope variety** is still similar to *nephele*. {The name *olympus* is a synonym of *nephele*--Brown et al. (1957) mistakenly used that name for females of *nephele*.} The Utah-Great-Basin ssp. *gabbii* does not occur in Colo.

Habitat open areas on the plains and lower mountains barely into the Canadian Zone, usually in valley bottoms. Hostplants in Colorado Poaceae: *Poa pratensis* (usually the "native" ssp. *agassizensis*) is the favorite, often *Schedonorus (Festuca) arundinacea*, sometimes *Bromus* (*Bromopsis*) *inermis, Agropyron* (*Elymus*) *lanceolatus* "*dastystachyum", Muhlenbergia montana*, *Schizachyrium "Andropogon" scoparius*, and Cyperaceae: *Carex praegracilis*.

Eggs pale lemon-yellow or white, developing orange-brown or pinkish mottling due to numerous tiny red spots. Eggs laid singly, as the female lands on a grass host and bends her abdomen down and forward and shoots the egg forward, and the egg is covered with glue so it sticks to whatever it contacts first: either some live or dead part of the grass, or the litter below after a parabolic fall described by the law of constant gravitational acceleration. Females lay 200-300 eggs (other *Cercyonis* lay ~100-150, Emmel 1969). Larvae of all *Cercyonis* eat leaves, without nests, mostly at night. Larvae of all *Cercyonis* are very similar: when young they have peculiar setae that are bent 90^o in the middle, and the outer half is aimed forward on thorax and rearward on abdomen. Older larvae green, with a dark-green heart band, a subdorsal weaker cream or yellowish narrow line, a lateral yellow or greenish-white stripe (whitish in ssp. *gabbii* from C Utah westward) (the lateral stripe appears narrower than subdorsal in photos but is sometimes stated to be wider) (these pale stripes in all *Cercyonis* are narrowly-edged by darker-green, and the dark heart-band is edged by creamy), and two pink or reddish tails (whiter laterally); head green without horns. Colo. larvae are greenish so far, but in NE U.S. there are some yellow variants, and an Alabama larva lacks the pale stripes and the dark heart-band is present only posteriorly (Bright & Ogard 2010). There are 5 or 6 larval stages in some ssp. (5 in other *Cercyonis*). Larvae are mostly nocturnal feeders, so are very difficult to find at the base of grass plants. Pupa light-green or yellowish-green, with whitish or sometimes yellowish bands (a weak middorsal cream line, and generally a white band along top of wing case that weakly connects to a transverse white line on the head), (ssp. *gabbii* also has a black and white pupal form, an intermediate form, and a green form with slightly-darker stripes on wings and thorax, but those forms may not occur in Colo.); cremaster & crochets red-brown. Unfed 1st-stage larvae hibernate. Common.

One flight end of June-M Sept. but mostly M July-Aug. on the plains, or flying as late as L Sept.; mostly M July-E Sept. at highest altitude. The flight period into Sept. in Colo. is fairly long, and the sex ratio after Sept. 15 is only 25% males, causing suspicion that adults might diapause in August, but in Colo. I recorded ovipositions all during July and August, and Marc Epstein got late July females to lay eggs, so there is evidently little or no diapause in Colo., just long life. Emmel's (1969) lab *Cercyonis* lived up to 45 days (just 5-10 in nature without diapause). In contrast, James & Nunnallee (2011) found that in dry C Wash., females may rest (aestival diapause) in shady areas in groups of up to 6-20 for at least 17-24 days in L July-E Aug. before ovipositing. And in E U.S. females much outlive July males and are found in L Sept. or even into Oct. (Opler & Krizek 1984), suggesting that females may aestivate in August there. However Shull (1987) found 42 mating pairs from L July-Aug. 25 (peaking M Aug.) in Indiana so males also have a long life. And in lowland C Calif., Shapiro (2007) found the female flight period was June-Sept. (even Oct.), yet they have not been found to aestivate. Thus aestivation seldom occurs in *C. pegala* (maybe in Wash.).

Adults visit flowers of all colors, including *Apocynum*, *Aster*, *Carduus* nutans, *Centaurea diffusa, Chrysothamnus* (*Ericameria*) *nauseosus, Cirsium, Clematis ligusticifolia, Liatris punctata*, *Medicago sativa* (favorite), *Monarda fistulosa* (favorite), *Nepeta cataria*, *Solidago, Tamarix chinensis*, often visit sap, and sometimes visit rotten fruit, decaying fungi including puffballs, dung, urine, mud, carrion, aphid honeydew, and can suck *Rubus deliciosus* berries. Adults bask laterally and dorsally (often body basking), but cannot shiver the wing muscles to warm up. Adults sometimes roost up to 4m up on *Quercus gambelii*, *Eleagnus angustifolia*, *Juniperus* trees, shrubs, large grass clumps, etc. Adults usually hop in flight up and down as if they close their forewings together when they fly, but they can glide for several seconds with wings partly spread. Adults evidently can hear using enlarged fw base veins; sounds of 95-105 decibels elicit antennal or wing or abdomen movement, regardless of frequency (H. Frings & M. Frings, 1955 Ann. Ent. Soc. Amer. 49:611). Adults are known to fall to the ground and feign death to presumably fool a predator. The uns is camouflaged when they land on tree trunks, where if they expose the eyespots some predators such as birds and lizards would be scared away.

Males fleek all day in grassy areas, mostly in moist valley bottoms, as they fleek ~1/2m up (higher than *C. oetus*) with the usual slightly-hopping Satyrinae flight, and they may prefer to fly near trees and bushes in semi-shade. Shull (1987) recorded mating pairs 09:05-17:20. In courtship, the male overtakes the female and flies just under her ~10cm and rises up and touches her up to ~30-40x to transfer his pheromone while she flies upward in sine-wave fashion in synchrony with his rises (it often appeared that she zigzags upward and he follows her each time), then receptive females land and remain motionless, the male lands and moves his forewings forward and flutters usually with mostly-wide strokes while often butting her head to transfer pheromone, and then he flutters at her side (sometimes at her front) with less-full or full strokes, then bends his abdomen and joins. Unreceptive females flutter strongly (the rejection dance) upon landing and crawl away and fly away. One unreceptive female fluttered widely on a plant as the hovering male fluttered and dipped down to her once/sec. for several seconds. If a mating pair is startled, the female flies, the male dangling. I found one mating pair in which the male was dead and stiffly dried with both antennae broken off! yet was still fastened to the unfortunate female. Females mate just once, rarely twice (J. Burns); females of *Cercyonis* can mate almost immediately after emergence, males after several days (Emmel 1969) or 3-4 days (Sourakov 1995).

Emmel, T. 1969. Taxonomy, distribution and biology of the genus *Cercyonis* (Satyridae). 1. Characteristics of the genus. J. Lepid. Soc. 23:165-175.

Sourakov, A. 1995. Systematics, evolutionary biology and population genetics of the *Cercyonis pegala* group (Lepid.: Satyrinae). Holarctic Lepid. 2:1-20.

Cercyonis sthenele paulus **Great Basin Wood Nymph**

C. sthenele resembles *C. pegala*, but the anterior fw eyespot is larger than the posterior in males (they are the same size in females), the wings are smaller (fw length 22 mm males and 24 mm females) and lack yellow suffusion (sometimes slightly yellowish on female fw), and the male upf stigma is like *C. pegala* but extends anteriorly into cell M_3. ***C. s. paulus*** occurs throughout the range in W Colo. to Nev., and *masoni* appears to be a syn. of it, as they are similar in the coloration of uns (amount of whitish or brown on unh and amount of reddish on unf). Rare adults are slightly orangish on unf (notably a female from Unaweep Can. in Mesa Co., and one from Rio Blanco Co. misidentified as *C. meadii* [a slightly reddish male is known from Morgan Co. in N Utah also]) and can be called *C. s. paulus* **form damei** {the *damei* original description--fromTL Grand Canyon, Ariz.-- described precisely the slightly-orangish *C. sthenele* adults frequent at Cape Royal on the E end of the N rim of the canyon, so Scott [2008, Papilio (New Series) #19:38] determined it came from Cape Royal, where the slight orangish is due to introgression from *C. meadii*}. *C. sthenele* interbreeds considerably with *C. meadii* in NW New Mex. (Chuska Mts.), N. Ariz. and S Utah (Iron, Wayne, Washington Cos.), but in C Wyo. those two are parapatric and do not overlap, and in Montana they are sympatric yet seldom interbreed [see J. Scott 2017, Papilio (New Series) #26:16]. There is apparently no interbreeding of *C. sthenele* with *C. pegala* in W Colo. or anywhere else, whereas *C. sthenele* does interbreed with *C. meadii* but not in Colo. so those two orangish adults are evidently due to ancient introgression (*sthenele* and *meadii* occur in Dolores, Montezuma, La Plata, and Archuleta Cos. without known interbreeding but I have seen few from that area). {Lab crosses between *Cercyonis* species generally produced no hybrid adults, while crosses between ssp. produced adults, except not many adults were produced between *C. sthenele behrii* and *C.* evidently-*sthenele incognita* [Emmel et al. 2012], and crosses between Ohio and Florida and Ohio and Colorado *C. pegala* populations sometimes produced few hybrids (Sourakov 1995)}.

Habitat Pinyon/juniper/*Quercus gambelii* open woodland, chaparral, and sagebrush. Hostplants in Colorado unknown Poaceae. In Nevada one pop. has only one grass *Heterostipa* "*Stipa*" *comata* which is therefore the hostplant there (Austin & Leary 2008). Usually uncommon, sometimes common.

Eggs resemble *C. pegala*, pale green when laid, becoming yellowish-cream with numerous tiny reddish spots. Eggs laid singly, evidently shot forward from resting female like *C. pegala* (James & Nunnallee 2011 report the *sthenele* eggs "are often deposited loose" and are "lightly glued on grass and inert surfaces at the bottom of the box" [evidently because his eggs with a bit of glue were shot forward like *C. pegala* and stuck to whatever they first contacted in his cage containing plant & female]) (Emmel et al. 2012 also wrote that *C. sthenele incognita* drops its eggs into grass clumps without attaching them. But they wrongly claim that other *C. sthenele* ssp. attach eggs to grass blades or grass stems, which is evidently only true for occasional eggs that touch or fall and land thereon--and Satyrinae eggs in general are laid on <u>dead</u> rarely-green parts). Larvae eat leaves, without nests. Older larva (mostly Wash. ssp. *sineocellata*, James & Nunnallee photos) yellowish-green with dark-green heart-band edged by yellowish-white, a weaker subdorsal white line and wider white lateral band both edged by dark-green (the subdorsal and lateral lines/bands yellow in Calif. ssp. *silvestris*), and two reddish tails (whiter laterally); head green. Sourakov (1995) has T. Emmel photos of *C. s. paulus* and damei larvae that are similarly greenish like Wash. larvae and other *Cercyonis* spp., plus a damei photo of a reddish-tan larva, plus a photo of a *C. s.* "*masoni*" larva that looks reddish, but all of those photos are bad with too much red backgrounds so evidently those larvae in nature (including Colorado larvae) are polymorphic with greenish forms and tan forms, and the "reddish" larva should be described as: older larva tan, heart-band blackish-brown edged by a white line, a subdorsal white band edged by brown, a wider lateral white band edged by brown; head greenish-tan. Larvae in Calif. and Wash. mostly feed at night. Pupa grass green with dorsal edge of wing cases white and a little white on front edge of head, perhaps a weak middorsal cream line (Colo. polymorphs may be tan). Unfed 1st-stage larvae hibernate.

One flight M July-Aug. (sometimes E July). There is no evidence of adult aestivation in Colo., but adults may live fairly long. In contrast, James & Nunnallee (2011) reported that in dry-summer C Wash. females aestivate (diapause) and rest in shady areas 2-3 weeks before ovipositing.

Adults often visit *Chrysothamnus* (*Ericameria*) *nauseosus* flowers.

Males fleek all day, especially in gullies and valley bottoms, as they fly fairly slowly but erratically ~1/2m up with the usual bobbing flight thus are difficult to follow, as they typically fly near and around small trees such as junipers.

Emmel, J., T. Emmel, & S. Mattoon. 2012. A new species of *Cercyonis* (Lepid.: Satyridae) from northern California. Bull. Allyn Mus. #163: 1-12.

Cercyonis meadii Mead's Wood Nymph (Red Wood Nymph)

C. meadii is identified by its orangish fw, esp. on unf, and by the small size of the male upf stigma (mostly in cell CuA_1 plus an upper and lower part in cell CuA_2). It is about the size of *C. sthenele*. Three ssp. are found in Colo.: ssp. ***meadii*** occurs from the N Wet Mts. north to the S Platte Can.; ssp. ***alamosa*** has whiter unh to match the frequent alkali soil in the closed-basin area of San Luis Valley; and ssp. ***melania***=*mexicana* occurs in SW Colo. and has more unh ocelli. (Rio Blanco Co. was an error, just a slightly orangish *C. sthenele paulus*.) Ssp. *alamosa* occurs in the closed-basin drainage of San Luis Creek and San Luis Lakes in the San Luis Valley, such as near Hooper, but in the south end of the valley the unh is not very whitish so the butterflies are evidently ssp. *melania*, and *melania* is also found in SW Colo. and NM-Ariz.-S Utah. The range of the butterfly is peculiar, as ssp. *meadii* occurs in several large areas (S Montana and NE & E-C Wyo. barely into Neb., then a separate patch centered on Colorado Springs), but not in between (not in N Colo., and not in S-C Colo.), for unknown reasons. It may be extending its range to try to fill in some of these gaps, as it seems to have spread south into the Royal Gorge and the N end of the Wet Mts. in the late 1990s, and a specimen has recently been found just S of Poncha Springs where it evidently spread north from the San Luis Valley. Adults from the four counties in extreme SW Colo. should be watched for introgression between *meadii* and *sthenele*, which occurs in all three adjacent states, demonstrating that *C. sthenele* and *C. meadii* are not completely-distinct species.

Habitat open pine/*Quercus gambelii* woodland. And I found one adult on the plains 10 mi. E of Colorado Springs. Hostplants in Colorado for ssp. *meadii* Cyperaceae: usually *Carex rossii*, sometimes Poaceae: *Bouteloua gracilis*. Ssp. *alamosa* is associated with two Poaceae: *Bouteloua gracilis, Sporobolus airoides*. In the Front Range, females oviposit in litter near low hosts in the edge of shade produced by *Pinus ponderosa* trees. In the San Luis Valley and Wyo.-Mont. females probably oviposit in the shade of shrubs. Usually fairly common.

Eggs resemble *C. pegala*, whitish-yellow when laid, becoming pinkish-tan due to ~100 tiny diffuse crimson spots. Eggs laid singly, glued onto litter or sometimes onto dead grass or dicot leaf near a hostplant (females never land on green grasses or sedges). Larvae eat leaves, without nests. Older larva yellow-green with a darker yellowish-edged middorsal stripe, a yellow-white subdorsal stripe edged by darker-green, and a wider lateral yellowish-white stripe edged by dark-green (the subdorsal and lateral stripes equally wide, like *C. sthenele*), tails reddish (whiter laterally); head green. Pupa yellowish-green, with front edge of head and dorsal edge of wing cases cream-white, usually suspended from several grass blades silked together. Unfed 1st-stage larvae hibernate.

One flight mostly L July-Aug. for ssp. *meadii* and *alamosa*. There is no evidence of long female aestivation before egg laying in Colo. so females may have just a short delay like *C. oetus* (though my ovipositions were all seen L Aug.-E Sept., and early females would have to be brought into lab to study this).

Adults visit mostly white or yellow flowers, sometimes pink or purple, including *Aster porteri, Heterotheca villosa* (favorite), and sometimes visit mud or wet soil. Adults roost on *Pinus ponderosa* trees even 5m up, or on low *Quercus*, etc. Females mainly rest, and just fly 2m then land again on bare ground or sometimes grasses etc.

Males fleek all day ~1/2m up, flying fairly slowly but erratically, everywhere in the habitat but mostly in open woods/brushy areas and often in valley bottoms. In courtship, the female hovers and the male rises up to touch her ~4-10x, then receptive females are presumed to land and remain motionless while they join, while the landed male probably flutters and butts into her like *C. pegala*. If a mating pair is startled, the female flies, the male dangling.

Cercyonis oetus charon **Small Wood Nymph**

Identified by the absence of a complete unf postmedian line (when present, found only basal to the lower eyespot), by the inward jut of the unh postmedian line in cell M_2, by the posterior unf eyespot being smaller than the anterior eyespot, and by the small size. The prominent male stigma is in four upf cells M_3 to 1A+2A. Two ssp. occur in Colo. Ssp. ***charon*** is darker on unh and occurs from Ariz. and NM to most of Colo. including SW Colo. The sagebrush areas of NW Colo. has populations of ***charonXoetus*** with the unh often a little grayer esp. females, occurring at Hayden in Routt Co. & SE Moffat Co. and the sagebush in S-C Wyo. Extreme NW Moffat Co. has ssp. ***oetus*** with the majority of adults a little grayish on unh (ssp. *oetus* with some grayish on unh occurs from lower Bighorn Mts. and Wind River Mts. of Wyo. to N and W Utah-Nev.-W Mont.-BC) (the grayest-unh ssp. is *C. oetus pallescens* in several desert sagebrush valleys in central Nev.).

Habitat open grassland and open woods, in foothills and Canadian Zone, sometimes Subalpine Zone. They inhabit open grassland much more than *C. sthenele*/C. *meadii*. Hostplants in Colorado Poaceae: in Front Range usually *Poa pratensis agassizensis*, occasionally *Koeleria macrantha*, in W Colo. *Festuca idahoensis* and surely other grasses. {Austin & Leary 2008 saw an ovip. on *Distichlis spicata* for *pallescens* in an arid Nev. valley} Common.

Eggs yellowish-cream, becoming mottled with tiny red or red-brown spots. Eggs laid singly, glued onto plants 0-10 cm up (lower than *C. pegala*), generally on dead grass blades (Emmel et al. 2012 wrongly claim that *oetus* drops eggs without glue, but all eggs I [Scott 1992] and James & Nunnallee [2011] observed were glued onto plants or inert cage surfaces). When ovipositing, females hop-flutter slowly over the grass and land, then crawl to find a spot. Larvae eat leaves, without nests; they feed mostly at night. Older larva yellowish- to whitish-green, with dark-green heart-band, a weaker narrow creamy subdorsal stripe and a stronger wider whitish lateral stripe (wider than other *Cercyonis*), two reddish tails (whiter laterally); head lacks horns. Pupae variable: pale yellow-green or green with whitish markings (a white middorsal line, and whitish along upper edge of wing and on front edge of head); or uniformly whitish-green, or greenish-black with gray stripes, or dark-brown with thick blackish and pinkish-white stripes. Pupa attached by cremaster under leaves etc. sometimes slightly pulled down with silk to form a bit of an umbrella. Unfed 1st-stage larvae hibernate.

One flight end of June-Aug. in the foothills, M July-Aug. (occasionally E Sept.) at higher elevations. Females do not oviposit until ~5 days old, and in Wash. females oviposited with little or no delay (James & Nunnallee 2011).

Adults visit usually yellow flowers, often white, seldom pink or blue/purple, including *Arnica mollis, Aster laevis, A. porteri, Berteroa incana, Centaurea diffusa, Chrysothamnus* (*Ericameria*) *nauseosus, Cirsium arvense, Erigeron speciosus, Eriogonum flavum, E. umbellatum, Heterotheca villosa* (favorite), *Rudbeckia laciniata, Solidago* spp., and sometimes visit fruit bait, carrion, dung, and often mud. Adults seldom visit *Medicago sativa* because *C. oetus* occurs in wild lands, not human-created habitats where *C. pegala* is common. Adults have a bouncing flight. Adults often roost on trees up to ~5m up.

Males fleek all day in open grassy areas or open brushy or forested areas regardless of topography, as they fleek ~1/3m up, often flitting around sage etc. In courtship, the male finds a female, the female hovers and the male hovers below and sometimes behind ~10cm and buffets/bumps her with his wings several times, they land and the male moves his forewings forward and flutters with wide amplitude as he gives the female a head butt (he repeats this fluttering/butting ~3x, at this point receptive females would remain motionless upon landing and accept the male, whereas unreceptive females land and they flutter their widely-spread wings when he comes near which induces the male to fly away). If a male encounters an unreceptive landed female, he may hover over her while she does her fluttering rejection dance. If a mating pair is startled, the female flies, the male dangling.

Erebia callias **Relict Gray Alpine (Colorado Alpine)**

The lead-gray unh is distinctive. In NW Wyo. the two fw eyespots in the red patch are occasionally absent (form brucei), but that form has not been found in Colo.

Habitat climax Alpine Zone tundra (mostly on dry knolls or tundra slopes, not on moist hummocky tundra or N-facing slopes). Hostplants in Colorado Poaceae: *Festuca brachyphylla coloradensis* (the most frequent host), *Poa fendleriana* var. *longiligula*, *P. nemoralis interior*; Cyperaceae: *Kobresia myosuroides* (males fleek commonly over this climax dry-tundra plant growing in swards on knolls and females ovip. on it sometimes, but *Kobresia* is somewhat tough and lab larvae don't like it much [a 1st-stage larva refused it in lab and ate *Poa pratensis* instead], so males may choose *Kobresia* mostly for mate-location purposes), *Carex rupestris drummondiana* (leaves of this are also somewhat tough), *C. foenea*. Common, often abundant.

Eggs laid singly on dead grass/sedge blades. Egg bluish-green, globose. Older larva tan with various black & brown & creamier lines and black dashes, with a black heart-band and a conspicuous paler subdorsal stripe, complicated black dashes laterally, no tails; the frontoclypeus on the head has four unique tubercles tipped with a seta; no horns. Some larvae may be greenish with the bands lighter in color (that larva died of disease). Pupa brownish-yellow (head & wings yellow-brown), heart-band brown, some dorsolateral brown spots. Hibernation stage unknown, but they are surely biennial like all other native Alpine Zone butterflies, so young larvae and ~4th-stage larvae probably hibernate.

One flight M July-Aug. (sometimes E July).

Adults usually visit yellow flowers, sometimes white or blue/purple ones, including *Sedum lanceolatum* and *Erigeron pinnatisectus*, they often visit dung, and very often visit mud. Adults bask dorsally (with wings spread).

Males fleek all day an average of 16cm up (~10-25cm, N=11) over alpine tundra (including cushion plant community), especially on rounded ridges such as those covered with swards of the climax tundra sedge *Kobresia myosuroides*, but often on grassy slopes. They often land after flying 3-10m. The flight is even & slow but has slow wingbeats so looks a bit odd as they chug along.

Erebia epipsodea **Common Alpine**

Identified by the two large fw eyespots (additional smaller eyespots sometimes occur on fw and hw). *E. epipsodea* is closely related to *E. medusa* of Eurasia and adults look identical, although the valva tip is wider, so they are presumably separate species. There appear to be no valid ssp. anywhere in the range of *E. epipsodea* as none of them look even slightly different (the Colorado name *rhodia* is a syn. of *epipsodea*). Adults usually have several black eyespots in the reddish-orange patches, but **form brucei** lacks these eyespots; it occurs mostly in the alpine zone in the central Front Range where it is up to 15% of the population in some places, but is also occasionally found in moist areas in South Park and occurs very rarely elsewhere even as single individuals in foothills valleys in the Front Range (2 sites so far, Apex Gulch & Tinytown); brucei is fully connected to regular *epipsodea* by intermediate individuals with all sizes of eyespots, and eyespot size may differ on upf and unf; William Henry Edwards reared one form from the other in the late 1800s.

Habitat lush (fairly tall) grassy areas mostly in valley bottoms, from the mid foothills to the lower Alpine Zone (I once found 6 in Apex Gulch in the lower foothills W of Denver, none before or since). Hostplants in Colorado moist meadow Poaceae: in the foothills and middle altitudes usually *Poa pratensis agassizensis*, sometimes *Koeleria macrantha, Danthonia parryi*, (and assoc. with the grass *Poa fendleriana* and others) and the Cyperaceae sedge *Carex inops* "*pensylvanica*" *heliophila*. Near and above timberline the hosts are Poaceae: usually *Deschampsia cespitosa* (common with the butterfly in long grass around willow carrs), also *Poa cusickii epilis, Danthonia intermedia*. Eggs are laid generally on dead blades: at low altitude eggs are laid an average of 10 cm up high on the host evidently to avoid the heat and ants, whereas in the Alpine Zone eggs are laid within several cm of the ground often after the female crawls deep into the clump, evidently to keep the eggs warm. Common or abundant.

Eggs cream, developing ~100 purplish/reddish spots consisting of numerous tiny reddish dots. Eggs laid singly, generally on dead grass/sedge blades. Larvae eat leaves at night, and rest in the host base at night. Older larva variable, yellow-green, or ochre, or brown, with many bands/lines all edged by contrasting colors, including a blackish heart-band, a subdorsal yellowish or cream band edged below by dark-brown then a wide brown band, a lateral line then a wide band (both yellowish or cream) the latter edged below by very dark brown; two short tails; head yellow-brown or brown, without horns. Pupa formed in a space among leaves silked together. Pupa whitish-brown, or mostly tan, with brown longitudinal stripes on the wings, a brown transverse stripe on each abdomen segment, and brown dorsal dots; cremaster with only a few straight bristles. 3rd- & 4th–stage larvae hibernate. Some Wash. larvae of James & Nunnallee [2011] reentered diapause as L5 so they suggested that some could be biennial, but in Colo. adults fly long from the end of spring, suggesting that they overwinter as L3-4 at least at lower altitude. However most or all alpine butterflies are biennial, where they overwinter evidently as young then old larvae [L1 & L3-4 most likely] like *Oeneis*. However about every night in the Alpine Zone can freeze even in summer, so maybe all larval stages are physiologically equipped for overwintering, so L1-2 and L3-5 are possible for overwintering, but L1 and L3-4 seem most likely at timberline/lower Alpine Zone.

One flight, mostly June-E July in the foothills, M July-Aug. at timberline. One year the Alpine Zone was very late, and the butterflies were common above timberline M Aug-M Sept. (and the population did not die out, suggesting that the first alpine overwintering stage is L1). Adults fly fairly slowly, but they can travel long distances in areas with uniformly-good habitat. P. Brussard and P. Ehrlich (1970 Ecology 51:119-129) found that adults can travel up to 13 km in W Colo. montane areas with large areas of good habitat, and more than 10% of recaptures traveled more than 500m.

Adults prefer white and yellow flowers, and sometimes visit pink or bluish etc. ones, including *Arnica mollis, rydbergii, Barbarea orthoceras, Erigeron ursinus, Senecio crassulus, Senecio* spp., and sometimes visit mud and dung (incl. bear). Adults evidently mostly bask dorsally.

Males fleek all day in open moist fairly-tall turf-grass or bunch-grass areas (especially in valley bottoms, but in long-grass *Poa* areas on ridgetop flats also), as they fleek evenly and steadily ~30-50cm up to find females, and may chase others a little and often have vertical encounters with other males (after an encounter with another male, they usually fly more linearly for a short time), and often rest in the grass/sedge (females spend most of their time there, so the % of females seen is small ~13-seldom 28%). In courtship, the male fluttered next to a female fluttering on a grass inflorescence, the female (form brucei) dropped into the grass with wings closed, he dropped down too with wings spread 90^o and crawled to her and butted her side (thorax) and fluttered with wings spread ~110^o 2x then fluttered ~120^o about 6x then crawled down just below her then up to her (her wings were spread only 20^o), and bent his abdomen and joined. Brussard & Ehrlich (1970) observed a completed courtship. In successful courtship with young virgins the male pursues a female until she lands or he drops near a landed female, then he generally flutters his fairly-widely-spread wings rather slowly near her before nudging under and joining the motionless female. Unreceptive flying females sometimes drop into the grass to avoid males. Mating lasts ~30 min. If a mating pair is disturbed, the female flies, the male dangling. Females usually mate just once, sometimes up to three times.

Brussard, P., & P. Ehrlich. 1970. Adult behavior and population structure in *Erebia epipsodea* (Lepid.: Satyrinae). Ecology 51:880-885

Erebia magdalena magdalena **Magdalena Alpine (Rockslide Alpine)**

Identified by the solid black wings, though rarely there may be faint traces of unh bands. The Colo. ssp. ***magdalena*** is solid black, although very rare adults have the fw very slightly reddish (usually just the unf) (the amount of unf reddish varies greatly in the Yukon where ssp. *magdalena* intergrades with the redder Alaskan ssp. *mckinleyensis*).

Habitat alpine and subalpine talus slopes. Females are mostly found on vegetated areas near the rockslides, and travel more widely than mate-locating males, though they usually rest on big rocks and seldom fly (males sometimes wander and travel between rockslides, when they fly faster). Females oviposit on the E- and NE-facing top edge of boulders among tundra near alpine talus, evidently to moderate the temperature of the egg, so the young larva has to crawl ~¼-1m to find a suitable grass/sedge, making determining hostplants difficult. Poorly-documented hostplants in Colorado are grasses/sedges (my 3 ovipositions were near 9 grasses/sedges): Poaceae: *Festuca brachyphylla coloradensis* was near several eggs and larvae eat grasses including *Poa pratensis* well so *F. brachyphylla* is surely a host; Cyperaceae: *Carex heteroneura=atrata* is probably a host (rarely ovip. on), and adults are assoc. with other sedges especially *Carex rupestris drummondiana* (but that has tough leaves so larvae would probably wander to some tenderer grass/sedge). (Near eggs also were grasses *Poa cusickii epilis*, *Danthonia intermedia*, *Trisetum spicatum*, and sedges *Carex deflexa* var. *boottii=brevipes*, *albonigra*, *phaeocephala*.) (Other grasses such as *Poa fendleriana* and *Helictotrichon mortonianum* also occur on those tundra slopes.). Uncommon, sometimes slightly & locally common.

Egg (Colo.) cream or pale greenish-yellow, turning slightly-reddish cream or yellow, mostly laid on large rocks. Egg (Alta., G. Hilchie 1990. Quaestiones Ent. 26:665-693) cream, ellipsoidal with ~40 small vertical ribs. 1st-stage larva tan or grayish-cream (greener anteriorly when young), with red or red-brown bands and a lateral cream band, collar & head blackish-brown. 1st-stage from Yukon is brown (photo Guppy & Shepard 2001). Older larva (Colo.) yellow-green, heart-line a brown band om thorax and brown irregular spots on abdomen, beside that a row of yellowish spots edged below by brown, a sinuous dark-brown row and a straighter sinuous redder-brown band are above an ochre lateral ridge, then a dark-brown band; thousands of tiny tan setae; head blackish-brown. Older larva (Alta.) greenish, mottled with dark; head dark-brown. Pupa (Colo.) greenish with yellowish spots, somewhat ellipsoidal with no conspicuous cremaster. Pupa (Alta., G. Hilchie) olive-green to brown (abdomen medium brown tinged by green). Immatures take 165 days in lab in Alta. Surely biennial, hibernation stages probably 3rd-stage larvae (one died in lab) the 1st winter (perhaps 2nd stage?), mature 5th-stage (Alta., G. Hilchie) the 2nd winter.

One flight mostly M July-M Aug. (occasionally E July in early years).

Adults visit low flowers of most colors, especially *Silene acaulis*. Adults mostly bask laterally.

Males mostly flait slowly all day ~30-67cm up in hollows of rockslides to await females, as they flait about the rockslide hollows for a short distance (~10-50m in good weather) for a few minutes then rest on a rock for awhile (mostly less than a minute in good weather) then fly again; they sometimes rait in the hollows also as they pursue passerbys from rest. Males sometimes find resting females, and a male was seen to drop down onto or next to a female. Mate-locating males sometimes fly around other males in a ball, as do many other butterflies especially raiting species. Adults can “ride the wind" with slow wingbeats to travel upslope quickly. In courtship, the male pursued and fluttered slowly near the female for 4m (males mostly flutter ~8cm below the females they court) and they reversed course and fluttered 4m more, then she landed on a large boulder with wings closed and he landed behind her and nudged her as he fluttered a bit (wings spread 0-45^o) with slow (~5/sec) wing frequency while nudging her, then he bent abdomen and joined.

***Erebia stubbendorfii* ("*theano*") Red-Striped Alpine (not "Theano Alpine")**

This butterfly is distinctive, as the wings have bands of red rectangles but no eyespots. The Asian butterfly *E. theano* formerly claimed conspecific with our Colorado butterflies is sympatric with *E. stubbendorfii* in the Altai Mts. of Siberia, and *stubbendorfii* is evidently the same species as *E. pawloskii* which is definitely the same species as our Colo. ssp. and was recently used to name them, therefore I place our Colo. ssp. into *E. stubbendorfii*. Ssp. ***demmia*** (San Juan Mts.) has the fw reddish band evenly tapered to the rear, the unh band mostly narrower, and a pair from the Flattops in Garfield Co. look similar. Ssp. **near-*ethela*** (Front Range) has the fw band wider anteriorly then narrower but the individual populations seem to differ somewhat in spotting: the 1st spot often absent or tiny in some populations, the 2nd & 3rd spot usually wider than that behind (and the rear spot of that band is usually wider in at least one population), while Wind River Mts. Wyo. *ethela* upf is similar with the 2nd spot wider so the first 3 form the parts of a ball. All those Colo. populations have the unh spots blockier and usually one spot has concave margin (often two in *demmia*) whereas Wyo. Yukon and Manitoba pops. have rounder unh spots lacking concavities, therefore the Front Range populations could be named a different ssp., but there are several variations there so it seems wrong to name ssp. when individual populations seem to differ considerably, evidently due to inbreeding in small populations, so there are probably several more of those colony variations in the Front Range.

Habitat long-grass (sometimes shorter grass) areas in Subalpine and lower Alpine Zones, generally in valley bottoms or grassy slopes or krumholz or tundra. A colony on Corona Pass in the Front Range found by M. Fisher occurred on grassy openings on a N-facing slope next to the old railroad line, where cinders from the original steam-powered narrow-gauge locomotive burned the trees and created the habitat, but the trees grew back because of misguided forest-fire suppression, and the colony was nearly gone by 1996. This butterfly sometimes occurs in the Canadian Zone in Wyoming (in long grass around Yellowstone Lake for instance), but in Colorado it flies in the subalpine and lower alpine zone, centered about the krumholz zone (mixed semi-tundra of grassland/sedges and tortured trees at timberline), sometimes on tundra in Boulder Co. A mystery is why so many colonies are so local, often only ~20m wide or only one hectare in size, yet they can be very abundant >100 in that small population, most of them hiding/resting in the grass because adults seldom fly; one should not collect many from these local colonies because they are so local and it is possible to seriously deplete them, as they fly slowly and are easy to catch unless they drop into vegetation. Why are colonies so local, and why does the butterfly occur in just a few places, and is absent in most of the geographic places where they could occur and evidently once occurred? Hostplants in Colorado Cyperaceae: *Carex scopulorum* on boggy tundra and larvae liked it (Charles Slater), *foenea*; Poaceae: *Poa nemoralis interior, Festuca brachyphylla coloradensis*, *Poa fendleriana* var. *longiligula*, *Agropyron* (*Elymus*) *trachycaulum*. Assoc. *Deschampsia cespitosa* also in Gilpin Co., and *Calamagrostis canadensis* tall grass at one site in San Juan Mts. Uncommon in non-preferred places, but tiny local colonies may be abundant; these tiny colonies should not be collected much despite the temptation to do so.

Eggs cream, with many reddish-brown spots, weakly ribbed, laid singly on dead blades of grass/sedge/rush (at Churchill Man., females often lay eggs on *Salix*). Larvae eat leaves; no nests. Larva tan, with a dark-brown middorsal stripe and three dark-brown stripes on each side, two short bumps ("tails") on rear; the body and hornless head covered with thick club-shaped hairs. Biennial, hibernating as young larva the 1st winter, evidently nearly-mature larva the 2nd.

One flight, L July (sometimes E July)-M Aug. It flies mostly in even years in Colorado (few adults on odd years), except for an odd-year colony in Ouray Co., and records from the Flattops in Garfield Co. are in even and odd years.

Adults visit mostly yellow or white flowers, sometimes pink or red-purple ones, especially *Solidago simplex* var. *nana*, often *Sedum*. Numerous adults roosted on low *Juniperus communis* bushes, some on *Picea engelmanni* and *Sambucus microbotrys* low bushes, or on fallen logs, and M. Fisher notes that females may rest on pine or fir trees nearby. Adults have a slow weak flight; when alarmed they may drop into the grass.

Males fleek all day about local grassy spots on hillsides or valley bottoms to find females, as they fleek fairly slowly and not very irregularly ~1m/sec., ~15cm above grass tops (~1/2m above ground on average, 25-61cm up). Males spend ~90% of their time hiding in the grass, and only ~10% flying; females fly <5%. Perhaps males find some females hidden in the grass by odor? Courtship was not seen.

Neominois ridingsii **Grasshopper Satyr (Ridings' Satyr)**

This butterfly has very distinctive brownish wings with creamier patches. It is closely related to *Oeneis*, but differs genitalically, the male lacks a stigma, the egg does not have coarse cross-ribs, the pupa is much different in coloration, and adults bask dorsally, and they mate only in early morning. It has spectacular geographic variation in Colorado. Ssp. ***stretchi*** is widespread on the W slope in Ouray & Montrose Cos. north to NW Colo., and has tawny (yellowish-brown) wing ups, and the uph postmedian band has big zigzags on its outer edge. Ssp. ***coloalbiterra*** is similar but whiter, varying from mostly-cream to brownish like other ssp., and occurs on whiter albite-rich soil spilling from cliffs on the Roan Plateau in W-C Colo. (it may extend westward on similar plateau sides nearly to the Wasatch Mts. of Utah, where the phenotype is similar). Ssp. ***curicata*** is similar but opposite in coloration, as it occurs in the Gunnison Basin where volcanic rock is often dark in color, so the dark-brown butterflies are better camouflaged as they land on the dark rock between the sage. Ssp. ***ridingsii*** occurs on the E slope including the Arkansas Canyon and San Luis Valley, plus Middle Park (probably North Park also) and Teller Co. and SW Colo., and the plains eastward nearly to Kansas; it has gray-brown ups coloration, and has smaller-zigzags on the outer edge of the uph postmedian band than the other ssp., and it mate-locates on ridgetops or little plateau tops unlike the others. Ssp. ***wyomingo*** is gray-brown like ssp. *ridingsii* but flies two months later, and has wing pattern like *stretchi* with larger zigzags on the outer edge of the postmedian uph band (like most ssp.), and it mate-locates in swales (like *stretchi*, *coloalbiterra*, and *curicata*); *wyomingo* overlaps the range of ssp. *ridingsii* by 500 miles from central Montana and most of Wyoming (barely into the Pine Ridge of NW Neb.) to north-central and NW Colorado (Moffat Co.) and NE Utah and the Wasatch Mts. of Central Utah. Yet *wyomingo* is not a distinct species, as its egg is intermediate to other ssp., its raiting location in swales is like other ssp., the larvae are similar but a little different (and Utah *wyomingo* larvae differ a little also), and its L1 diapause stage is evidently shared by biennial high-altitude Calif. *pallidus*. Ssp. *ridingsii* may be the most distinctive ssp. This species may be becoming extirpated in the warmer parts of its range: ssp. *wyomingo* was common on the E edge of Rocky Mtn. Nat. Park when first found by A. G. Lauck in 1950 and Ritterbush in 1956 (see Papilio {New Series} #18), but was less common recently and was last seen there in 2008; and visits to the Lowry Bombing Range SE of Denver (about the only extensive grassland left on the plains near Denver) in 2015 failed to find ssp. *ridingsii* at formerly inhabited sites; and ssp. *ridingsii* may be absent at a colony in W Jefferson Co. Colorado has great variation in *N. ridingsii*, and there is still more variation in Mexico mts. (Nuevo Leon, Coahuila) where the uns pattern of *pseudochazaroides =carmen* (which may be a distinctive ssp. of *N. ridingii*) is weaker and the ups is orangish esp. on females although the orangish fades. Scott (2019) and references there research this genus.

Habitat shortgrass prairie, hillside grassland/brush, and sagebrush, from the upper plains to the Canadian Zone (though I found one sure stray at 12000' in the Sangre de Cristo Mts.). Hostplants in Colorado Poaceae: Ovipositing females of ssp. *ridingsii* just fly a little slower than usual (rather than hovering like most butterflies), then land and generally glue the eggs singly to dead leaves/twigs, somewhat indiscriminately on or near the main host, which for ssp. *ridingsii* is *Bouteloua gracilis* (6 ovipositions seen), one egg each on the grasses *Koeleria macrantha*, *Agropyron* (*Elymus*) *elymoides* (=*Sitanion hystrix*) *"longifolius"*, & *Hesperostipa* "*Stipa*" *comata*, and on top of the shrubs *Helianthus pumilus*, *Gutierrezia sarothrae*, *Artemisia frigida* (2 eggs). *B. gracilis* seems to be the main host for ssp. *ridingsii* based on association at many sites. Various undetermined bunchgrasses are hostplants for ssp. *curicata*. *Agropyron* (*Pseudoroegneria*) *spicatum* var. *inermis* is evidently the main host for ssp. *coloalbiterra* and *Achnatherum* "*Oryzopsis*" *hymenoides* is rather certain. Ssp. *wyomingo* hostplants in S Wyoming are bunchgrass Poaceae: *Agropyron* (*Pseudoroegneria*) *spicatum* (1 egg on dead stem—this is the host in Wasatch Mts. Utah also, and is common at the former Rocky Mtn. Nat. Park colony), *Achnatherum* "*Oryzopsis*" *hymenoides* (2 eggs), *Schizachyrium* "*Andropogon" scoparius* (1 egg), *Aristida purpurea* (1 egg), *Hesperostipa* "*Stipa*" *comata* (1 egg) (hostplants include most of the bunch grasses in the habitat--most eggs were found on dead leaves). Common, often abundant.

Egg dull-whitish (often greenish-white in *ridingsii*), barrel shaped with ~30-50 bumps on top and ~14-20 ribs on side (averaging 17 *curicata* & *wyomingo* & *ridingsii*, 19 in several *coloalbiterra*), the ribs narrower than *Oeneis calais*/*O. chryxus* eggs. The *wyomingo* egg is longer than the oval ssp. *ridingsii* egg (*curicata* a bit longer), but is ~20% shorter than the long *coloalbiterra* egg. The tiny larva chews around the top rim leaving a small flap and pops the top open like a can of corn (*Oeneis* do this also). Older larva mostly tan (sometimes a little greener in *curicata, wyomingo,* & esp. *ridingsii*) with many bands/stripes like those of *Oeneis chryxus* etc.: #1 heart-band darker, #2 a wide light-brown band (sometimes paler in Utah), #3 a wide paler subdorsal band has tiny sl. pinker squiggles in the center, #4 a wide darker band, #5 a mottled less-wide brown band contains spiracles and numerous minute brownish squiggles, #6L a tan lateral ridge above #6 browner band, underside light-brown, two short tails; head tan with three vertical brown stripes on each side just like *Oeneis* and brown markings in corners of frontoclypeus. Ssp. *ridingsii* frequently has a rosy lateral narrow band #6Ljust below spiracles (slightly rosy on brown larvae, stronger on greenish larvae), and the heart band seems to be a set of brown dashes on the browner larvae. Larvae are sluggish and seldom move, so obviously spend most of their time hidden in the base of the grass, and probably come up in early morning to eat quickly. The mature larva can worm itself into loose soil or detritus at the bottom of a grass clump and pupates in a loosely-silked nest there on little plant bits it chews up (like *Oeneis* & *Hipparchia*). Pupa orange-brown (wings may be slightly yellower-orange-brown in *wyomingo* and some *coloalbiterra*), often with weak subdorsal brown line on abdomen, the T1 spiracle large and dark-brown with white filter, ellipsoidal, with no crochets on cremaster (*Oeneis* also lack crochets); pupates in loosely-silked opening in grass clump base. 4th-stage larvae hibernate in most ssp. (*ridingsii, coloalbiterra, curicata, stretchi*--reports of 3rd are not confirmed by me or Utah workers so seem to be errors), but 1st-stage larvae hibernate in ssp. *wyomingo* (the high-altitude biennial Calif. ssp. *pallidus* probably hibernates in both 1st- and 4th stages). Scott (2019) illustrates immatures of ssp. *curicata*.

One flight June-E July at low altitude such as the plains, M July-E Aug. at high altitude (overall mostly M June-July and seldom M Aug.). Ssp. *coloalbiterra* flies in L June-E July, ssp. *curicata* M June-July (mostly L June-M July). But ssp. *wyomingo* flies L Aug-M Sept. I studied ssp. *ridingsii* in the Arkansas Canyon in Chaffee/Fremont Co. (Scott 1973c). Marked adults of ssp. *ridingsii* moved an average of 94m for males, 119m for females during their lifetime (adults seldom moved more than 200m, one moved ~300m), which averaged 11 days in nature in a cool year (maximum 15), 5 days in a hot year evidently because adults seldom drink.

Adults seldom visit flowers (yellow ones, often white, sometimes cream), including *Chrysothamnus* (*Ericameria*) *nauseosus*, *Eriogonum spp.*, *Heterotheca villosa*, and *Hymenopappus filifolius*. To get warm adults spread the wings horizontally (dorsal basking), and to bask they generally turn to face away from the sun (except when the sun is near-vertical) with wings spread. In hot weather (mostly afternoon) they close the wings and turn toward or away from the sun and cast no shadow to minimize heating, and sometimes lean with wings parallel to the sun for minimal insolation; they turn less often on the cooler tops of bushes ~20-50 cm up (where they sometimes oviposit) and seldom turn on top of taller grass; in very hot weather they usually rest in the shade under bushes.

Males of all ssp. rait mostly in early morning to await females, as they rait mostly on the ground. They rait from 07:50-10:40 and sometimes as late as ~11:00 or 11:30, or rarely even 12:20 (maximum raiting 08:30-10:00) for all ssp., except for ssp. *coloalbiterra* which can rait as late as 12:30 evidently because they occur in a steep canyon that does not become sunlit until much later than usual in morning. Ssp. *ridingsii* raits on ridgetops/little mesa tops, ssp. *pallidus* in California similarly seems to rait on ridgetops and ridgetop saddles, whereas the other ssp. *curicata*, *coloabiterra*, and *wyomingo* (perhaps also *stretchi*) rait in swales/gulch bottoms. After the morning mate-locating period, adults mostly just fly when disturbed, and they look like grasshoppers in flight as they take off and land some meters away on the ground between grasses with wings upraised (hence the common name Grasshopper Satyr). Adults generally land into the wind. In hot weather they bounce a little more in flight. In courtship of ssp. *ridingsii*, the male pursues the female who lands and the male lands a few cm behind; in several matings the male merely crawled beside her and bent his abdomen to mate, while in other matings either the female or the male or both then flicked their wings (opening them from 30° from vertical to 70° rapidly a few times/second) and then the male crawls up to her and touches "butts" the end of her abdomen or her side with his head. (He spreads his wings in the basking position often during the courtship, as does the female occasionally.) The male then joins and faces opposite. In one completed mating the male alone flicked, in another both flicked, and in a third only the female flicked. Mating lasts only ~20 minutes. Unreceptive females fly when courted (*Neominois* and evidently all *Oeneis* do not flutter their wings to repel him). Females may possess a pheromone, as males remain behind young females and usually ignore old females; males lack the androconia patches of *Oeneis*, but still might possess a pheromone. Females mate only once, very rarely twice. If a mating pair is startled, the female flies, the male dangling.

Scott, J. 1973c. Convergence of population biology and adult behaviour in two sympatric butterflies, *Neominois ridingsii* (Papilionoidea: Nymphalidae) and *Amblyscirtes simius* (Hesperioidea: Hesperiidae). J. Anim. Ecol. 42:663-672

Scott, J. 2008. *Neominois ridingsii coloalbiterra* natural history and early stages. Papilio (New Series) #18:16-21.

Scott, J. 2014. *Neominois ridingsii wyomingo* early stages and natural history (Nymphalidae). Papilio (New Series) #22:16-20.

Oeneis uhleri uhleri Rocky Mountains Arctic (Uhler's Arctic)

Identified by the striated unh usually lacking a strong median band, and the nearly-absent brown unf postmedian line. The ups veins are dark, and there are few to many eyespots. The male valva is uniquely triangular, without lobes or teeth. The name *reinthali* has been applied to W Colorado darker-brown adults (TL near Gothic, Gunnison Co.), but there is so much individual variation and so little geographic or altitudinal variation that the name *reinthali* is best considered as just a dark-brown **form reinthali**, more prevalent at higher altitudes in W Colo.

Habitat not-wet grassland places (bunchgrass or turfgrass) in the mountains from foothills to subalpine (sometimes lower Alpine Zone grassy not-wet tundra) including large clearings. Hostplants in Colorado Poaceae: *Poa pratensis* (usually var. *agassizensis*), occasionally *Koeleria macrantha*, on

W slope and South Park *Festuca idahoensis*, undetermined above timberline. In Gunnison Co. they ovip. on grasses and sedges. Common, sometimes abundant.

Egg white, with ~20 vertical ribs. Older larva (Colo.) tan but varies individually and perhaps geographically (greenish-tan in some larvae), heart band #1 solid undashed blackish-brown, #2 band cream with red line through it (or gray-black in some), a red-brown line with tan center, broad cream band #3 with weak red-brown line through it (greenish-tan in some), #4 dark brown band of striations edged with black lines (black in some), a narrow cream line edged below by an orange-brown line, a light-brown band #5 along spiracles and a brown irregular weak line just below spiracles, #6L a cream-tan lateral ridge, a brown line, #6 underside brownish-tan (blackish or greenish-tan in some), with two short tails; head light-brown, with 3 dark-brown stripes on each side. (S Canada larva greener.) Pupa (Colo.) yellow-brown, abdomen brownish, wing cases greenish-brown. (S Canada pupa greenish-yellow-brown, the abdomen greenish-yellow.) Pupates just under the soil/litter like *Neominois*. Larvae hibernate in 2nd, 3rd, 4th, and 5th (mature) stages in lab, so evidently biennial at least at high altitude and in colder Canada (where ssp. *nahanni* flies in odd years in Yukon), but low-altitude (foothills to Canadian Zone probably) populations are evidently annual. W. Edwards, and T. Emmel et al. (1992) state larvae hibernate as 4th-stage, and high-altitude biennial pops. would hibernate probably mostly as 2nd-stage plus 4th and perhaps 5th stage.

One flight L May-M July (M May-June in foothills, L June-M July at high altitude [M-L July at 12000' in Alpine Zone]).

Adults sometimes visit yellow and whitish flowers, and often sip mud. In Nebraska, adults flew down-valley to find mud to sip. One strayed from the foothills 1 mile to Green Mtn. in Jefferson Co.

Males rait and sometimes flait all day in small depressions (if available) on swards of the hostplant (mostly on hillsides or gentle slopes, sometimes on saddles or flat ridgetops) with abundant hostplant grasses (*Poa pratensis agassizensis* in the foothills, *Festuca idahoensis* in South Park) to await females, as they rait on the ground or on 10-33 cm rocks etc. (In NW Nebraska males raited even on ridges with lots of grass and bunchgrass & *Carex inops* "*pensylvanica*" *heliophila*). In courtship, the male overtakes the female, they hover and land, and she flies away, or unreceptive females continue to hover when a male has discovered them, and the hovering male then flies away. If a mating pair is startled, the female flies, the male dangling.

Oeneis chryxus Chryxus Arctic

O. chryxus is one of the larger *Oeneis*, orangish on ups, with numerous brown unh striations and a darker median unh band generally edged by white, and the unf usually has a postmedian line. Males are most similar to *O. calais*, but usually have a larger stigma which extends 1-2mm into the upf discal cell (place a light underneath the fw to see this well), and males have the upf oranger because the basal brown area is usually smaller and the oranger distal area larger than *calais*, the postmedian line on upf is often absent posteriorly and it usually jogs outward along vein M_3 a shorter distance than *calais*, the upf veins generally have less or no brown edging, the uph fringe is usually more checkered with white, and the fw margin is often straighter (less convex). Males are usually just ordinary tawny-orange, but I found a rare adult from Jefferson Co. that is straw-colored. There is some variation in these traits, so some individuals are difficult to identify, but by using these traits, and the altitude and the habitat (in or near woods or not) and mate-locating behavior one can identify most males well. The male valva has a small dorsal lobe near the base, like *O. calais*, *O. alberta*, *O. bore* (and *O. nevadensis*). Females are hard to identify because they are variable and are similar to *O. calais altacordillera*. *O. chryxus* occurs largely at lower altitude, in even years, and males rait on hilltops, not in swales as does *O. calais* and *O. alberta*, and *chryxus* always occurs in/beside open pine forest with sedge mats under the trees (females oviposit on attached [dead or alive] or fallen branches above the sedge mats). Those habitat/behavior differences are good identification clues also. There are no other ssp. within *O. chryxus*, which ranges from the northern Sangre de Cristo Mts. of Taos Co. New Mex., and all the

Colo. mts. north into NE Nevada (the Egan Range), Utah (poorly studied), Wyoming, Montana, Washington (Okanogan Co. commonly), Alberta, to Racing River in N BC. Papers by J. Scott {some by N. Kondla, & C. Guppy, in Papilio (New Series) 2006 #12:13-28; 2008 #18:25-29; 2014 #22:20-28; and J. Scott 2019 News of Lepid. Soc. 61:146-150 & 175} thoroughly discussed *O. chryxus* and its relatives *O. calais altacordillera* etc. In the 2014 paper I fixed the horrible nomenclatural problems involving the name *chryxus* by designating a neotype from Jefferson Co. Colo. using the proper interpretation of the 4th edition of the ICZN Code. {An earlier-designated unidentifiable lectotype female was invalid because only the lost obviously-holotype male closely matching the neotype was mentioned in the original description by E. Doubleday and a second associated paper by J. Westwood (see Art. 73.1) (syntypes do not exist when there is a valid holotype, and the holotype was valid, and a holotype remains valid even if it is lost, until it is replaced by a neotype). And the author of the name *chryxus* E. Doubleday in another publication may have included the invalid lectotype female as one of three specimens he called merely "Chionabas ---- ? a—c. Rocky Mountains, North America. Presented by the Earl of Derby" (*Chionobas* was misspelled), therefore there is no proof that Doubleday considered that female to be the same taxon as *chryxus* (the ? means that he wasn't even sure that the invalid lectotype female was in the genus/species *Oeneis=Chionobas*) thus the invalid lectotype is not a syntype so cannot be designated lectotype, and that female lectotype is grossly different from the male holotype and is unidentifiable and has only a locality of "Rocky Mts." The Code permits the designation of a neotype to properly define a taxon that needs definition, even if paratypes are extant (Art. 75.1) in case someone considers the invalid lectotype female to be a dubious paratype. Actually we don't know for sure that the holotype male and invalid lectotype female and another female labeled Rocky Mountains were part of that Doubleday phrase "Chionabas ---- ? a—c", because Doubleday couldn't count very well and Doubleday's 1845 list of Lepidoptera specimens in the British Museum Nat. Hist. missed 29 of the 50 specimens presented by the Earl of Derby and missed whole species, and got many of the numbers wrong [Scott 2014 Papilio (New Series) #22:64-69]. After nine years, the ICZN Aug. 30 2019 ruled (opinion 2434 on case 3495, Bull. Zool. Nomenclature 76:141-143) that the name-bearing type of *Oeneis chryxus* is the male illustrated by Doubleday because it is the holotype by monotypy; thus they ruled that the lectotype from Rock Lake Alberta designated by J. Shepard in 1984 is invalid, and the neotype from Rock Lake proposed in 2010 by J. Scott [Bull. Zool. Nomenclature 67:121-128] was never approved by the ICZN so does not exist. That Doubleday holotype is lost, therefore the neotype designated in 2014 by Scott from Colorado is now the valid name-bearing type.}

Habitat open pine woods (mostly Ponderosa Pine in the foothills often with some Douglasfir, open Lodgepole Pine at higher altitudes) from foothills to Canadian Zone (spruce trees have branches that droop nearly to the ground thus shade and kill plants on the ground beneath them, so *O. chryxus* does not breed under spruce trees). Hostplants in Colorado turflike sedges and sometimes grasses growing in green mats under those trees: Cyperaceae: *Carex rossii* (the usual host, because the plant is very common), *C. geyeri*, *C. inops* "*pensylvanica*" *heliophila*, *C. foenea*, *C. pityophila*=*geophila*, *C. deflexa* var. *boottii*=*brevipes*; sometimes Poaceae: *Poa pratensis agassizensis*. Larvae eat sedges and grasses well. To oviposit, females flutter slowly through the open forest and find nice green usually-sedge turf below trees, then find a small branch just above the sedge mat (the branch dead or alive, thin or thicker, attached or fallen from the tree) and lay a big white egg on the branch (mostly on underside). The larva evidently emerges from the egg and drops onto the turf. Usually uncommon, often common.

Egg white, globose but tapering a little toward top, the top fairly flat with tiny bumps, with ~20 very jagged vertical ridges (a little more jagged than *O. calais*). 1st-stage larva tan, with brownish-red stripes (redder than *O. calais altacordillera* and *O. alberta*) on body; head tan. Older larva striped brown {this book uses the stripe terminology of Scott [1986a] which named each of the major wide stripes #1-6 from top to bottom [adjacent major bands are always separated by a narrower cream stripe], plus in this book I call the lateral pale ridge [the widest of the cream stripes] stripe #6L so the browner area below that is stripe #6}: the heart band (#1) solid blackish in most larvae and dashed light-brown and dark-brown in some paler larvae, #2 brown or light-brown due to minute brown sinuous dashes "wiggles", #3 cream-tan with weak brown irregular line of tiny pinkish wiggles through center, #4 dark-brown with blackish edges, #5 a cream broad line above a light-brown band [due to minute brownish wiggles] containing spiracles, #6L a lateral cream-tan ridge, #6 browner; head light-brown with usual vertical stripes (the lateral stripe narrower than the other two vertical stripes nearer the midline). Older larvae are similar to *O. calais altacordillera* but the paler larvae are slightly pinker in overall coloration (the darker-brown larvae are not pinker), and the heart-band (band #1) is usually solid brown (not dashes possessed by most *altacordillera*). *O. nevadensis* larva is similar to *chryxus* but its head stripes seem narrower (photo in Neill 2007). Pupa similar to *O. calais altacordillera*, ellipsoidal, tan with paired brown dots on abdomen segments, antenna and orbit blackish, proboscis less blackish, but the tawny wing veins are usually a bit wider on the dark-brown wings (they are narrow in many *altacordillera*); pupae may average a bit pinker than *O. calais*. Pupa formed in a loosely-silked cavity partly in soil/litter or under moss or stones. Larvae biennial, evidently hibernating in 1st, 2nd (maybe 3rd) stages the 1st winter, then 4th & 5th the 2nd winter, though there isn't much data at the moment: mature larvae (L5) diapause (lab rearing by Clyde Gillette in Utah, reported in Papilio (N.S.) #12); and L1 larvae (evidently of *O. chryxus*) diapaused in Wash. (James & Nunnallee 2011). T. Emmel et al. (1992) report that L2 larvae hibernate, but they confused *O. chryxus* and *O. calais altacordillera* and their color figs. of adults are the latter from above timberline on Horseshoe Mtn. and if they actually saw them oviposit on grasses then those eggs were *altacordillera*.

One flight M May-July (mostly L May-E July). Adults are biennial in even years in the Southern Rockies of Colo. and S Wyo. (odd year adults are rare) and most of the range northward in Yellowstone Wyo. and Idaho and Mont. etc. (in E Nev. they occur in the Egan Range in even years), but are biennial in odd years in Teton Mts., Wind River Mts., and Bighorn Mts., Wyo. and evidently in Okanogan Co. Wash.

Adults sometimes visit yellow and white flowers, including *Helianthus pumilus, Rudbeckia hirta, Sedum lanceolatum, Senecio* spp., and often sip mud. Adults including numerous females sometimes fly down-gulch to find mud etc. to sip. Adults sometimes glide. Adults bask laterally and sometimes dorsally. They roost most often in Ponderosa Pine trees 2-4m or more up.

Males rait all day in clearings preferably on hilltops or ridgetops to await females, as they rait an average of ~31 cm up (0-70 cm, N=16) on rocks or less often on fallen logs or the ground or bushes; sometimes (esp. after pursuits) they fly (flait) in a bouncy way and lazily fly a 2-3m circle on the hilltop then land again. But males sipping mud in a valley bottom may chase each other for mate-locating (females sip mud too). *Oeneis chryxus* (and *O. uhleri*) usually chase butterflies that flap fairly slowly, and seldom chase faster-flapping *Vanessa* etc. In courtship, the female flies over a ridgetop until a raiting male sees her and pursues, they hover (if the female seems a little unreceptive he rises up and bumps her as many as ~10-40x to transfer pheromone), the female lands with wings closed, he flutters and lands beside or just behind her and flutters his wings beside her to transfer pheromone, he bends abdomen and joins; in one successful mating they appeared to grapple in midair (probably the male just bumping into her to transfer pheromone), and when they landed or shortly thereafter they were mated. If the mating pair is startled, the female flies, the male dangling.

Oeneis calais altacordillera Calais Arctic

From *O. chryxus*, males are distinguished by having a smaller stigma (which extends less into the discal cell, just 0-1mm--actually 10-15% of males appear to have no dark stigma at all), and the male upf is browner because the brown basal area usually extends out to the postmedian line, and the veins beyond that into the orangish area are usually wider brown (due to extra brown scales), and the hw fringe is more-weakly checkered (less whitish), and the postmedian line jogs outward farther along vein M_3 on average, and the fw margin averages more convex. These are averages of considerable variation, but males can usually be identified and the altitude and habitat and raiting site helps. The ups color of males varies greatly, from orangish (usually) to yellower-orange, occasionally cream colored or seldom solid-brown with no markings; *O. chryxus* is much less variable (usually orangish). The male valva has a small dorsal lobe near the base, like *O. chryxus*, *O. alberta*, *O. bore*, and *O. nevadensis*. Females are hard to identify and usually must be identified by associating them with males. *O. calais* occurs mostly at higher altitude (Montane Zone meadows to Alpine Zone tundra) and flies every year, and males rait in swales, not hilltops, and populations also occur in habitats without trees such as alpine tundra and large high-altitude treeless places, because females oviposit on grasses/sedges in sunlit grassy clearings/meadows/tundra, not on tree branches. ***O. calais altacordillera*** extends north into Wyoming, Montana, Utah (poorly studied), NE Nevada (the Snake Range), Idaho, Wash. (at least the Olympic Mts.), Alberta and most of BC, and southward into most of N New Mexico where the unh often becomes a little more finely-striated "strigulated", and in the San Mateo Mts. of central NM the unh median band becomes weaker in *O. calais socorro*. This butterfly was formerly confused with *O. chryxus*, but after several decades of working out the mate-locating and oviposition behavior and finally studying the details of wing pattern, habitat and hostplants and larval coloration etc., it became obvious that they are distinct species, which overlap in range and are sympatric in at least 21 localities from Colo. to Alberta {see J. Scott et al. Papilio (New Series) #12:13-28 & pl. IV [2006]; #18:25-29 & pl. V [2008]; & #22:20-28[2014]; written mostly by J. Scott, and J. Scott 2019 News of Lepid. Soc. 61:146-150 & 175}. *O. c. altacordillera* is actually part of a polytypic species *O. calais* with many ssp. that ranges across most of North America, whereas *O. chryxus* is a specialist butterfly of limited distribution just in the Rocky Mts. with peculiar natural history and has no ssp. {This discovery affects butterflies found over most of boreal North America, so some time will be necessary to properly identify the 20,000+ specimens in collections. Some people ignored or failed to read the extensive evidence that *O. calais altacordillera* and *O. chryxus* are distinct species, and some then exaggerated the importance of a similar butterfly *O. calais tanana* they named from S Alaska and mis-claimed it to be a distinct "hybrid species", which cannot be true because one parent *O. bore* still occurs with *tanana*; actually *tanana* is just another ssp. of *O. calais* (along with ssp. *strigulosa*, *calais, caryi*, *valerata, altacordillera*, *ivallda*, *stanislaus*, and *socorro*) which resembles some *O. calais* near-*caryi* from Yukon except it evidently introgressed with *O. bore* to get a whiter-bordered unh median band (some adults from Bonanza Creek etc. in Yukon have a whiter-bordered unh median band like *tanana*, and some variable Yukon adults have *tanana* mtDNA [C. Guppy research]--at the other end of the *O. calais* range in C New Mex., *O. c. socorro* has the weakest median band). Yukon is a meeting ground where the butterflies best-named "near *caryi*" average paler unh veins and intergrade between ssp. *calais*, *altacordillera*, and even *tanana* and are quite variable in wing pattern and mtDNA.} {A male from Nonda Crk. E of Muncho Lake Prov. Park BC looks like it may be from a population transitional between *altacordillera* and Yukon near-*caryi*.}

Habitat open grassy areas from Canadian Zone to Alpine Zone tundra. They range well above timberline on tundra in the Sangre de Cristo Mts. and San Juan Mts. and Sawatch Mts. etc. In N New Mex. they occur on top of high mesas and in all the mountain ranges. Hostplants in Colorado Poaceae: *Bromopsis inermis pumpelliana, Poa fendleriana fendleriana, Festuca calligera, Bromopsis ciliata, Poa nemoralis interior*; Cyperaceae: *Carex deflexa* var. *boottii=brevipes*. {*O. calais valerata* host *Festuca roemeri* Olympic Mts. Wash.; *O. calais strigulosa* hosts in Ontario the grasses *Oryzopsis pungens* and *Phalaris* (*Phalaroides*) *arundinacea*, in Mich. the sedge *Carex pensylvanica*; and *O. calais ivallda* host in Calif. the sedge *Carex spectabilis*}. Lab larvae eat sedges and grasses well. Common or uncommon.

Egg white, globose with numerous ~20 jagged ridges but tapering a little toward top, the top fairly flat with tiny bumps. Eggs laid singly on dead parts in sunlit hostplant clumps (not under trees). Ovipositing females fly slower than usual as they flutter slowly over the grassland or tundra then land on a suitable host. (Non-ovipositing females mostly rest on the ground or on a low plant and occasionally fly fast 10-20m+ upslope or downslope in grassy open areas and sometimes fly over walls of tall *Picea engelmanni* trees to another grassy area.) Larvae eat leaves, by day or night if warm enough, without nests. 1st-stage larva tan, with reddish-brown (redder on *O. chryxus*) and cream etc. stripes on body; head uniform tan (stripes occur only on 2nd-mature *Oeneis* heads). Older larvae similar to *O. chryxus* and there is variation from darker to paler, but usually of a yellower-tawnier shade: using the major bands described by Scott (1986a--[adjacent major bands are always separated by a narrower cream stripe]), #1 heart-band usually tan with blackish dashes, sometimes all dark-brown, #2 band tan or light-brown, #3 band creamy with tiny pinkish-brown sinuous dashes "wiggles" in middle on L5 (L3 & L4 have an oranger center in band #3), #4 brown band edged with dark-brown lines, #5 light-brown band (due to numerous tiny brownish [not as pinkish as *O. alberta*] wiggles) containing spiracles on L5 (L3 & L4 have band #5 creamy between two reddish-brown lines), #6L lateral ridge tan, #6 wide brown band, uns tan, two short tails; head tan with 3 vertical brown stripes on each side which narrow on lower front (the first two wide, the third lateral stripe is narrow and is often absent on paler larvae), frontoclypeus has 2 vertical triangles or streaks of brown, tan along coronal sulcus and adfrontal sulcus. The photo of 3rd- or 4th-stage larva of *O. calais valerata* by R. Pyle (Butt. Cascadia) is very similar to the paler larvae of *altacordillera*; *valerata* and *O. calais strigulosa* have dashes on heart-band like most *altacordillera*. Older larvae and pupae of *O. calais stanislaus* in Calif. are similar to *O. c. altacordillera* (James & Nunnallee 2011). Pupa tan with rows of paired brown dots on abdomen segments, the head & thorax browner, & wings blackish-brown with tawny lines & veins, the tawny wing veins often very narrow to broader (some pupae are darker with brownish-tan abdomen and head more brown), the proboscis and antenna and orbit blackish-brown; cremaster lacks crochets. The pupa is formed in a cavity, which is just below the soil surface in a grass/sedge clump or in loose soil/litter. Like all biennial *Oeneis*, larvae hibernate the 1st winter as young larvae (late 1st, 2nd, maybe 3rd stage), the 2nd winter as old larvae (4th & 5th-mature stages), based also on evidence for all ssp.: lab larvae of *altacordillera* evidently diapause in 2nd-3rd and later in 5th stages (and probably hibernate as L4 also); ssp. *valerata* overwinters in late L1 and early L4 (R. Pyle); ssp. *ivallda*/*stanislaus* evidently hibernated as L5 (Keith Wolfe, in James & Nunnallee 2011); ssp. *strigulosa* evidently hibernates as L2 and mature larvae (W. Forbes 1960 Lepid. NY & Neighboring States, Cornell Univ. Ag. Experiment Station Memoir 371); William H. Edwards' lab-reared larvae from S Colo. (most likely of *altacordillera*, possibly *O. chryxus*) hibernated as L3, L4, and L5; the statement by Douglas & Douglas (2005) that *O. calais strigulosa* hibernates as L3 & early L4 evidently came from W. Edwards' rearing of most-likely *O. c. altacordillera*?, because W. Howe's (1975) Butterflies of North America statement that *O.* "*chryxus*" hibernates as L3 or early L4 came from W. Edwards.

One flight mostly M June-E Aug. (extremes June 1-Aug. 22), mostly L June-M July at 9000', mostly July at or above timberline. Adults of all known populations fly every year (both even and odd years) in Colo. even though larvae surely overwinter twice and the population consists of even- and odd-year populations mixed together (they are obviously biennial in the Subalpine and Alpine Zones). And the fact that there is no known population that is absent in alternate years suggests that it is multiannual and some may have three-year cycles (like *Chlosyne whitneyi* and *Boloria improba*) or possibly an annual cycle sometimes esp. in the Montane Zone. {Other ssp. sometimes fly only in alternate years, including ssp. *strigulosa* North of Lake Superior in Ont. [Douglas & Douglas 2005], *strigulosa* is more common in even years in Mich and Wis., *ivallda* and *stanislaus* mostly odd years in Calif., and *tanana* flies in odd years in Alaska.}

Adults sometimes visit flowers (mostly yellow and white, sometimes blue-purplish) including *Achillea millefolium lanulosa, Arnica* spp., *Erigeron ursinus, Eriogonum subalpinum, Sedum lanceolatum, Senecio spp., Taraxacum officinale*, and sip moisture from tundra soil/mud. Adults bask laterally (often strongly leaning to the side) and often dorsally. Adults roost on those spruce trees ½-4m up (and of course on low plants on tundra).

Males rait all day in open grassy/tundra swales (often at the base of a grassy hillside, or swales on slopes), as they rait on the ground or low rocks (an average of <10cm up evidently, occasionally on low plants up to 30 cm and rarely on a 50 cm boulder) to await females. {*O. calais strigulosa* in Ont. raits on sandy/small rocks [evidently in swales/clearings] and some males remained up to 14 days [averaging 6] though the raiting sites changed somewhat each day, R. Knapton 1985 Behav. Ecol. Sociobiol. 17:389-395.} In courtship (seen by Daniel Petr in a large meadow near Horseshoe Mtn.), the female flew over a raiting male who pursued, there were two spirals upward [when the male wafted pheromone as they flew not far upward and when the male probably bumped the female, as high flights of female butterflies represent rejection behavior], the female landed, the male turned to find her, she flew, the male pursued and both landed and he landed on "top" [surely on one side] of her and bent his abdomen under and joined. I observed males flying 8-10cm below a female and a *Euptoieta claudia* to transfer pheromone. If a mating pair is startled, the female flies, the male dangling.

Oeneis alberta alberta **Alberta Arctic**

Identified by the smaller size and mostly somewhat grayish ups coloration, the long and pointed (jogging outward along vein M_3) unf postmedian line like *O. calais*--unlike the absent or vestigial postmedian line of *O. uhleri* which is sympatric in South Park), the very weak or absent male stigma, the weak uph fringe checkering, the convex fw margin, the strong unh median dark band, and the early flight period. Adults are very variable on ups, from grayish-brown to brownish-gray or even somewhat orangish-gray. The eyespots vary from few to many. The male valva has a basal prong like that of *O. calais*, *O. chryxus*, *O. bore*, & *O. nevadensis*, lacking in *O. uhleri*. Ssp. ***alberta*** could be lumped as the ssp. that occurs in Colo.-NE New Mex., because the populations named ***oslari*** (TL South Park CO) and *capulinensis* (TL Capulin Mtn., Union Co. NM) are similar to ssp. *alberta* from Alberta considering the great variation in color from gray to orangish (one Colorado area has slightly grayer-brown adults on average but occupies a very small range so those should not be named because the difference is slight and collectors might go there and exterminate it); S Colo.-NE New Mex. populations have the unh median band averaging considerably stronger with whiter edges and could be called ssp. **capulinensis**, but that trait is variable and all taxa have some adults with strong and weak bands. Some from South Park and Middle Park have weaker unh bands, while those bands are stronger in Alberta and in S Colo.NM *capulinensis*. 7 of 8 from Middle Park have dark-brown upf. *O. alberta* evidently evolved as an early-flying offshoot of the ancestor of *O. calais* on cool open dry grasslands, where larvae adapted by feeding completely and growing fully-mature before winter diapause, so adults can fly early the next spring without larvae bothering to feed; adults are small evidently because they cannot grow larger with just one annual generation. *O. alberta* occurs only in widely scattered places (montane open grasslands), where it spread at the end of the Pleistocene, and has become extirpated in all the intervening areas, in contrast to *O. uhleri* which is widespread and much more adaptable. It is not known why it occurs in some of those montane grasslands, and not in others. The small populations in "Middle Park" in Grand Co. seem to be extinct or nearly extinct and I found none in Middle Park (they are no longer found at the first location discovered there in 1963, suggesting overcollecting or overgrowth of sagebrush, but are also absent in a nearby better location, suggesting global warming contributed). J. Scott (2019, News of Lepid. Soc. 61:146-150 & 175) reported most of what is known about *O. alberta* and relatives.

Habitat open bunch-grasslands (sometimes sage grasslands) mostly in Canadian Zone, on meadows, usually sloping hillsides. On gentle slopes it often prefers the middle portion of the slope, sometimes the lower portion, males are commoner wherever swales are most pronounced. Hostplant in Colorado Poaceae: *Festuca idahoensis*. Often common, but may be local.

Egg pale-green rapidly changing to white, oval with ~19-21 rather thin vertical ribs. Eggs laid singly, placed on dead parts of host grass clumps. Larvae eat leaves, without nests. 1st-stage larva similar to *O. calais altacordillera* but the browner stripes lack reddish tints (and *O. chryxus* has some stripes redder). Older larva similar to *O. calais altacordillera*, striped brown, heart-band #1 either solid brown on darker larvae or usually tan & brown dashes on paler larvae, #2 stripe light-brown or brown with tiny brown wiggly dashes, #3 tan-cream or tan with faint pinkish wiggles along center, #4 light-brown or brown edged by black lines then edged below by white line, #5 containing spiracles light-brown due to numerous tiny mostly-pinkish wiggles (in Alta. sometimes greenish speckled with black) (band #5 is pinkish in photo of an Alberta 4th stage in Guppy & Shepard 2001 Butt. BC), #6L a cream-tan or pinkish-tan lateral ridge, #6 brown, (Alta. larvae often greenish esp. on top and band #4 and head), the usual short tails of *Oeneis*, underside grayish-tan (or bluish-green); head tan with three dark-brown stripes on each side (two wide to very wide—averaging wider than *O. calais*/*O. chryxus*--and the 3rd lateral stripe short and narrow). Larva probably pupates like other *Oeneis* in silked-chamber in grass clump. Pupa like *O. chryxus*, cream or pinkish-tan (or greenish-gray in Alta.), abdomen has the usual paired brown dots on each segment, orbit antennae and legs blackish-brown, the wings blackish-brown (or olive green in Alta.) with wide tan veins. Fully-fed mature L5 larvae hibernate (nearly always refuse to pupate in lab); life cycle evidently annual. (These *Oeneis* take a very long time ~3 mo. in lab to rear.)

One flight May-June (mostly L May-E June), earlier May (peaking E May some years) along the Colo.-New Mexico border in Las Animas/Colfax Cos. Ernest Oslar mislabeled specimens from South Park as “Deer Creek [Jefferson Co. Colo.] 25 Sept. 1909” and sold them, fooling everyone until 1938 when Bernard Rotger rediscovered them in South Park; Oslar mislabeled and sold thousands of specimens (Scott 2016b), so his name should not be used in any common name. Adults fly on even and odd years, and may be just annual, as they definitely hibernate as fully-fed mature larvae (if the young larvae also hibernate, they would have to spend most of the whole summer not feeding, which seems doubtful, though perhaps L3 could hibernate—but they do not occur in the Subalpine Zone, so they are probably annual).

Adults probably visit flowers rarely. They often visit mud: on a dry day in NM I saw many adults (mostly males) fluttering toward a mud cattle pond and landing 1.3m from it, then probing the soil with proboscis as they crawled and fluttered til they reached mud, then they sipped it.

Males rait all day in swales of gentle slopes in the open grassland (swales may be on the middle or lower part depending on the slope), as they rait mostly on the ground (on hillsides of mts. without any swales they just rait randomly on the slope). In courtship, the male overtakes the female and they slowly land, and they flutter a little, then unreceptive females fly.

Oeneis bore edwardsii White-Veined Arctic

This tundra species (once called *O. taygete edwardsii*) is grayish-brown like *O. polixenes* and the ups looks similar to *O. melissa*; it is identified by the unf postmedian brown line (lacking on the other two), and the unh has a strong white-edged median band similar to *O. polixenes* (and *O. c. altacordillera*), but the unh veins are mostly white (veins brown in the other two). The unh usually lacks eyespots. The valva has a dorsal lobe near the base (so it has been placed in the *O. nevadensis/ chryxus/ calais/ alberta* group which have that lobe) which is lacking in the other two, and the uncus protrudes from the abdomen about 1 mm.

Habitat moist hummocky alpine tundra, mostly on gentle slopes. *O. bore* and *O. polixenes* seldom occur together in the Rocky Mtns. from New Mexico to Alberta (colonies do occur very near in the Wind River Mts., the richest mountains in the U.S. for alpine butterflies), because they occupy the same moist hummocky tundra habitat and may interfere with each other while mate-locating. Because of that habitat preference they tend to occur in local colonies. *O. bore* ranges throughout the San Juan Mts., north through the Sawatch Range to Independence Pass in Lake and Pitkin Cos. Hostplants at Churchill, Man. Cyperaceae: *Carex misandra*, and Poaceae: *Festuca brachyphylla, mibra, vivipara* (*Festuca* in Europe) (larvae eat grasses in lab); unknown sedges/grasses in Colo. Often common.

Egg whitish, with ~30 vertical ribs. Eggs laid singly. Larvae eat leaves, without nests. Older larva from Churchill like other *Oeneis* but with strong contrast between pale and dark bands (photos in Butt. Canada and Scott 1986a book), the body joints paler, heart band #1 dark brown with dashes (blackish at joints), band #2 darker brown or mottled whitish-brown, #3 mottled whitish with reddish in the center except at joints, #4 dark-brown, #5 containing spiracles is a wider set of reddish dashes (mottled light-reddish-brown) except white at joints, #6L lateral ridge cream, #6 brown, underside lighter-brown, the lines between stripes #1-6 are cream, two short tails; head brownish with 3 blacker stripes on each side, the lateral stripe also wide. The egg suggests that *O. bore* is closely related to *O. polixenes* and *O. melissa* despite the larva and adult male valva lobe. Biennial (it flies in even years in Labrador and Churchill Man.): young larvae hibernate the 1st winter, 4th & 5th-stage/mature larvae the 2nd winter.

One flight mostly July-E Aug. Flies every year--even and odd years--in Colo., because even-year and odd-year cohorts fly at the same sites.

Adults occasionally visit yellowish flowers.

Males rait all day in hummocky tundra swales to await females, as they rait on or near the ground. If a mating pair is disturbed, the female flies, the male dangling.

Oeneis jutta reducta **Jutta Arctic**

Identified by the orange rings or bands around the ups eyespots, which contrast with the dark-brown ups. The unh is mottled grayish, often with a darker median band. The unf of females usually has a postmedian line. Adults are large in size. Ssp. ***reducta*** occurs in Colo.-Mont. and has the outer third of ups widely orange; the orange ups bands vary in width. The male valva resembles *O. melissa*.

Habitat semi-shaded (not dog-hair thick as usual) not-wet Lodgepole Pine forest mostly in the Canadian Zone with an understory of green *Carex*. They are seldom common, and good locales are hard to find because adults do not occur where the lodgepole pines are disgustingly dog-hair thick and choke out most other living things (luckily, bark beetles and global warming are killing millions of those trees and are killing the equally horrible dense Engelmann Spruce trees whose branches grow down to the ground and kill every macroscopic thing beneath). Hostplant in Colorado Cyperaceae: *Carex geyeri* (D. Parshall) which grows among the trees where some sun reaches the ground. In other regions *O. jutta* occurs in wet places. Hostplants elsewhere are sedges *Eriophorum spissum*=Cotton Sedge in four regions [*Eriophorum* does not occur with *jutta* in Colo.], *Carex concinna*; grasses *Molinia*, *Glyceria*; at Churchill larvae ovip. on and eat Juncaceae (*Juncus*). In Poland females oviposit on a tree trunk or branch not greater than 1m above a peat bog, and the host is *Eriophorum vaginatum*. Lab larvae prefer sedges to grasses. Uncommon, sometimes locally common.

Egg whitish, with ~20 vertical ribs. Eggs laid singly, elsewhere on green *Eriophorum* and on dead and green conifer branches. Larvae eat leaves, without nests. 1st-stage larvae have brownish-red stripes (redder than *O. calais* & *O. alberta*). Older larva (Utah) usually brownish-tan (sometimes greenish), the browner larva rather similar to *O. calais altacordillera* and *O. chryxus*, heart band #1 alternate tan & dark-brown (or solid posteriorly and dashed anteriorly), #2 variegated tan with reddish-brown sinuous dashes, #3 creamy with fine undulating reddish-brown wiggly dashes, #4 brown edged by darker-brown, #5 cream with tiny reddish-brown wiggles near top and bottom, includes spiracles, #6L lateral ridge cream, edged below by #6 brown then a line of orangish tiny squiggles sublaterally; underside medium brown, two short tails; head light-brown with 3 medium-width head stripes on each side all about the same width (the 2nd widest). Some Que. larvae (and pupae) are green, some are tan. Pupa light-brown, the proboscis & orbit blackish; the abdomen has slightly bigger blackish paired spots on abdomen than *altacordillera* and *chryxus* and some blackish suffusion around them, and the wings appear mostly tawny with the veins wide and blackish (whereas *O. calais altacordillera*, *O. chryxus*, *O. alberta* pupae look the opposite with pale veins on blackish wings). Biennial, hibernating as 1st- to 3rd-stage (esp. 2nd in Utah) the 1st winter, 4th- to 6th (mature) larvae the 2nd winter (*Oeneis* generally have just 5 larval stages).

One flight mostly L June-M July (sometimes L July). Adults fly in even-years in Colo.

Adults rarely visit flowers such as *Arnica mollis* & *Geranium caespitosum*, and visit small yellow flowers in Wyo. and white *Ledum groenlandicum* in Wis., and mud and decaying matter in NE N. Amer. Adults bask laterally, occasionally dorsally, but M. Douglas notes that they cannot warm up by shivering the wing muscles. Adults can live several weeks.

Males rait all day in semi-shaded gently-sloping partial clearings (3-6m wide) (including gentle swales and saddles) of lodgepole pine forest with abundant *Carex geyeri*, as they rait mostly ~1/2m up on logs, trunks, or low branches (on cotton "grass" or herbs or tree trunks, Masters 1969). Masters noted the young female has a pheromone that attracts males. Females fly through woods and seldom are observed to stop. In Europe males sometimes fly upward along a lower pine trunk because newly-emerged females rest there and mating pairs are found on tree trunks (D. Van Katwijk 1978 Nota Lepid. 3:137-138).

Masters, J. H., & J. T. Sorensen. 1969. Field observations on forest *Oeneis* (Satyridae). J. Lepid. Soc. 23:155-161.

Oeneis melissa lucilla Melissa Arctic

Identified by the grayish-brown wings generally lacking ocelli (small ocelli are present on some females), and the unh is heavily mottled with a darker mottled median band. The unf lacks a brown postmedian line. The valva is broad without a basal lobe and has many teeth on the wide end. Ssp. ***lucilla*** in the S Rockies resembles some brown arctic ssp., and is much different from the blacker ssp. *beani* from C Wyo. (Wind River Mts.) to Alberta.

Habitat rocky alpine tundra, up to 14,000'. Hostplant in Colorado Cyperaceae: *Carex rupestris drummondiana* (a tough plant, so other sedges/grasses may also be used, though *C. rupestris* is recorded as host in Man. and NW Terr. also) (*C. bigelowii* is recorded in N.H., several other *Carex* in Japan), and perhaps Poaceae. Uncommon, seldom common.

Egg gray-white with ~30 vertical ribs. Eggs laid singly in litter or loose sticks etc. near hostplants. Larvae eat leaves (at night in lab, surely mostly daytime in nature as nights are too cold), without nests. Older larva (Colo.) light-brown, heart band #1 has black dashes alternating with tan bullet-shaped dashes, #2 cream but ventral 60% tan with a blackish dolphin-shaped dash on each segment just above a longer blackish dash on lower edge of #2, #3 cream, #4 tan-brown (edged above with two blackish dashes on each segment (the rear longer), edged below by a blackish line that is thinner posterodorsal to spiracle), #5 a narrow tan band (edged below by tiny brown specks) above a pale-tan-brown band containing spiracles, #6L lateral ridge cream-tan, #6 a brown line below it, underside tan, with two short tails; head pale-brown with the usual three dark-brown vertical stripes on each side. Some larvae are a little greener. Larvae mostly like other *Oeneis* but are variable in whole range, in N.H. larvae vary from red-brown to dusky green, and the larva photo in Butt. Canada is of a mostly-green larva with dashed heart-band. Larva pupates under moss or stones or partly in the soil in a loosely-silked chamber. Pupa greenish-yellow on thorax, abdomen yellowish and brown-gray with dots, wings dark-brown. Biennial, hibernating as young larva commonly 2nd or 3rd stage the first winter, mature 5th stage [and probably 4th stage] the 2nd winter.

One flight July-M (sometimes L) Aug. Adults fly every year (even and odd years) in Colo. (mostly odd years at Churchill, Man., even years in some Alaska sites).

Adults rarely visit flowers, including *Silene acaulis* (in N.H. sometimes on *S. acaulis*, *Arenaria* & *Vaccinium*, in the arctic *Rhododendron lapponicum*, *Dryas integrifolia*, *Andromeda polifolia*). Adults occasionally flew up to 787m in N.H., and lived up to 8 days. They bask laterally. Adults may fly

10m when disturbed then land. They fly with a fluttery flight, they do not glide, and do not hop like many Satyrinae.

Males rait and sometimes flait all day on rocky areas on alpine zone hilltops and ridgetops, often including rocky slopes (and even chutes there on a windy day), but not tundra swales, as they rait on low rocks or the ground. Courtship was not seen, but in N.H. three "spiral flights" (the kind two adjacent male butterflies often do during mate-location especially while raiting/flaiting) between male and female ended immediately in copulation (A. Gradish & G. Otis 2015 J. Lepid. Soc. 69:108-113) (which tells us only that males pursue females and get close enough to transfer pheromone then a receptive female lands and they join). Mating lasts >33 min, and the male bends his valvae in the middle to squeeze her abdomen while mating. If a mating pair is disturbed, the female flies, the male dangling.

Oeneis polixenes brucei **Polixenes Arctic**

Identified by the grayish to gray-brown wings without ocelli (small ocelli in a few females), with a dark median unh band edged with white like *O. bore* (this white band stronger than the weaker browner band of *O. melissa*), but the unf lacks the brown postmedian line of *O. bore* and the unh lacks the white veins of *O. bore*. Ssp. ***brucei*** in the U.S. Rocky Mts. has more transparent grayish-brown wings than other ssp. The valva lacks a basal lobe and is narrowed and curved upward to a point bearing fine teeth, but the valvae of it and *O. melissa* are variable and are sometimes very similar.

Habitat mostly moist hummocky alpine tundra (esp. on N-facing slopes) in Colorado, but often reported on dry tundra in New Mex. and in Canada and the arctic. Because of their habitat preference in Colo., they tend to occur in localized colonies. *Oeneis polixenes* and *O. bore* divide up the moist hummocky tundra habitat in Colorado and New Mexico, as *O. polixenes* occurs only in northern Colorado south at least to Mosquito Pass on Park-Lake Cos. (2 specimens caught by Maurice Howard in the middle of the Sawatch Range at Williams Pass in Chaffee/Gunnison Cos. perhaps were *O. bore taygete* which occurs there) (a recent record from San Juan Mts. is also dubious); it does occur in the Sangre de Cristo Mts. in northern New Mexico, while *O. bore* occurs only in southwestern Colorado north to the middle of the Sawatch Range at Independence Pass. Hostplant in Colorado Cyperaceae: *Carex rupestris* var. *drummondiana;* and evidently Poaceae: *Festuca brachyphylla coloradensis*, and perhaps *Helictotrichon mortonianum* and other grasses/sedges. Females oviposit on ~30 cm-wide boulders level with the ground or sticking up ~5-8cm or less in the tundra or sometimes oviposit on the plants next to it, in order to keep the eggs warm, and deposit them mostly near *C. rupestris* var. *drummondiana*, but 1st-stage lab larvae ate none of it (leaves are rather tough) and ate *Poa pratensis* well, so it would be eaten only when leaves are young, or larvae prefer other grasses/sedges that are more tender. (*Carex misandra* is the usual host at Churchill, Man., and several ovipositions were on the grass *Festuca mibra* there.). Often locally common (now quite uncommon at Loveland Pass probably due to collecting).

Eggs dull white with ~30 vertical ribs, laid singly as noted above. Larvae eat leaves, without nests. Older larva elsewhere striped like other *Oeneis*, heart band #1 gray-green (black at joints), #2 gray-tan with blackish streaks, #3 tan with brown streaks, #4 black, #5 dark-gray, #6L lateral ridge pale, #6 gray, with two short tails; head greenish-yellow, the middle stripes on each side broken. Or larva (Colo.) has #1 heart-band alternating black and tan dashes, #2 striated brown and the lower part on segments T3-A5 has tan ovals in black band, #3 striated light-brown, #4 solid black edged by cream or tan lines, #5 mottled-brown, #6L lateral ridge cream or cream-tan, #6 a blackish-brown stripe (an irregular brown line just below), underside light-brown, two short tails; head light-brown with three blackish-brown stripes on each side, a few brown marks on side of frontoclypeus, a small brown crescent (concave upward) behind eye #1. Biennial, larvae hibernating in 1st-2nd-3rd-stages the first winter, in 4th- or 5th-stage the second winter.

One flight July-E Aug. (E July only in early years). Adults fly in even and odd years in Colo., because even-year and odd-year biennial cohorts occur at the same sites (flies mostly in odd years across the arctic but even years in Maine).

Adults occasionally visit white and yellow flowers including *Dryas octopetala*, and mostly the same arctic flowers as *O. melissa*.

Males rait and frequently flait all day in alpine zone swales/hollows among or below moist hummocky tundra, as they rait on or near the ground to await females. They occur on all slopes, esp. N-facing slopes which tend to be moister. In courtship of very receptive females, the male pursues the female, they land, and the male bends his abdomen to join. Males often flutter behind/next to less-receptive females to transfer pheromone, as in other *Oeneis*. Males also bend their valvae in the middle as they squeeze the female's abdomen during mating lasting ~1.5 hours.

Nymphalidae, Charaxinae, Anaeini Goatweed butterflies

Most Charaxinae are tropical (~339 species worldwide), and Colorado has only two species, one very rare stray and the only temperate zone American species, which ranges north to Canada. Adults often feed on sap. Charaxinae larvae often live in silked-leaf nests; the larvae are mostly rather simple, though some foreign species have horns and tails. Pupae are stout.

Anaea andria Goatweed Leafwing

The wing margins are smooth (non-serrated) in this butterfly, unlike *A. aidea*. The fw is hooked, and the hw has a short sharp tail. Females are yellower-orange on ups and have a much stronger ups pattern of black lines and markings and a tawny stripe, whereas males have little pattern. The fall-early spring **overwintering form morrisonii** of this distinctive butterfly has a more pointed fw, and has slightly stronger black markings including darker margins all around the ups wings, and slightly grayer uns, than July butterflies; it results from short photoperiod acting on mature larvae (T. Riley 1988 J. Lepid. Soc. 42:263-268). Adults with wings closed mimic leaves.

Habitat the plains mostly among Cottonwood tree groves where the host is common, esp. in sandy areas. Hostplant in Colorado herb Euphorbiaceae: *Croton texensis*. One of the few butterfly species which have significantly large proportions of their ranges on the Great Plains, in Colorado it occurs only on the plains where the host is common. But adults seem to be highly dispersive, because only rare strays have been found in N Wyo. and Michigan and S Ohio and Ind. It evidently overwinters in S Ill. and much of Mo. and evidently is a breeding resident in Fremont Co. Iowa but is a stray elsewhere in Iowa (Schlicht et al. 2007). It is an uncommon breeding resident in extreme S-C & SW South Dakota including multiple captures in Tripp Co. (Marrone 2002). In Colorado there are records all over the plains, and several were caught in late winter and late fall (Six Mile Can. Boulder Co. Feb. 26, 1950 Don Eff; 2-Mile Can. Boulder Co. E Apr.1967 M Fisher; Fort Lupton in Weld Co. Oct. 22, 1963 J. Scott; Indian Gulch Jefferson Co. Nov.) which seem to represent overwintering adults, so it probably hibernates in most of the Colorado plains. M. Fisher reared it from Lincoln Co. But it is rare in N Colo and commoner in S Colo., so probably it is a year-round usually-overwintering resident in S Colo. including the Arkansas River valley and perhaps in E-C Colo. near Kansas, but may be just an occasional-breeding occasional-stray and occasional overwinterer northward. The record from Dolores Co. in SW Colo. is evidently a stray from New Mexico. Uncommon to rare in Colo.

Eggs greenish-cream, becoming mottled with red on top, laid singly under host leaves esp. on leaf tips. Larvae eat leaves at night. 1st- and 2nd-stage larvae eat the leaf tip except the midrib on which they rest, and they silk dung pellets to their backs and to the uneaten midrib base or tip and rest on the tip, evidently to repel ants. 3rd-stage larvae live in a folded-leaf tent. Older larvae live in a rolled leaf, the leaf edges silked together above the body, the sclerotized head blocking the entrance. Older larva gray-green with many tiny pale and orangish dots, the body thickest at the rear of the thorax, sometimes a weak yellowish line just above spiracles, the abdomen often with subdorsal or several supralateral black patches; head gray-green, with four dorsal bumps and smaller ones on the top and side which are orange, or whitish with brown bases, or the inner bumps white, the outer ones black, three vertical black lines on side and middle of frontoclypeus; eyes black. Pupa stout (coming to a slight point near wing base), light-green, sometimes speckled with white and sometimes with brown, the edges of the wing cases and rim of head and middorsal ridge on T2 and ridge across A4 all cream. Adults hibernate, under bark etc., and then mate in spring.

Two flights, end of June to M or L Aug., then the overwintering-adult generation starting M Sept.-Oct. has been found in L Oct. & Nov. & Feb. & April and evidently lives into May.

Adults never visit flowers (the proboscis is too short for many flowers), but often visit tree sap, and sometimes visit rotting fruit, mud, carrion, bird droppings, urine, rotting wood, and dung. Adults have a fast, powerful, erratic flight. Adults are dorsal baskers, and can warm up by shivering their wing muscles. Adults rest and roost with wings closed; they often land with wings closed on uns of twigs and resemble dead leaves; they seldom land on leaves. If frightened, they may pretend to be dead and drop to the ground and remain motionless, which may help them survive predator attacks.

Males rait all day in clearings among *Populus deltoides monilifera=sargenti* groves in valley bottoms to await females, as they rait an average of ~1.6m up (0-4m, N=12) (P. Opler saw raiting 9m up) mostly on *P. deltoides* branch tips but sometimes on sand or low rocks or logs or tree trunks; on branch tips raiting males may even rest sideways or upside down! In E U.S. males also concentrate along ridgetops (P. Opler).

Anaea aidea aidea Tropical Leafwing

A rare stray from Mexico to Colorado (Denver, Sept. 1975, and possibly El Paso Co.), S Nebraska, and Illinois. Distinguished from *A. andria* by the projections on the hw margin at the end of each vein. The fw is more hooked in the fall/winter **form morrisoni**. Occurs intropical wooded areas in Mex. & S Tex., where the hostplant is several genera of herb & shrub Euphorbiaceae including several *Croton* spp. Eggs laid singly on young leaves. Larvae eat leaves, young larvae make dung chains on the eaten midrib, and older larvae live in a nest of several leaves silked together. Allen et al. (2005) has photo of older larva, which is reddish-cream with wide white lateral band, and reddish-brown supralateral patches on A2, A5, A8, greenish on top of T1 & A9; head pale reddish-brown with some redder little dorsal and lateral cones (including on two rudimentary horns) and ~6 whiter patches around rim. (The Fla.-Caribbean *A. troglodyta* is evidently a different species from *A. aidea*, and has a different larva which is green with white lateral stripe; the head creamy with orange cones/horns.) Larva rests with T3-A2 raised upward into a hump. It flies Apr.-Nov. at least in S Texas. Adults feed on sap, rotting fruit, dung, & mud. Males rait 0.6m to 5.5m up on tree limb tips in clearings/trails, at least in afternoon, to await females.

Nymphalidae, Nymphalinae

Nymphalinae are tremendously variable butterflies, in eggs, larvae, pupae, and adults. There are ~2527 species worldwide. Larvae have various kinds of branching spines (scoli) on the body and very often on the head.

Nymphalidae, Nymphalinae, Limenitidini Admirals

Colorado has just two genera of Limenitidini (which has ~966 species worldwide), *Limenitis* which also occur in Eurasia, and *Adelpha* which has 100+ species in Latin America. Adults of some species of both genera are involved in Mimicry. The larvae have long and short tubercles/projections, and the pupae may have a “saddle horn”. Larvae of *Limenitis* resemble bird droppings, and hibernate in a silked leaf “hibernaculum.” Older larvae lack middorsal BD1 scoli/clubs.

***Limenitis archippus archippus* Viceroy**

Easily identified everywhere: the black postmedian line across the hw always distinguishes *L. archippus* from *Danaus* (except in NE Mexico ssp. *hoffmanni* lacks the line). In Colorado and elsewhere in northern N. Amer. the reddish-orange ssp. ***archippus*** resembles the Monarch *Danaus plexippus*, whereas several southern brown *L. archippus* ssp. (*obsoleta* in Ariz.-W Tex., *watsoni* in E Tex.-Ark.-SC, *floridensis* in Fla.) resemble the brown Queen *Danaus gilippus* ssp. (*thersippus* in Ariz.-Tex., *berenice* in SE U.S.). *L. archippus* was thought to be a Batesian mimic of *D. plexippus*, but *L. archippus* has been found to be somewhat noxious for predators like those *Danaus*, because it sequesters phenolic glycosides from the hostplant *Salix* (Prudic et al. 2007), and D. Ritland (1991 Oecologia 88:102-108) found that Blue Jays only ate 40% of *L. archippus* abdomens (vs. 98% of palatable control butterfly abdomens), so it is more of a Müllerian mimic. A rare *archippus*X*weidemeyeri* hybrid was found in Colo. but I have never found one; rare hybrids between *archippus* and *Limenitis arthemis*, *L. weidemeyerii*, & *L. lorquini* occur elsewhere.

Habitat streamsides/irrigation ditches near *Salix exigua*, primarily in lowlands on the plains and SW Colorado but a little higher on the floor of the San Luis Valley. Hostplants in Colorado small tree/shrub Salicaceae: *Salix exigua exigua, S. exigua interior*. It eats *Populus* (a possible Colo. host) and many other occasional hosts elsewhere, but in Colo. it always seems to be near *S. exigua*, and the same is true in most of Nevada (Austin & Leary 2008). Colo. adults are not seen near Rosaceae (plum, cherry, apple, pear, etc.) that have been reported as hostplants in E U.S. (Scott 1986a). Uncommon in Colo.

Eggs pale-green or pale-yellow, turning grayish later, laid singly mostly on upperside of tips of young host leaves. Larvae feed at night, on catkins in spring, on leaves later. 1^{st}-and 2^{nd}-stage larvae eat leaf tips except for the midrib, they silk dung and leaf bits to augment the base of the midrib and the larva rests out on that midrib, and they also silk a ball of leaf bits and frass to the base of the midrib that may blow in the wind; these frass structures evidently repel ants, and the dung ball may divert predators. Mature larva reddish-brown or brownish-yellow, sometimes olive-green with tan thorax (most larvae are brownish, some are green, photo Allen et al. 2005; a green & white larva photo Neill 2007), five pairs of mammary-like projections (that may be brownish or yellowish or yellow-green) near very top of T3-A8 (T2 has a long reddish-brown or greenish-ochre or yellowish thorny club, a little shorter than other *Limenitis*) (the A7 projection is a little longer than the shortest ones on A3 & A8), thorax looks enlarged (sometimes with transverse whitish ridges on top), a pinkish-white or creamy ragged-edged saddle-like patch on A4-6 that makes the larva look like a bird dropping, a lateral band of cream blotches on abdomen; head reddish-brown (or green) with small thorny spikes. When disturbed, larvae wave their T2 spikes around to repel predators. Older larvae may rest in a J-shape, with rear raised, and front off to the side. Pupa resembles a finless dolphin with a western saddle, brown and white, or mottled with blackish-green, tan, pinkish, and gray, palest on abdomen, darkest near saddlehorn and outer part of wings and rear of abdomen, the saddle horn angled more toward the head than in other *Limenitis*. Short photoperiod of ultraviolet light acting on 2^{nd}- and early 3^{rd}-stage larvae cause older 3^{rd}-stage larvae to diapause (A. Platt & S. Harrison 1988, J. Res. Lepid. 26:177-186), and hibernate in a rolled-leaf "hibernaculum": the larva eats the tip of the leaf except the midrib, silks the remainder into a tube, silks the leaf petiole to the twig, and then enters it so its head is next to the petiole.

Two flights mostly L May-E July and L July-E Sept. (some perhaps-3^{rd}-generation adults fly L Sept.-E Oct.).

Adults visit flowers of all colors, including *Asclepias* and *Cleome serrulata*, and visit mud, and in E U.S. visit sap, carrion, decaying fungi, aphid honeydew, rotting fruit, rotting wood, and dung. Adults bask dorsally, and M. Douglas notes that they can shiver their wings to warm up but seldom do so. Adults glide sometimes, by holding their wings relatively flat to the side.

Males flait, and rait almost as often, all day along creeks and irrigation ditches, as they fly and rait an average of ~1m up (50-150cm, N=9) to await females. In E U.S. they also rait on the ground to 1.5m up, and may flait back and forth ~20m, all day. Males seem to move little when mate-locating, and sometimes a male may stay at one flaiting/raiting site for up to 1-3 weeks. Courtship was not seen. If a mating pair is startled, the female flies, the male dangling.

Prudic, K., S. Keara, A. Solyom, & B. Timmermann. 2007. Isolation, identification, and quantification of potential defensive compounds in the viceroy butterfly and its larval hostplant, Carolina willow. J. Chem. Ecol. 33:1149-1159.

Limenitis arthemis astyanax Red-Spotted Purple

A large black butterfly with the uph bluish with whitish-blue spots and no tails. A rare stray from Nebraska and Kansas to eastern Colo., caught in El Paso, Arapahoe, and Sedgwick Counties. Scott (1986a) describes the other ssp. and genetics of this species (the blue hw and red uph spots are due to several genes, the white band of ssp. *arthemis* is due to a recessive gene). Adults of the Colo.-E U.S. ssp. ***astyanax*** and the Ariz.-Mex. ssp. *arizonensis* mimic the unpalatable *Battus philenor*, whereas in NE U.S. and most of Canada adults of ssp. *arthemis* and *rubrofasciata* have wide white stripes and are not involved in mimicry.

Habitat open areas with host trees. Hostplants unknown in Colorado: various deciduous trees and shrubs in E. U.S. including *Prunus*, *Populus*, *Quercus*, *Ulmus*, etc. A rare stray in Colo.

Eggs whitish-green or whitish-tan, laid singly on ups of host leaf tips, preferably of young plants. Larvae eat leaves. Young larvae rest on a long bare midvein at the leaf end augmented with frass silked onto that midvein base, and may make a leaf ball of frass and leaf bits that swings about near the base of the bare midvein, like other *Limenitis*. The older larva resembles a bird dropping and is similar to *L. archippus*, brown with white saddle on A4-6 connected to a lateral cream irregular band, two mammary-like white or yellowish domes on A2 and some smaller dark ones along body including A7-8, grayish or creamy transverse ridges on T3 and T2 with two long dark-brown or black sticklike spiky projections on T2 (longer than those on *L. archippus*) (some Ariz. ssp. *arizonensis* have black ground color); head reddish-brown (sometimes creamy-brown) with little spines. Pupa similar to *L. archippus*, often white esp. a lateral whitish stripe and whitish midventral stripe on abdomen, with brownish wings head thorax saddlehorn and rear, the saddle horn sometimes less or more angled. 3rd-stage larvae hibernate in a hibernaculum.

Evidently two flights most commonly June and August eastward where those strays came from.

Adults sometimes visit various flowers of many colors, and in E U.S. also visit sap, rotting fruit, rotting fish, carrion, honeydew, Cercopid spittle, mud, dung, urine, blood, and decaying wood. Adults bask dorsally, and can warm up by shivering the wing muscles. Adults often fly by gliding with spread wings and occasionally flapping the wings.

Mate-location possibly occurs all day, but nearly all the reports suggest males mostly rait and often flait from 11:00 through afternoon, mostly along linear rows of bushes/trees (ssp. *arizonensis* sometimes on hilltops). A. Porter (1989 Amer. Midl. Nat. 122:275-280) wrote that ssp. *arizonensis* males mostly “patrol” (maybe he meant just “fly”) fast before 11:00 and later rait on shady side of trees/shrubs in a stream bed, and found 3 mating pairs 14:00-17:00. R. Lederhouse (1993 J. Lepid. Soc. 47:22-31) reported that ssp. *arthemis*X*astyanax* usually rait 82% of the time 1-7 m up [esp. 2m] mostly from 11:00-16:00 on linear hedgerows in NY and flait 14%. And Opler & Krizek (1984) report that males rait on tree foliage and periodically fly back and forth (flaiting), but do not stay as long as *L. archippus*, and note that A. Shapiro (Butt. New York State) reported that mate-locating behavior occurs in afternoon. E. Shull found two mating pairs 14:25 and 15:45. I saw S. D. males fleek along trees in early afternoon, and sometimes rait in clearings to find females, about 1-2m up. Ssp. *arizonensis* mostly raits on willows in Ariz. I saw a male in C Texas flying around on a hilltop in afternoon, and a male briefly raiting on a hilltop in Minn. All *Limenitis* bend their valvae in the middle during mating (A. Platt 1979 J. Lepid. Soc. 32:305) like *Erynnis* (probably numerous butterflies can do this, it just hasn't been noticed).

Limenitis weidemeyerii Weidemeyer's Admiral

The white bands and the mostly-white unh are characteristic of this species. On unh the inner row of blue marginal crescents is thicker than the outer row, and a black line is between those rows. Ssp. ***weidemeyerii*** occurs east of the continental divide, and westward adults average a slightly wider white band so can be called ***weidemeyerii*X*latifascia*** (pure ssp. *latifascia* from Utah-E Calif. has wider white bands). It is not quite a separate species from *L. lorquini* (though their valvae differ slightly, the valva tip has numerous small spikelets in *weidemeyerii*, versus mainly just one long spike in *lorquini*), because in E Calif. *L. weidemeyerii* form fridayi is intermediate with fw tip slightly orange, and a reddish-brown line between the rows of blue unh marginal crescents (form fridayi is uncommon at/near Mono Lake and at Lee Vining Creek and Devils Gate Summit & Sweetwater Mts. [it is a majority in Sweetwater Can.] in Calif. to the Wassuk Range Nev.); fridayi represents somewhat-inferior hybrids between sympatric *lorquini* and *weidemeyerii* there and every locality has different frequencies of the three kinds, whereas in N Nev. in Santa Rosa & Pine Forest Ranges etc. a stable population of mostly hybrids occurs with some pure *weidemeyerii*). They have been considered to be just ssp. (A. Porter 1990 Syst. Zool 39:131-147) as N Nev. suggests, but hybrids are somewhat inferior in the Mono Lake area (Boyd et al. 1999), and they do not hybridize in W Mont. So they are not-quite separate species; they belong to stenchospecies *L. arthemis*.

Habitat canyons and valley bottoms from the plains to Canadian Zone. Hostplants in Colorado tree and shrub Rosaceae: *Prunus virginiana var. melanocarpa, Holodiscus dumosus, Amelanchier alnifolia*; Salicaceae: *Populus angustifolia, deltoides monilifera=sargenti, deltoides wislizeni, tremula tremuloides, Salix exigua, irrorata, drummondiana, amygdaloides*. The same genera are reported as hostplants in Nevada (Austin & Leary 2008)! My larvae even ate *Malus pumila* (apple, Rosaceae) in lab. Moderately common.

Egg whitish-green, laid singly on ups of host leaf tips, often on young plants. Larvae eat leaves, with feeding and resting habits similar to other *Limenitis*. Older larva resembles a bird dropping: olive-green, the thorax mostly yellowish-tan, or larva grayish, mottled with gray and white patches, or larva often just variegated reddish-brown, abdomen with a cream or yellowish-tan saddle on A4-6 connected with a broad irregular white lateral band, T2 mostly cream with long sticklike spiny black projections, and mammary-like mounds on A2 (this one yellowish) and A7-8 and smaller ones elsewhere; head red-brown, with small spines. Pupa blackish-brown (including the end of abdomen and the saddle horn), with a black streak extending obliquely back from the saddle horn, the basal 2/3 of wings paler or whitish (outer part or most of wings darker), the top of head and thorax tan, abdomen whitish with a pink tint and some tan and slight greenish mottling on top, the saddle horn slightly more circular in outline than *L. archippus*. 3rd-stage larvae hibernate in a hibernaculum.

One flight June-E Sept. (the Sept. ones partial 2nd gen.?) but mostly L June-E Aug. (this long flight-spread occurs even in plains/foothills and Arkansas Canyon).

Adults sometimes visit flowers of all colors, including *Apocynum androsaemifolium, Physocarpus monogynus*, often visit tree sap (some made by sapsucker birds), sometimes imbibe fluids from Coccidae and aphids, sometimes visit carrion and dung, and often visit mud. Adults bask mostly dorsally, and in very hot weather they can rest on a shaded bank. Males seldom appear to wander, yet marked males in Saguache Co. moved 75m, 146m, 1288m, and I saw several males flying over the top of Green Mtn. near Denver.

Males rait all day in gulches and valley bottoms to await females, as they rait on dicotyledon bushes and tree limbs an average of ~2.5m above ground (1.2-4m, N=66), and often glide about (a bit of flaiting) before returning to a raiting spot. In courtship, the male overtakes the female and they hover some (males surely move below the female and rise up to buffet her as does *L. lorquini*—a male was seen to fly under another male then up and back around him in a vertical circle ~15 cm diameter ~20x, evidently transferring pheromone while thinking the male was a female), she lands with wings closed, he lands behind and spreads his wings fully or nearly so and vibrates them near her a lot, or sometimes vibrates his nearly-closed wings, or he just flutters his wings widely, and tries to join (receptive females would remain motionless and allow the male to join). Unreceptive females often crawl under the twig to hang (the male sometimes crawls under to try to mate) or crawl or fly away or fly high in the air to try to elude the male. Once a male and female were seen to vibrate their nearly-closed wings after landing (the male more motivated than the female). Males investigate white butterflies such as *Pieris rapae*, but seldom the orangish *Poanes taxiles* or the brown *Euphyes vestris* (though a brown *Asterocampa celtis* was investigated). {G. Lederer (1960, Zeit. fur Tierpsychologie 17:521-546) found European *Limenitis camilla* rait and approach flying objects or find landed wings-spread females, and recognize females by the pale-against-dark wing bands, males pursue and flutter near the female and she lands with him behind, if her odor is attractive the male may tap his antennae and creep under her spread wings and nudge her with his palpi, then they mate if the female is receptive.}

Boyd, Bret, Bruce Boyd, G. Austin, D. Murphy 1999. Hybridization of *Limenitis* in the western Great Basin (Lep.: Nymphalidae). Holarctic Lepid. 6:37-74.

Limenitis lorquini lorquini Lorquin's Admiral

A rare stray to Colo., recorded from Garfield, Mesa, and La Plata Counties. It is also a stray in Utah and W Wyo. and is a native only in BC-W Mont.-Ida.-Nev.-Calif., so it would seem to occur in Colo. only because of human transport of ?nursery trees. Resembles *L. weidemeyerii* and also has much white on unh, but *lorquini* has a russet fw tip and a diffuse red line between the marginal rows of blue unh crescents (this line is black in *weidemeyerii*); the valva apical spine differs a little. Closely related to *L. weidemeyerii* and mostly allopatric to it: many hybrids (form fridayi) occur just E of the Sierra Nevada (at Mono Lake etc., see *weidemeyerii* writeup above) and introgressed populations of *L. weidemeyerii* occur in N Nevada where form fridayi is more common, although in W Montana they do not hybridize. Adults are edible to Blue Jay birds, and are Batesian mimics of *Adelpha californica* which is distasteful to those birds (Prudic et al. 2002).

Habitat mountains esp. valleys with deciduous trees. Hostplants elsewhere trees and shrubs mainly Salicaceae (*Salix* and *Populus*), sometimes Rosaceae (*Prunus*, etc.).

Scott (1986a) describes immatures (older larva very similar to *L. weidemeyerii*); Allen et al. (2005) & Neill (2007) have photos. Eggs whitish-green. The young larva chews the leaf and leaves a vein and augments it with dung pellets and rests on that vein to deter predators, like *L. archippus*. Older larva resembles a bird dropping, reddish-brown or dark-brown with white or pinkish-tan on thorax, and a white lateral band on abdomen that merges with white (or pinkish-gray) saddle on A4-6, two long black clubs on T2, two large dark-red mounds with tiny black "teats" on A2. Pupa resembles *L. archippus*, slick brown with whitish T2-3 & A4-6 mostly, a white lateral band on abdomen, some blackish subdorsal raised blotches on T3-A4, head wings & rear dark-brown. 2nd (supposedly) and probably 3rd-stage larvae overwinter in a hibernaculum.

Adult habits are like *L. weidemeyerii*. They frequent flowers, sap, and mud. Adults often rest with wings partly open, and *Limenitis* often fly with the wings mostly spread to the side. A rare transport to Colo.

Males mostly rait all day in valley bottoms, as they rait on shrubs ~2-3m above ground to await females, and Shapiro (2007) notes that they also flait back and forth along streamsides. In courtship, the male overtakes the female, and rises up to buffet her from beneath to transfer pheromone, then they presumably land and join if the female is receptive.

Prudic, K., A. Shapiro, & N. S. Clayton. 2002. Evaluating a putative mimetic relationship between two butterflies, *Adelpha bredowii* and *Limenitis lorquini*. Ecol. Entomol. 27:68-75.

Adelpha eulalia Mexican Sister

A rare stray to central and SE Colo., but evidently more common in SW Colo.; it is widespread and fairly common farther north in latitude in Utah. *A. eulalia* is reported to be sympatric with *A. bredowii* in S Mexico where they eat different *Quercus* species, so *A. eulalia* is evidently a distinct species ranging north to Ariz.-Texas. Like *A. bredowii* and *A. californica*, it has an orange apical fw spot and has a broken white fw band. *A. eulalia* has one orange unh discal cell bar and two wavy dark-blue unh submarginal lines, distinguishing it from *A. californica* (Calif.-Ore.) which often has two orange bars and the inner line is wider and paler blue and mostly straighter (but the blue varies in width and shape and pallidity) (*A. californica* is presumably a distinct species also, and differs in venation). It resembles the Calif. *Limenitis lorquini*, and in California *Adelpha californica* is the poisonous (to birds) model and *L. lorquini* the Batesian (edible) mimic (Prudic et al. 2002). So perhaps *A. eulalia* is poisonous also. The Mexican butterfly *Doxocopa pavon* females mimic A. *eulalia* yet eat *Celtis* so are evidently Batesian mimics of the presumably poisonous *A. eulalia*.

Habitat lower mountains mostly at low altitude, especially in *Quercus gambelii* areas. Hostplant in Colorado tree Fagaceae: *Quercus gambelii* (*Q. turbinella* is also eaten in Utah). A rare stray.

Egg green, laid singly on leaf edge at the base of a spine (if spine is present on that *Quercus* species). Larvae eat mature leaves. 1st-stage light-brown. Young *californica* larvae leave the midrib/vein and extend that vein by silking dung pellets to it, then rest on the dung portion when they are not feeding, evidently to repel predators (ants repelled by dung perhaps), and they use the excess dung to silk together a ball of leaf bits and dung that hangs from the leaf base and blows in the wind, perhaps to divert predators. Older larvae attempt to bite if disturbed. Older larva (Utah *eulalia*) green but becoming yellow on sides of abdomen containing spiracles, just below that a reddish-brown line demarcates the top of the orangish-brown uns, collar pale-brown, with six pairs of brown dorsal tubercles (those on middle of abdomen much shorter); head tan, with brown vertical bands, and some short spines. Older larvae rest in a cryptic position with the front and rear looped upward, the body hunched upward at about segments A1 and A8. L2-4 (only 4 stages occur unlike other *Adelpha*) have a ventral neck gland evidently producing a noxious smell for defense (James & Nunnallee 2011 for *A. californica*; James et al. 2012). Pupa creamy, abdomen tan with fine brown marks, wing cases reddish-brown, cremaster area brown, a conspicuous saddle horn, the head with short horns. Larvae hibernate (probably early L3 of 4 stages), but not in a hibernaculum.

Adults have been found in Colo. in May-June and Aug.-Sept. (evidently two flights are possible here, with occasional breeding—I found an adult at Tinytown in Sept. which probably grew on *Quercus gambelii*, because earlier I found an adult of the first generation there). In Texas it reportedly migrates eastward in droughts, but Colo. adults come north.

Adults sometimes visit flowers, and very often visit mud, and elsewhere are known to visit aphid honeydew and rotting fruit (and *A. californica* visits sap, rotten fruit, spilled wine, dung, honeydew, & carrion). Adults bask dorsally. Adults often glide slowly with wings spread. Adult *californica* usually keep the wings open even at mud.

Males fleek and sometimes rait 2-3m up esp. in gulches, at least from late morning to late afternoon (probably all day) to find females, as they often glide, and male *californica* may keep the wings open while raiting.

Prudic, K., A. Shapiro, & N. S. Clayton. 2002. Evaluating a putative mimetic relationship between two butterflies, *Adelpha bredowii* and *Limenitis lorquini*. Ecol. Entomol. 27:68-75.

Nymphalidae, Nymphalinae, Heliconiini

Heliconiini now combines what once was considered to be two tribes Heliconiini and Argynnini, which are now demoted to subtribes Heliconiina and Argynnina, totaling ~661 species worldwide. Most Heliconiina species are neotropical, whereas most Argynnina species are boreal (some are in the Andes, and many are Holarctic). The two subtribes are similar, and the genera *Euptoieta* and *Dione* are "missing links" between them. Both subtribes have species that eat *Passiflora*. Males of both subtribes have androconial scales on their ups wing veins, adults of both have similar pheromone systems, and during mating of both the male abdomen tip even transmits a substance to females that repels later males. Larvae lack middorsal branching spines (scoli) thus BD1 is absent (the uppermost scolus is BD2), as the dorsal scoli are positioned away from the middorsal heart-line, but they have head spines. Adults bask dorsally.

Nymphalidae, Nymphalinae, Heliconiini, Heliconiina Heliconians

Heliconiina mostly occur in the American tropics, with a few others in tropical Asia. Heliconiina larvae have branching spines on the head, and pupae often have long processes, which Argynnina lack. Heliconiina larvae usually eat Passifloraceae. Many species are unpalatable to vertebrates such as birds, and are members of five different major Müllerian mimicry complexes in the neotropics, involving Ithomiini and Danaini and some *Phyciodes* and some Pieridae and other butterflies. (The rest of this paragraph refers mostly to *Heliconius*.) Behavior of *Heliconius* is rather amazing, some of which is reported below for species that are just rare strays to Colorado. Older larvae have a ventral neck gland, and *Heliconius erato* uses it to get rid of attacking ants, by squirting some non-volatile stuff onto an intruding ant and silking it into a ball then passing it back beneath the body with legs and prolegs until it is past the rear (Borges et al. 2014). *Heliconius* adults can adapt to live in greenhouses and fly normally. Adults trapline through their habitat to find flowers and hostplants and communal roosting sites. They feed on pollen rolled up in their proboscis; knobs on the proboscis pick up pollen incl. from Cucurbitaceae flowers (*Anguria* & *Gurania*) and they roll it up with their proboscis and exude saliva into a drop filling the rolled proboscis to absorb amino acids from the pollen, then suck the saliva, which enables adults to live up to 6 months. This saliva has cocoonase, the same chemical that enables silk moths to digest their cocoons (PBS TV show "Butterfly Blueprints" Jan. 2022). Males are attracted to female pupae and can mate with the female before she emerges. Pupae make squeaks, and adults can hear (a membranous spherical sac in axillary sclerite of uph base where $Sc+R_1$ and Cu join is sensitive to 1200hz; a similar organ on upf base evidently does not hear [S. Swihart 1967 J. Insect Physiol. 13:469-476]). During mating a gland on the male's valva transfers a chemical onto the female's "stink club" which repels other males later (though the stink club is absent in Mexican *Dryadula*). Those male-contributed repellent pheromones are complex mixtures that are very variable between species; they serve to repel harassing males (C Estrada, S. Schulz, S. Yildizhan, L. Gilbert 2011 Evolution 65:2843—2844). Their *Passiflora* hostplants in the tropics have evolved to minimize damage from *Heliconius* larvae, by evolving numerous different leaf shapes in the numerous species; *Passiflora adenopoda* evolved hooked trichomes to hook into larvae and kill them, and several *Passiflora* have stipules that resemble *Heliconius* eggs to keep females from ovipositing.

Heliconius charithonia vazquezae Zebra Heliconian (Zebra Long Wing)

Easily identified by the zebra stripes and the long wings. A rare stray to Colorado, known from 9 counties on the plains. *Heliconius* are special butterflies that are good at learning their habitat (its hostplants and nectar flowers and roosting sites etc.), and can adapt to flying in a greenhouse where many other butterflies just mindlessly batter against the windows; adults can learn the locations of flower sites and roosting sites and then repeatedly "trap line" there to get nectar and pollen and roosting spots. Adults are unpalatable to birds etc. because of their bad odor and yellow juice, due to the cyanogenic glucosides linamarin & lotaustralin (precursors of cyanide) that are synthesized by the butterflies from valine & isoleucine the larvae get from their *Passiflora* food (A. Nahrstedt & R. Davis 1983 Comparative Biochem. & Physiol. 75B:65-73). In Mexico, adults are models for the Batesian mimic *Itaballia viardi*, Coliadinae).

Hostplants southward vine Passifloraceae. Females can oviposit up to 1000 eggs in their life, on meristems of *Passiflora suberosa* in Fla., *P. lutea* and *P. affinis* in Tex., *Passiflora* (*Plectostemma*) species and *Tetrastylis lobata* in Costa Rica (J. Smiley 1985 Oecologia 65:580-583). The hostplants do not grow in Colo.

Scott (1986a) details the early stages. Eggs yellow, laid singly (sometimes in a cluster of 2-5) on terminal leaf buds or leaves. Young larvae prefer meristems; older larvae also eat leaves and feed at night; no nests. Allen et al. (2005) and Wagner (2005) have photos of the older larva, which is white with black spots and very long narrow black scoli, the underside black, the prolegs brown; head whitish with 6 large black spots (the dorsal two have small scoli) and black mouthparts. The very long pupa is mottled brownish-orange with silver or gold spots on top of the saddle and head, flanges on the abdomen, short spines, and two long flanged horns on the head. Pupae can make a faint squeaking sound. They cannot survive freezing Colo. winters.

A rare stray to Colo. Adults fly most of the year in Mexico.

Adults visit flowers esp. white or bluish ones to gather nectar, trap-lining the route each day between flowers, and gather pollen loads into the loop of their proboscis and secrete saliva into the loop, which causes the pollen to release amino acids and peptides, then they suck up the drop containing those nutrients from the pollen, then they discard the pollen after several hours; those nutrients allow them to lay 1000 eggs and live up to 6 months in greenhouses (in nature marked adults live an average of ~40-50 days, up to 133). Adults flutter slowly along and fly with very shallow wingbeats as they keep the wings mostly to the side. Adults roost in groups of up to 70 or more (but average just 4-5), usually within 2m of the ground (sometimes 3-4m up) on twigs, tendrils, or leaves, returning to the same roost every night (they do this to suffer fewer losses from predators such as birds who may taste one and learn not to eat them). New recruits evidently follow others from pollen sites to the roost site. {In *H. erato*, roosting adults usually share the same trapline route to flowers.}

Males fleek mostly within several m of the ground to find females, evidently all day. Late female pupae produce the male-attracting pheromone linalool oxides (furanoid) (C. Estrada et al. 2010. Proc. Royal Soc. B: Biol. Sciences 277:407-413). The male is attracted to a mature female pupa by her pheromone (not attracted to male pupae), and most females are mated before they emerge (Dr. William Wittfeld [M.D.] of Florida was the first to observe this, as reported by W. Edwards 1881 Papilio 1:209-215); up to three males hang from one female pupa and when the female is about to emerge one male breaks through and mates with her before she has emerged. Despite this trauma, after mating the female can emerge and spread her wings. Females mate just once and mating lasts >2 hr. (C. Boggs 1990, Amer. Nat. 136:598-617), whereas males can mate several times. If the mating pair (a female first mated after emergence) is startled, the male flies, the female dangling. The anti-aphrodisiac pheromone on the female stink club is beta-ocimene, manufactured from glucose in adult butterflies (S. Schulz 2008. J. Chem. Ecol. 34:82-93).

{Courtship of the females that manage to emerge before being mated is probably similar to that of ***Heliconius erato***, described by Crane (1957): Males evidently fleek most of the day to seek females, ~1-2m up more or less. Female *erato* generally mate <u>after</u> emergence from the pupa (J. Mallet 1986 Oecologia 68:210-217); my sister found a mating pair *H. erato* at 10:30 in Honduras, proving they do mate sometimes after the female emerges from pupa. The male nudges a resting female making her fly, then pursues her or pursues a flying female until she lands (the male or female may try to fly above the other before landing), the male fans her from behind and she elevates her abdomen and extrudes her dorsal abdominal glands to waft its pheromone that attracts males (these glands presumably produce the attractant pheromone until after mating when a chemical from the male converts the glands to repulsion), then she closes the anterior margin of her forewings but the posterior margin and her hindwings are spread and vibrated. The male then fans her from in front, separating his forewings and hindwings, to transfer pheromone from his uph scent scales to her. She closes her wings, lowers her abdomen, and withdraws the glands, then he lands, still quivering, and joins. Young females have fewer wing movements in courtship than older females. During mating the male deposits a repellent pheromone from a pocket-gland on his valvae (H. Eltringham 1925 Trans. Royal Entomol. Soc. London p. 263) onto her two abdominal A7 stink clubs (L. Gilbert 1976 Science 193:419), and when the abdomen is retracted after mating the stink clubs evidently swing dorsally and the chemical is then transferred onto her dorsal yellow abdominal gland, evidently converting the attractant pheromone there into a repulsive pheromone (smelling like "witch hazel"), which in mated females of all *Heliconius* females repels other males (she spreads her wings and raises her abdomen and exposes the glands to repel the male) (I am deducing the apparent pheromone mechanisms here, which have not been fully investigated and chemically identified). If a mated female is brought near males hanging onto a female pupa, the stink causes the males to fly away by convincing them that the pupa has already mated. Unreceptive females spread her wings so that the male cannot join, and unreceptive females may flutter her wings to repel the male. Males are several days old before they can mate.}

Crane, J. 1957. Imaginal behavior in butterflies of the family Heliconiidae: changing social patterns and irrelevant actions. Zoologica: 42:135-146.

Dryas iulia moderata **Orange Long Wing (Julia Heliconian)**

Identified by the very long orange wings. A rare stray to Colorado from Texas/Mexico, recorded from El Paso Co. Far southward it is involved in Müllerian mimicry with *Dione vanillae* and others; it is unpalatable to tanager birds.

Hostplants southward vine Passifloraceae: *Passiflora* (including nearly all subgenera). Adults are distasteful to birds. A rare stray.

Early stages are detailed in Scott (1986a). Each female can lay much more than 100 eggs. Oviposition begins 3-7 days after eclosion. Eggs laid singly, usually laid on new terminal growth such as tendrils and tender leaves, sometimes on dead tendrils or old leaves. Some hostplants produce stipules that attract egg-laying females, then the stipule drops off carrying the egg with it, thus protecting the plant from damage. Photos of larva in Wagner (2005) & Minno et al. (2005): larva brown, with mostly whitish top, numerous brown & black & white transverse lines over top, a light-brown heart-band, a lateral band of twinned-white spots (the larger ones may lead to wide white diagonal marks extending up and back to BD2 scolus [photo in R. Neck 1996 Field Guide to Butt. of Tex.]) and red or brown diagonal dashes/spots, white spots on abdomen uns, red or brown legs/prolegs, and humongous long narrow black scoli that exude yellow or greenish fluid that cause a rash on human skin (A. Muyshondt noted that larvae cause a rash on human skin, probably because of fluid exuded from scolus tips, which can snap off); head orange-brown or white, with black triangular markings in "eyes and nose and cheek" positions, rear red-brown, with two long black spiny horns. Larvae are unpalatable to predators such as birds and lizards owing to cyanogenic glucosides that come from valine & isoleucine in their *Passiflora* hostplants. Pupa like *Dione vanillae* in shape but the fin-like dorsal projections on abdomen much more prominent, color brown and whitish resembling bird dung, with cream lateral and near-top lines on abdomen, cream costa of wing, with silver spots in the thoracic depression. No diapause stage.

Adults visit flowers (esp. red and bluish ones) and *Lantana* fruits and may trap-line to visit them repeatedly, often visit mud/sand to get dissolved minerals, and sometimes sip the tears of alligators & turtles evidently to get salt. Adults live only a few weeks (max. 32 days) and do not feed on pollen. Adults roost alone or in small groups near the ground on grass leaves, etc.

Males fleek all day to locate females. In courtship (J. Crane), males approach females from behind, the female flies if she was not already flying, he flies above and in front of her while fanning her with his scent scales, she tries to rise above the male but eventually lands, he fans her while above and in front of her (facing the same direction), she spreads her hindwings and partly spreads her forewings, and she vibrates them while raising her abdomen and extruding her scent glands, he fans her from behind then from in front, she closes her wings and lowers her abdomen and withdraws her scent glands, then he lands beside and they join. Males have a genitalic scent gland used during mating, as in *Heliconius charithonia*, evidently to convert the female to male-repulsive mode. Females can mate up to 4 times. If a mating pair is disturbed, the male always flies.

***Dione* (*Agraulis*) *vanillae incarnata* Gulf Fritillary**

Resembles *Argynnis*, but the fw is longer, and the unh silver spots are elongated. It is the connecting link between *Heliconius* and *Argynnis*, because *Dione* and *Euptoieta* have similar hostplants, and *Argynnis* also has silver unh spots like *Dione*. A rare stray to Colorado in the summer, recorded from 20 counties over most of the state except the NW, but it is evidently a regular migrant (rarely to Wis. and N.D.). In northern Florida T. Walker and others used malaise traps and found that it flies N about Feb.-June, S from Aug.-Nov. (more precisely, it flies SSE from E Sept.-L Oct., with peak flight ~Sept. 22). It is involved in Müllerian mimicry with *Dryas iulia* in Mexico, and adults are unpalatable to tanager birds.

Habitat semitropical and tropical open woodland and brushy areas. Hostplants southward vine Passifloraceae: many species of *Passiflora* of all subgenera. Despite alkaloids in the hostplants that make larvae distasteful to birds (tanagers at least) (*Passiflora* have cyanogenic glycosides), insect predators and lizards and roadrunner birds sometimes eat them, and parasitoid tachinid flies kill the larvae. An occasional stray to Colo.

Eggs yellow, becoming mottled brown, laid singly on hostplant leaves, stems, tendrils, and buds; larvae eat those at night, and rest in a J-shape. Older larvae variable (Wagner 2005, Allen et al. 2005, Minno et al. 2005), some are all orange except for black scoli and dark heart-band, in E U.S. often orange with dark heart-band, a dorsolateral mottled white above orange above brown stripe along BSD scoli, a lateral brown stripe, and a subspiracular orange above white-crescents stripe; slaty-gray in Calif., in much of the west grayish-black, with a red band beside slaty heart-band, a red row of crescents beneath each BD2 scolus, and a broken red lateral band under the BSD scoli (with a whitish line edging the bottom); 6 rows of long black scoli; head black (or whitish in Calif.) with a reddish patch on top and on side; a reddish crescent on side of face, and two black long scoli. Pupa brown or reddish- brown (mostly whitish-gray in Calif.) (mottled with gray and brown patches) or greenish-brown or blacker, a reddish-tan lateral band on abdomen edged beneath with greenish-brown (or whitish on A4-8), two pink spots on head, a black figure 3 or streak on wing, silver spots on top of the saddle, small subdorsal keels on abdomen, subdorsal bumps on thorax, and two short appendages on head, the wings bulging downward and start of abdomen depressed and dark, head pointed. This subtropical species does not diapause and overwinters only in warmer places (larvae and pupae may hibernate in N Fla. after their hostplant freezes [A. Sourakov 2008 J. Lepid. Soc. 63:127]; and pupae can survive freezes in Dallas TX [J. Harges 1996 News Lepid. Soc. #4 p. 148-9]); it regularly migrates N to Kansas but then freezes (W. Howe 1965 J. Lepid. Soc. 19:33-34).

Many flights all year in S. Fla., S Tex., and S Calif.

Adults visit flowers including *Asclepias, Buddleja davidii, Cirsium vulgare, Clematis, Lantana camara, Verbena*, and sometimes feed on mud. They like yellow colors but can learn others. They do not feed on pollen and only live a few weeks to a month in nature. Adults bask dorsally, and M. Douglas (in Douglas & Douglas 2005) notes that adults are apparently not able to warm up by shivering their wings. Adults may roost in groups of 6-16 or alone, mostly near the ground on grass leaves.

Males fleek all day to seek females, flying “close” within several m of the ground. In courtship (R. Rutowski & J. Schaefer 1984 J. Lepid. Soc. 38:23-31), the male overtakes the female and they slow and the female lands, the male often hovers over her then lands beside her at an angle, and he opens his wings halfway and "vibrates" them (he claps them closed and opens them 0-90^o open) ~30 times in a ~5 second burst (6 claps/sec.) to transfer his upf pheromone to her antenna (which often rests between his wings) (some males do not vibrate their wings) and bends his abdomen to join. Receptive females are nearly motionless (she may expose her dorsal abdomen-tip gland hidden between the hindwings which before mating evidently transmits a pheromone attractive to males, as proven by Tveten & Tveten [1996] who found males mating with newly emerged females sometimes before her wings were expanded or just as she emerged from the pupa); unreceptive females flutter their wings frequently to repel males, or spread their wings and raise the abdomen to expose the two "stink clubs" attached to the underside of A7 on her abdomen (those clubs after mating and a transfer of a "stink" chemical from the male evidently work in a system with the dorsal scent gland to repel other later males). Females usually mate just once, often several times. Mating lasts ~78 min. If a mating pair is disturbed, the male flies, the female dangling.

Dione moneta poeyi Mexican Silverspot

A rare stray to Colorado (one record Jimmy Camp Creek Park, El Paso Co. CO April 18, 2017, Sharon Milito photo on white plum flowers). Resembles *Dione vanillae*, but the unf is extensively black, and the ups wing bases are brown. Hostplants vine Passifloraceae southward: *Passiflora* spp. Eggs laid singly or up to 23 in a cluster, on leaves, stems, tendrils, & buds. Early stages similar to *D. vanillae*, described by Scott (1986a). Older larva dark red with three parallel yellow dorsal stripes, a pale lateral stripe, black scoli and collar; head black & white with two branching spines. Pupa rust-brown with wing streaks, metallic spots on A2, flanges on abdomen and short head processes. It flies most of the year in Mexico. Adults visit flowers and mud. They fly faster than *D. vanillae*. Adults also roost in loose groups, mostly near the ground on grass.

Nymphalidae, Nymphalinae, Heliconiini, Argynnina

Argynnina are basically the Holarctic portion of Heliconiini, although a few species occupy Africa, the Asian tropics, and South America including the Andes. Many have silver spots on unh, present on most *Argynnis* and some *Boloria* (and present on the Heliconiina genus *Dione*). Larvae lack branching spines on the head that are present in Heliconiina, and lack middorsal BD1 scoli on the body, and pupae are simpler without the long processes of some Heliconiina. Older larvae of most *Argynnis* and even *Boloria selene* & *bellona* have a fairly similar pattern of twinned pale middorsal lines, and black blotches and paler oblique dashes in the area around BD2 and BSD scoli (forming a pale tapered dual-dash mark aimed anteriorly from those two scoli). Many *Argynnis* species have both paler and blacker older larvae (the blackest are *A. diana*, some *aphrodite*, *cybele, hydaspe*, some *mormonia*, some *egleis*, some *hesperis*, some *zerene*). Older larvae generally have a ventral neck gland evidently producing a predator-detering stink. 1st-stage larvae seem to have evidently-defensive droplets on their long seta tips. The number of vertical ribs on eggs varies, from ~20 in *Euptoieta* and most *Argynnis*, to ~16 in *A. atlantis* and some *A. hesperis* and *A. hydaspe* and *A. cybele*, and *Boloria selene* 14, *B. eunomia* 19, *B. bellona* 15-19, *B. epithore* 16, *B. astarte* 34, *B. freija* 36, *B. titania* 28. *Argynnis* is an amazing Holarctic genus (called *Speyeria* until recently, and many people still use that name); in North America in 1900 people thought there were about a hundred species of them, but Lionel Paul Grey studied and identified 100,000+ specimens collected from mountain ranges and woods and scrub and prairie habitat everywhere in North America for about five decades (specimens assembled by dozens of people including J. Scott, which Grey identified and returned), and carefully studied how they change and intergrade across the continent, and reduced the number of N. A. *Argynnis* species to only 14 (we now know there are 16 species, confirmed by wing pattern study and morphology early stages etc., and confirmed using DNA by Thompson et al. 2019). Adult *Argynnis* have a complicated pheromone system: males have androconial scales on upf and base of uph that transmit a fragrant pheromone to seduce females, and the male abdomen tip has a pheromone (reportedly stronger in *A. idalia*) that evidently transfers to the female and interacts with her dorsal A7-8 gland attractant pheromone after mating to produce an obnoxious stink that repels other males (the hairlike ventral scales on A8 help waft the before-mating attractant). Adults have darker ups wing veins, which evidently helps warm the hemolymph a little during dorsal basking. Adult *Argynnis* & evidently *Euptoieta* mostly keep their wings spread while they flower-feed. *Argynnis* shiver with wings spread to get warm.

Euptoieta claudia Variegated Fritillary

Easily identified by the unique unh pattern.

Habitat open areas including grassland, fields, scrub, and open woodland, even above timberline sometimes, but more common at low altitude. A dependable migratory species (they migrate as far as S Canada). *E. claudia* migrates every year into Colorado, I saw them migrating averaging roughly to the ~NNW every year (although 2017-2018-2019 were poor years with fewer migrants) from the end of April to M June depending on the earliness of the season, then they often produce a generation mostly in L June-E July which often produces many adults in L July, which produce scattered adults later in Aug.-Oct., then some migrate south (roughly averaging to ~SSE) Sept.-E Oct. (I saw a number flying S in Kit Carson Co. Sept. 1, 1986) to return to the moister areas in Texas-SE New Mex.-Ariz. to breed. Fairly common.

Hostplants in Colorado herb Violaceae: *Viola nuttallii, adunca, tricolor* (vars. *tricolor, hortensis*), *sororia*, *~odorata*, *Hybanthus verticillatus*; Linaceae: *Linum lewisii*; Crassulaceae: *Sedum lanceolatum* (recent reports prove that females oviposit on *S. lanceolatum* in Colorado & Utah and larvae grow on it in lab).

Eggs pale green or cream, laid singly on leaves and stems of the hostplant. Larvae eat flowers and leaves, feeding by day at least, without nests. Older larva striped with alternating bands of red and bands of white spots (the subdorsal and supralateral rows of white-spots are often engulfed in black bands containing black scoli), the middorsal red band contains only one white dash per segment, many long black spines, prothorax with two very long black subdorsal scoli (twice the length of the others) with enlarged tips, legs black; head darker red. The bright red and black larva probably represents warning coloration, therefore *E. claudia* may be in the same larval mimicry complex as *Poladryas minuta arachne*, *Euphydryas anicia eurytion*/*capella*, and the moth *Meris alticola* (Scott J. 2016c), and resembles *Dione vanillae* and *Dryas iulia*, as a Batesian mimic if birds probably do not consider Argynnina palatable. Pupa pale shining blue-green, with small black dots and streaks including longer streaks on the wings, a black proboscis, yellow antennae, orange spots on the eyes, and gold/reddish dorsal cones; pupa resembles Melitaeini rather than the *Dione vanillae* pupa. Overwinters evidently just in the south including Houston Tex., and migrates north each late spring.

Many flights all year in S Texas, several flights mostly L April-Oct. (mostly L June-Oct.) in Colo. as noted above. At higher altitudes there seem to be peaks of abundance in M-L June and L July.

Adults visit flowers of all colors including *Chrysothamnus* (*Ericameria*) *nauseosus*, *Cirsium arvense, Gaillardia aristata*, *Heterotheca villosa*, *Liatris punctata*, *Lobelia siphilitica, Medicago sativa*, *Sedum lanceolatum*, *Senecio* (*Packera*) *fendleri, Taraxacum officinale*, and sometimes visit mud and aphid honeydew. Adults often roost on small weeds. Adults bask dorsally with wings spread a little or completely. Adults vibrate widely-spread wings to get warm. They may feed on flowers while spreading wings mostly/partly open.

Males fleek all day regardless of topography, often on flats, to seek females, as they fleek only ~10 cm up (3-15 cm). In courtship, the male overtook the female and she landed with abdomen up a little, he landed behind her and vibrated his 130^o-spread wings a little behind her, she kept her wings spread ~50^o apart, then he crawled alongside her and fluttered his ~40^o-spread wings, she remained motionless with wings still spread 50^o and her abdomen up a little as he bent his abdomen and joined, then they basked some and occasionally waved their wings a little. Unreceptive females fly away or fly vertically to try to avoid the male. If a mating pair is startled, the female usually flies (16x) toting the dangling male, but sometimes the male flies (3x).

***Argynnis* (*Speyeria*) *idalia occidentalis* Regal Fritillary**

The outer part of uph is black with white spots. The eyes are reported to be dark-brown, compared to amber in most *A. cybele* and *A. aphrodite* and gray in other *Argynnis* (those eyes always have dark spots). Ssp. ***occidentalis*** (Colo.-Kans.-ND-Ill. and evidently east to Ohio because most I caught in Cleveland in the early 1960s are like it) is distinguished by larger unh silver spots, compared to ssp. *idalia* (originally Va.-N.S.) which has smaller silver spots esp. on unh base where some spots are ½ size (B. Williams, 2001 J. Lepid. Soc. 55:144-149—they are little different in mtDNA); ssp. *idalia* is mostly extirpated now in E U.S.

Habitat open tall-grass and mixed-grass prairie and moist grassy valley bottoms in the Great Plains (populations do not exist on short-grass prairie/chaparral in the western Great Plains, and the westernmost colony in Colo. occurs just out of sight of the mountains and occupies only a moist grassy valley and should not be collected). Very rare strays have been found in all NE Colo. counties, including E Park Co. 8710' (a fresh female) and Teller Co. and Douglas Co. in the mountains, and one was found in Baca Co. in extreme SE Colo. *A. idalia* is extirpated in most of E U.S. including the Great Lakes area (it greatly disappeared from E U.S. in 1970s-1980s and is found now only at Fort Indiantown Gap Military Reservation in Pa. and Radford Army Ammunition Plant in Va.). The species *A. idalia* now occurs mainly in the eastern and central Great Plains and is still common there incl. Kans. Neb. Iowa Minn. S.D. N.D. Mo. and a few colonies still occur in SW Wis. & NE Ill.-NW Ind. Perhaps the Great Plains was its original range, and then it spread eastward when humans cut most of the eastern deciduous forest, which created many grassy openings, but the forest is now growing back and most of the grassy places remaining there have been plowed or developed, leaving little good habitat for *A. idalia*, and adults fly so far that they cannot survive long on tiny bits of habitat (they fly away, then cannot find another little bit of suitable habitat). Hostplant in Colorado herb Violaceae: *Viola pedatifida* on moist prairie (*V. sororia*, *nuttallii*, *lanceolata*, *sagittata* and others are used eastward, *V. sororia* in prairie and moist meadows [McCullough et al. 2017]; and the annual *V. bicolor* is evidently eaten in a restored metapopulation in NE Ill.-NW Ind.). Females often fly fast 1.5m up, evidently looking for *Viola* patches. Unfed 1st-stage larvae hibernate. Uncommon, sometimes common in the best places eastward on the plains.

Eggs pale yellow, becoming tan, up to 2450 per female lifetime (Wagner 2005 has *Argynnis* larva photos and also stated that some lay over 2000), eggs laid singly and haphazardly near green *Viola*. Females are reported to aestivate and delay egg laying and oviposit only late in the summer (B. Kopper et al. 2001, J. Lepid. Soc.54:96-97; & Kopper et al. 2001 Annals Entom. Soc. Amer. 94:427-432), even though the habitat is somewhat moist, thus females do not lay many eggs until M Aug. Larvae eat leaves, without nests. Older larva comparatively pale, marked with orangish & black & cream, with a yellowish (sometimes orangish anteriorly) middorsal stripe (containing a black heart-line that is weak on thorax and mostly absent on most or half of abdomen), the large area containing BD2 and BSD scoli has black blotches above between and below cream dashes, lateral black marks are in front of and behind black spiracles, lateral ridge orangish (orange around BL1 scoli), between segments over most of body are ~3 orangish & cream transverse lines sandwiching 2 black transverse lines, BD2 scoli brown or cream, BSD scoli cream or brown but both are orangish at base, the BL1 and BSV scoli mostly cream, all scoli have black setae, black sublateral patches include small SV scoli, underside cream with black tiny markings; head black, reddish on top half. Older larvae can survive fires by being under rocks and unburned litter etc. (McCullough et al. 2017), but they feed by day and are inactive at night (B. Kopper 2001 J. Lepid. Soc. 54:96-97) unlike other *Argynnis*. Mature larvae of this surely silk leaves together to form "pupation tents" where the pupa hangs. Pupa light mottled brown or tan tinged with pink, with small black spots and streaks on wings and thorax, short black dorsal cones, and black streaks and sometimes yellow transverse bands on abdomen. Unfed 1st-stage larvae hibernate.

One flight M June-M Sept., mostly end of June-M Aug., and both sexes occur throughout that whole flight, but mating occurs more often M June-M July, and females aestivate then oviposit mostly M Aug.-M Sept.

Adults visit flowers of all colors, including *Asclepias* and *Cirsium*, and sometimes sip mud. Adults bask dorsally, and can warm up by shivering their wings. Adults fly fast and far when scared.

Males fleek all day over tall-grass prairie and tall-grass meadows in valley bottoms, as they fleek usually ~50cm or sometimes even 1m up. Sometimes males dip down into hollows 10-20-33 cm above ground among the grass to seek females, then they may fly fast 1m up. The male has a sweet-smelling pheromone. If a mating pair is startled, either sex may fly, the partner dangling.

McCullough, K., G. Albanese, D. Haukos. 2017. Novel observations of larval fire survival, feeding behavior, and host plant use in the regal fritillary, *Speyeria idalia* (Drury) (Nym.). J. Lepid. Soc. 71:146-152.

Argynnis* (*Speyeria*) *nokomis **Nokomis Fritillary (Western Seep Fritillary)**

Adults are large in size, fly late in summer (mostly July-M Sept.), and lack the black spot near the base of unf cell CuA_2. The silver spots are surrounded by black much more than other *Argynnis*, esp. the submarginal unh spots (the submarginal black marks are connected on uph also in females, but not males). Males are orange on ups with smaller spots on the outer part of ups, whereas females are black basally and cream distally on ups. The unh is always silvered, and the "disc" (basal to postmedian areas between silvered spots) is mostly brown (or greenish-brown on some females) varying to yellow (greenish on some females). Adult eyes are amber colored with dark spots. The Colo. populations vary somewhat geographically, and Scott and M. Fisher (2014) found that various metapopulations occur in Colo.-NM ssp. *nokomis*, determined by small changes in variable wing pattern. They suggested that all the specimens collected by Ernest J. Oslar (including the neotype of *nokomis*) were mislabeled specimens collected at Beulah, San Miguel Co. New Mex. (mostly by Wilmatte Cockerell, a teacher and the wife of T. D. A. Cockerell—Beulah in the Sangre de Cristo Mts. of N NM is the TL of synonym *nigrocaerulea*). However the *nokomis* neotype from "Sneffels Mts." Ouray Co. has DNA (determined by Nick Grishin) of recently-caught Ouray Co. specimens, and that neotype looks like it might have come from Ouray Co. (esp. the wide unh pale band), so Oslar apparently did collect some *nokomis* in Ouray Co., evidently along the same river it still occupies, so the TL of *nokomis* is evidently Ouray Co. (Oslar mislabeled thousands of insects and butterflies [Scott 2016b], tainting the study of his specimens, but some of his specimens from "Oslar Sneffels Mts Ouray Co Col Aug. 9000 ft" and "Hayden Peak SW Colo. Aug. *nitocris* male" are from Ouray Co. Scott 2016b illustrates 6m1f of at least 8m2f specimens from Oslar's remaining collection at CSUC (at least 6m have no data, 1m1f have that Hayden Peak label), and the paler uph base and wider pale unh submarginal band seem to resemble Ouray Co. specimens rather than Beulah specimens, so most of those are probably from Ouray Co. (the DNA found that most of those have Ouray Co. DNA, but one has Beulah NM DNA). The USNM specimens from "Mt. Sneffels" and "Hayden Mts." illustrated by Scott & Fisher 2014 look like they are mostly from Beulah NM). (Some old museum specimens labeled Beulah may not be from Beulah, including one Calif. ssp. *apacheana* labeled Beulah. And one that Oslar labeled "Durango" has Beulah DNA. Oslar mislabeled two *nokomis* from "Hall Valley" in Park Co., a ridiculous alpine locality.) {The bogus ssp. "*tularosa*" supposedly from the Sacramento Mts. of Otero Co. NM were actually collected near but not at Beulah (based on DNA of 2 females mislabeled "Mescalero" in Otero Co. sequenced by Grishin, and Scott & Fisher's study of wing pattern of the 4 known specimens), so those are ssp. *nokomis*=*nigrocaerulea*=*tularosa*}. All SW Colorado populations

(Ouray to Costilla Cos.) are ssp. ***nokomis*** because the unh is mostly brown, but they vary somewhat in the darkess of the unh, the thickness of the veins on upf of females, the strength of the uph postbasal marks and the darkness of the basal areas of uph, the width of the yellowish submarginal area on unh, etc. (Scott & Fisher 2014). {Chuska Mts. in NW NM and NE Ariz. populations I also consider to be ssp. *nokomis* because adult wing pattern resembles SW Colo. ssp. *nokomis*, even though the Chuska Mts. DNA resembles ssp. *nitocris* farther south in Ariz.-NM} In **near-*nokomis*** from Mesa and Montrose Counties, the unh of males varies from light to dark brown (some males are yellow, some females are greenish-brown on unh, most are brown), because they are starting to clinally intergrade with ssp. *apacheana* from Nev. and Calif., which has a yellow unh in males and a green unh disc in females (most of the intergradation occurs in NE to SW Utah). (A higher altitude population in Mesa Co. is darker on unh disc more like regular ssp. *nokomis*.) But at the west end of Dinosaur Nat. Monument in or near Moffat Co., ssp. ***apacheana*X*nokomis*** occurs, with some males and females having brown disc like ssp. *nokomis*, but some males have the pure yellow disc and most females have greenish disc (traits of ssp. *apacheana*), thus most adults are intermediate and the population is a little closer to *apacheana* because some adults resemble that. Scott (1993h, J. Res. Lepid. 20:174-175) illustrated a hybrid *S. nokomis apacheana* X *S. cybele leto* from Calif.

Habitat Upper Sonoran to lower Canadian Zone spring-fed grassy meadows/seeps on usually open wooded valley bottoms (sometimes seeps on lower slopes). Hostplant in Colorado and nearby herb Violaceae: *Viola sororia=affinis=nephrophylla*. Adults oviposit haphazardly near green violets, in litter or even on tree trunks. Populations can tolerate some cattle grazing because host *Viola* can grow on dirt mounds made by cattle stomping, but do not occur in wet coarse-sedge meadows. Some colonies occur along narrow creeks where *Viola* grows on spring-fed banks just above the creek. Females are commonest where *Viola* is thick, or on flowers. The main host *Viola sororia=affinis* grows in tall grass that shades them some, even in treeless moist meadows, but more often grows nearby in the semi-shade under *Salix*/*Populus*/*Alnus* trees in riparian areas of the colony. There is no adult aestivation; females obviously do not aestivate because the habitat is moist, and the flight is so late in summer. Often locally common, but the tiny local colonies should not be collected.

Eggs cream, soon speckled with brown, becoming tan (dirty-white with purplish markings), laid singly and haphazardly near *Viola*, in litter or even under fallen trees or on lower tree trunks. Larvae eat leaves, without nests. There are six larval stages in most or all *Argynnis*, and *A. nokomis* larval head widths of the six stages are .35, 0.6, 1.0, 1.4, 2.4, and 3.5mm, ~60% growth at each molt (J. Scott & S. Mattoon 1982 "1981", J. Res. Lepid. 20:12-15). Older larvae orangish-ochre in ground color (or yellowish-ochre or yellowish-cream in Calif., light yellow in Mex. ssp. *coerulescens*), a middorsal orangish-ochre band (mostly on abdomen) enclosing a very weak darker heart-line, a black patch anterodorsal and a larger black patch posteroventral to BD2 scoli, a very large black patch with wider front and much wider rear around and below BSD scoli, two narrow black transverse stripes edged by cream run across the rear of each segment from top nearly to side, orangish-ochre lateral stripes enclose BL1 scoli, BD2 scoli dark-ochre, BSD scoli orangish-ochre with blackish tips, BL1 scoli orangish-ochre, underside of larva dark; head black, pale-reddish-brown on top and subdorsal side. Mature larvae surely silk leaves together to form "pupation tents" where the pupa hangs. Pupa orangish-ochre, with a black transverse serrate band on front of each abdomen segment, the thorax and all but the center and dorsal and posterior margins of the wing blackish, top of thorax with an orangish triangular spot, and a black spot at the end of the discal cell. {Pupae of ssp. *nitocris* and *apacheana* paler with paler wing cases, and ssp. *coerulescens* usually has mostly-pale wing cases with dark veins.} Unfed 1st-stage larvae hibernate (half-grown larvae of *coerulescens* may also aestivate in the Apr.-June Mexican drought).

One flight L July-M Sept. (mostly M Aug.-E Sept.).

Adults visit all colors of flowers, including *Carduus nutans*, *Cirsium vulgare*, *Chrysothamnus* (*Ericameria*) *nauseosus*, evidently *Helenium autumnale*, and sometimes visit mud. Scared adults can fly far at high speed with the wind. Adults bask with wings spread, and can shiver the 170°-spread wings to warm up. They mostly keep the wings spread when feeding on flowers. Adults can often move ½ mile in large habitats.

Males fleek all day about spring-fed meadows/seeps, mostly in valley bottoms or spring-fed lower slopes, as they fleek ~30 cm above the grass and often dip into hollows to seek females. The open meadow areas serve as the "eye" of the colony where males spend more time fleeking to seek females. In courtship, the male pursues the female and they flutter, and the female slows (whereupon receptive females would presumably land and be quiescent and accept the male, [the male surely moves his fw forward and flutters them to transfer his pheromone to her, using the techniques of *A. aphrodite* and *A. hesperis* etc.] while unreceptive females would flutter strongly to repel him). If a mating pair is startled, the male usually flies, sometimes the female, the partner dangling.

Scott, J. A., & M. S. Fisher. 2014. *Argynnis* (*Speyeria*) *nokomis nokomis*: geographic variation, metapopulations, and the origin of spurious specimens. Papilio (New Series) #21:1-32.

***Argynnis* (*Speyeria*) *cybele* Great Spangled Fritillary**

The base of fw cell CuA_2 generally lacks a black spot, distinguishing it from all other similar species except *A. nokomis* (*A. nokomis* is distinguished by a double black spot near end of uph discal cell, the outer part thicker, whereas *A. cybele carpenteri* has the inner part missing or vestigial, and *A. cybele charlotti* has the inner part missing/vestigial or undetectable in the blackish uph base). The *cybele* unh is always silvered, and males have heavy sex scaling on the upf veins. The pale unh submarginal band is very wide, as the brown disc color stops at the postmedian silver spots. Females have a constricted bursa copulatrix. Adult eyes are mostly amber colored with dark spots, or more tan in Calif. Several ssp. occur in Colo.: Ssp. ***cybele*** in the far eastern Colo. plains near Kansas has large unh silver spots, both sexes are brown on ups and the upf bases are not very dark (thus the inner and outer parts of the black spot at end of uph discal cell are both visible). *A. cybele* is absent in the remaining area east of the continental divide. Ssp. ***carpenteri*** in SW Colo. is similar, but smaller and paler, the fw black bars smaller. Ssp. ***charlotti*** in NW Colo. is like *carpenteri* but ups wing bases are darker blackish-brown, unh silver spots smaller, female ups whiter; female *charlotti* from Gunnison Co. are less whitish, and are somewhat intermediate between tawny *carpenteri* females to the south and whitish *charlotti* to the north. (Northward in Wyoming at the N end of the Laramie Range, adults become similar to ssp. *leto* as females are even whiter, unh submarginal band narrower, uph less dark. All these butterflies prove that *A. cybele* and *leto* are conspecific [and they also intergrade in C Mont.].)

Habitat open moist forest/*Quercus gambelii*/aspen groves usually with ferns in the Transition & Canadian Zones of western Colo.; moist valley bottoms near Kansas. Common in E N.A. Hostplants in Colorado herb Violaceae: *Viola* elsewhere (no records for Colorado; ssp. *charlottii* is assoc. *V. canadensis scopulorum*). Female ssp. *charlotti* and *carpenteri* evidently oviposit on *Viola* that remains green enough in the understory of *Quercus* thickets and other bushes/trees, and there is evidently no July-Aug. adult aestivation in the W Colorado ssp., unlike ssp. elsewhere (the 1st-stage larvae overwinter so fully-green *Viola* are unnecessary until spring). Fairly common.

Eggs pale yellow, becoming tan, laid singly and haphazardly near *Viola*. Larvae eat leaves at night, without nests (reportedly older larvae can be captured in pitfall traps near the host). Older larva velvety-black in ssp. *cybele* (Allen et al. 2005) and Wash. ssp. *leto* (James & Nunnallee 2011) and Ore. ssp. *pugetensis* (Guppy & Shepard 2001), with many orange black-tipped scoli (except BD2 scoli all black in ssp. *leto* in Wash., and BD2 & BSD scoli all black in Ore.); head blackish on front, reddish-yellow on most of top sometimes orange on sides. Older larvae resemble poisonous *Battus philenor* so could be Batesian mimics, although they reportedly feed at night and hide by day so are not exposed to birds much, and some other *Argynnis* have similar black larvae and occur in western U.S. outside the range of *B. philenor*. 2nd-6th-stage larvae of all *Argynnis* have an orangish ventral neck gland that produces a musky defensive odor when the larva is handled (James, 2008). Mature *cybele* larvae and other *Argynnis* silk leaves together to form "pupation tents" where the pupa hangs (James & Nunnallee 2011). Pupa dark mottled brown, often with orange-brown mottling, distal part of wing case may be a little lighter, abdomen with small dorsal cones (that are black in front, yellow/orange behind), front of abdominal segments darker-brown. Unfed 1st-stage larvae hibernate (James 2008 found that *Argynnis* 1st-stage larval diapause is broken by overwintering them in darkness at 5°C and 75% relative humidity for ~80 days; he studied *A. cybele leto, A. coronis, zerene, egleis, hydaspe*, and illustrated eggs and larvae and pupae of each; and James & Nunnallee 2011 illustrated *A. callippe, hesperis, atlantis, mormonia*).

One flight, L June-July and probably to Aug. in far eastern Colo. plains for ssp. *cybele*; July-M Aug. for ssp. *carpenteri* in SW Colo. and ssp. *charlotti* in NW Colo. Evidently Colo. western-slope ssp. do not aestivate. However, eastern N. Amer. (and presumably near Kansas) ssp. *cybele* adults emerge L June-July and females may aestivate and wait a month or so until Aug.-Sept. to oviposit (W. Edwards found that eggs become full size inside females by late Aug. [1877 Can. Ent. 9:35-36]). And Wash. ssp. *leto* flies June-E Oct. and females aestivate until Aug. to oviposit (James & Nunnallee 2011).

Adults visit flowers of all colors including *Medicago sativa*, *Rudbeckia, Senecio,* and sometimes visit *Quercus* sap, dung, carrion, and mud. Adults sometimes glide, and they often spread wings on flowers. Adults bask dorsally, and they can warm up by shivering the wing muscles. A male was seen roosting on the uns of a leaf 4m up.

Males fleek all day in tiny clearings and the edge of brushy areas with host *Viola*, as they fleek an average of ~87cm up (20-200, N=8) and dip down into vegetation to search for females. The courting male moves his closed forewings forward and rapidly opens them a little and closes them next to the female, to transfer pheromone. Females have the usual abdominal glands dispensing pheromone. If a mating pair is startled, the female usually flies, the male sometimes, the partner dangling.

{Courtship of the European ***Argynnis paphia*** (Magnus, 1950) is detailed here to compare courtship with N. A. *Argynnis*: In courtship, the male overtakes the flying female (attracted to her rapidly-flickering orangish color) and dips under her then rises up vertically directly in front of her to transfer pheromone from his ups wing vein androconial scales to her antenna, then he flies down under her again and rises up again to transfer pheromone, and does this repeatedly, she lands and spreads her wings and moves her slightly-raised abdomen a little and he flutters around her some at about her height and lands, then she keeps her wings mostly raised while he crawls to her side and "bows" by moving his forewings forward some and spreads his wings ~30° apart then closes his wings very fast (he closes his wings like this repeatedly to forcibly waft pheromone to her antennae) and his palpi touch her hindwing and he touches her head and hindwing with his antennae, then he moves to her side and joins when she bends her abdomen a little down and toward him.   The young female has a pheromone from dorsal abdomen glands that is attractive to males even when placed on a paper model, while mated females lack it [evidently because the male's paired glands at abdomen segment 8 annihilate her pheromone as in *Heliconius*.]}

James, D. 2008. Comparative studies on the immature stages and developmental biology of five *Argynnis* spp. (subgenus *Speyeria*) (Nymphalidae) from Washington. J. Lepid. Soc. 62:61-66.

Magnus, D. B. 1950. Beobachtungen zur Balz und Eiablage des Kaisermantels *Argynnis paphia* L. (Lepidoptera, Nymphalidae). Zeitschrift der Tierpsychologie 7:435-449.}

Argynnis* (*Speyeria*) *aphrodite **Aphrodite Fritillary**

Identification: The unh is always silvered and the basal 2/3 is reddish-brown, there is usually a black spot at base of fw cell CuA_2, males have little dark sex scaling on the narrow upf veins, the unh vein Rs generally is completely bordered by tan (which distinguishes it from *A. hesperis electa*), and the male uncus is thick with a notch beneath the tip. Adult eyes are amber colored with dark spots. The unh submarginal pale band generally has a little red-brown suffusion, which is absent in *A. cybele*. Two ssp. occur in Colo.: Ssp. ***whitehousei***=*ethne* in most of the state is comparatively large (*ethne* ranges north to BC where it seems to be identical to BC ssp. *whitehousei*), and has more infusion into the unh submarginal band. Ssp. ***byblis*** in W-C and SW Colo. is much smaller. Some females of Colo. ssp. *whitehousei* have the unh submarginal band narrow due to encroaching reddish-brown (similar to ssp. *alcestis* from Iowa-Mich. etc. which does not occur in Colo.) so those (more frequent in NE Colo.) can be called **form alcestis**. In *byblis* the male upf has narrower veins than *A. hesperis*, and the unh vein Rs runs across the unh inside a tan track, whereas in *A. hesperis* unh vein Rs is covered by reddish-brown. Female *A. aphrodite* have a constricted bursa copulatrix like *A. cybele*.

Habitat the foothills to Canadian Zone. Hostplants in Colorado herb Violaceae: *Viola nuttallii* & *V. adunca* for ssp. *whitehousei*. Females oviposit in litter, near green *V. adunca* if present, but if the *Viola* is dried up for the year (in the lower foothills especially with *V. nuttallii*) females oviposit in litter mostly under bushes where *Viola* will regrow the next spring (females evidently smell the roots). Females aestivate, as noted below. Common.

Eggs pale-yellow, turning violet-tan with a cream lateral ring, laid singly and haphazardly near *Viola* leaves or dormant roots. Larvae eat leaves, without nests. Older larva grayish-black, weak twin brown middorsal lines edge the black heart-line, BD2 scoli black with light-brown bases, a large black patch around BD2 scoli except beneath, BSD scoli black on distal half and brown or light-orangish-brown on basal half, a black patch around BSD scolus (except dorsally) encloses black spiracle, BL1 scoli black on distal third & brownish-orange on basal 2/3 and BL1 rest on an orange mound, uns and prolegs dark-brown, legs black; head black, the rear rim of head orange (with tiny brown dots) laterally (above eyes) and dorsally (except middorsal valley is black). Colo. and BC (Guppy & Shepard 2001 photo) ssp. *whitehousei* larvae are equally blackish. Mature larvae of *A. aphrodite* surely silk leaves together to form “pupation tents” where the pupa hangs. Pupa orangish-cream, wings creamy (brown on distal 2/3 of inner margin or brown in middle of outer part) with brown wing veins and numerous small transverse brown striations, a brown spot at end of discal cell, a large black patch on uns of head, orbit black, eye mostly black, very base of forewing black where it slopes forward from a point, dorsal slope of inner margin of forewing black, hindwing sliver black, top of head has a transverse black patch and a black posterolateral area, T1 has a black subdorsal cone and a black central patch, head & T1-2 have a narrow black middorsal line, T2-3 have a twin middorsal tan band, T2-3-A1 mostly tan with black mottling, A5-7 have a middorsal tan cone on front of each segment which is the front end of a tan area, and similar tan areas are on A3-4, a subdorsal cone on head-T1-3-A1-7 (this cone is at the edge of a black anterior area and rear of cone is in a tan area), on abd. these cones have a tiny orangish tip, black intersegmental areas between A4 and A7, A2-7 have the usual black serrate anterior spots (including a black triangle on A4-7), on A4-7 below this triangle the black is reduced to a small black spot near middle of segment above a small black patch containing spiracle, appendages mostly black except hind leg partly tan, antenna segments black with tan joints. Unfed 1st-stage larvae hibernate.

One flight M June-M Sept. (rarely L May, mostly L June-E Sept.). In Colorado, females evidently go into reproductive aestivation in July-Aug. like *A. edwardsii* and *A. coronis*. *A. aphrodite* starts emerging in M June, several weeks later than those two, and is common L June-E Sept., then females oviposit in M Aug.-Sept. (my ovipositions were seen Aug. 17-Sept. 10) beneath still live *Viola adunca*, and along the lower mountain front they also oviposit under *Cercocarpus montanus* etc. bushes or grass etc. where *Viola nuttalli* grew earlier but is now absent (females obviously can smell the *Viola* roots even though the green tops are dried and gone). In late July a female was seen investigating *Pinus ponderosa* tips then crawled into needles 12m up and remained quiet and nearly invisible, and other adults were seen 6m up on those pines, so maybe they aestivate there for a month or two except when feeding (camouflaged somewhat resembling pine cones); a male was seen investigating

Douglasfir cones in late July, evidently to find females for mating (courtships were seen from near the start of the flight to late August).

Adults greatly prefer *Monarda fistulosa* flowers and visit it nearly 10x as often as any other flower, and otherwise visit all colors (even orange and reddish) especially purpish flowers, including *Apocynum androsaemifolium, Aster laevis, Carduus nutans* (a favorite), *Centaurea diffusa, Chrysothamnus* (*Ericameria*) *nauseosus, Cirsium arvense, Gaillardia aristata, Liatris punctata* (a favorite), *Rudbeckia laciniata, Trifolium pratense*. They sometimes visit carrion, dung, sap, and mud. They often spread wings on flowers. Adults sometimes glide. They can fly far; 11+ adults strayed 4-7 miles from the foothills to my house in Lakewood, including two females 23-26 Aug. 2019, suggesting breeding on cultivated *Viola*? Adults bask dorsally (by spreading their wings), and can warm up by shivering the wing muscles. Adults roost up to ~5m+ on *Picea engelmannii* and *Juniperus* etc. trees and *Vernonia* plants etc.

Males fleek all day regardless of topography (esp. in valley bottoms), mainly in open areas, as they fleek ~1m up. As noted above, a male was observed searching *Pseudotsuga taxifolia* cones evidently to find females (H. Clench once saw an *aphrodite* probing the eastern branches of a row of trees multiple times in late afternoon, perhaps trying to locate females ?roosting). Males often locate females on flowers. In courtship, the male overtakes the flying female and evidently usually contacts her (the male moved laterally etc. and contacted her to place his pheromone near her antennae, as *Argynnis paphia* and *A. edwardsii* do), (sometimes he spots a female on a flower and hovers over her some), she lands and he lands next to her, he moves toward her antennae and moves his closed forewings forward to maximally expose his upf pheromone scales, then vibrates or flutters his wings (either vibrates his wings from closed to an average of 30^o open [fw tip to fw tip, N=8] often in bursts [roughly ~5 vibrations/burst, ~3-5 bursts/sec. in one case], or he flutters his wings from closed to ~60-70^o open--movies would be required to detail the vibrations/fluttering precisely, but there is much variation) to transfer pheromone, then he moves alongside and bends his abdomen to try to join. Receptive females would remain motionless and join, while unreceptive females flutter their wings mostly at wide amplitude to repel the nearby male who generally soon departs. If a mating pair is startled, the female usually flies, sometimes the male, the partner dangling.

***Argynnis* (*Speyeria*) *mormonia eurynome* Mormon Fritillary**

Identified by the small size, the rounded fw, the narrow upf veins of males (with few dark androconial scales), and the mostly subalpine habitat, where adults fly close to the ground. The dark unh crescents capping the silver marginal spots are usually cone-shaped. The unh usually has many pale areas among the ground color, which is mostly greenish in Colo. ssp. ***eurynome*** (sometimes brownish-green) (mostly brownish in Black Hills S.D. ssp. *kimimela*), nearly always with silver spots. The unh spots are always unsilvered in two Nevada and Ariz. ssp., but unsilvered spots are very rare in Colo. (I found only one unsilvered at the Summit Co. tunnel, M. Fisher found none, C. Boggs found only 13 unsilvered of 6,844 near Gothic, Gunnison Co.). {The eyes are gray with dark spots as in most *Argynnis*, except are reportedly amber in the Calif. Sierra Nevada.}

Habitat mostly upper Canadian Zone to lower Alpine Zone meadows. Lower altitude adults are strays, as adults often travel widely, and may be found at lower altitudes than where they breed. In late summer I found ~3 females on the plains, where they wandered ~40+ km from the subalpine zone. Hostplants in Colorado herb Violaceae: *Viola labradorica*, *adunca*, rarely *nuttallii*, and Polygonaceae: *Polygonum* (*Bistorta*) *bistortoides, viviparum*. Keith Wolfe (2017, including nice photo of mature larva) found 5 larvae on *P. bistortoides* in Calif. (*Viola* not present) that fed well on it and pupated so that is a host also, and I found an ovip. 4 cm from *P. bistortoides* near Rollins Pass Gilpin Co. CO, and an oviposition 17 cm from *P. bistortoides* and 7 cm from *Viola labradorica* SW Tennessee Pass CO, and a preoviposition 4 cm from *P. viviparum* at Loveland Pass CO, and S. James (2012, J. Lepid. Soc. 66:199-204) found that in Oregon *Viola* was absent at the site and *mormonia* oviposited well on *P.*

bistortoides in lab. Thus those *Polygonum* (*Bistorta*) are also hostplants. But Colo. females oviposit on dead leaves/twigs etc. on other plants such as *Fragaria* (3 eggs) and *Achillea lanulosa* and *Salix reticulata* var. *nana*=*nivalis*, and near other plants such as *Cirsium coloradense* var. *acaulescens*, and between *Rumex densiflorus* and *Potentilla plattensis*, etc. Evidently *A. mormonia* is somewhat polyphagous and there may be more proven hostplants (in addition to *Viola* and *Polygonum*), explaining its rather haphazard oviposition. Females evidently lack aestivation and oviposit near green hostplants. Common.

Eggs yellowish-cream, turning pinkish-cream, laid haphazardly near hostplants. Larvae eat leaves, without nests. Older Colo. larva mottled brown with light-brown to orangish scoli, a twin cream band containing black heart-line, black marks near upper scoli outline two pale tapered dashes coming from BD2 and BSD scoli that converge near each other anteriorly, BSD scoli above band of black dashes (or a solid black band in W Wash.), a paler lateral ridge with BL1 scoli, the BD2 scoli dirty-light-brown with ochre or light-brown tips, BSD and BL1 scoli dirty-orangish-cream (brown near body) (larva from BC has BD2 scoli orange-brown, but larvae from Ore.-Wash. have paler dorsal scoli than most other *Argynnis*,); head black, with top and side orange-tan with many tiny black spots as usual in *Argynnis*. In Washington there is some variation from paler to blacker in larval coloration: paler like Colo. larvae in some Yakima Co. & NE Wash. & BC larvae, blacker at higher altitude in NE Ore. and in some Yakima Co. larvae and on ssp. *artonis* in Steens Mtn. Ore. (James & Nunnallee 2011; D. James 2012 J. Lepid. Soc. 66:199-204; Guppy & Shepard 2001). Older larvae of *Argynnis* evert the ventral neck gland evidently to repel predators with its bad odor. Mature larvae silk leaves together to form "pupation tents" where the pupa hangs. Pupa blackish-brown with orange-brown pale areas on outer part of wings and abdomen, blacker on front of abdominal segments, patterned like most *Argynnis*. Unfed 1st-stage larvae hibernate. Females do not aestivate, because they live in moist boreal habitats.

One flight July-Sept. (mostly M July-E Sept.). Females do not aestivate. Lab females live 19 days on average (up to ~35), and lay eggs for 14 days on average because the eggs are not mature at pupal emergence (C. Boggs 1986 Ecol. Entomology 11:7-15).

Adults visit flowers of all colors (even part-red) but usually yellow, including *Arnica mollis*, *Arnica* spp., *Erigeron ursinus*, *Haplopappus parryi*, *Heterotheca pumila*, *Senecio* spp., *Taraxacum officinale*, and sometimes visit carrion, and dung; males often (esp. young males) and females sometimes visit mud. Adults bask with wings spread. An adult was seen to roost 4m up on a *Picea engelmanni* tree; sometimes several roost nearby.

Males fleek all day in open vegetated areas regardless of topography, most often in meadows/valley bottoms, as they fleek ~10-20cm up. In courtship, the male overtakes the female, they land and the male flicks his wings rapidly from closed to ~30-50º and sometimes bumps against the female and attempts to join; at this time receptive females would remain motionless with wings raised and accept the male, but unreceptive females flutter at usually-wide amplitude to repel the male, who soon departs. If a mating pair is startled, either sex may fly, the partner dangling. Females generally mate just once.

Wolfe, K. 2017. Natural non-*Viola* hostplant of a Sierran *Speyeria* [*mormonia*] and an associated parasitoid. J. Lepid. Soc. 71:129-131.

Argynnis* (*Speyeria*) *hydaspe rhodope **Hydaspe Fritillary (Forest Fritillary, Lavender Fritillary)**

Distinguished by the large unsilvered unh spots (making the postmedian spots close together) on the lavender-tinted red-brown (also described as purplish-maroon) unh disc. The pale unh submarginal band is uniformly partly-suffused with this color also and blends with the discal color. The uph submarginal black crescents are often M-shaped especially that near the tornus, a fairly useful unique trait. The ups wing bases are dark. The name *sakuntala* was misapplied in British Columbia and western U.S., and the correction means Colorado butterflies are named ssp. ***rhodope***, not *sakuntala*. And the name *conquista* from "SW Colo." was thought to be based on mislabeled specimens from NW Wyo. thus cannot be applied to any population (a nomen dubium), but DNA of the holotype proves it is a NW Wyo. *Argynnis hesperis tetonia*. Adult eyes are grayish with brown spots as in most *Argynnis*.

Habitat moist aspen-rich woodland in Canadian-Subalpine Zones. Hostplant in Colorado herb Violaceae: *Viola* (unknown species in Colorado, surely including *V. canadensis*). Uncommon.

Eggs yellowish-white turning brownish-red; laid haphazardly near hostplants. Neill (2007) wrote that females oviposit near withered remains of *Viola* in Ore.?, but in Colo. the habitats seem fairly moist where *Viola* leaves would stay green. Larvae eat leaves, without nests. Older larva (photos in Neill 2007 from Ore.?, James & Nunnallee 2011 from Wash., & Guppy & Shepard 2001 from BC) similar to blackish ssp. of *A. hesperis*, grayish-black with some black splotches near BD2 scoli and a black band along and below BSD, between those scoli in Calif. may be two rows of indistinct gray dashes, Calif. larvae may have heart-band edged by paler lines; scoli all blackish except BL1 scoli creamy-orange (bases of BSD scoli may be slightly orangish); head nearly black with little or no orangish in Wash., but top rear orangish-brown in BC. Larvae feed at night. Mature *hydaspe* larvae surely silk leaves together to form “pupation tents” where the pupa hangs, because all *Argynnis* pupate in “leaf tents” (James 2008, who has photos of eggs larvae pupae of 5 spp., and James & Nunnallee 2011 show 9 spp.). Pupa reddish-brown with the usual markings, irregular black border on front of abdomen segments, some black splotches on wings & veins blackish, eyes & appendages black. Unfed 1st-stage larvae hibernate.

One flight July-Aug. Females evidently do not aestivate in Colorado because they live in moist NW Colo. mts. Females aestivate in Calif., and aestivate 3-5 weeks in Wash. (James 2008, James & Nunnallee 2011).

Adults visit flowers evidently of all colors, and mud.

Males fleek all day in semi-shaded fairly moist woodlands in NW Colorado, roughly ~1/2m up (few observations). If a mating pair is startled, the female flies at least sometimes, the partner dangling.

Argynnis edwardsii **Edwards’ Fritillary (Green Fritillary)**

The unh is green (mostly green on most males and brownish-green on most females), with silver spots (the postmedian spots elliptical, the submarginal spots often roundish). Similar to *A. callippe*, but larger, the unf more red, the unh veins brownish, the ups borders very dark and the rest of ups is lighter ochre than most *Argynnis*, and the male fw is more pointed. The narrow prong on the male valva is only 1/3 to ½ as long as that on other *Argynnis*. There seems to be no geographic variation. The eyes are grayish with dark-brown spots.

Habitat intact shortgrass prairie on the plains, foothills chaparral, and open pine etc. woodland in the mountains including the Canadian Zone, sometimes straying into the Alpine Zone. Hostplants in Colorado herb Violaceae: *Viola nuttallii*, *adunca*, evidently also urban cultivated *Viola* (~*odorata*), evidently *V. pedatifida* on the eastern plains. Violets (*Viola ~odorata*) have become common in old lawns in the Denver metropolitan area, so for the last couple decades *A. edwardsii* has become a breeding resident in Denver, where they probably eat those lawn *Viola* and fly conspicuously in L May-June. Females aestivate, as noted below. Females oviposit in litter, under bushes where *V. nuttallii* is usually absent but will regrow the next spring (females evidently can smell the roots). Uncommon, sometimes common.

Eggs greenish-yellow, becoming tan, laid singly haphazardly near *Viola*, or where it will grow the next spring. Larvae eat leaves, without nests; they feed at night and hide under wood, stones, plants etc. by day. Older larva yellowish middorsally, elsewhere mottled with black orangish & yellow, a brown middorsal line within yellowish heart-band, with black patches in front and back of BD2 scoli, yellow-brown areas with small black streaks occur in area between BD2 & BSD scoli (this area anteriorly on each segment has two yellowish cone-shaped marks aimed forward), four black "butterfly wings" spots around bottom of BSD scoli and the "butterfly" abdomen surrounds each spiracle, bases of BD2 & BSD scoli black or gray-green, most of BL1 scoli yellow or slightly orangish, between segments from near top to near side are several narrow transverse orange-brown lines between yellowish lines; head brown-black, yellowish on top and rear. Mature larvae surely silk leaves together to form "pupation tents" where the pupa hangs. Pupa mottled yellow-brown, the front reddish-brown, abdomen mottled gray, with a serrated dark-brown transverse stripe on front of each abdominal segment. Unfed 1st-stage larvae hibernate.

One flight L May-M Sept. The pattern of adult emergence is similar to *A. coronis*, as they are seen in flight L May-July mostly, when females are seen much less than males, and Aug. males are worn, then many somewhat-fresh females are seen L Aug.-E Sept. Females go into reproductive aestivation like *A. coronis* and *A. aphrodite*, and oviposit in L Aug.-E Sept. beneath dead or near still-green *Viola adunca* and *V. canadensis*, and also oviposit where *Viola* grew earlier but is now dried up and roots dormant (under bushes such as *Cercocarpus montanus* in foothills chaparral for *Viola nuttallii*, on plains grassland for *V. pedatifida*); females obviously can smell the *Viola* roots even though the green tops are dried and gone. Theodore L. Mead described female aestivation of *A. edwardsii* well based on his trip to Colorado in 1871 (Scott 2016a); he collected them in early June at Denver, and months later observed them reappear and lay eggs in August. Female aestivation allows those *Argynnis* to survive the low-altitude areas that dry up in summer. A male investigated male staminate cones on a Ponderosa Pine tree, perhaps trying to find diapausing females to mate with.

Adults visit flowers of all colors (even red) including *Apocynum androsaemifolium, Carduus nutans, Chrysothamnus* (*Ericameria*) *nauseosus, Erysimum capitatum, Jamesia americana, Liatris punctata, Monarda fistulosa,* and sometimes visit dung and mud.

Males basically fleek all day throughout the habitat to seek females. But in mountainous places with ridgetops and hilltops (many places I often visited on top of the Front Range foothills) males most often flait in openings in brushy/woodsy areas just off a hilltop (anywhere from 6-40m or more from the highest point of the hilltop/ridgetop), as they fly back and forth in that area and sometimes rest (rait) there in between those flights (when they rait ~30cm-1m up); males sometimes fleek in valley bottoms also. While flaiting or fleeking, those males fly 3/4m-1m above ground esp. in brushy areas or sometimes just 10-20cm up investigating low spots of prairies. In courtship, the male overtakes the female and rises up under her to buffet her with pheromone several times to induce her to land, she lands with him behind, and the male flicks his wings from 0-30^{o} apart in several quick bursts separated by motionless periods (like all *Argynnis*), and if her wings are spread he tries to crawl under her to mate (receptive females would then remain motionless and allow the male to join, while unreceptive females flutter fully vigorously like other *Argynnis* to repel the male). If a mating pair is startled, either sex may fly, the partner dangling.

***Argynnis* (*Speyeria*) *callippe* Callippe Fritillary**

The unh disc is green in Colorado. Adults are characterized by distinctive unh marginal silver spots, which are triangular and capped with a thin triangle of green or brown. The unh spots are always silvered in Colorado, tend to be elongated, and show through as light areas on uph. The ups is more yellowish-brown than bright orange in Colo. The unh submarginal pale band is not wide. Ssp. ***meadii*** E of the continental divide and in Grand Co. and nearby high-mountain areas has the unh bright green and the submarginal area usually green (sometimes cream). Ssp. ***calgariana***=*harmonia* from lower altitude sagebrush and mesas on the W slope has this submarginal area cream, and adults have smaller ups markings. Adults are sometimes common but usually not abundant; the commonest I have found them in the Front Range was in S-facing fairly-dense pine woods in lower Gilpin Co. where

Viola was abundant in the understory. Adult eyes are grayish with dark-brown spots in *callippe* and the remaining *Argynnis*.

Habitat open areas (chaparral and open woodland) in lower mountains from Upper Sonoran to Transition Zones (I found one on Squaw Mtn. 11450' in Clear Crk. Co.). Hostplants in Colorado herb Violaceae: *Viola nuttallii* for ssp. *meadii*, and surely others such as *V. canadensis* at higher altitudes. Females in the foothills oviposit in litter under bushes where no *Viola* is visible then but where *V. nuttallii* grows the next spring. {C. Durden (1965, J. Lepid. Soc. 19:186-7) observed ovipositions on *Artemisia tridentata trifida* "*tripartita*" in Mont. Wyo. & Utah on loose bark near base of the trunk and found "unidentified *Speyeria*" larvae on branches of *Artemisia* in Wyo., and thought they eat *Artemisia*, but they probably just eat *Viola* under those bushes the next spring.} Moderately common.

Eggs pale yellow, becoming pinkish-brown, laid singly haphazardly near host leaves or roots. Larvae eat leaves, without nests. L1 larvae have droplets on the long seta tips, and older larvae have ventral neck gland. Older larva in S Wash. brown mottled with black areas in a pattern like similar paler *Argynnis* esp. the other *callippe*-group species (*callippe* to *coronis*), a middorsal twin yellowish band endloses blackish heart line, fairly small black blotches occur beside BD2 and BSD scoli, between them edging those black spots is a volcano-shaped pale-tawny figure aimed anteriorly, blackish squared dashes above BL1 scoli, scoli brown except BL1 scoli cream beyond orangish bases (but larva from Okanogan Co. in N Wash. [Guppy & Shepard 2001] is pale and all scoli pale-ochre and BSD & BL1 have orangish bases); head black with orangish top rear in Okanogan Co. N Wash., but just an ochre patch on side of top in photos from Wash. (James & Nunnallee 2011) and not-Texas (Allen et al. 2005—*callippe* does not occur in Tex.). Mature larvae silk leaves together to form "pupation tents" where the pupa hangs. Pupa slightly-orangish brown, with dark wing veins, black blotches on rear of wing, and the usual blackish front of abdominal segments. Unfed 1st-stage larvae hibernate.

One flight L May-July (sometimes E Aug.) in the Front Range, M June-E Aug. in western Colo. Adults incl. females do not aestivate in Colorado: in the dry Front Range foothills they fly L May-M July (mostly June on Green Mtn. at low altitude W of Denver) and are uncommon and worn by L July and rarely live to E Aug. (the three diapausing *Argynnis* species survive into M Sept.). Females do aestivate in Wash.-BC, where they move to high elevations, then return to lay eggs in M-L Aug. (James & Nunnallee 2011).

Adults visit yellow and white flowers especially, often purplish, sometimes visit reddish and orange and violet ones, including *Apocynum androsaemifolium, Carduus nutans, Eriogonum flavum, E. umbellatum, Erysimum capitatum, Gaillardia aristata, Heterotheca villosa, Jamesia americana, Monarda fistulosa, Rudbeckia laciniata ampla, Sedum lanceolatum*. They sometimes imbibe human spit, and visit carrion and mud. To get warm, adults shiver with wings mostly spread (160^{o}) (all *Argynnis* shiver with wings spread, Douglas & Douglas 2005).

Males mate-locate all day, as they usually flait or often fleek mostly on or near the tops of ridgetops/hilltops and often rait there (they sometimes fleek on hillsides and valley bottoms where they even chase over flowers), as they fly an average of ~30-40cm up (extremes 8cm to 1m). Males often rait on or near ridgetops/hilltops also, as they land mostly on bedrock or low rocks/boulders or sometimes on small bushes. (Scott 1976a wrongly stated that raiting occurs mainly only until ~13:00, but my hundreds of records now show no difference during the day as they mate-locate by flaiting mainly on hilltops/ridgetops all day and they occasionally rait all day, and males may rest slightly more often earlier in cooler mornings just to bask.) Males flaiting on hilltops obviously travel farther than the classic flaiting species *Papilio eurymedon*, but surely do not travel as far as most fleeking *Argynnis* (except on valley bottoms or open hillside forests where they surely are fleekers), so the word flaiting (and raiting) seems to properly describe frequent *A. callippe* behavior on hilltops. {*A. callippe* evidently prefers to mate-locate on ridgetops/hilltops where available everywhere in the range: ssp. *calgariana*=*harmonia* in NW Colo. and Neb. flait on hilltops also; on Mt. Diablo in Calif. ssp. near-

callippe flait (and often rait on grass, shrubs etc. until about noon) all day mostly in clearings on the upper ~30m of the ridge top, as they fly ~1/3m up; in Glenn & Mendocino Cos. CA ssp. *shasta* & El Dorado Co. CA ssp. *rupestris*, males fleek all day ~1/2m above ground in the flatter forest. In Oregon locales males congregate on hilltops (Neill 2007).} In courtship, the male overtakes the female and comes close to her (probably buffeting her with his pheromone as other *Argynnis* do), they land with the male behind, he moves toward her antennae and opens his closed wings ~0-40°–spread in bursts (~10?x in each rapid burst lasting maybe ½ sec., with about one burst per second for up to ~1-2 minutes), and then receptive females surely would remain motionless and the male would join. When the male flutters (with his wings opening up to ~60° or more) near her to try to make her more receptive, unreceptive landed females flutter with mostly-full strokes (or she may flutter when he hovers over her) to repel him, and unreceptive females crawl or fly away; discouraged males soon depart. If a mating pair is startled, the female--about as often the male--flies, the partner dangling. Females mate mainly just once (Shields, 1967). A female was seen to crawl into a *Pinus ponderosa* bough 3m up and rest under a pine cone, evidently to rest? because *A. callippe meadii* does not have adult aestivation; but late in the afternoon I saw males flying the sunny side of pine tree boughs (fleeking) evidently searching for roosting females, and I saw a male searching orangish staminate pine conelets evidently to seek females.

***Argynnis* (*Speyeria*) *atlantis sorocko* Atlantis Fritillary**

A. atlantis ***sorocko*** is identified (compared to *A. hesperis*) by the always-silvered spots on the chocolate-brown unh (males are the color of "Hershey's Chocolate Kiss" milk chocolate, females a little darker), the unh submarginal pale band is narrow, the male fw margin is usually convex or straight (concave or straight in *A. hesperis*), the fw postmedian black bars are usually more rectangular and narrower, the black oval spot near tornus in unf cell CuA_2 is ½ the area of spot just above, the ups is slightly creamier-orange, the unh marginal silver spots are mostly more triangular, and the ups wing margins are somewhat blacker esp. on upf, and it usually occurs in wetter areas. Adult eyes are gray with dark spots. *A. atlantis* and *A. hesperis* were once thought to be the same species (they were lumped by Lionel Paul Grey the famous *Argynnis* expert), but they are actually very different in adults, larvae, pupae, habitat, and mtDNA, and are not even very close relatives {J. Scott, N. G. Kondla, and S. M. Spomer 1998; also Guppy, C. S., Kondla, N., & Scott, J. A. 2014. Correction of the status of *Speyeria atlantis* and *S. hesperis*. J. Lepid. Soc. 68:286-287. And Thompson et al. 2019 confirm by DNA that they are separate species; dna confirms the existence of the 16 accepted species in North America. Note that COI mtdna alone was proven to be useless for determining *Speyeria* phylogeny by E. Campbell, E. Gage, R. Gage, and F. Sperling 2019. Systematic Entomology 12 p.}

Habitat moist open areas in conifer woodlands, including open moist grassy meadows, from upper foothills to Subalpine Zone (it is rare in the lower foothills, where at Tinytown SW of Denver I found a female once, two males once). Hostplants in Colorado herb Violaceae: *Viola sororia=affinis*, *V. canadensis* var. *rydbergii*, & probably *V. canadensis* var. *scopulorum.* Females always oviposit near green violets (in litter usually). Uncommon, sometimes common at the largest best locales. A few colonies are small and restricted to local isolated moist meadows, which should not be collected.

Eggs pale greenish-yellow, soon turning reddish-brown, laid singly haphazardly near green *Viola*. Larvae eat leaves mostly at night, without nests. Older *sorocko* larva mostly brown mottled with black, a middorsal pair of cream (sometimes orangish-cream) lines edge the black heart-line, a paler-brown band encloses BL1 scoli and a black band is above BL1 scoli, between those places is a complicated set of black blotches edged narrowly by cream dashes (those black blotches notably larger and closer together than other species) which area was aptly described as resembling "crocodile skin" by James & Nunnallee (2011) (the creamy-tan dashes just above BSD resemble a narrow cream line, a thin oblique dash extends front and back from BD2 scoli and a similar dash extends front and back from bottom of BSD scoli), a light gray-brown transverse band containing two faint tan lines runs over the top rear of each segment except middorsally, underside dark-brown, the black-tipped scoli are mostly brown on BD2 and BSD, mostly orangish-tan with black tips on BL1 and BSV scoli; head black, brownish-orange on top rear. {*A. a. atlantis* and *A. a. hollandii* larvae are very similar, and *A. a. pahasapa* from the Black Hills SD is similar but darker.} Older larvae have an eversible neck gland producing a musky odor when disturbed that evidently repels predators such as ground beetles and ants. Mature larvae silk leaves together to form "pupation tents" where the pupa hangs. {Scott (1988a, J. Lepid. Soc. 42:1-13) described larvae and pupae from Colo. before Colo. butterflies were proven to be separate species, and his silvered-unh-spot rearings (from Tinytown and Corwina Park) were *A. a. sorocko*, while his unsilvered rearings (from O'Fallon Park, Critchell, Mt. Judge, and Cherry Gulch) were *A. hesperis hesperis*.} Pupa variegated brown or reddish-brown, blacker on head and legs/proboscis, with the usual blacker anterior part of each abdomen segment, abdomen with weak to stronger middorsal tan lines, wing cases orange-brown, and the brown spot around each abdominal spiracle evidently larger than most *Argynnis* that have mostly black spiracles. Unfed 1st-stage larvae hibernate.

One flight July-E Sept. Females do not aestivate before laying eggs, because *A. atlantis* occurs in moist boreal habitats.

Adults visit yellow flowers usually, often white or purple, occasionally all other colors, including *Agoseris glauca*, *Rudbeckia* spp., *Cirsium*, also dung, sometimes mud. Adults bask dorsally.

Males fleek all day to seek females, mostly in moist meadows or moist open forest especially near streams, as they fleek ~1/2-1m up. In courtship, the male overtakes the female{probably rising up in front of her repeatedly to place his pheromone near her antennae, as *Argynnis paphia* and *A. edwardsii* do}, they land (or he lands on her flower) and she may flutter her wings with moderate or small amplitude very briefly, he moves more to face her and moves his forewings forward and vibrates his wings 0^o to 25-30-35-40^o spread beside her (evidently in bursts like *S. hesperis*) to transfer pheromone (males of *sorocko* and *A. hesperis* have a pheromone which smells sweet but slightly peppery pungent), she becomes motionless with wings raised and raises her abdomen ~25^o (in the completed mating I saw) and he spreads his wings slightly 45^o apart and bends his abdomen to join. After they land, receptive females remain motionless (or become motionless after brief fluttering) and accept the male, but unreceptive females flutter their wings at fairly wide amplitude to repel the male if he flutters near her to try to seduce her, and females lower their abdomen slightly down (observed on two females who failed to mate as the male flew away) and partly extrude her abdomen tip, or females crawl away or fly away. Females of *Argynnis* have a dorsal gland in the abdominal segment 7-8 membrane which produces a pheromone that attracts males, and males also have a gland in abdomen segment 8 above the valvae which presumably transfers a chemical to the female during mating that inactivates the female's attractant pheromone and makes her repulsive to males especially when she exudes her abdomen tip (a system like that of *Dione* and *Heliconius* and other Heliconiini, see Scott [1986a] and its fig. 37; *Argynnis paphia* males turn away from mated females after antennal contact). 3-4 females that were virgin (as proven by later dissection) failed to mate with common *A. hesperis* males in nature, evidently because of differences in their pheromones. If a mating pair is startled, the male usually flies, often the female, the partner dangling.

Argynnis (*Speyeria*) *hesperis* Red-Disc Western Fritillary (Northwestern Fritillary)

A. hesperis always has a red-brown unh disc usually with large pale areas, unlike *A. atlantis*. The unh marginal cream or silver spots are mostly triangular with fairly thin triangular reddish-brown caps, and the unh submarginal tan area is fairly narrow. The male upf has fairly-wide brown band of androconial scales over the posterior veins (wider than *A. aphrodite*). More than half the unf is orangish, distinguishing it from *A. egleis*. Three ssp. of *A. hesperis* occur in Colo.: in the Front Range ssp. ***hesperis*** usually has unsilvered unh spots (partially-silvered in many, but fully silvered in only ~1%). The percentage of silvered adults increases with altitude westward, so ssp. ***electa***=*nikias* throughout the western slope of Colorado and San Luis Valley mts. always has silvered unh spots, the ups wing bases are darker, and the ups postmedian black bars are wider than ssp. *hesperis*. (Ssp. *electa* spills eastward over the continental divide of the Front Range a little, so the Subalpine Zone just a few miles E of the continental divide has mostly silvered near-*electa* in Gilpin and Clear Creek Cos. etc.) Ssp. *electa* occurs in Lake County also. The Wet Mts. has mostly adults near *hesperis*, with some silvered ones. The Sangre de Cristo Mts. W of the Wet Mtn. Valley (from S of Salida to Huerfano Co.) has *electa*X*hesperis* intergrades with silvered or unsilvered unh adults about equally frequent; along the Sangre de Cristo Mts. at Cucharas Pass southward to New Mexico the generally-silvered adults are mostly ssp. *electa* but some adults have paler unh tending toward *ratonensis*. Ssp. ***ratonensis*** from Raton Mesa on the New Mexico border is always silvered and is much paler on ups and on the unh disc than other ssp. *A. hesperis electa* has darker ups margins, a darker unh disc, and more extensive and uniform unf orange than does *A. zerene sinope*. Reportedly, the eyes of living *A. atlantis* and *A. hesperis* are bluish-gray with dark-brown spots (except for *A. hesperis* ssp. from Ariz. and C and S New Mex. which are amber), like most *Argynnis* including the *callippe*-group. Scott et al. (1998) proved that *A. hesperis* is a distinct species from *A. atlantis* and detailed their ssp.

Habitat Transition Zone foothills to Subalpine Zone open often-aspeny woods. Hostplants in Colorado herb Violaceae: *Viola canadensis* (vars. *scopulorum* & *rydbergii*), *adunca*. Females always oviposit in litter near green *Viola*, mostly in the shade of trees. Ovipositions were seen end July-E Sept. Aestivation of females in Colorado for several weeks is possible but is doubtfully present (James & Nunnallee could not confirm aestivation in Wash.) (the flight period can start in M June and extends sometimes as late as E Sept. but was mostly M June-E Aug. at Red Rocks in the lower foothills and is mostly July-Aug. in Colo.); the *Viola canadensis* and *V. adunca* hostplants where females oviposit stay green on wooded N-facing slopes in the foothills. Common.

Eggs cream, soon turning mottled reddish-brown, laid singly haphazardly near *Viola*. Larvae eat leaves, without nests. Older larva of ssp. *hesperis* and *ratonensis* dark-black or brown-black, with the twin middorsal lines nearly invisible dark-gray, black patches about BD2 and BSD scoli, a few gray or absent subdorsal paler dashes, scoli have black tips (BD2 scoli mostly brown seldom orangish-cream, BSD scoli with orangish-cream basal part longer, BL1 and BSV scoli mostly creamy-orangish); head black with very top reddish-brown. {Northward, the older larvae of *A. hesperis* ssp. are slightly less black in Black Hills SD ssp. *lurana* and NE-Wash.-SE BC ssp. *beani* (not *brico*) and NE Ore.-SE Wash. *cottlei*=*dodgei*. Southward, older larvae are much paler with full *callippe*-group pattern in *A. h. dorothea*X*nausicaa* in the Chuska Mts. Ariz./NM and the three Ariz.-NM ssp., and middorsal cream lines are thicker in Kaibab Plateau Ariz. *A. h. schellbachi* and are even thicker nearly fused with weak heart-line in AZ-NM *A. h. nausicaa* & NM *A. h. capitanensis*; that suggests that SW Colo. larvae could possibly be somewhat paler than ssp. *hesperis*, see Scott et al. (1998) and James & Nunnallee (2011).} {Scott (1988a, J. Lepid. Soc. 42:1-13) described larvae and pupae from Colorado before Colorado butterflies were proven to be separate species, and his silvered rearings (from Tinytown and Corwina Park) were *A. atlantis sorocko*, while the unsilvered rearings (from O'Fallon Park, Critchell, Mt. Judge, and Cherry Gulch) were *A. hesperis hesperis*.} Mature larvae silk leaves together to form "pupation tents" where the pupa hangs. Pupa orange-brown, the anterior half of each abdomen segment blackish, with weak tan middorsal abdominal lines, wing cases orangish-brown or sometimes dark with black veins & black blotches. Unfed 1st-stage larvae hibernate.

One flight M June-E Sept., mostly July-Aug. Females feed on flowers in July-Aug.

Adults visit flowers of all colors except perhaps pure red, including *Apocynum androsaemifolium, Arctium minus, Aster laevis, Carduus nutans, Centaurea diffusa, Cirsium arvense, Gaillardia aristata, Heterotheca villosa, Liatris ligulistylis, Monarda fistulosa* (favorite), *Nepeta cataria, Rudbeckia hirta, R. laciniata* (favorite), *Solidago altissima*, sometimes visit sap and dung, and often sip mud. Adults bask with wings spread. To warm up, adults shiver the fully-spread wings a few mm. Adults were seen to roost on top of 3 & 10m tall *Pinus ponderosa* & *Pseudotsuga taxifolia* trees. Three adults strayed ~7 mi. from foothills to my house in Lakewood.

Males fleek all day mostly in valley/gulch bottoms and woods (N-facing woods in the foothills), as they fleek ~1/2-1m up. In courtship, the male overtakes the female {probably usually rising up in front of her repeatedly to place his pheromone near her antennae, as *Argynnis paphia* and *A. aphrodite* and *A. edwardsii* do, and they hover (or he discovers and hovers over a landed female on a flower etc.), she lands with him behind, he crawls to her with wings closed and moves his forewings forward and vibrates them from closed to ~1cm apart (average 0-30º spread, varying 0-20-45º, N=13) in bursts (each burst lasting ~1sec. or less consists of typically ~5 wing flicks [the average of my 8 observations ranging from 2-10; movies would be required for precise counts]) and he may vibrate the wings just a little between bursts of wing flicks, and the male vibrates/flicks his wings that way for just a few seconds or even a minute (sometimes he flutters widely at 0-70º-90º) behind or beside her (this transmits pheromone from his wing ups to her antennae), and he bends his abdomen to join. Receptive females would remain motionless after landing and accept the male, while unreceptive females flutter continuously at part- to wide-amplitude (seldom closing the wings completely) to repel him, and unreceptive females may raise the abdomen up between the hw so he cannot join, or they crawl and fly away. That full-flapping rejection dance is also used by males who are courted by another male, causing the courting male to depart. Her wings were raised up exposing her abdomen in an unsuccessful courtship, her abdomen raised into the closed wings in another; the meaning of this would depend on whether her pheromones were repulsive (long-mated females) or not yet repulsive (just mated) (virgins desiring mates would presumably expose the abdomen and its attractant pheromone), as noted for *A. atlantis* and *A. paphia* and *Dione*. During mating, the male bends his uncus downward at the top of the vinculum, and bends his valvae in the middle. If a mating pair is startled, the male usually flies with the female dangling (21x), but the female sometimes flies (5x).

Scott, J., N. Kondla, & S. Spomer. 1998. *Speyeria hesperis* and *Speyeria atlantis* are distinct species. Papilio (New Series) #8:1-32p.

***Argynnis* (*Speyeria*) *egleis secreta* Great Basin Fritillary**

A. egleis is characterized by the unf basal half being sickly-dull-yellowish with very little (if any) orange at the base; and the unh submarginal pale area is narrow and suffused with brownish-tan. The unh spots are silvered (rarely just lightly-silvered). The silver unh marginal spots are similar to *A. zerene* (lenslike and capped with narrow plateaus of brown in Colo.), while the other silver spots are a little smaller than those of *A. callippe*, *A. zerene*, and *A. coronis*. The ups is orangish-brown. *A. egleis* ***secreta*** resembles *A. hesperis electa*, but the silver unh spots show through onto the uph as pale spots more, the tawnier unf basal area is much smaller and more sickly-yellowish rather than wide and orangish-flushed, the pale unh submarginal band is more suffused with brownish, the silver unh marginal spots and caps are less triangular, and the ups wing bases are a little less dark.

Habitat mostly upper Transition and lower Canadian Zone woods, often where the boreal forest meets the sagebrush and oak zones. Hostplant in Colorado herb Violaceae: *Viola* (unknown species in Colorado, assoc. *V. canadensis*). Adults evidently oviposit near green violets. There is no adult aestivation. Uncommon.

Eggs pale yellow, becoming tan, laid singly haphazardly near *Viola*. Larvae eat leaves, without nests. Larvae feed mostly at night. Older larva rather dark with lateral pattern not very visible, brown with twin orangish middorsal lines enclosing black heart-line, with oranger-edged thick black patches near the black-tipped paler-brown BD2 and orange-brown BSD scoli, the lateral area brown with orangish around the orangish BL1 scoli (SE Wash. ssp. *mcdunnoughi* larvae dark-brown with pattern less visible, twin middorsal lines weak, body pattern weak, scoli black except bases of BSD scoli and most of BL1 scoli orangish-cream, James & Nunnallee 2011); head black with orange-brown on top rear. 1st-stage larvae produce droplets from their seta tips, and older larvae produce a musky odor from ventral neck gland, evidently for defense. Mature larvae silk leaves together to form “pupation tents” where the pupa hangs. Pupa orangish-brown with black on front of abdominal segments, and dark veins and eyes. Unfed 1st-stage larvae hibernate.

One flight L June to the start of Aug., as females evidently do not aestivate.

Adults visit various flowers, and mud. Adults bask dorsally, with wings spread fully.

Males fleek all day mostly along partly-shaded forest lanes in Colo., ~10-13-33cm above ground. (In ssp. *oweni* in Mendocino Co. Calif. and ssp. *egleis* in Alpine and El Dorado Cos. Calif., males fleek all day near the ground especially near hilltops [Scott 1976a]; in ssp. *albrighti* in Sweet Grass Co. Montana males fleek evidently near hilltops; I have not studied them on Colo. hilltops). If a mating pair is startled, the female flies, at least sometimes.

***Argynnis* (*Speyeria*) *zerene sinop*e Zerene Fritillary**

The unh spots are always silvered and are rather large, and the unh of the Colo. ssp. ***sinope*** is brownish with many paler areas that seem to be greenish-tinted, and sometimes the unh is mostly greenish-tinted. The unh submarginal silver spots are a little more triangular than those on *A. coronis*, and they are capped with usually-greenish-tinted crescents in ssp. *sinope* (these submarginal unh spots and their caps form a rough cline in shape from very triangular in *A. callippe*, a little less triangular in *A. hesperis* & *A. atlantis*, more lenslike capped with narrow plateaus in *A. egleis* and *A. zerene*, and lenslike capped with wide plateaus in *A. coronis*). *A. zerene* occurs mostly on the W slope in NW Colorado, but barely and uncommonly extends just a few miles E of the continental divide in Clear Creek, Gilpin, and Larimer Cos.

Habitat mostly Canadian Zone open forest and sagebrush. Hostplants in Colorado herb Violaceae: *Viola* (no Colorado records, probably *V. canadensis* [assoc.], *adunca*). And C. Durden found that a *zerene* larva eating *Spiraea* (Rosaceae) developed to a normal adult (2017, J. Lepid. Soc. 71:131). In Colorado females probably oviposit near green violets, without adult aestivation. In Calif.-Wash., females aestivate in July-Aug., but I have seen no evidence of adult aestivation in Colorado where there is apparently not an abundance of records in L Aug.-Sept. (the aestivating *A. aphrodite*, *A.edwardsii*, & *A. coronis* fly and oviposit in L Aug.-Sept after their aestivation, and their females can smell *Viola* roots of plants whose leaves have dried and gone). *S. zerene* ssp. in Ore. can smell a volatile compound coming from *Viola*, even 20 cm downwind of dried violet leaves (D. McCorkle & P. Hammond 1988 J. Lepid. Soc. 42:184-195). Common.

Eggs cream, turning pinkish-tan; laid haphazardly near *Viola*. Larvae eat leaves mostly at night, without nests. The 1st-stage larva produces tiny droplets at the tip of its setae, evidently for chemical defense. And the ventral neck gland on older larvae produces a musky substance evidently also for defense. Older larva brown with usual *A. callippe*-group pattern just a little obscure in Colo. *sinope* (and ssp. *picta* from SE Wash. photo James & Nunnallee 2011) with tan instead of cream dashes (body blackish in some other ssp.), with twin middorsal orangish-tan lines enclosing brown heart-line, with large tan-edged black blotches around BD2 and BSD scoli, most of body appearing finely-mottled brown, a lighter-brown lateral band has brownish red around bases of BL1 scoli which are ochre with black tips (all scoli except brown BD2 ochre in Colo. *sinope*, similar in Ore. ssp. *hippolyta*), spiracles black in all *Argynnis*; head black with some orange-brown on top rear. Some *A. zerene* ssp. in NW Calif. [Allen et al. 2005], W Ore? [Neill 2007], and Alaska [Guppy & Shepard 2001] have blackish larvae: those are black with just gray middorsal lines containing a brown heart-line, large black patches on gray-black remainder of body, brownish BD2 & sl. paler BSD scoli, orangish BL1 scoli. Mature larvae silk leaves together to form “pupation tents” where the pupa hangs. Pupa orangish-brown, with black on front of abdomen segments, the wing veins eyes & appendages black. Unfed 1st-stage larvae hibernate.

One flight July-Aug. Females do not aestivate in Colo., unlike in Wash. where adults occur M May-M Sept. and females fly to higher elevations and aestivate and do not mature their eggs for 3-5 weeks, then return to lower elevations in Aug.-M Sept. to oviposit (James & Nunnallee 2011). Females aestivate in Calif. (Yuba Pass, Sims & Shapiro 2016), and live more than a month even in lab and take 3-4 weeks in lab before they oviposit, so the 1st-stage larvae are not exposed to dry summers. Other *A. zerene* populations (higher altitude and coastal Calif.) and most other *Argynnis* in moister habitats do not have a female aestivation, and females lay eggs in lab after only 2-4 days.

Adults visit flowers of all colors (especially yellow) except red, including *Medicago sativa, Rudbeckia laciniata, Senecio* spp., and sometimes visit dung, carrion, and probably mud. Adults bask dorsally.

Males fleek all day in fairly open areas of brush or forest regardless of topography, as they fly ~1/2-1m up, thus seem to have no special mate-locating area preference. Courtship is similar to other *Argynnis*. Unreceptive females flutter their wings and expose their abdominal scent glands to repel males. If a mating pair flies, either the female or the male may fly, the partner dangling.

Sims, S., A. Shapiro. 2016. Reproductive strategies and life history evolution of some California *Speyeria* (Nymphalidae). J. Lepid. Soc. 70:114-120.

Argynnis* (*Speyeria*) *coronis halcyone **Coronis Fritillary**

A. coronis is identified by the brownish marginal unh silver spots and their caps: those silver spots are lenslike (not triangular) and are capped by thick wide "plateaus" of brown (or in other ssp. greenish), while similar *Argynnis* usually have those silver spots and caps narrower (more triangular spots, narrower plateaus). The unh spots are large and fairly round and always silvered. Those silver unh spots do not show through the wing on uph as they do especially on *A. callippe* and *A. egleis*. The ups is orangish. Males tend to have a pointed fw. Typical ssp. ***halcyone*** (in most of Colo.) has the unh disc brown, but in northern Larimer Co. and far NW Colorado (**near-*halcyone***) there are some adults with greenish-brown unh which represent intergrades with the larger ssp. *snyderi* with greener-brown to greenish unh which occurs in Utah and N Wyo. westward. NW Colo. *coronis* may resemble *A. callippe*, but the *coronis* marginal unh caps are wider, the unh green is more brownish, the ups is oranger, the unf is much more orange, adults are larger, and the silver spots are larger.

Habitat open woods and sagebrush from the foothills to Canadian Zone. Hostplants in Colorado herb Violaceae: *Viola* (no Colorado records, but surely *V. nuttallii* and others). *A. coronis* is uncommon in Colorado (M. Fisher notes it is commoner in Larimer Co.), so I have not been able to get ovipositions, but *Viola nuttallii* is probably used, as well as *V. adunca* and *V. canadensis*. Females in the foothills evidently smell *Viola* roots and oviposit in litter, under bushes where *V. nuttallii* is dormant without green leaves and will regrow the next spring. Females aestivate, as noted below. Uncommon.

Eggs cream, becoming mottled with reddish dots & dashes, laid haphazardly near *Viola* (generally near dried-up plants or where *Viola* will regrow the next spring--females evidently smell the *Viola* roots). 1st-stage larvae have evident droplets on the tips of their long setae. Young larvae prefer *Viola* flowers/young leaves, older larvae eat leaves. They feed at night, hiding under rocks or litter etc. by day, without nests. Older larva similar to A. *callippe*, brown, two middorsal twin creamy lines enclose the black heart-line, BD2 & BSD scoli mostly pale-brown, a lateral lighter-brown band contains a reddish spot around each orangish-cream (brownish-orange in Wash.) BL1 scolus, the area between top and side has cream-edged black blotches (most *Argynnis* older larvae [those that are not blackish—many *Argynnis* species have some blacker ssp. and some paler ssp.] resemble *callippe* by having on the anterior part of each segment a cream dash extending forward and down from BD2 scolus and a cream dash extending forward and up from BSD scolus and below that another extending forward and down from BSD scolus [the cream-edged black blotches mentioned above occur in front of and behind those scoli], and the lowest cream dash is a well-developed crescent in some Wash. *coronis* [photo of James & Nunnallee 2011, but weaker in photo of Neill 2007 and in Neb.]), the transverse pale & black lines over the intersegmental areas that are strong in *A. nokomis* & *A. idalia* but weaker in other species are weak on *coronis* abdomen but stronger on thorax; underside blackish; head black with orangish top & rear in Neb. (top just brown in Wash.). Older larvae (2nd-stage to mature 6th-) of *Argynnis* have an eversible neck gland that emits a bad odor for defense. Mature larvae silk leaves together to form "pupation tents" where the pupa hangs. Pupa light brown with blackish along front of abdomen segments, and dark veins and streaks on wing cases, eyes & thorax black as usual in *Argynnis*. Unfed 1st-stage larvae hibernate.

One flight L May-M Sept. (as late as L Sept.). Adults seem to be strong flyers everywhere, traveling comparatively far. In the Pacific Northwest such as the lowland shrub-steppe on the eastern foothills of the Cascade Mts. of C Wash., *A. coronis simaetha*/*snyderi* 1st-stage larvae overwinter then feed on *Viola trinervata* March-May, then adults occur M-L May-June and in ~M June females and some males (some males die before dispersing) fly up to 160km to higher mountains ~7000-8000', where they aestivate for 1-2+ months feeding on flowers and then return in M Aug.-E Sept.+ to oviposit in litter etc. near absent-senescent *Viola* in L Aug.-E Oct. (James & Nunnallee 2011; D. James & J. Pelham 2011 J. Lepid. Soc. 65:249-255). In California, Shapiro (2007) wrote that San Francisco Bay area adults emerge in May-June then disappear as females aestivate and reappear in Sept.-Oct. and oviposit. Females at Yuba Pass in Calif. aestivate (Sims & Shapiro 2016), and live more than 7 weeks even in lab and take 5 weeks in lab before they oviposit, to protect the 1st-stage larvae from hot dry summers. And in San Diego Co. O. Shields noted that females aestivate and fly down to lower areas in Sept.-Oct. (News Lepid. Soc. 1984 p. 66)—females evidently fly upslope in spring. In Colorado I have not seen adults migrating upslope, and have not seen concentrations in the higher mountains where they might end up, but females aestivate in the southern Rocky Mts. also, because males and females show a different pattern of records: males emerge sparsely in L May and mostly in E June-M July and some occur in L July and fewer through L Aug., while females emerge evidently starting just days or a week later than males but are not often seen until a peak of records in L Aug.–E Sept. This suggests that males fleek swiftly to mate with females as long as males live (mate-locating behavior was also observed in males chasing butterflies later in summer L July and occasionally as late as Aug. 20) and the females mainly rest in aestivation until L Aug.-Sept. 25 when females in fairly-fresh condition oviposit and join the *Chrysothamnus* (*Ericameria*) *nauseosus* flower-feeding guild that is easily seen at the lower mountains/plains edge (like *A. aphrodite* and *A. edwardsii* which also aestivate) (*Vanessa Polygonia Nymphalis Aglais* are also members of that guild).

Adults mostly visit yellow and white flowers, often purplish/blue ones, including *Apocynum androsaemifolium, Carduus nutans, Chrysothamnus* (*Ericameria*) *nauseosus*, *Medicago sativa*, *Cirsium*, and sometimes visit mud.

Males fleek fast all day in open areas incl. open woods regardless of topography, as they fleek ~1m up (*A. callippe* & *A. egleis* fly lower). *A. coronis* is generally uncommon so would seem to need some special kind of mate-locating preference to bring the sexes together, but lacks one of the usual strategies, except they seem to like to fleek over concentrations of flowers where they may find females (seldom staying long enough to be called flaiting), and once I saw a male rait on a slope of *Apocynum androsaemifolium* flowers by raiting on the ground ~6x and chasing *A. aphrodite* 4x from those spots. F. M. Brown's Colorado Butterflies in 1957 described *coronis* as a "hillside species", accurately noting that it does not prefer to mate-locate on hilltops or meadows as do some other *Argynnis*. All *Argynnis* fly fairly fast, *coronis* perhaps a little faster than other species (Shapiro 2007 wrote it is the most dispersive *Argynnis* in C Calif.), so evidently *A. coronis* males' mate-locating strategy is <u>speeding through the habitat</u> to find enough females and get enough matings. *Argynnis* keep their wings spread on flowers, which helps fleeking males notice flower-feeding females. If a mating pair is startled, the male and often the female flies, the partner dangling.

Boloria eunomia caelestis **Bog Fritillary (Ocellate Bog Fritillary)**

Identified on unh by the row of postmedian circles, the marginal row of large unsilvered triangles, and the median spot in cell CuA_2 which is rounded distally and basally (other *Boloria* have this spot hourglass-shaped, indented distally and basally). Colorado has ssp. ***caelestis***, which has yellowish unsilvered unh bands (*ursadentis* from the Wind River Mts. and Beartooth Plateau in Wyo. is very similar and is a synonym). The name *laddi* [TL Lewis Lake, Albany Co. Wyo.] is claimed to be slightly darker, but the unh varies, and J. Masters reported a Gunnison Co. population with dark unh that he called *laddi*; it is treated as a syn. of *caelestis*.

Habitat open moist meadows and shrub-willow carrs, often the hummocky areas where the willows are drying out, mostly in Subalpine and lower Alpine Zones (rarely Canadian Zone). Hostplants in Colorado (mostly herbs) (*main hostplants) Polygonaceae: *Polygonum* (*Bistorta*) *viviparum**, *P. bistortoides*; shrub Salicaceae: *Salix planifolia**, *brachycarpa, reticulata* var. *nana=nivalis*; Violaceae: *Viola labradorica**; Ericaceae: *Vaccinium cespitosum, V. myrtillus oreophilum*; rarely used are Asteraceae: *Potentilla diversifolia, Sibbaldia procumbens*. *Polygonum* (*Bistorta*) *bistorta* and *Viola* are known hosts in Europe. *B. eunomia* is polyphagous, and occurs at a wet meadow habitat in Teller Co. that has no *Salix*, where *Polygonum viviparum* may be the host. (*Boloria* oviposit somewhat haphazardly and often eat numerous plants, so determining usual hostplants in nature is difficult, so lab-feeding tests are desirable. *B. eunomia* and *B. frigga* in lab eat Violaceae, *Vaccinium*, Polygonaceae, Rosaceae, and Salicaceae, Scott 1992). Usually uncommon.

Eggs pale-yellow, turning tan, laid in clusters of 2-4 (rarely up to 20) on leaf undersides. Larvae eat leaves, and young larvae eat holes in the leaves. Older larva reddish-brown with numerous brown striations, a middorsal band of brown marks, a cream lateral band, some V-shaped cream cones in front of some BSD scoli, many brownish-red scoli; head dark-brown with red-ochre zone around eye area, a red-ochre stripe on each vertex, a red-ochre lenslike patch on lower front. Pupa unknown. 3^{rd}-4^{th}-stage larvae hibernate (at timberline biennial populations may hibernate as 1^{st}- and ~4^{th}-stages). It may be biennial in Scandinavia.

One flight July-Aug. near timberline, L June-M July at 10000’.

Adults visit flowers of many colors, most often yellow, including *Arnica* spp., *Erigeron ursinus, Polygonum* (*Bistorta*) *bistortoides, Rhodiola rhodantha, Senecio* spp.; I have not seen it on mud. Marked adults can move a few hundred meters between habitats through dry pine woods between wet habitats (J. Shepard), and move up to 920m in Belgium. Adults are dorsal baskers. Adults roost mostly on top of *Salix* bushes, sometimes on low herbaceous plants.

Males fleek all day in low swales in wet willow carrs or wet meadows with abundant hosts, as they fly ~1/3m up or just above the shrub *Salix* canopy. In courtship, the male overtakes the female, she lands with wings closed and he lands behind and flutters his wings widely (0-100^o varying to 45-130^o) and bends his abdomen to mate. A male finding a female on a flower hovers near her briefly and may dip down to her several times evidently to transfer pheromone. Unreceptive females flutter widely to repel the male, or fly away. A male may sometimes search up and down *Picea* trees in a cloudy period evidently to find ?roosting females. If a mating pair is startled, the female flies at least usually, the male dangling. Females usually mate just once.

Boloria selene myrina **Silver Meadow Fritillary**

Identified by the four rows of silver spots on unh, and the absence of the unh postmedian circles of *B. eunomia*. Some European *B. selene* look different from N. American adults, while some are very similar, so I treat them as the same species as most people do; the genitalia are reported to be the same (T. Simonsen et al. 2010. Systematics & Biodiversity 8:513-529.). Several weak ssp. occur in Colorado, which could be lumped into one ssp. ***myrina*** because adults are so similar (though larvae & pupae differ somewhat). The high mountains *myrina* =“***tollandensis***” has less reddish-brown on unh bases, while the NE Colorado plains *myrina* =“***sabulocollis***” has a bit more reddish-brown there. The plains had only four *sabulocollis* colonies, and now there are only ~three (one evidently safe on the AF Academy). The *sabulocollis* colony at Timnath along the Cache la Poudre River in Larimer Co. became extirpated due to habitat loss and removal of horses causing overgrowth of vegetation, and the ground water evidently seeped out a dirt bank from under an irrigated corn etc. field so the last colony there was unnatural anyway, and the little collecting that was done was perhaps too much given the puny size of the habitat, which was so small after a hundred years of river abuse that the colony was doomed to extirpation. There is a higher-altitude colony in Las Animas Co. that has redder unh bases like *sabulocollis* also and a smaller spot, which is hard to apply a ssp. name (ssp. ***myrina*** arguably has synonyms *tollandensis* and *sabulocollis*, and in E Canada *terraenovae* is intermediate *myrina*X*atrocostalis* based on wing pattern thus is also a synonym).

Habitat wet/moist meadows/seeps from the upper plains to the lower Subalpine Zone, in the mountains often with *Salix* bushes and *Potentilla fruticosa*. Grazing is necessary in most populations to remove plants (including shrubs) that try to overgrow the habitat and eliminate the *Viola* and butterflies. Hostplants in Colorado herb Violaceae: *Viola sororia=affinis=nephrophylla* at least at lower and middle altitudes (on plains and Gilpin Co.), *Viola* probably *adunca* and *V. labradorica* at higher altitudes (hosts in Europe 4 species of *Viola*). Oviposition occurs near *Salix* also but larvae may not eat it. Uncommon, sometimes locally common; the plains colonies should not be collected.

Eggs pale-green or yellowish-white, becoming tan, laid singly and haphazardly near but seldom on *Viola*. Larvae eat host leaf uns when young, the whole leaf when older; no nests. Older larva dark grayish-black with a bluish tint, thorax black, many black large and small spots, heart-line blackish, black patches (narrowly edged by creamy) mostly surround the dorsal scoli and behind the BSD scoli, an orange-brown lateral line; scoli orange in *sabulocollis* and in Wash. (slightly-orangish-cream in *tollandensis*—both ssp. have scoli with black tips and black hairs), the black dorsal prothoracic scoli are three times as long as the others (about same length as head width in *tollandensis*, 1.5 times head width in *sabulocollis*, evidently <½ in Wash.) and project forward like horns; a ventral neck gland; head blackish. (Interestingly, the West Virginia larva in Allen et al. [2005] is much paler perhaps overexposed [the smaller photo from W.Va. is dark], creamy-tan with blackish thorax and cream scoli, and the Wash. larva in James & Nunnallee [2011] is similar but a little darker.) Pupa dark brown (wing cases may be lighter, and a photo of E U.S. ssp. *myrina* shows some brown streaks on wing) in *sabulocollis* (black-brown in *tollandensis*), with a row of subdorsal cones, the cones on thorax and A1-2 metallic reddish-gold or silvery (*tollandensis* cones have no nipple, *sabulocollis* cones longer with a protruding nipple), in Wash. A5-8 cones black with cream medial dash at base, a point on top of thorax, and two brown cones on head. 2^{nd}- to 4^{th}-stage larvae hibernate (mostly 3^{rd}), in annual life cycle. In Britain, larvae from the first gen. hibernate as 2^{nd}-4^{th}-stage, while larvae from the partial second gen. hibernate as 3^{rd} stage (C. Turnbull 1979 Ent. News 90:125-130).

Three flights on the plains mostly L May-E June, M-L July, L Aug.-E Sept.; perhaps two flights Wet Mtn. Valley June and L July-E Sept.; one flight at high altitude June-Aug. (mostly July-E Aug.).

Adults visit a variety of flowers of most colors esp. yellow (*Geum, Potentilla*, *Rudbeckia*, mustards), and sometimes imbibe mud. Adults bask dorsally. Marked adults in Gilpin Co. often moved 1300’ between meadows and lived up to 17 days (B. Bartell).

Males fleek all day in wet meadows/wet ditches and springs, as they fleek ~20-33cm (sometimes 67cm) up. In courtship (completed courtships observed by Scott and several by B. Bartell), the male hovers and flutters with full-strokes over a landed female, or pursues a flying female and they land, and the male flutters widely beside her (~5x/sec. for 3-12 sec.) and (in some courtships) flutters/bumps into her thorax, and bends his abdomen to join while his wings are partly spread and her wings are closed and abdomen slightly (?) raised. Receptive females may flutter briefly with slow wide strokes or may remain motionless, while unreceptive females flutter widely ~5x/sec. to repel the male, or crawl down into the grass, or evidently raise her abdomen so high he cannot join (and presumably evert her repellent glands [like those of *Argynnis*] to waft a repellent pheromone), or fly away. Mating lasts ~22min. If a mating pair is startled, the male flies at least sometimes, with the female dangling.

Boloria bellona near-*bellona* Meadow Fritillary

Similar to *B. frigga*, but distinguished by the squared-off fw tip, the paler ups and uns and larger size, and the more extensive and jagged black unf markings. The uph submarginal black spots are mostly thin and lenslike. Colo. adults resemble the E U.S. ssp. *bellona*, but are a little smaller, so could be called **near-*bellona***.

Habitat in Colorado Canadian Zone moist valley bottoms with moderately large ~2-4m *Salix* bushes (and perhaps a few *Alnus* etc.), where (in Grand Co.) it sometimes flies with low-altitude populations of *B. frigga*. Mostly in NW Colo., but one was found at E portal of Moffat Tunnel in Gilpin Co. Females oviposit near *Viola* growing under those large bushes. Hostplants in Colorado herb Violaceae: *Viola adunca*. Lab larvae eat only *Viola*, and not the myriad of other hosts of other Colo. *Boloria*. Ssp. *bellona* expanded its range southward into most of Kentucky (starting in ~1979), S Ohio, C Illinois, and S Indiana (Belth 2013), but has apparently not expanded its range in Colo., where it was widespread in 1949-1950 and T. Mead collected it in Grand Co. in 1871. Uncommon, sometimes locally common.

Eggs whitish, laid singly haphazardly near *Viola*. Larvae eat leaves at night, without nests. Older larva purplish-black or dark-magenta-gray or brown, with a subdorsal cream band edged below by black dashes that are edged below by weak white dashes, a black mark in front of BD2 scoli and a black mark below BSD scoli, a lateral cream line, scoli orangish-brown (the upper three rows with black tips), the scoli on top of T1 nearly twice as long as the others; head black. Pupa brown mottled with numerous dark-brown striations and mottling including on wings, the abdomen with some paler lateral and supraventral and darker sublateral bands, with three or four blackish V-shaped chevons near top end of abdomen, small cones on abdomen and several silvery or gold cones on the "saddle" and top of the head. Unfed 4th-stage larvae hibernate.

One flight M June-M July (sometimes L July).

Adults visit various flowers of all colors including *Penstemon confertus procerus*, and mud and dung. Adults bask dorsally.

Males fleek all day over marsh "grass" moist meadows near 2m *Salix* bushes to seek females, as they fly 30-40cm up. In courtship, the male sometimes hovers in front of the female, who may also flutter (as a rejection dance evidently). If a mating pair is disturbed, the female flies, the male dangling.

Boloria frigga sagata Willow Bog Fritillary (Frigga Fritillary)

Identified on the unh, which has an ochre-gray outer half, plus a large white patch on the anterior base that contains a dark spot (that patch is shorter than that of *B. improba*). The fw is pointed. The uph submarginal black spots are mostly thick blobs. It flies with *B. bellona* in Middle Park (Grand Co.), but usually flies at higher altitude. The Colo. ssp. ***sagata*** is much smaller with paler ups wing bases than other ssp. from Canada etc.

Habitat shrub *Salix*/*Betula* carrs (often wet) mostly in Subalpine Zone, sometimes Canadian & lower Alpine Zones. (Willow "bogs" are properly called carrs.) Hostplants in Colorado shrubs: main hostplants Salicaceae: *Salix planifolia, wolfii, brachycarpa*, occasional hostplant *S. monticola*; Betulaceae: *Betula glandulosa* is also a host because it is almost the only plant growing in a Larimer Co. carr with abundant *frigga* and is a known host in Mich., and lab larvae eat it. Females oviposit only on seedlings of *Salix* (including those growing in the inside of a little creek meander) in my experience, and surely also on *Betula glandulosa* seedlings, a hostplant. My lab larvae also ate *Salix* 7 spp., *Vaccinium* 2 spp., *Polygonum* (*Bistorta*) 2 spp., *Potentilla diversifolia, Sibbaldia procumbens* (both Rosaceae), but just ate some *Viola labradorica and V. sororia*, and ate none of various diverse other plants. Wolfe et al.'s (2010) larvae ate both *Salix* & *Viola* in lab. Oviposition has been reported on *Andromeda glaucophylla* and *Kalmia polifolia* in Mich. (both Ericaceae), but my larvae ate just a little *Kalmia*. In Europe, hosts are *Rubus chamaemorus* (Rosaceae), and lab larvae eat *Polygonum* (*Bistorta*) *viviparum*. Thus there may be occasional other hostplants. (An oviposition was seen on *Dryas integrifolia* [Rosaceae] in Alaska, evidently the valid hostplant for *B. frigga gibsoni* which may have different habits). Uncommon, sometimes locally common.

Egg light-orangish-tan, laid singly on/near a host. Older larva black, a wide white chainlike subdorsal band containing black spots in the wide places on the chain, and BD2 scoli occur just above the narrow places of that white band; the scoli are orangish-brown basally with black tips; head black. Larvae hibernate nearly mature (probably 4th-stage), plus young larvae at high altitude.

One flight June-M July (mostly M June-E July).

Adults visit whitish flowers and probably all other colors, including *Cardamine cordifolia* and *Rhodiola rhodantha*, briefly visit *Salix* catkins, and visit mud. Adults are dorsal baskers. M. Douglas (Douglas & Douglas 2005) notes that they cannot warm up by shivering their wings. Adults roost on *Salix* bushes with fw within the hw and antennae along the fw costa.

Males fleek all day usually about shrub *Salix*/*Betula glandulosa* carrs "willow bogs", as they fleek swiftly ~20-50 cm up. In courtship, the male pursues the female and both hover, the female lands and the male may continue to hover over her if she flutters widely (receptive females would be quiescent while the male joins; unreceptive females flutter widely to repel the male).

Boloria improba acrocnema **Dingy Fritillary**

Easily identified by the ochre-grayish outer part of unh, the pale median band across unh, the very rounded fw margins, the blotch-shaped spot in the fw discal cell, and the often whiter ups areas in the middle of the wings. *B. improba* was thought to be just an arctic butterfly, then ssp. *acrocnema* was discovered in SW Colo. in 1978, and a similar ssp. *harryi* was found several years later in the Wind River Mts. then in the Absaroka Mts. etc. in NW Wyoming. The unh median spot in cell M_2 is longer in Colo. ssp. ***acrocnema*** than in ssp. *harryi*. Another ssp. *nunatak* with whiter median ups areas and oranger outer areas of ups and blacker uph postmedian band was later found in the Rocky Mts. in central-western Alberta. Arctic ssp. are even more dingy brown (ssp. *improba* with dingy brown ups ranges to Baffin I., Alaska, Siberia, and a similar ssp. in Norway).

Habitat Alpine Zone (~12,000-13,500') mats of prostrate *Salix*. I studied this sp. and worked out its life history and population size (Scott 1982). Hostplant in Colorado prostrate woody Salicaceae: *Salix reticulata* var. *nana=nivalis*. *S. arctica petrophila* (also called var. *petraea*) is evidently a rare Colo. host, because one egg (of 69) was laid on it (seen by A. Seidl), and my lab larvae ate many kinds of *Salix* even *S. babylonica* trees (*S. arctica* is used by Wyo. *harryi*, because *S. arctica* dominates the moist tundra there); herb Polygonaceae: *Polygonum* (*Bistorta*) *viviparum* may be an occasional host if larvae can eat it (I saw an oviposition on it, and oviposition also occurs on it in Scandinavia, where adults are assoc. with *Salix herbacea*). Adults are very local, but sometimes stray 250m or more from a colony. The *Salix* hosts grow only 5 cm or less high, in mats above timberline that can be 50m (even 1 km) in size and exclude most other plants, but adults evidently do not occur on most of those mats. The colonies occur especially on NE- (sometimes N-, seldom NW-) facing nooks on alpine ridges & cirque basins where snow accumulates and lasts long after winters. Some colonies can have thousands of adults in just a 15-hectare colony in a flight lasting about a month, but most colonies are very small, and the population size varies greatly from year to year, varying with snowfall and temperatures. There are 15-16 known colonies in Colorado (~5 more if we add subcolonies), most of them very small, all in the San Juan to S Sawatch Ranges in SW Colo. Ssp. *acrocnema* occurs in that area but not in most Colorado alpine areas, evidently because monsoon rains provide more summer moisture to supply the SW Colo. *Salix* mats with moisture during hot sometimes dry summer months (the *Salix* mats are less abundant in other mts. including the Front Range where they are small and scattered).

Ssp. *acrocnema* is currently legally considered a Threatened Species under the Endangered Species Act and cannot be collected. Sometimes locally abundant, but uncommon at the tiny colonies, which should not be collected even if collecting were legal.

Eggs cream, becoming tan, laid singly mostly on host leaf ups or uns or base (nearly always on opened leaves) or petiole or litter below the host, but 14% of eggs were laid on nearby plants (grass, moss, *Erigeron, Silene acaulis, Salix arctica*) (A. Seidl 1996 J. Lepid. Soc. 50:290-296), eggs not well cemented so 2/3 of eggs fall off; egg duration 23-32 days in nature. Young larvae eat holes in the leaves, older larvae eat the top or apex of unopened leaves (one larva ate a little root), without nests. Older larva light-brown or sl. reddish-brown, with a weak brown middorsal line (no middorsal scoli), a dark undulating band encloses pale scoli (this band blackish and larger in front of the scolus, brown behind on each segment), edged below by a bright-cream subdorsal narrower stripe, an equally-broad blackish band below this stripe, a brown line along bottom of 2nd row of scoli, a light-brown wide band encloses spiracles on abdomen, tan on thorax around third row of scoli (on thorax darker along spiracular area), a bit darker tan just below 3rd row of scoli, uns light-brown; scoli pale (reddish-brown); head blackish-brown, with a brown subdorsal bar on top of head and a brown spot above eyes. Pupa usually horizontal between leaves or in dense leaf litter etc. loosely silked together by the larva. Pupa mottled light-brown or sl. reddish-brown, side of T3-A3 slightly darker, A4-8 more grayish-tan, with a tan subdorsal line when young, some pale and darker bars on head, orbit blackish, browner veins (except R veins) on wings, a slightly darker middorsal V (aimed forward) on rear of T2, weak paler and darker bands on abdomen seem to be remnants of the larval pattern, and with many subdorsal bumps, A5-7 segments each having a small paler middorsal "saddle horn" in the front at the point of a gray flaring triangle (each triangle between two black semi-circular spots [these areas are domes between black triangles on Wyo. ssp. *harryi*]), the intersegmental membrane in front of A5-7 reddish; pupa duration 21-32 days in nature. Biennial/multiannual (doubtfully rarely annual), because unfed 1st-stage larvae usually hibernate the first winter (1st-stage diapause also proven by Ted Pike in Alta., where *nunatak* fly mostly even years), unfed 4th-stage the second (some of my 1st-stage larvae but no 4th-stage larvae developed instead of diapausing under constant light in the lab). But there is evidently plasticity in this system, such that one or both of these hibernation stages can take several years, because sometimes they overwinter three years (one colony had no adults seen for two years in a row--zero butterflies seen July 1-25--yet was common the next year and the year after that, proving that the life cycle can be three years and maybe four as the 4th-stage diapause may take several years (similar to *Chlosyne whitneyi damoetas*). Thus it is frequently multiannual. That makes new colonies hard to discover; there are places where huge amounts of the hostplant look ideal but no adults were seen, but maybe they would be there the next year, and one must prove adults are absent for three years in a row to declare a colony missing (a colony may occupy only a small NE-facing nook within a huge hostplant sward of sloping/flat topography). A one-year life cycle seems impossible, occuring only if an egg were laid late June and took 4 weeks to hatch and if the 1st-stage did not diapause (this diapause is prevented in lab with constant light whereas the unfed 4th-stage diapause is not bypassed) and took 56 days to feed to 4th stage (twice my lab time of 26 days) in late Sept.; but that would be unlikely because the host starts to senesce in Aug. and leaves fall in M Sept. and the young larvae would have to eat old tough leaves, and early cold/snows may make Aug.-Sept. feeding difficult. For these reasons larvae probably mostly also hibernate as unfed 1st stage.

One flight mostly end June-E Aug. in Colo. (extremes June 29-Aug. 18) (ssp. *harryi* in Wyo. flies E-M Aug. in Wind River Mts., and L June-M July in the N part of that range and the Absaroka Range).

Adults visit various flowers of all colors including *Silene acaulis*, *Salix reticulata* catkins, *Phlox multiflora*, *Hymenoxys grandiflora, Minuartia* "*Arenaria*" *obtusiloba*, *Geum rossii turbinatum*, *Erigeron ~pinnatisectus*, *vagus*, *simplex*, *Polygonum* (*Bistorta*) *viviparum*, *P. bistortoides*, and they often probe wet soil to suck moisture. Adults bask dorsally, often by spreading the wings flat on dark soil. Adults fly slowly unless disturbed, and they rest for long periods of time in the tundra; females spend at least ~90% of their time resting, males perhaps 80%. Lifespan is up to a week in nature, but mark-recapture study suggests the average adult only lives several days. A ¼" hail in Wyo. killed only 1 of 10 adults under my oviposition net. A marked adult moved 250m and several strayed >1km, though most are rather local.

Males fleek all day (even after 16:00) on moist swales or flat slopes with a preponderance of the prostrate *Salix* hostplants, as they fly fairly slowly ~10 cm up. In courtship, they land and the male flutters behind the unreceptive female who flutters widely to repel him or she crawls away (successful courtship would be like other *Boloria*, the female quiescent after landing).

Scott, J. 1982. The life history and ecology of an alpine relict, *Boloria improba acrocnema* (Lep., Nymphalidae), illustrating a new mathematical population census method. Papilio (New Series) #2:1-12.

Boloria freija browni Zigzag Fritillary (Freija Fritillary)

Identified on unh by the distinctive sawtooth median band (which has two white spots), the white arrowhead-shaped marginal unh spots, the can-opener-like white spot near the lower unh base (in cell CuA_2), and the yellow-brown bases of the postmedian band spots in cells Rs and M_1. The Colo. ssp. ***browni*** is paler on ups than other N. Amer. and Eurasian ssp. (Manitoba adults are intermediate between *browni* and N Canada ssp. *freija* in unh pallidity.) {*B. freija* has red-brown areas on unh, whereas the Pleistocene Fritillary *B. tarquinius* has just brown there; *B. tarquinius* is a very dark species in cold alpine/arctic areas ranging from Baffin Is. and Boothia Pen., and as *B. t. natazhati* etc. to Victoria I. and northern N.W. Terr. and Alaska-Yukon-N BC.}

Habitat valley bottoms in the Subalpine-lower Alpine Zones, often in/near willow carrs, rarely as low as 8600' in Canadian Zone. Hostplants in Colorado herb Ericaceae: *Vaccinium cespitosum* {*Kalmia* (p*olifolia*) *microphylla* may be an occasional host}. Cranberry (*Vaccinium* spp.) are hosts in Mich. (Lab larvae eat Violaceae, *Vaccinium*, Polygonaceae, Rosaceae, and *Betula* [Scott 1992]). Hostplants elsewhere and in Europe and Japan are various Ericaceae (*Vaccinium uliginosum, Rhododendron aureum, Empetrum nigrum, Arctostaphylos uva-ursi*) and Rosaceae (*Rubus chamaemorus, Sieversia,* and perhaps *Dryas integrifolia*); so far Colorado butterflies seem uninterested in those other plants but further work might validate a few more hosts. "Bog" butterflies in general seem to be rather polyphagous. Usually uncommon, occasionally common.

Eggs greenish-cream, laid singly under leaves. Larvae eat leaves, without nests. Older larva (James & Nunnallee 2011, Nielsen 1999) black, often with a brownish dorsolateral stripe, scoli blackish with pale greenish-gray or tan scolus bases. Pupa blackish, with black streaks on wings and a black lateral abdominal line, five pairs of blacker bumps on the paler abdomen, the posterior three pairs with connecting ridges. Fed-4th-stage larvae hibernate, and evidently 1st-stage at timberline.

One flight L May-M July, in lower Alpine Zone L June-July (rarely M June & M Aug.).

Adults visit flowers of most colors, and sometimes visit mud. Adults bask with wings spread; they cannot warm up by shivering the wings.

Males fleek all day about valley bottoms (often the drier edge of willow carrs) where *Vaccinium* is common. In courtship, the male may hover over a landed female or behind a fluttering female, or he overtakes the female and they land and he flutters his wings behind her, while an unreceptive female flutters a little and spreads her wings 80-90^o and raises her abdomen 45^o and may crawl into grass, and the male leaves (unreceptive females evidently flutter the wings strongly like other *Boloria* & *Argynnis* to repel the male).

Boloria titania Purplish Fritillary

Identified on unh by the thin white marginal spots (rarely missing) capped by brown crescents or triangles that are pointed inward. The unh is red-brown with a conspicuous ochre unsilvered (sometimes partly-silvered) median band. North American ssp. have a slightly different valva than European, but the E Canada ssp. *grandis* is so similar to European ssp. *titania* that they must belong to the same species *B. titania*. Ssp. *grandis* intergrades with ssp. *chariclea*-type subspecies at many places across the arctic (E. Pike), even though near Fairbanks Alaska they sometimes fly in the same taiga bogs, though the flight periods overlap little there (*chariclea* flies mostly earlier and is biennial and usually scarce there), so I still treat *chariclea* as a ssp. of *B. titania*. The Colorado subspecies are somewhat similar to *chariclea* in appearance and habitat. Two ssp. occur in Colo.: Ssp. ***helena*** has ochre unh median band and other areas, and females have the black marks on ups narrow like males, whereas ssp. ***sangredecristo*** females in the southern Sangre de Cristo Mts. are similar except they always have those black marks wider (some females in NW Wyoming also have wider black marks but most have narrow marks, so the darker female phenotype is named an occasional form sangredecristo in Wyoming, named a valid subspecies *sangredecristo* in Colo.). There is great variation in the length of the spot in the middle of the unh median band, and in general the Southern Rocky Mts. butterflies have features of both ssp. *titania* and *chariclea*, as the unh also varies in amount of silvering.

Habitat mostly forested valley bottoms with numerous *Vaccinium* in upper Canadian-Subalpine Zones, and it often occurs on alpine tundra *Salix* mats. Hostplants in Colorado mostly herbs (*main/frequent hosts): Ericaceae: *Vaccinium myrtillus oreophilum**, *V. scoparium**, *V. cespitosum**, *Gaultheria humifusa* (oviposition, perhaps a doubtful host), *Kalmia* (*polifolia*) *microphylla* (oviposition, perhaps doubtful host); Violaceae: *Viola labradorica**; shrub Salicaceae: *Salix reticulata* var. *nana*=*nivalis** above timberline, *S. planifolia*, *brachycarpa*; Polygonaceae: *Polygonum* (*Bistorta*) *bistortoides*, *viviparum*; Rosaceae: *Potentilla diversifolia*, *Sibbaldia procumbens*, *Erigeron ursinus* (oviposition, doubtful host). (European ssp. *titania* hostplants reportedly *Polygonum* & *Viola*.) Larvae are evidently polyphagous, and multiple ovipositions were obtained for most of these (only one for the doubtful ones), so it would be desirable to see if lab larvae eat these plants well; unfortunately 1st-stage larvae have strong diapause so larvae are very difficult to rear. Ssp. *sangredecristo* is associated with *S. reticulata* var. *nana*=*nivalis*. Common.

Eggs tan, turning orangish, laid singly on leaf uns. Larvae eat leaves, without nests. Older larva (Utah, photos by Nicky Davis) dark somewhat-reddish-brown with numerous tiny gray dots, a middorsal black line edged by a cream line, a pair of lateral weak creamier dashed lines sandwiching a blackish line and the pair edged above and below the pair by dark areas, the scoli blackish-brown, although BD2 and BSD scoli have gray bases; head black. Pupa mottled somewhat-reddish-brown with subdorsal cones on abdomen. Pupates under rocks or amid vegetation. Unfed 1st-stage larvae hibernate the first winter, 4th-stage larvae the second, so upper Subalpine-Alpine Zone populations are surely biennial (just as arctic *chariclea* is biennial, flying mostly in odd years in Alaska and Yukon), while perhaps some of the lower-altitude populations that start flying in early summer hibernate just once as 4th-stage larvae. However females usually lay eggs near trees so the temperature is cooler there and they may be biennial there also.

One flight M June-start of Sept. (most often M July-M Aug.).

Adults visit flowers of all colors, mostly yellow and white, including *Arnica mollis*, *Erigeron* spp. esp. *ursinus*, *Senecio* spp., and sometimes visit mud. Adults rest and nectar with spread wings, and adults bask dorsally with wings mostly spread, and like to land on dark rocks/soil to get warm; they cannot warm up by shivering their wings. Adults roost several to 12m up on conifer trees, mostly *Picea*.

Males fleek all day to seek females in moist swales, including swales at the edge of willow carrs, moist valley bottoms, subalpine open forest swales with abundant *Vaccinium*, and alpine/subalpine zone swales/chutes covered with prostrate *Salix reticulata* var. *nana*=*nivalis*. Males fleek ~10-20 cm up. Late in the day males often search high up *Picea engelmanni* trees to find roosting females (some adults roost even 10-12m up on them), and earlier in the day some males searched lower parts of those trees. In courtship, the male hovers over a female on a flower or overtakes a flying female, he lands behind her, then he spreads his wings ~70º or ~100-130-135-150º and flicks them at small amplitude (or sometimes flutters them at wider amplitude), in both cases the wings move ~2-3-3-4-5-8x/second [it varies, and without video I cannot record those details accurately] for ~3-5 sec., while the female either closes her wings or more often spreads her wings widely 135-140º and raises her abdomen 20-25-30º, he stops fluttering and raises his wings fully and moves to her side while she usually closes her wings and he bends his abdomen to join (if he is alongside her he backs up to her rear to join if her wings are still spread somewhat). Unreceptive females flutter her widely-spread wings to repel landed or hovering males; once she spread her wings and raised her abdomen and the male flew around and landed on her wings and attempted to mate (she raised her wings and flew away). A female was observed upside down on a grass head with wings spread and fluttering (the usual rejection dance) and exposing her reddish (grayish-tipped) abdominal glands, evidently to waft her already-mated rejection pheromone. (The female abdomen may be raised much more and those glands everted when she is attempting to repel a male, and raised little if she is merely ready to mate, but I note some variation and more observations are desirable.) If a mating pair is startled, the female flies at least usually, the male dangling.

Nymphalidae, Nymphalinae, Cyrestini

Cyrestini is a tropical group, with ~43 neotropical species. Older larvae have middorsal spines/scoli.

Marpesia petreus petreus Ruddy Dagger Wing

A very rare stray to Colorado from Mexico (where it flies most of the year), recorded S of Denver in Douglas, El Paso, and Crowley Counties (near Olney Springs, Aug. 31, W. Howe), flying as far north as Nebraska. The long tails and pointed fw and red ups coloration are unique. A long "twig" line runs from the smaller tail straight across the leaflike unh and unf. The lower body legs and palpi and proboscis are white, perhaps for camouflage when resting on pale substances. In the tropics its hostplant is Moraceae: *Ficus* (fig trees). The larva is spectacular with russet, black, slate, and white markings (the top of A3-9 is white shaped like an oak leaf), four middorsal black spikes, and two very long black head horns (photos in Allen et al. 2005, Wagner 2005). Pupa green or gray-white, with black subdorsal etc. spots/patches/band, with black spines on abdomen and wing base and head.

Nymphalidae, Nymphalinae, Apaturini Emperors

There are ~85 Apaturini species worldwide in 20 genera; all but *Asterocampa* and *Apatura* are in the old world. Adults often prefer sap to flower nectar. Larvae may have thick antlers on the head and short tails on the rear; our species lack adornments on the body but various tropical species elsewhere have such adornments, and Apaturini is just a tribe of Nymphalinae, not a subfamily. Pupae of our species are flattened sideways with two head horns; they resemble leaves.

Asterocampa celtis Hackberry Butterfly

Asterocampa have complex patterns including many black eyespots near the margin of uph. *A. celtis* has one bar and two broken half-spots in the upf discal cell, unlike other species in nearby states. Ssp. ***jeffermont*** occurs in the Denver area and NE Colo. north to S.D.; the anterior eyespot in upf cell M_3 is black with white dot, and the posterior eyespot in cell CuA_1 is solid black. Ssp. ***antonia*** in SE Colo. (including the Pueblo area) (plus S & SE Kansas/Texas/Tamaulipas) has both eyespots black with white dot. {Ssp. *montis* in S NM and SE Ariz. has the two eyespots a black ring and a solid black spot, and the ups is oranger-brown. Ssp. *celtis* in E US incl. E Neb. has the eyespots a white spot and a black spot, and the ups is dark-brown.}

Habitat gulch/valley/ bottoms on the plains and lower foothills. Hostplants in Colorado tree Cannabaceae: native *Celtis reticulata*, and cultivated *C. occidentalis*. Common where the hostplant is common; it was once common in Lakewood, but disappeared ~1980s despite *C. occidentalis* trees still present in yards.

Eggs pale-green or cream, laid singly or in small clusters of several eggs (rarely larger clusters from 5 to 50) under host leaves (sometimes on twigs or bark), preferably on young hostplants or new growth. Larvae eat leaves (esp. new leaves), and rest on the underside, without a nest. Older larva green with yellow middorsal dashes and yellow subdorsal and lateral lines with a zigzag yellow line between those lines; head green with four vertical cream stripes, and two long forked horns (which can be brown in Fla. but not in western U.S.), a yellow line behind each horn. Pupa bluish-green, with a yellow middorsal line on the ridge, many white subdorsal oblique lines (a thick line starts from tornus of wing case, and the other thick line runs from the top of each of the two head horns and extends backward onto middle of thorax nearly to dorsal line), and a white wavy line on side of abdomen extending around top of the wings; pupae rest flat on uns of leaf attached by an anteriorly-elongated 3mm cremaster hooking into a long silk pad. 3rd-stage larvae hibernate singly or sometimes in small groups, turning brown before winter, in a curled leaf shelter.

Evidently two flights on the western plains/foothills (in Pueblo and Denver areas) mostly M June-July and Aug.-Sept. (sometimes L Oct.) (the latter flight seems to be about as strong as the earlier, and northward S.D. also has two flights with similar peak flights), in Baca Co. in extreme SE Colo. the first flight is June, the second maybe Aug.-Sept.

Adults mainly visit and prefer tree sap especially on *Salix amygdaloides* and *Ulmus pumila* (they usually rest head-down on tree trunks to avoid getting stuck in the sap if they approached from below [and the topmost point of the sap flow is likely to be less-viscous easier to suck]), and often visit flowers of all colors but prefer whitish and yellow colors, including *Cirsium, Helianthus, Holodiscus dumosus, Monarda,* etc. (they commonly feed on flowers in Colo., but rarely do in E U.S. [sometimes on *Asclepias, Trifolium*]). They also feed on rotting fruit, aphid honeydew, *Rubus deliciosus* berries, mud, and in E U.S. human sweat, carrion (of dogs, pigs, snakes), rotten fowl & fish & shrimp, dung, and urine. R. Neck (1984 J. Lepid. Soc. 37:269) saw adults esp. females visit *Colubrina texensis* flowers in Tex. to get something (amino acids?) from the green central disc (carrion and dung flies visit those flowers). Males often rest in a head-down position. Adults often glide with wings spread (they flap then glide). Males make sounds (muffled clicks) when accelerating in flight. Adults bask dorsally, with wings spread. Adults can warm up by shivering their wings.

Males rait in gulch bottom open spots (near or on the host trees on flat land) to await females, by raiting an average of 2.8m up (0.5-8m, N=56) mostly on tree branches but also on boulders, a telephone pole, my hat and shoulder, etc. They are rarely observed raiting/chasing as early as 08:40 and 09:00 and 10:30, and seldom are observed thus from 11:00 to 12:25, but thereafter they rait and chase strongly until late afternoon ~16:30 or so (based on several hundred observations) (this fits Timothy Friedlander's letter to me in 1981 "males perch from early afternoon to late in evening, typically inside the canopy in sunspots"). Adults can fly far from their host trees sometimes, and they do not seem to stay long at their raiting sites. In courtship, the male overtakes the female and she lands with wings closed, the male lands behind and flicks his wings (from closed to ~90^{o} spread), or vibrates them at small amplitude while spread ~90-100^{o}, ~3X every second or two, and bends his abdomen to try to join; a receptive female would remain motionless and accept the male, but most females are unreceptive and fly. Unreceptive females may also undulate up and down or "forward" [sideways evidently] up to 10 cm each way in flight to evade the pursuing male.

Nymphalidae, Nymphalinae, Biblidini

Biblidini is a tribe of ~290 species worldwide, mostly tropical, one of which is a rare stray to Colo.

Mestra amymone Noseburn Wanderer.

A very rare stray to Colorado from Mexico, recorded from four counties on the plains (Boulder, Jefferson, El Paso, Prowers). The whitish color and orange hw rear and unh pattern are unique. The base of the fw costal vein is swollen--an ear? Its hostplant is evidently Euphorbiaceae: *Tragia* in the U.S. (*T. ramosa* occurs in Colo., and *T. neptifolia* occurs in Neb.). Common far southward. The older larva is brown, striated with numerous longitudinal white slivers, with large green 3-lobed patch along top of ~A1-7 (photo in Allen et al. 2005); or larva green with 7 whitish and 7 dark-green large oblique streaks along sides (larva is bent upward at T3 and rear sticks up), many starry brown or green scoli (Wagner 2005) (middorsal BL1 scoli evidently present only on rear); head dark- or light-brown with two very long reddish-brown or light-brown horns with a ball at the tip. Flies all year in S Texas, and sometimes has large migrations and rarely strays north as far as S.D. & Minn. It overwintered once at Waco Tex., and sometimes breeds in Okla., and many northern records involve multiple captures (J. Masters 1970 J. Lepid. Soc. 24:203-208) so it could breed in Colo. Northern captures are from July-Oct. Adults fly weakly, and visit flowers and rotten fruit.

Nymphalidae, Nymphalinae, Nymphalini

Nymphalini has several hundred species worldwide, including many Holarctic species of *Nymphalis*, *Aglais*, *Polygonia*, and *Vanessa* which are closely related and hibernate as adults. Adults of those genera have the annoying habit of disappearing during courtship, resulting in very few observations available for completed courtship and mating. Older larvae have middorsal BL1 scoli. Few vertical ribs occur on eggs but the average varies somewhat: *Vanessa atalanta* 10, *virginiensis* 13, *carye annabella* 11, *cardui* 15-17, *Nymphalis l-album* 12, *californica* 8, *antiopa* 8, *Aglais milberti* 8-10, *Polygonia satyrus* 9-11, *gracilis* 10, *oreas* 10, *faunus* 10-11, *Junonia coenia* 12.

Vanessa atalanta rubria Red Admiral

The reddish bands and apical white fw spots are unique. Ssp. ***rubria*** inhabits N. America, and differs by having the fw subapical anterior white bar narrow, compared to European ssp. *atalanta*.

Habitat open areas/clearings everywhere in valley bottoms with enough moisture to grow *Urtica*, uncommon in Colorado and rare above the Canadian Zone. In California Shapiro (2007) noted no clear evidence of migration, and adults overwinter in lowland C Calif. But in Oregon Warren (2005) considered it mostly a migrant which seldom overwinters and only on the coast. Adults evidently migrate somewhat in eastern North America, where massive migrations have been seen in Florida, Maine, and New York (reported by J. Glassberg, Opler & Krizek, and A. Shapiro), and it migrates sometimes by “hundreds of millions” near the Great Lakes where it is “probably more of a migratory species than a native one” (Douglas & Douglas 2005). And it does not survive most winters in Penn. where it sometimes migrates massively north into Penn. in April etc. (Monroe & Wright 2017). It evidently hibernates sometimes in Iowa and occurs L Mar.-L fall, but occasionally migrates in large numbers into Iowa and spring adults may be mostly migrants that then breed (Schlicht et al. 2007). In Ohio it evidently overwinters but high-density years are probably supplemented by migrants from the south; sometimes large migrations fly in (Iftner et al. 1992). It does not overwinter in S.D. and adults migrate in each spring, sometimes in large numbers (Marrone 2002). So in fall it flies S (westward on Long Island NY) and overwinters in southern U.S., then flies N in spring. In Colorado it is generally uncommon and I have seen no evidence of migration at ground level, but M. Fisher saw a migration northward in L May 1968 when hundreds fed on a *Prunus virginiana* bush in Denver. In Europe (where it migrates into England and Scotland), good research has shown that *V. atalanta* and *V. cardui* regularly undertake high-altitude windborne migrations up to 1000-3000m up, traveling an average of 14m/sec. (maximum 24), as nearly all the adults (82-96%) flew due north in spring and due south in fall (see *V. cardui* for references). It is a year-round resident of Alabama (Bright & Ogard 2010) and Texas (Neck 1996). It is common in all of New Mexico (Holland 2009) but usually uncommon in

Colo. where there are not many early spring and overwintering records. This evidence seems to suggest that, based on latitude, sometimes some *V. atalanta* overwinter in Colo. (esp. near Kansas and in SE Colo.), but most *V. atalanta* migrate N to repopulate Colo. in modest numbers in L April-May and those produce several generations between M June-Aug. (when records seem to be continuous) then some presumably migrate south in Sept.-Oct. at high altitude where we cannot see them. Scott (1986a) mapped it as a resident all the way to the S part of the Northwest Territories in Canada, obviously a big mistake as it is evidently <u>a usual overwintering resident only much farther south in the middle of continental U.S.</u> At Winter Park Fla., Henry Swanson (mss.) recorded adults seen on 4,794 days over 22 years, and found that adults were abundant and mated from Nov. to M Aug. (most common Dec.-June), but were usually uncommon from M Aug.-Oct. when they were absent in a period averaging 75 days long because most had evidently migrated northward in most years. Usually uncommon to scarce in Colo. (it swarmed over most of Colo. in June 1977).

Hostplant in Colorado herb Urticaceae: *Urtica dioica gracilis*. Many other Urticaceae are used elsewhere. *Humulus lupulus* (Cannabaceae) is actually not a host, because James & Nunnallee (2011) found that larvae refuse it and die and 8 years of hops inspection in Wash. found no larvae, and adults are not assoc. with it in Colo.

Eggs green/bluish-green with whitish vertical ribs, laid singly on ups and sometimes on uns and often on edges of very young leaves. Larvae eat leaves. Young larvae may make loosely-silked nests to cover themselves. Older larvae bite through the petiole making the leaf droop, then silk the leaf edges together above the larva and live inside the leaf nest. Older larvae are incredibly variable between larvae, being cream, yellowish, yellow-green, grayish, reddish, reddish-brown, chocolate-brown, or mostly black, some with lateral greenish-yellow or white patches or two rows of jagged lateral white stripes or just one lateral row of undulating white crescents on ~A2-8, numerous tiny white dots mostly in transverse rows across segments, many branching spines that are usually black but sometimes pale-yellow-white and some esp. BSD scoli may have reddish bases, prolegs red-brown or black etc.; a ventral neck gland; head black or brown, the long head hairs often white (black in *V. cardui*). Pupa reddish-gray or blackish-brown or brown, with black reticulations, or pale greenish-gray or creamy-gray or gray, with yellowish and gold or silvery dorsal cones, and a somewhat-darker lateral abdominal band visible on the paler pupae; the thorax rises to a point like other *Vanessa* and *Aglais*; hanging in a nest of silked-together leaves (Neill 2007 photo). Adults (doubtfully pupae) hibernate at least southward.

Several flights at lower altitudes, L April-May and at least two flights M June-Sept.; about two flights at higher altitudes ~M June-Aug. Determining the number of generations is difficult and depends on whether it migrates every year high in the air.

Adults visit flowers of all colors even red, including *Chrysothamnus* (*Ericameria*) *nauseosus*, *Cirsium arvense*, *Physocarpus monogynus*, *Symphoricarpos albus*, *Trifolium pratense*. They often visit tree sap, rotten fruit, and sometimes feed on honeydew, dung incl. bird dung, mud, carrion, garbage, human sweat, diseased flowers, and *Pinus edulis* cones. Flight is fast and erratic. Adults can live at least 21 days in summer, and overwinter. Adults bask dorsally with wings mostly spread. They can warm up by shivering the wings/wing muscles (~15 times/sec. usually when the wings are closed, sometimes when fully outstretched) to reach 34ºC (they can fly from 20-42ºC body temperature, but not well at the lower temperature [A. Krogh & E. Zeuthen 1941 J. Exp. Biol. 18:1-10]).

Males rait preferably on hilltops, from early afternoon to dusk to await females. They rait an average of <1/2m up mostly on flat ground (they even rait near the edge of flat roofs--which I have seen at two Colo. sites and often on my grandmother's porch in Ohio—because those roofs look like flat ground), but sometimes rait 0.7-1.3m up on warm shrub nooks such as beside a sheltering row of bushes/trees (often on linear sidewalks or beside rows of trees, rarely on a building wall or low branch of a tree [Bitzer & Shaw 1979]). They noticed that males spend 4-12% of their time flaiting rather than raiting, and males move to a different spot each day. In Colo. I have seen raiting behavior as early as 12:15 (once 11:30) and as late as 19:30, but they rait mostly ~13:00-18:00. The exact starting time depends on temperature: the starting time changes from ~12:30 at 15^{o}C, to 14:00 at 30^{o}C in S Calif. (Shields 1967). The departure time changes with the changing time of dusk (and clouds of course): it is later as dusk gets later during the Ariz. winter (Brown & Alcock 1990). European *V. a. atalanta* also rait late in the day, with reports of at least 17:00-20:00 in the S Alps. Adults move often and evidently travel long distances, as Shields found the recapture rate on hilltops was only 7% after one day and *Vanessa* spp. did not stay longer than 2 days. In courtship near dusk (T. Dimock 1984 J. Res. Lepid. 23:236-240), males vibrate their nearly-closed wings and palpate their antennae onto her antenna & thorax, then she is quiescent and they join. Mating lasts ~90 min. or overnight. (Courtship is rarely seen in *Vanessa-Nymphalis-Polygonia*, as the female evidently leads the male away before mating--they became lost from the view of Brown & Alcock.)

Bitzer, R. & K. Shaw. 1979. Territorial behavior of the Red Admiral, *Vanessa atalanta* (L.) (Lepidoptera: Nymphalidae). J. Res. Lepid. 18:36-49.
Brown, W., & J. Alcock. "1990" (1991). Hilltopping by the Red Admiral butterfly: mate searching alongside congeners. J. Res. Lepid. 29:1-10.

Vanessa cardui cardui Painted Lady

The upf subapical spot is white, versus orange in *V. caryе*. The unh has four or five eyespots like *V. carye*, versus two giant eyespots in *V. virginiensis*. The upf has a jagged black median band, which is mostly in two parts in *V. virginiensis*. Early spring migrants average smaller and less bright than adults breeding later. *V. cardui* is almost the most widespread butterfly worldwide (*Danaus plexippus* may be more widespread): ssp. ***cardui*** occurs south to Venezuela, the Bahamas and Antilles, Eurasia, Africa, Madagascar, the Azores and Canary Is., India, Sri Lanka, and straying to Bermuda and Iceland. *V. cardui kershawi* occurs in Australia and New Zealand (straying to Fiji), and is intermediate to ssp. *cardui* in Hawaii (E. Zimmerman), and both forms have been reared from a single female.

Habitat everywhere, even above timberline. Hostplants in Colorado herb Asteraceae: *Cirsium arvense* (including =var. *incanum* with tomentose leaf uns), *ochrocentrum, vulgare, centaureae, hesperium, scopulorum, canescens, undulatum, parryi, scariosum=coloradense, tweedyi, neomexicanum, discolor, Onopordum acanthium, Carduus nutans macrolepis, Anaphalis margaritacea, Artemisia frigida, ludoviciana, Helianthus annuus, Helianthella, Rudbeckia laciniata* var. *ampla*; Fabaceae: *Lupinus argenteus*; Malvaceae: *Malva neglecta*; Boraginaceae: *Cryptantha minima, Cynoglossum officinale*. Many other species of 18+ plant families are hostplants elsewhere (and Austin & Leary [2008] has an impressive list in Nevada), but it prefers *Cirsium*. Abundance: absent to swarming, depending on migration status.

<u>Migration</u>. *V. cardui* is a famous migrant worldwide, rarely as far N as Greenland and Iceland. Migrations northward are greatest when there has been much rain in deserts far southward during the winter, producing the vast swarms in 2017 & 2019 in Colorado for instance. Insect migration is "post-teneral, pre-reproductive", meaning that the wings must be dry, so they migrate no later than their 2nd- or 3rd-day, and after migrating for some days they eventually turn to mating and oviposition. In the huge year of 2017, the first migrants came to Denver L Apr.-E May, then there were peaks? of abundance in E-M June, M July, E-M Aug. (some migrating southward M Aug.), M. Sept. (some migrating southward), L Sept.-E Oct. In spring (L April-E June usually) some can be seen flying in most directions in Colorado but they migrate predominantly ENE all day (Scott 1994b), proving they have the time-compensated sun-compass navigation system used by bees and other migratory insects, which *Danaus plexippus* and other butterflies use to maintain a constant direction during the day. And R. Nesbit et al. (2009, Animal Behaviour 78:1119-1125) proved this time-compensated sun-compass mechanism in England, where their tested autumn *V. cardui* migrants oriented most often to the SSW), while the spring adults mostly go ENE (the ridiculous theory of R. Baker that butterflies migrate by

maintaining a constant angle to the moving sun has been thoroughly disproved). In Wyoming they reportedly were seen migrating through an April snowstorm. {In Calif. Shapiro (2007) noted they migrate to NW in spring in the Central Valley until the June 21 solstice, then do not migrate, and then migrate SE in Sept.-Nov. east of the Sierra Nevada. Also in Calif. the northward path reported by D. Giuliani & O. Shields (1997 J. Lepid. Soc. 51:256-263) was NW-NNW. One wonders if those Calif. butterflies are genetically different in their path from Colo. butterflies?} In Calif. in Sept.-Nov. they are observed to migrate southward nearly every year. In W U.S., large spring migrations occur especially after green winter conditions in southern New Mex.-Ariz.-Calif.-Mexico (the Mojave-Sonoran-Chihuahuan Deserts) produce massive successful breeding; most of those butterflies are rather small in wingspan and duller in coloration because winter precipitation is normally not great there, and they migrate north in early spring. During the spring migration they follow the flowering of yellow dandelion *Taraxacum officinale* northward through Colo. and eagerly sip its nectar. In the Great Plains adults tend to fly roughly northward in spring (sometimes even in July), returning southward in less-obvious fashion from L July-Aug. (more obviously at high altitude above 8000') through fall. In SW U.S. they migrate NE in spring, SW in late summer and fall. While northward the eggs they lay produce mostly larger brighter summer adults. I saw few return migrants flying southward in late summer-early fall, and a compendium of human sightings all over U.S. would conclude that the return migration is generally small, to the SW predominantly in records from Colorado and vicinity (I saw fewer to WSW & SSW & S, less to W and SSE, very few to SE and ESE etc.), and I noticed southward migration most often at higher altitude in the mountains in August (>8000', going to the SW), and seldom noticed it on the plains (mostly in Sept.-Oct.-rarely Nov.) when adults mostly just feed on *Chrysothamnus* (*Ericameria*) *nauseosus* and dozens of other flowers. But T. Emmel and R. Wobus (1966, J. Lepid. Soc. 20:123-4) witnessed a huge southward migration of 600 per hour across a 20-foot line Aug. 22-25, and they continued south in reduced but still significant numbers Sept. 1-19 (this was in the mountains from Florissant to Wilkerson Pass in Park Co., ~2700m). R. Stanford saw 30/hour going SE, Sept. 16-27, 2005 in Denver. And in Alberta M. Myres (1985 Can. Field-Naturalist 99:147-155) saw a "million" fly south Aug. 13-Sept 1, 1983. (I have never seen a major S migration). And a large flight south even against wind occurred in Yellowstone NP in E Sept. 1979 (D. Owen & R. Wiegert 1985 Southwestern Naturalist 30:158-159).

However, observers on the ground evidently miss the main migration: In Europe, good research including extensive use of radar has shown that *V. atalanta* and *V. cardui* regularly undertake high-altitude windborne migrations, and in Europe the autumn migration (and much of the larger spring migration) takes place at high altitude up to 1000-3000m up, as migrants speed an average of 14m/sec. (maximum 24) as they intelligently use their internal time-compensated sun-compass navigation system to select favorable high-altitude winds and aim their bodies in directions that correct for crosswind drift to achieve the proper flight paths and fly up to 300 miles/day, so as a result nearly all the adults (82-96%) fly due north in spring and due south in fall {Jason Chapman et al. (2010, Science 327:682-5) and K. Mikkola (2003 Entomol. Fennica 14-15) studied both *V. cardui* and *V. atalanta*, as Chapman used radar plus nets attached to balloons to study *V. cardui* in England}; and Constanti Stefanescu et al. (2007, J. Anim. Ecol. 76: 888-898, & 2011 J. Lepid. Soc. 65:15-26) studied *V. cardui* migration between Morocco and Scandinavia; a 2018 PBS TV show "Nature" summarizes the results}. Feb. colonists in the Mediterranean area often came from the sub-Sahara (G. Talavera et al. 2018 Biology Letters 13 June 2018). European *V. cardui* can use high-altitude winds to migrate from Scandinavia to the Sahara in Africa in several generations or just a week if there are good wind conditions. Stefanescu used stable isotypes of hydrogen in *V. cardui* bodies to determine that butterflies in Morocco came from as far as 3000 miles in Scandinavia near the arctic circle. The northward spring migration over the Atlas Mts. into Spain and over the Mediterranean into Rome, Marseille etc. may take several generations to get to Scandinavia. Evidently in N.A. they do migrate in large numbers southward, we just can't see them thousands of feet in the air (a ground-level observer did see migrants 100m in the air going over a moderate-altitude ridge near Big Pine Calif.). High-altitude migration solves the problem that if they only migrated north then froze and never migrated south, the migration genes would soon disappear. Proof of higher-altitude migration in U.S. was provided by radar images taken by the National Weather Service of Boulder Colo. on Oct. 3, 2017, which showed a swarm of thousands of small objects in the air over Denver (Larimer to Jefferson to Douglas Co. and east to Weld, Adams, Arapahoe, & Elbert Cos.) which proved to be *V. cardui* (the prior winter was wet in S Ariz.-Sonora etc. and swarms migrated north to Colo. and produced peaks of abundance including large numbers in M Sept.-Oct.). But the wind was not southward on Oct. 3 and the butterflies went from SE to NW a little, and through early Nov. I observed no substantial southward wind at ground level. Non-migratory adults have a rather erratic flight, and the vast swarm in Oct. 2017 in Denver were rather docile and fluttered and glided to flowers. They mostly just fed on flowers until a 25^{o}F freeze Oct. 9 killed most of the flowers, then on Oct. 12 most survived and some were seen migrating ~SSW near the ground, and Oct. 18 a few were seen flying SW and one S. Thus it would seem that comparatively few of those Oct. 3 adults migrated back to the Chihuahuan/Sonoran Deserts. {There was drought in the southwestern US in the winter, then I only saw 4 *V. cardui* in Denver in 2018 [in Sept.], then they returned in numbers in 2019} In the U.S. W. Howe observed hordes flying N in waves for 20 minutes above a precipice on the E side of a mountain in Montana at 6500' July 7 (1967 J. Lepid. Soc. 21:39-40), perhaps part of a high-altitude migration north that became visible to someone standing on a mountain. Research is needed to determine the usual months of high-altitude migration. Adults occur all year in Houston Tex. (commoner in spring and fall, Tveten & Tveten 1996), maintaining the species if high-altitude winds are inadequate.

Eggs pale-green (reportedly bluish-green), laid singly on ups of host leaves, up to 700 eggs per female. Larvae eat leaves. Older larvae live in silk nests on top of leaves, the leaf edges bent upward and tied around them. Mature larvae may be blackish, gray, grayish-brown, greenish?, yellowish, or orangish, or reddish-brown, with twin yellow middorsal lines, some short subdorsal cream dashes, a lateral yellowish or cream stripe esp. on abdomen, and many branching spines that are usually cream, and the BD2 and BSD scoli may have reddish bases, many black transverse lines across segments; head black or reddish-brown, wider than that of *V. carye*, with many short white hairs on tiny cones, but the long dorsal hairs on the cones are black, not white as in *V. atalanta*. Pupa metallic-greenish, dark-gray and white, bluish-white, whitish-gold, copper-gold, golden-tan, tan, or brown, with a brownish lateral band on abdomen running along inner margin of wing, brownish near-middorsal and supraventral bands, sometimes brown or gray patches on wing and thorax, checkered antenna shaft, and many tiny gold or orangish dorsal cones. Adults evidently hibernate, but only in mild winters or the south (in SW U.S. and Mexican deserts, S Fla.). Short photoperiod causes a reduction in juvenile hormone causing the male and female reproductive systems to stop functioning (no eggs are produced) in Sept.-Oct., in preparation for hibernating (W. Herman & S. Dallmann 1981 J. Insect Physiol 27:163-168). I did frost-hardiness experiments on *V. cardui* and *V. atalanta* and *Aglais milberti*, by placing fall adults in a 0^{o}F freezer, and all died after ~one hour, proving that in nature the winter-hibernating adult Nymphalini must gradually increase the amount of glycerol/sorbitol in their body during many weeks of slowly-decreasing fall temperatures in order to become winter-hardy, because adults survive in nature after 22^{o}F nights in early fall, and survive far colder temperatures later.

About 3-4 flights at lower altitudes, mostly May then M June-Sept. and sometimes Oct.; two or three flights at higher altitudes. Very rare in S Texas in summer, evidently because they already migrated northward.

Adults visit flowers of all colors even some red ones, including *Apocynum* spp., *Arnica mollis, Asclepias incarnata, Buddleja davidii, Carduus nutans, Centaurea diffusa, Chrysothamnus* (*Ericameria*) *nauseosus, Cirsium* spp.*, Dipsacus fullonum, Echinacea purpurea, Erysimum asperum, Medicago sativa, Muscari botryoides, Prunus cerasus, Senecio crassulus, S.* (*Packera*) *fendleri, Silene acaulis, Syringa vulgaris, Taraxacum officinale, Trifolium pratense, T. repens, Verbena, Zinnia* *elegans*. It relies on *Taraxacum officinale* during spring northward migrations, and *Chrysothamnus* (*Ericameria*) *nauseosus* in late summer when southward migrations are seldom seen. Richard Attenborough (TV) shows an adult pollinating a Fragrant Orchid by transferring pollinia stuck to the proboscis. Adults also visit rotting fruit, sap, dung, aphid honeydew, and mud, and it was once reported sucking something from grass inflorescence. Adults bask dorsally. Flower-feeding adults close or sometimes open the wings, and can keep the wings spread up to 180^o apart to simultaneously bask. Adults shiver (vibrate the wing muscles to create muscular thermogenesis) with closed wings to warm up, and I saw one shiver after it opened its wings 90^o to bask as the sunlight disappeared. Adults often roost on low plants, such as *Bromus* (*Anisantha*) *tectorum*, and they often land on low tree branches in bad weather including a cedar tree, one roosted 4m up on dead *Pinus ponderosa* needles, and many roosted on a cottonwood tree. As they fly about, they can interrupt straight wing flapping with bits of gliding. Reportedly adults can hear, using receptors in wing membranes.

Males rait preferably on hilltops to await females. They mostly rait on the ground on hilltops, and on flat land rait beside rows of bushes/trees (especially on the W or SW side of those rows), but sometimes rait up to 3-4m up on those trees; males sometimes flait as they fly beside those rows of bushes/trees 1-1.5m up, and during migrations they often fleek and chase females and others while in flight. They mate-locate mostly from early afternoon to dusk; but 45 times I observed males chasing other butterflies as early as 08:45 to noon, often during migrations when males seem to take any chance to mate while flying (fleeking); they increase their frequency of chasing after noon and esp. after 13:00, and then mate-locate eagerly until dusk, thus their usual afternoon mate-locating time is similar to *V. atalanta* (with the same effects of temperature and changing dusk time, Shields 1967). And Opler & Krizek (1984) recorded raiting and occasional flaiting 13:30-19:30, and mating pairs 12:00-19:30. In courtship, the male overtakes the female, both flutter then land, or he flutters over a landed female; at this point receptive females would presumably be quiescent while the male joins. In Europe, G. Barrett (Proc. Ent. Soc. London 1904 p. xlv) and V. Temple (Entomol. Gazette 4:154-5, 1953) saw two completed courtships: the female flew about in a wild rushing manner closely pursued by the male (V. Temple described a wild flight in figure-of-eight patterns parallel with the ground 2/3m above it up and down with the male near but without contact), then they quickly landed on a branch of an oak tree or a hedge and joined. In Australia *V. cardui kershawi* (J. Alcock & D. Gwynne 1988, J. Res. Lepid. 26:120-121) males rait ~15:00-18:00 in sunlit clearings on hilltops (on a sunlit patch at a site without hilltops); three completed matings were seen at 17:07, 17:29, & 17:33: the female flew near a raiting male and he pursued, and she landed 5m away from the raiting site and he landed beside her in same direction and bent abdomen and joined; two other matings were the same but one female flew twice more and landed after 25m then joined, and in the third mating she flew a long way pursued by the male and returned several times back and forth over the raiting spot before finally landing on a cone 3m up (10m from the raiting site) and they joined; two other probable matings were when the female flew near the raiting male and he pursued her in the usual slow horizontal flight of males pursuing females, then they were lost from sight. (Clearly *Vanessa-Nymphalis-Aglais* mate quickly, and the ridiculous "several hours" courtship flights reported by fanciful-imagination people are ludicrous.) Mating lasts ~1 hour, and can last overnight.

Scott, J. 1994b. Direction of spring migration of *Vanessa cardui* (Nymphalidae) in Colorado. J. Res. Lepid. 31:16-23.

Vanessa carye annabella **Western Painted Lady**

The fw tip is squared and the upf postmedian bar at the end of the discal cell is orange, distinguishing it from *V. cardui* which has a rounded fw tip and white bar. Also, the fw discal cell has a black bar extending completely across it, and a black line crosses the white area in fw cell CuA_1. Ssp. ***annabella*** from North & Central America is only distinguished from ssp. *carye* of South America and Easter Island by a small bit of the male valva, and slight differences detected with electrophoresis; the wing pattern is virtually identical including the specimens I caught in Colombia, and J. Herrera (1989 J. Lepid. Soc. 43:82) raised hybrids (in Calif. occasional wild hybrids are known with *V. atalanta*!), so I find it difficult to believe that they are separate species.

Habitat open areas everywhere, even wandering above timberline (~13,000' at Hermit Pass Custer Co. in the Sangre de Cristo Mts., 12,000' at Loveland Pass). Hostplant in Colorado herb Malvaceae: *Alcea rosea*; elsewhere *Malva* is often eaten, and it is surely a host in Colo.; at least 8 genera of Malvaceae are the usual hosts elsewhere, and herb Urticaceae (*Urtica*) is eaten in Calif., where it is common. It is evidently fairly common in Nevada, where Austin (2008) reported hostplants Malvaceae: *Alcea rosea*, *Malva neglecta*, *Malvella leprosa*, *Sidalcea oregana*, *Sphaeralcea ambigua*, *emoryi*, *grossulariifolia*; Rosaceae: *Potentilla gracilis* var. *elmeri*; Urticaceae: *Urtica dioica holosericea*. It is scarce in Colorado and only one or a few are seen each year (mostly in late summer on lowland flowers such as *Chrysothamnus*, a seasonal pattern typical of rare migrants), so I have few observations. Shapiro (2007) states that adults migrate altitudinally in California by heading to higher mts. in summer, and notes that *V. carye carye* migrates altitudinally in Argentina. So one wonders if most adults in Colorado are migrants. But their fresh condition in Sept. suggests those were bred in the state (they certainly do not migrate from California) (they were common at Lusk in S Wyo. Aug. 23, 1994 where they obviously bred), and as far as I know altitudinal or north-south migration has never been seen in Colorado. Brown et al. (1957) list three records from the Subalpine Zone (Boulder, La Plata, Summit Cos.) and I found one in the subalpine (Pueblo Co.) and three above timberline (Custer & Fremont & Summit Cos.) but those records seem to be northward migrants, because nearly all the Colo. records of *V. carye* are July-Oct., a pattern typical of northward migrants. Unfortunately their rarity in Colorado makes them almost impossible to study here. Rare migrants are known in BC, Alta. and eastern N.D. and Kansas, so it can fly far. H. Sicher (1953, Lepid. News 7:53) observed a vast northward migration on March 29 in the Santa Rosa Mts. of S Calif. esp. near 5000', and fewer at lower altitude, suggesting high-in-the–air migration north in spring and south in fall like *V. cardui*. It is evidently just a less-energetic migrant than *V. cardui* that may breed but does not overwinter in Ore.-Wash. (James & Nunnallee 2011), whereas it overwinters in C Calif. near sea level (Shapiro 2007). It is common in much of NM including the Chuska Mts. but uncommon to absent near Raton (Holland 2009) so it evidently overwinters in much of NM, but evidently is just an occasional migrant into Colo. where it sometimes temporarily breeds in late summer. Rare in Colo. (I once found 3m1f near Golden Oct. 22, 1998).

Eggs pale-green, laid singly on host leaves, usually on ups. Larvae eat leaves and make a silk nest of leaves, on ups of large leaves (in wet weather in Calif. they may make a nest on uns of leaf [Shapiro 2007]). Larvae can be blackish with orange blotches, black and yellow, or sometimes grayish-white, greenish-white, pinkish, tan to orangish or reddish, orange and gray; the heart-band dark, often a pale lateral line, scoli vary in color from dark to creamy (the hairs on the body scoli are longer than *V. cardui*); head blackish, with vertical whitish-tan stripes in pale larvae, shape like *V. cardui* but smaller 2.5 mm wide (versus 3mm in *cardui* and *atalanta*) and the black head cones are much larger. If disturbed, the larva everts then retracts its ventral neck gland (C. Gillette 1984 Utahensis 4:26). Pupa light-brown with white or gold tiny cones, a lateral darker band on abdomen, sometimes hanging from a silked leaf chamber. Adults hibernate and overwinter in lowland C Calif., but the species probably cannot overwinter in Colo.

About three flights at lower altitudes May-Sept., but usually just migrants found in late summer (often breeding producing adults L Aug.-Oct.); evidently just two at higher altitudes if they don't freeze.

Adults visit flowers of all colors except perhaps pure red, including *Chrysothamnus* (*Ericameria*) *nauseosus*, *Medicago sativa*, sometimes visit manure, and probably visit mud. They bask with wings spread (dorsal basking or body basking) to get warm. Adults can live up to 28 days in summer and several months in winter in Calif. (Shapiro 2007). Adults fly by gliding and wing flapping frequently, the frequencies correlated with their speed.

Males rait preferably on hilltops, or on flat land, by raiting on sheltered ground behind large trees/cars etc., sometimes on bushes <1m up, mostly from early afternoon (13:00, once 12:30) to dusk (the daily times dependent on temperature and dusk time, Shields 1967). Sometimes they flait there. Ariz. males prefer raiting sites just below a peak top, several hours before then to dusk; only 22% of males were sighted a day later (W. Brown & J. Alcock 1991 J. Res. Lepid. 29:1-10).

Vanessa virginiensis American Painted Lady

Similar to *V. cardui*, but identified by the two giant unh ocelli on the cobweb-patterned unh. The fw margin is a little more indented. Fw cell CuA_1 is orange with a small 1mm white submarginal spot, except in some males.

Habitat open areas everywhere, even above timberline. Hostplants in Colorado herb Asteraceae: *Antennaria parvifolia, neglecta, Anaphalis margaritacea*, *Artemisia ludoviciana* (it surely eats *Gnaphalium* in Colo. also, and eats it in Utah). Elsewhere it also eats other plant families such as Malvaceae, Boraginaceae, Leguminosae, and Urticaceae, but it prefers the Asteraceae tribe Inuleae (*Gnaphalium, Antennaria, Anaphalis*). Adults are scarce in Colorado but are more common than *V. carye*. Adults can fly far, and males are sometimes found on hilltops above timberline in Colo., but there are no records of migration in Colo., even though it sometimes has lengthy migratory movements in E North America, reaching Canada by May, and adults have flown to Labrador, Iceland, Hawaii, SW Europe, and islands west of Africa (established on the Canary Is.). In N Florida malaise traps caught numerous adults flying N in spring, few adults in fall (T. Walker 1991 Ecol. Ent. 16:241-252). It is common evidently hibernating all over Texas and flies year-round in Houston esp. in spring and fall (Tveten & Tveten 1996), and is evidently resident in most of C & S U.S., including Ohio where it overwinters and is only occasionally migratory (Iftner et al. 1992), and in the southern Great Lakes region where it has a “permanent population” but migrants may appear in early April (Douglas & Douglas 2005). In Indiana numbers are usually similar each year (Belth 2013) suggesting a breeding population, and it is a breeding resident evidently overwintering in Iowa (Schlicht et al. 2007). But it overwinters just south of the southern Penn. state line (Monroe & Wright 2017), and it evidently does not overwinter in R.I., and in W. Va. the first generation is reportly due to immigration not overwintering (Allen 1997—surely it overwinters often there). It is reportedly not a year-round resident and does not overwinter in Ore.-Wash. It is an uncommon migrant into S.D. by E June (Marrone 2002). In Colorado nearly all the records are from M June and later, with few in May, and there are at least a dozen records of singletons at timberline or above, a pattern characteristic of migrants, not overwinterers; several fresh adults were seen Oct. 5-6 2019 in Lakewood, suggesting local breeding. It is common throughout N.M. including the Chuska Mts. so it probably overwinters there, but is scarce or uncommon in the Raton area of NM (Holland 2009) and is usually scarce in Colo. so it is evidently just an occasional-overwinterer and occasional migrant into most of Colo., but may be able to overwinter frequently in extreme SE Colo. *V. virginiensis* adults have fewer aberrations than other *Vanessa*, and are reportedly less subject to aberrations produced by pupal cold shock than *V. atalanta* & *V. cardui* (*V. carye* is most susceptible), perhaps because its permanent range is farther north than the others (perhaps *V. carye* is the most southern) (this book clarifies the migration status of these *Vanessa* which was incorrect in Scott 1986a). Rare in Colo., a bit less rare than *V. carye*.

Eggs pale yellowish-green, laid singly on the ups of leaves, which the larvae eat. Young larvae live in nests made under plant hairs (1^{st}-stage larvae may stay between leaf membranes thus creating “windowpane” areas), then make nests of leaves (more often flowers/flower buds) silked together into a messy web including dry chaff of old flowers, while 5^{th}-stage mature larvae may leave the nest and rest exposed on stems/leaves. Older larvae are whitish to pale-yellowish in intersegmental areas between 4-5 black transverse lines across top half of body in each whitish area, with broad blackish areas across top half of body between the whitish areas (these black areas contain black scoli BD1-2 & BSD [but BSD and sometimes BD2 have much orange or red at the base], and a large white subdorsal spot [with black above and below it] on each A2-8 or 9 segment), a whitish, yellowish, or orangish lateral band contains cream or tan BL1 scoli (Nielsen 1999 figures a larva that has the black transverse lines so weak that larva is mainly white except the broad black-with-red-&-white-spots areas); head black. Pupa grayish-white, or gray & white, golden-green with purplish areas, greenish-yellow, yellow, or pale-brown, with dark tiny spots on wings etc., brown middorsal and lateral and near-midventral and midventral stripes, and many tiny orange or blackish dorsal cones on dorsad of abdomen, and two tiny cones near wing base and on each corner of head and on point on top of thorax, hanging from a nest of leaves slightly silked together. Adults (doubtfully pupae) hibernate at least in much of southern U.S. as noted above.

About three flights at low altitude May-M Oct., evidently two at higher altitudes where and when it can breed without freezing.

Adults visit flowers of all colors seldom red (but visit red *Trifolium pratense* in Ohio), including *Chrysothamnus* (*Ericameria*) *nauseosus*, *Verbena*, *Centranthus ruber* (red), and sometimes visit rotting fruit, sap, dung, mud, even urine, carrion, and dead fish. They bask dorsally (sometimes with wings spread little, body basking), and can get warm by shivering the wing muscles. Their flight is a little weaker than other *Vanessa*, but is still somewhat erratic like other *Vanessa*, fairly close to the ground.

Males usually rait to await females, preferably on hilltops if available, or on flat land, and often flait there (sometimes they spend more time flying than resting). They usually rait on sheltered ground next to bushes/trees, but sometimes rait 1/3-1m up on bushes or 2 or 3m up on Douglasfir/*Pinus* trees on hilltops, and once I saw them flying around and landing 10m up on a *Pinus ponderosa* tree on a big hilltop, apparently mate-locating. Sometimes they court at flowers. They mate-locate from early afternoon ~12:00 to dusk (mostly 13:30-dusk), those times influenced by temperature and time of dusk like *V. atalanta*.

***Aglais milberti* Fire-Rim Tortoise Shell (Milbert's Tortoise Shell)**

The flamelike outer part of ups is unique. The uns is camouflaged black with a gray-brown stripe, while the bright ups perhaps shocks a predator bird into flight. Western U.S. adults usually have considerable yellow at the base of the ups orange bands, whereas only a third or half of eastern U.S. adults have much yellow, so the Colo. name ***subpallida*** could be considered to be a weak ssp.

Habitat mostly moist valley bottoms on the plains and lower mountains for larvae and winter-spring adults, the Canadian Zone to Alpine Zone (where it is common to nearly 14,000' [I found it at 13,800' near Hermit Pass in the Sangre de Cristo Mts.]) for aestivating adults. Hostplant in Colorado herb Urticaceae: *Urtica dioica gracilis*. Uncommon to moderately common.

Eggs pale green with ~9 vertical ribs, laid in clusters of several hundred (up to 900 total) on the uns of upper host leaves; this huge number may reduce attack by parasitoid wasps and flies that can reach only the upper layer of eggs. Young larvae gregarious in a silk nest near the top of plant. Young larvae produce a scent (probably from the ventral neck gland) that repels ants which refuse to walk onto that leaf. Older L4-5 larvae are usually solitary and live in a leaf rolled (usually upward) and tied above the larva with silk. Larva black with tiny orange-and-white dots, two greenish-yellow undulating lateral lines, a black middorsal line edged by a band of yellowish dots, many black scoli (except BL1 scoli creamy); head black. Pupa (photos Neill 2007, Guppy & Shepard 2001) variable, golden-brown or golden-tan, golden-green, somewhat creamy, or nearly black, with a slight lateral brown band on abdomen, numerous little dorsal cones on abdomen, a point on top of thorax, and two projecting conelike corners of the head. Emerging adults void red meconium, like other Nymphalini.

Adults hibernate, in piles of rocks or crannies in wood in decaying fallen trees, etc.; sometimes dozens choose the same hibernation site and pack themselves together.

Adults have been found March-Nov. plus "mid-winter", but evidently there is mainly one generation per year: the adults emerge L June-E (& M?) Aug. and fly to the high mts. (the Montane Zone and above, especially the Alpine Zone throughout the mountains) to aestivate, then fly back to the lowlands in ~Sept. to overwinter diapause, then lay eggs the next spring. There is a partial second generation at lower altitude (some adults do not aestivate and migrate to and from the Alpine Zone, and instead produce adults in Sept. that overwinter). Adults are strong altitudinal migrants every year. My records of eggs and larvae and adults occur over a long time. Eggs/ovipositions were found April 21, May 15, 22, June 7, 5-7, 26, July 5, 8, 13 (& 1st stage June 17, 2nd stage Aug. 8), and older larvae were found May 20, 26, 27, June 2, 4, 6, 6, 7-8, 13, 17, 17, 18, 18, 21, 21, 21, 27, 30, 30, July 1, 1, 2, 2, 2, 7, 8, 14, 15, 16, 20, 21, 22, 25, 27, 31, 31, August 4, 29, Sept. 6. The late Aug. and Sept. larvae clearly prove at least a partial second generation (Scott 1992 in Papilio [New Series] #6 notes that there seems to be a second generation in some years, and in 1990 there was a 2nd generation on the plains). The few ovipositions and small plant size in April seem insufficient to produce many adults, so I conclude that the overwintering adults mate in spring and lay eggs in spring in the lower mountains and western plains, then larvae are abundant L May through July and adults emerge L-June-E Aug. and migrate to the high mountains, where they are common every year in July-Aug. on Alpine Zone flowers, even though there is no *Urtica* there for larvae. Then adults evidently fly back to the foothills/plains in September where they can be found on *Chrysothamnus* and other flowers, and where they then evidently overwinter . My observations of courtship were in the foothills in spring, and most mate-locating behavior was seen April-June and some E July, but some mate-locating behavior of males was seen as late as July 10, 15, 21, 22 and Aug. 1 and Sept 2 and Oct. 2 as those were evidently trying to reproduce the second generation rather than aestivate. In Calif. (Mt. Shasta) adults also have altitudinal migration (A. Shapiro 1979, J. Lepid. Soc. 33:200-201). In Ore. they evidently migrate to become common in high mtn. meadows (Neill 2007). They nectar above treeline in the Adirondacks NY (R. Dirig (1998 Lepid. News 40[2]:56)) and also on Mt. Washington NH, Utah, and BC. In E N.A. adults stray from the north sometimes and go as far south as Arkansas and Georgia rarely, and sometimes multiply and become common in states like Indiana but then become uncommon there (Belth 2013). Adults occasionally migrate southward in fall into Penn. (Monroe & Wright 2017). But in Ohio it is absent in SE Ohio so it does not migrate that far south (Iftner et al. 1992). In Iowa it mostly migrates in from the NE and occurs mostly M July to frost (Schlicht et al. 2007).

Adults visit most often yellow and white flowers, sometimes blue-purple or orange or reddish, including *Arnica mollis, A. rydbergii, Chrysothamnus* (*Ericameria*) *nauseosus, Senecio* spp., and sometimes visit *Salix* catkins, sap, rotting fruit, dung, and mud. Adults have a rapid, darting flight. Adults bask dorsally (with wings spread). Adults shiver their closed wings with their thorax muscles to warm up (this often occurs while hanging beneath a leaf). Adults roost with both antennae between their closed wings, like *Nymphalis* and *Polygonia*.

Males rait in spots amazingly like those of *Papilio indra* to await females, and as a result males of the two species are often found together. Males usually rait on sunlit clifflike spots just off a hilltop/ridge to await females, as they rait on outcropping rock or rocky scree or sometimes (if rocks are absent) on the ground (which may be the dirt or rock wall of a road cut) or rarely on an *Arctostaphylos uva-ursi* patch or ½ m up on a bush there. Of the dozens of *milberti* raiting spots I have found in the Front Range, nearly all are clifflike, only several are on the very top of the hill, and nearly all occur a few m from the highest point of the hilltop/ridge to up to 100m away (raiting spots are most often 3-10m from the very top of hilltop {5m being the most common distance}, often 13-35m, occasionally even 50, 60, 100, or 100m away); the raiting sites are usually W of the hilltop and less often SW, S, NW, or N and almost never in any eastward direction, evidently partly because they rait most often in afternoon warmth and sun. Sometimes they rait on the side of little gulches in valley bottoms (typically ~3m deep-and-wide and eroded out of dirt, sometimes rocky, often next to *Urtica* patches), and on flat land several times males raited on grass or concrete beside a brick or concrete building wall; those gulch-flat land sites evidently mimic the ridgetop cliff sites. Based on nearly 200 observations, males begin raiting ~10:30 (discarding a 09:30 observation that might not have been mate-locating) and continue until ~15:30 (several records were 16:00-16:10) (European *Aglais urticae* similarly mate-locate ~11:00-16:30, Baker 1972). In courtship, the male overtakes the female and flutters behind her a little, they land and the male usually nudges her abdomen (sometimes her side) with his head/antennae as both may open their wings widely every few seconds, and they repeatedly (up to 10x or more) do the following two-part sequence of him frequently flicking then vibrating his wings and jerking his antennae toward her while her wings are closed: 1) he flicks his wings several times/sec. for several seconds as his wings travel from partly-open {90°-to-150°} to fully 180° open at the end of each flick, 2) then he vibrates his wings at small amplitude while they average usually widely-spread {~135° to 170°, most often 150°, but sometimes they are spread just 20°} for 4-5-7sec.; during most or all of these flicking/vibrating cycles he jerks his antennae forward ~4mm to almost or perhaps touch her abdomen/wings; at this point or before, receptive females would presumably fly down into the vegetation and join with the male as does *Aglais urticae*, or remain quiescent and accept the male, while unreceptive females fly away or flap their wings fully ~once/sec to repel him. An unscientific internet site (learningaboutbutterflies.com) reports that the *milberti* male drums on the hw of the female with his antennae and "walks over her wings" [which I did not see, that would seem to be accidental] and reports that the male chases the female from place to place for a long time [dubious, how could someone follow that?]. I recorded *A. milberti* behavior similar to those male-male or male-rejecting female flights of *A. urticae*: a male was seen to chase an apparent male 1-2m up then 1-2m down about 10x in a minute then they flew away, and another pair was seen to jerk upward in zigzag fashion. *A. milberti* seems to have a very similar courtship to *A. urticae*, except when the *milberti* female had her wings closed the male usually did his wing-flicking with more-fully-outstretched wings. The male wing fluttering/flicking/vibrating evidently transfers pheromone to her.

Baker, R. R. 1972. Territorial behaviour of the Nymphalid butterflies, *Aglais urticae* (L.) and *Inachis io* (L.). J. Anim. Ecol. 41:453-469.

Aglais urticae mating in Europe. Completed-courtship descriptions are very hard to get in *Vanessa-Aglais-Nymphalis-Polygonia*, so I pieced together the following *Aglais urticae* completed courtship description from the several completed and more non-completed courtship portions described in Europe by E. B. Poulton et al. [Proc. Ent. Soc. London 1904 pages xli-xlv, & 1931 vol. 5:99-100]; and V. Temple 1953 [Entomologist's Gazette 4:151-154]; and T. A. Chapman (Chapman, T. A. 1911. The pairing of *Aglais urticae*. Entomologist's Record 23:208-210). (Males rait on hilltops in France [Aice Choko 1954 Lepid. News 8: 143].) The male flies slowly behind the female low to the ground winding about the same area for a long time [also described as flying in figure-8 patterns 2m up with the male close behind] and after landing if both [usually] have spread wings the male jerks his head forward and "audibly" drums his antennae onto her outspread wings ~17x/min. while often vibrating his outstretched wings, or if both have closed wings he jerks his head forward and taps his antennae onto her closed hindwing while opening his wings to about 1/8 of their full span at each bow, then after the preceding events which supposedly can last more than 30 min., they fluttered down into the grass then came most of the way up and landed side by side on a *Ranunculus* leaf and joined at 16:15 and remained joined that night. The female seems to have a scent allowing the male to remain nearby. One female in an unsuccessful? courtship flew ~20m up with the male spiraling about her and buffeting her at every completed circle with his wings, which I presume involves rejection behavior by the female. Other apparent male-male or male-unreceptive female interactions of *A. urticae*: another male [really female?] flew along and jerked upward once/sec. while the male jerked upward to follow her as both flew in a zigzag beeline; 3 other pairs flew over the trees up to 10m up and away, which I presume involves rejection behavior or two males [these long flights are behavior that amateurs/internet sites usually mistakenly claim are normal courtship]. Adrian Hoskins' website reported a variation of the above behavior, based on unknown sources presumably in UK (maybe the above sources): Courtship is prolonged and can last several hours, as male follows female as she flies about. When she settles and opens her wings, he crawls onto her hw and taps them with his antennae, this process repeated several hours, during which the male drives off competing males. Eventually the female leads him to a sheltered spot typically beneath a small bush, where joining occurs. [Several-hours of courtship is very dubious, because butterflies don't have that much time and energy to waste and a person could not follow them for that long time.] Another Adrian Hoskins description says that a [raiting] male flies out at a passing female and overtakes and chases her until she lands on the ground. If she is receptive she opens her wings and the male opens his wings and crawls onto her hindwings which he vigorously drums with his antennae. The pair fly a short distance and repeat the process. Any other male which attempts to interfere is chased away by the resident male, who then returns to his female to continue wing-drumming [this is highly dubious imagination as the male would not be able to relocate the female]. This "bonding" process continues for several hours [dubious] until just before dusk, when the female accepts him, as she leads him to a sheltered and shady spot, typically beneath a bush or hedge. Both sexes hold their wings erect as he crawls alongside her and bends his abdomen to join. "After 20 minutes the pair straighten out to face opposite directions" [this has to be an error because all butterflies face opposite directions immediately after joining] and remain joined overnight. A photo on Flicker from Hungary shows a male just behind her and on top of the female's abdomen (aimed the same direction as she) tapping her with his antennae.

Aglais* (=*Inachis*) *io mating in Europe is detailed here to help study courtship of *A. milberti* (the two are very closely related): European workers report that *io* males rait from about noon to dusk in sunny sheltered spots close to hedgerows or woodland edges to await females (I saw a male raiting at 17:00 in Deutschland=Germany). In courtship (video at colinknightblogspot.com by Colin Knight at www.seapic.com) the female is motionless with wings fully closed while the male is behind her about 5mm with his antennae aimed forward and outward as usual and he opens and closes his wings (0^o to 120^o open each time) ~10 times while each time he moves a couple mm to her left [and evidently palpates her left unf with his antennae which we cannot see] as he bobs his head up and down while he opens and closes his wings and makes contact (the male was so close to her that his antennae would not be able to hit her abdomen). The website https://shar.es/1OUUWv shows an Adobe flash player video, showing a male flapping slowly (~1.5 complete full-stroke [0^o to 180^o open] flaps per second while resting on the side of her body (on the anal margin of her hindwing just over the abdomen) as he is aimed forward toward her head, while she is resting with wings closed with left side up while resting on the stem of a plant. Richard Roebuck (www.sussex-butterflies.org.uk March-April 2010 has a photo of male alongside female, and reported that they landed quickly with male behind female and both had wings spread and they joined quickly and became quiescent. Adults are reported to produce sounds as they open their wings due to the buckling of a small area of the fw between the costal and subcostal veins. (This is dubious as sounds are also reported to be made from *Nymphalis antiopa* unf vein CuA_2 which has a "file" of notches that supposedly rubs on an uph projecting vein to make sounds like the trickle of a brooklet, but other people looked at 20 specimens and found no such file.)

Nymphalis californica timidar California Tortoiseshell

Identified by the lack of a silver unh mark, the orangish ups, and the uns, which in Colorado is mostly dark and unstriped. The Colo. ssp. ***timidar*** (Colo.-S Wyo.-NM [except Chuska Mts.]-S Ariz.) has dark uns with weak stripe, thus may be camouflaged to resemble bark. The other ssp. *N. c.*

californica ranges from Calif. to Wash.-Idaho-BC-Utah-N Ariz. in Chuska Mts. and has paler uns frequently with strong white stripe [that uns may camouflage them as creekside stones]. Ssp. *californica* frequently migrates, sometimes in a directed manner, and often in random swarms going in random directions, with defoliation and mass movements at ~5-13 year intervals (J. Powell 1972 J. Lepid. Soc. 26:226-228). *N. c. timidar* does not migrate and eats a different host *Ceanothus fendleri* in the eastern Rockies foothills, and adults are absent in high mts. along the continental divide and in the counties just W of the divide; so Colorado adults evidently aestivate all summer in the lower mts. then hibernate, then mate-locate in spring in the foothills and produce the single yearly generation. The name *timidar* was derived from TIMID (staying at home) with dARk unh.

Habitat the foothills and lower Canadian Zone (one straying to the top of Greenhorn Mtn. 12347' in the Wet Mts.). Hostplants in Colorado bushy Rhamnaceae: *Ceanothus fendleri* (and probably *C. velutinus* occasionally, which is the main host in most of the range of ssp. *californica* but is uncommon near Denver). Quite uncommon in Colo.

Migration occurs only in ssp. *californica*, which occurs from Calif. to BC (northward the unh white stripe lessens somewhat which some people call the weak ssp. *herri* [TL Okanogan Co. Wash.]) and evidently migrates eastward sometimes to Alberta Montana Utah and NE Arizona (Chuska Mts.). Migrants fly 1m up (sometimes 6m), sometimes even above trees. In central California adults are claimed to migrate in this pattern: they hibernate in the lowlands including the Coast Range and migrate to higher mts. in spring and breed on young tender foliage mostly of *Ceanothus velutinus*, then they may fly moderate distances in swarms in those higher mts. (often flying south to the southern Sierra Nevada to aestivate), then in late Sept. they fly back to the lowlands (Shapiro 2007); in northern Calif. they tend to fly N or NE in spring, and S or SW in the fall. However, most of the reports of migration appear to be local population explosion "swarms" that move in just random directions, including a swarm in the Sierra Nevada foothills flying W in L May. So there seem to be two kinds of migrations in ssp. *californica*: programmed migration mostly at low density, and random-direction swarms. (Ssp. *timidar* does not migrate.)

Eggs light green, laid in large clusters up to 250 on the host stems/leaf ups or uns, and 1st-3rd-stage larvae are gregarious and sometimes silk leaves together but don't live in nests. Young larvae prefer young tender foliage; they may jerk their heads in unison to repel predators (James & Nunnallee 2011). Older larva black to reddish-black with tiny white dots, a black heart-band edged by yellow, a whitish lateral band, and many orangish (in L4) or black (in L5) scoli (the middorsal row yellowish); head black. Pupa ashy-gray with bluish tint (abdomen tan), or orangish or nearly black, middorsal paler line and lateral slightly-darker band on abdomen; all with dorsal bumps on the saddle and much of abdomen, the bumps whitish at base (all the bumps have black, then orangish or cream tips) (bumps on saddle may be white with black tip), thorax comes to a dorsal point, and the head is double-pointed. Pupae may aggregate under driftwood etc., and in population explosions westward pupae may twitch in unison when disturbed. Adults hibernate.

One flight, as overwintering April-E June Colo. adults visit flowers and oviposit and their older larvae become conspicuous on the hostplant from L May to about June 24 and produce nice fresh adults at the end of June to M July that may sip mud then aestivate and mostly disappear then overwinter.

Adults prefer whitish--sometimes yellow--flowers, and visit mud, sap, rotting fruit, and Homoptera honeydew. Adults bask dorsally. Adults can shiver when basking with wings spread flat (but probably usually shiver with wings closed) to get warm. An adult was seen roosting on a tree trunk 4m up in cloudy weather July 17 in the foothills, and I found one Aug. 18. A few adults strayed from the foothills 1 mile away to Green Mtn. west of Denver.

Males rait on hilltops to await females (sometimes they flait almost as much as rait), as they rait usually on the ground but sometimes rait on 10cm or 1/2m vegetation or on a big rock there. Chasing in a gulch was observed once in Colorado (California *N. californica californica* usually rait on hilltops but sometimes also rait on W-facing gully banks, Scott 1976a), and once I saw a male raiting with *Nymphalis antiopa* in one of the latter's off-hilltop raiting clearings. Based on ~95 Colorado observations, they rait from 10:10-17:00+, but evidently most often ~noon to 16:30. They chase only butterflies of similar darkness and size, and fly slower than *Vanessa*. Courtship was not seen.

Nymphalis antiopa Mourning Cloak

The rufous-black ups with blue spots and yellowish rim is unique. Colo. butterflies are evidently the weak ssp. ***lintneri*** which is larger with not much ups reddish and slightly-dusky ups border (ssp. *antiopa* is Eurasian with paler less-scalloped border, less reddish, larger blue ups spots; ssp. *hyperborea* Alaska-Alta. has ups redder, borders duskier, smaller) (N. Kondla research).

Habitat everywhere up to Subalpine Zone. Females lay several hundred eggs (up to 250) in rings "collars" up to ~3 eggs deep surrounding a twig of *Salix exigua*, and are reported to lay eggs in large clusters on the bark of thicker trees that are too large to be encircled; they are rarely laid on leaves. Egg coloration when laid depends on how long the eggs have been retained inside the female in order to accumulate the huge number laid at one time: the eggs are light-green when laid if the eggs were retained for just a short time, or pale-orangish, or orangish, or dark red! for eggs retained evidently for weeks, or black with the larva visible inside if retained very long. The darker eggs remain inside the female for a long time while she accumulates enough eggs to lay the very large mass of eggs, so one mass can have pale AND orangish, or orangish AND black, eggs! The eggs have vertical ribs, like all *Nymphalis*, *Aglais*, *Polygonia*, and *Vanessa*. Larvae eat leaves and are gregarious throughout life, without nests. James & Nunnallee (2011) note that young larvae may be in a very weak silk-strand nest, each larva tied to the group with a single strand, and when disturbed they raise and wave their heads in unison to repel predators. Older larva black, with many tiny white dots (~3 transverse rows of white dots across each segment), orange or red middorsal spots connected by black dashes of the heart-band, and long black scoli (no scoli on top of A2 or head), there may be subdorsal and lateral rows of black dashes, prolegs red; a ventral neck gland; head black. Pupa blackish-gray to gray to whitish-tan to light brown, a light-brown lateral band includes the spiracles, with many dorsal sharp abdominal cones/long spines each with a pink tip above a black anterior chevron on the cone, a few small cones on top of thorax and two cones on each corner of the head are all slightly pinkish. Older larvae and clustered pupae (dozens of pupae under the eave of a house for instance) twitch in unison audibly when disturbed, evidently to discourage predators like birds. Newly-emerged adults void reddish wastes called "meconium". Adults hibernate, in tree holes or under loose bark (esp. of *Salix nigra* in E N. Amer.) or in wood piles, rock walls or piles, old shacks, etc. Adults do not freeze until the temperature reaches -30^{o}C in Alaska (K. Philip 2009, J. Res. Lepid. 41:46).

Flight periods: In Colorado there is just one generation in the higher mountains, but at lower altitude in the foothills and plains there are two generations at least sometimes. In higher mountains, overwintering adults live until June or rarely into July (wings very battered), and a new generation is produced in L June-July which may be found in August and then overwinters in the mountains; whereas on the plains the L June-July adults sometimes produce a second generation in Sept. that overwinters. *N. antiopa* evidently overwinters even in the arctic, for instance C. Wyatt found it hibernating at Fort Smith N.W.T. (1957, Lepid. News 11:47), and it occurs throughout Alaska (except the treeless North Slope) and obviously hibernates there. *N. antiopa* migrates a little in Europe (H. Roer [1970 Zeitschrift Angewahnte Entom. 65:388-396] released hundreds of marked adults in Deutschland and found that adults fly up to 70 km after emergence aided by air currents in June-July and go into aestivation until the fall, feed and grow fat, then hibernate and mate in the spring). In New York adults have been observed flying south prior to hibernation (Shannon 1917), and E. Teale (1955 Lepid. News 9:143) observed 25 migrating W along the shore of Long Is. NY on Sept. 8 perhaps migrating. And "migratory" *N. antiopa* has been observed to glide and ride thermals in E Ontario {D. Gibo 1981. Some observations on soaring flight in the mourning cloak butterfly (*Nymphalis antiopa*) in southern Ontario. J. NY Ent. Soc. 89:98-101}. So adults may sometimes migrate, although I have never observed them migrate, except for two adults flying S Sept. 27-28 1971 in Colo. that perhaps were migrating. Shapiro (2007) wrote that on the California coast it is resident and has 2-3 non-migrating generations, but he wrote that adults at inland California lowlands overwinter and produce a new generation in June which migrates to the Sierra Nevada above 5000' and feeds on flowers, then some aestivate there and some migrate back to the lowlands in Oct. But I have not seen this altitudinal migration in Colorado, and *N. antiopa* is not common in the high mountains in July-Aug. as is *Aglais milberti* (and I saw no rapid unidirectional fliers), so altitudinal migration evidently does not occur in Colo. (Research found that juvenile hormone produced by the corpora allata matures the ovaries and the male and female reproductive glands [W. Herman, D. Bennett 1975 J. Comp. Physiol. 99:331-338], so the absence of that hormone would provide the endocrine mechanism of adult diapause if it occurred, as the July butterflies would diapause somewhere until the next spring.) Proof of a 2nd generation: I found a cluster of hatching eggs July 23 on the plains of Douglas Co., larvae on Wet Mountain Valley floor Aug. 24, another report of oviposition in Denver in July (Scott 1992), I found an older larva near Boulder Oct. 4, and found fresh adults in Sept. I recorded numerous records of mate-locating (raiting, chases, etc.) in L June-July (even Aug.) for foothills/plains adults of the new generation and found a mating pair July 4, which suggests that they are NOT in diapause, because diapausing adults would presumably not want to mate (maybe they mate but do not mature their eggs or oviposit?). However, I found numerous larvae in Lakewood June 4 and reared them to get virgins to release to study courtship, but when released they showed no interest in mate-location. Perhaps they were just not old enough to want to mate, or the rearing conditions may have made them go into diapause?, because internet reports state that people rear July adults and then must diapause them in lab bins for many weeks to get them to reproduce. Herman & Bennett report that it takes 10 days for eggs to mature within females, but presumably they would want to mate long before that. I dissected a fresh female caught Sept. 9 and found no mature eggs, she had not matured her eggs yet; evidently *N. antiopa* routinely lives a long time. If there were usually just one generation on the plains, the adults would have to diapause somewhere (evidently in crannies etc., as they do not fly to high altitude in the mountains) then reappear in Sept. on the *Chrysothamnus* etc. flowers. What is the verdict?--evidently most adults aestivate then diapause and just have one generation, while <u>a minority on the plains have two</u>.

Adults visit flowers less often than most butterflies, but visit whitish and yellow ones, sometimes ochre, pink, and purple flowers, including *Chrysothamnus* (*Ericameria*) *nauseosus*, *Prunus americana*. They also visit *Salix* catkins, tree bark fungus, fermenting tree sap (sometimes from Sapsucker-drilled tree holes), rotting fruit, and mud. On tree trunks an adult lands above the sap and crawls downward to it, to avoid getting stuck and fossilized into amber, and the topmost sap is likely to be the most watery thus easier to suck because it dries out as it slowly creeps downward and finally gets so thick it does not move. They are highly camouflaged as they rest on a tree trunk. Adults of all *Nymphalis* and *Polygonia* roost with the forewings far forward, hiding the antennae between them for camouflage, and they can "play dead" in torpor to confuse predators. Adults sometimes glide up to 4m during flight. When disturbed they may produce an audible click as they fly away. Adults bask dorsally with wings spread widely, or spread little (body basking), as their very dark body and wing ups get warm from the sun. And they can get warm by shivering the wing muscles.

Males rait from ~10:20 to ~16:30 based on numerous observations (a few observations a bit earlier and later, and I saw raiting at 17:00 in Deutschland=Germany) to await females, as males rait/chase an average of 1.4 m up (10-300cm, N=26) on branches, rocks, grass, tables, logs, wires, my hat, etc., in little clearings, usually in gulch/valley bottoms/clearings in woods. But males also rait in small flat-bottom clearings (commonly roughly 4x5m) surrounded by small trees near a hilltop/ridgetop (the slope of the hill can substitute for one tree side of the clearing—these clearings look similar to a gulch clearing, tricking the butterflies into mate-locating there); males sometimes flait (fly/search a small area) there also, which becomes more notable in the near-hilltop clearings. It's surprising to find males mate-locating in clearings near a hilltop, but that is normal behavior as I found them raiting in those special little near-hilltop flat-bottom clearings on most of the wooded big hilltops in the Front Range foothills near Denver, and in multiple years. Perhaps Bright & Ogard (2010) found one of these clearings in Alabama when they reported that *N. antiopa* hilltops there; it generally raits in gulches. <u>Courtship</u>: I saw one completed courtship: the female and male flew slowly ~5 cm above ground and landed on a log, the female slowly opened and closed her wings, the male behind fluttered his wings (transferring pheromone), then bent his abdomen to join, then both were quiescent. R. Bitzer & K.Shaw (1983, J. Lepid. Soc. 37:1-13) saw a mating: the female flew into the ravine, the raiting male pursued and they flew about 1/3 of a circle there and the male "prodded" the female who fluttered her wings twice 3 sec. apart, they "interacted" for 20 sec. [evidently transferring pheromone], he prodded her downward (probably just approaching close to transfer pheromone), and they dropped into grass near top of the ravine and 7 min. later they were found mated there (the mating lasted 2 hr.). Kan & Stirum (2010) observed another completed courtship in France as the female flew 1 m above ground into the clearing where the raiting male overtook her and they slowed as the male fluttered above and below her (evidently to transfer pheromone) then they landed 4m up on the trunk of an oak tree where the male joined (the mating lasted 15:30 until 18:30 when the observer left so probably lasted overnight). They observed another courtship at 14:30 in which the male (evidently raiting in a clearing) encountered a female and flew slowly around the female then they landed farther up on an oak tree ~4m up, where the male tried to join for a few minutes but she dropped and flew away so the male returned to his raiting site. Adults mostly fly 1-2m above ground, so most of the uncompleted courtships I saw were higher above ground with the male flying up to ~10 cm behind and below the female, then they land, and the male flutters his wings fairly widely behind the female (to transfer pheromone), and the unreceptive female flies. If the mated pair is startled, the female flies, the male dangling. Overwintering adults mate-locate and mate in spring (although Shapiro [1986 Great Basin Nat. 46:115] reported courtships and matings frequently in spring and occasionally in autumn in Calif., and A. Young (1980 Entomol. Gazette 31:10) reported 16 mating pairs in early Oct. in Wis. [evidently a 2nd gen.]).

Kan, P., & B. Kan Van Limburg Stirum. 2010. Des centaines de chenilles de *Nymphalis antiopa* (L.) dans les saules (Lepidoptera: Nymphalidae). Lepidopteres-Revue des Lepidopteres de France 19: 129-135.

***Nymphalis l-album j-album* (="*vau-album*") Compton Tortoiseshell**

The uns is leaflike and there is a silver J-mark on unh like some *Polygonia*, so it has been considered to belong to an intermediate genus such as *Roddia*, but after DNA study etc. it still resides uncomfortably in *Nymphalis*. The uph has a distinctive white spot near the apex. A very rare stray to Colorado from Canada, recorded from El Paso (Williams Can.), Clear Creek (Fall River Rd.), and Larimer Counties. The main range of this butterfly is Nova Scotia-Pennsylvania to central Saskatchewan and Alberta-BC-Washington, and this is almost the only butterfly in North America that sometimes migrates SOUTH of its main range as well as north (*Aglais milberti* occasionally does so), in swarms that are not regular migrations. It varies greatly in numbers from scarce to abundant, when it may wander. It rarely strays to Calif., Florida, Tennessee, and Baker Lake, NWT Canada. A. Shapiro (1979, J. Lepid. Soc. 33:200-201) notes that in NE N.A. fresh adults are found at high altitude in July, and overwintered adults at low altitude Nov.-April, indicating altitudinal migration after they breed at low altitude in spring. The American ssp. <u>*j-album*</u> has larger uph submarginal yellowish spots than Eurasian *l-album*. {After wandering in the Old Name Sewer, the name *vau-album* died as a nomen nudum, and the American bugs are properly called ***N. l-album j-album***.}

Habitat mostly Canadian Zone deciduous-tree-containing woodlands, usually in moist canyons in the Rocky Mts., a very rare stray to Colo. Hostplants unknown in Colorado; various trees and shrubs elsewhere, especially Betulaceae: *Betula*; and sometimes Salicaceae: *Salix, Populus tremula tremuloides*, even Ulmaceae: *Ulmus*.

Eggs evidently greenish, laid in small clusters of 17-36 (average 26) in Wash. on hostplant terminal twigs several cm from a green unopened leaf bud. Young larvae are gregarious, and eat leaves from the edges, without nests; they thrash together when disturbed. Young larvae are attached to the plant by a single silk strand (James & Nunnallee 2011). Older larvae also gregarious (more photos in Allen et al. 2005 and Wagner 2005 and Guppy & Shepard 2001), black, with a line of white dots or dashes next to heart-line, a weak dorsolateral line of pale dashes, two lateral rows of pale zigzaggy dashes/marks, many long narrow black scoli; but some larvae are whitish on the lower sides and underside, and some larvae in Wash. and often in E U.S. (Wagner 2005 p. 121) are green all over with the same whitish bands/marks (except subspiracular sinuous line yellowish); BL1 scoli may be greenish, other scoli black; head black with many white-tipped small spines and two small antlers on top (the only "*Nymphalis*" with antlers like *Polygonia*). Pupa pale green turning tan, or golden-tan (Guppy & Shepard 2001) , the top washed with orangish, with silver cones in the saddle, many dorsal blackish-tipped points, orbit white, a rounded or sharp peak on top of thorax, and two short head horns. Immatures are frequently victims of virus disease. Emerging adults secrete red meconium fluid that looks like blood, like numerous other butterflies. Adults hibernate under bark, in hollow logs, under stones, etc., sometimes gregariously (several dozen).

One flight, adults emerge M July-E Aug., then hibernate, then mate & lay eggs the following spring. Varies greatly in abundance from year to year.

Adults sometimes visit flowers and *Salix* catkins, but mostly visit sap (by approaching from the top with head downward to avoid getting stuck in the sap), rotting fruit, mud, & carrion (including porcupines). They (and *Vanessa* and *Polygonia*) visit holes made by sapsucker birds to get sap. They rest head-downward on tree trunks. They bask dorsally, and can get warm by shivering the wings. They have a fast erratic flight.

Males rait along forest edges to await females, then pursue them.

Polygonia interrogationis Question Mark

A rare stray in most of Colo., commoner near Kansas. Identified by the unique silver question mark on unh, the hooked fw, the long black postmedian spot in the base of upf cell M_2 (absent in other *Polygonia*), and the longer uph tail which is often tipped with violet. The black unf median band has its outer edge straight as it runs from the rear anteriorly to a sharp point on vein M_3 (it is straight in some *P. comma* and *P. satyrus* also, but is somewhat sinuous in most of those and in other *Polygonia*). A black spot on middle of uph is always present or obscured, but a black spot on base of upf cell CuA_1 is usually absent (sometimes weak or strong). The two anterior "sausage" marks in the unf discal cell are far apart and the distal sausage is ~ shaped (they are closer together and more linear in *P. comma*/*P. satyrus*/*P. faunus*, and even more so in *P. gracilis*/*P. oreas*/*P. progne*). The summer generation **form umbrosa** has the outer half of uph black, whereas the hibernating generation has that area reddish like the upf; but these forms are not constant in Colo. *Polygonia* spp. may be conspicuous in flight with their orange ups, then when they land and look like leaves they disappear and avoid predation.

Habitat valley bottoms at low altitude. Adults of this E U.S.-NE Mex. butterfly sometimes stray to central and W Colo., Nfld., Alta., and Cuba. Adults are evidently somewhat-regularly migratory: adults hibernate approximately as far north as the S edge of Pennsylvania or New York City, and migrate northward to repopulate as far north as S Ontario each spring, then migrate south in fall (Monroe & Wright 2017; Shannon 1917) (including going W in Rhode Island and Long Island, and S along the Atlantic coast). It overwinters in Ohio and evidently in Iowa. It is rare in central Colorado (I found singletons at Pueblo, Canon City, & N Golden) where almost all adults are evidently just rare migrants, but it rarely breeds in C Colo. (3 were caught June 24, 1987 at "Top of theWorld" 9200' in Park Co. by T. Emmel & J. Nation Jr., and adults in mid Oct. in Boulder etc. probably bred locally). It is scarce or uncommon in New Mexico except near W Texas, so there is not much of a source population for migrants to get to Colo. It is commoner only at the creeks and towns at the eastern border of Colo., where it may overwinter often. Hostplants in Colorado tree Ulmaceae: *Ulmus pumila*, *americana*; and associated with herb Cannabaceae: *Humulus lupulus* var. *neomexicanus*. Many other hostplants in E U.S. are from those families including *Boehmeria*, *Celtis*, plus the herb Urticaceae: *Urtica*.

Eggs pale-green, laid singly or stacked up to eight in a column on the uns of young leaves. Larvae eat leaves. Larvae live under the leaf, seldom with the leaf edges drawn down with silk (Wagner [2005] notes that older larvae do not make shelters on the stiff leaves of *Ulmus* and *Celtis*, but on flexible *Urtica* and *Humulus* they make a shelter on a leaf underside). Older larvae variable, varying from yellow through orange (usually) and red to almost black: body black dotted with white, sometimes with several orange or yellowish or creamy wavy near-middorsal and subdorsal rows of dashes, often a cream line that includes the red bases of BSD scoli, then often a white lateral band containing BL1 scoli; BD1 & BD2 cream but usually orangish at least at base, BSD scoli reddish or black with red bases, BL1 scoli cream with slightly-orangish bases, the T1-2 scoli may be blacker; prolegs black or often red; head red-brown or sometimes black, with black head scoli "horns" (all *Polygonia* have two black scoli "horns" on the head and black eyes, and small cream setae). Pupa dark-brown, orangish, yellow-brown, gray-brown, or greenish, with silver or gold spots in the saddle, sometimes a dark-green or brown lateral abdominal band that sometimes extends around top of wings, a dorsal "saddlehorn" keel on the thorax, two short horns on the head, and four pairs of sharp dorsal gold ones in the saddle; the cremaster is hooked into a pink silk pad. Adults hibernate.

Perhaps two flights, M June-E Aug., then L Aug.-Oct. overwintering to May.

Adults visit various flowers evidently of all colors, rotting fruit, sap, and mud, sometimes dung, carrion, and human sweat. Adults have a powerful, often zigzagging flight, with slower wingbeats than *P. comma*. Adults bask dorsally, and can get warm by shivering the wings.

Males rait to await females, on the ground or rocks or tree branches or trunks 1/5m-7m up, from at least 14:00-19:30, based on few observations (they probably start raiting ~12:00-13:00 like other *Polygonia*). Adults hibernate.

***Polygonia comma* Eastern Comma**

Scarce in Colo., yet recorded from all but four of the counties in NE Colo. (and recorded from adjacent Jackson Co.). The unh is brown like *P. interrogationis* and *P. satyrus*, but has the silver mark shaped like a comma and swollen at both ends, unlike other *Polygonia* (except some *P. satyrus*). The fw is not quite as hooked as *P. interrogationis*, and the hw tail is smaller. Also, the uph dark border is fairly wide and surrounds the pale spots, unlike *P. satyrus*. A black spot on middle of uph is always present, but a black spot on base of upf cell CuA_1 is usually absent (sometimes weak or strong). The base of upf cell M_2 lacks the black spot of *P. interrogationis*. Summer **form umbrosa** adults have the outer half of uph blackish (and the uns is often slightly yellower) like the same form in *P. interrogationis*, the uph border much wider than on hibernating adults. It is basically non-migratory (unlike *P. interrogationis*), but may wander a little.

Habitat lowland valley bottoms on the plains and rarely in the foothills. I have few observations, because *P. comma* is only present on the plains and is scarce in Colorado except it may be more common on the eastern border. Hostplant in Colorado herb Cannabaceae: *Humulus lupulus* var. *neomexicanus*. In E U.S. it also eats herb Urticaceae including *Urtica*, *Laportea*, & *Boehmeria*, even Ulmaceae: *Ulmus*. Colorado *P. comma* seems to prefer *Humulus* or at least likes it as much as *Urtica*, as I found individuals at a big *Humulus* patch in Wheatridge 4-5 times, and collected an F1 hybrid *P.*

*comma*X*P. satyrus* there July 7, 2001 (I did not carefully examine the specimen and kept it in an envelope and thought it was *P. comma* and traded it to Norbert Kondla, who discovered its hybrid identity when he mounted it). Rare in most of NE Colo. except commoner near Nebraska and the NW tip of Kansas.

Eggs pale-green, laid singly or stacked up to nine in a tilted column under young host leaves or on stems. Larvae eat leaves at night, and when older live under the leaf by silking the leaf edges downward and toward each other. Older larva extremely variable, greenish-white or cream-white (with few other strong markings except above spiracles a row of red spots on A3-7), or red-brown or greenish-brown, or black. The dark-and-cream larvae have many transverse black & white dorsal lines in the area between segments, the rest of top cream with black middorsal dashes between scoli and a black crescent running over top of body touching BD1 scoli, a wide black band above spiracles nearly encloses small or larger red oval spots on A3-7 each one anterodorsad of each BSD scolus (these red spots may be diagnostic for *P. comma*), a wide lateral cream stripe includes spiracles and BL1 scoli; all scoli usually cream; head mostly black with small black scoli "horns" (orangish on some larvae) and small cream setae. (Many larvae resemble *P. satyrus*, except the orangish later L marks of *interrogationis* are just small orange spots, and below those spots a wide white lateral area on photo of Allen et al. 2005.) Pupa brown or tan or whitish with various markings including a brown streak(s) on wings and a lateral brown band on abdomen, and gold or silver cones in the saddle, many brownish small dorsal cones on the abdomen. Adults hibernate.

There are probably 2 generations on the Colo. plains, evidently L June-E Aug. and E Sept.-overwintering to May. Adults do not migrate, or migrate very little.

Adults visit various flowers, catkins, sap, and mud, and elsewhere are known to visit human sweat, rotting fruit, urine, dung, and carrion. They land on a tree trunk with head downward and walk to the sap. Adults bask dorsally. Adults can "play dead" as a predator-avoidance device. Adults roost with the forewings far forward enclosing the antennae, like relatives.

Males mate-locate in clearings in afternoon from 12:00-18:00, often flaiting in the sides of ravines, mostly raiting on sunlit tree trunks or foliage or sunlit ground to await females, like other *Polygonia* (R. Bitzer & K. Shaw 1983 J. Lepid. Soc. 37:1-13).

Polygonia satyrus satyrus **Satyr Comma**

The unh is usually more yellowish than other *Polygonia*, but varies from medium brown on unh (most males) to golden tawny on uns (many females, esp. in the summer generation). The uph brown margin is nearly absent, making the submarginal pale spots blend some with the middle of the wing. The base of upf cell CuA_1 always has a black spot like the one behind it (uncommon in *P. comma*), the unh median line is much straighter than *P. comma*, and the uph is much paler than *P. comma*. The uph nearly always has a black spot in the middle, which is also present or obscured in *P. interrogationis* & *P. comma* but variable in other *Polygonia*. The unh silver "comma" spot is often larger with more enlarged ends than that of *P. gracilis/P. oreas/P. faunus*. Summer generation females are usually yellower on uns (**form hutchinsoni**), the opposite of the darker uph of summer *P. interrogationis*/*P. comma*/*P. progne* form umbrosa. Nylin et al. (2005) found that *P. satyrus* adults get paler with longer photoperiod, but that minor difference is only part of the massive difference that occurs between the two generations of adults of Eurasian *P. c-aureum*, *P. c-album*, and *P. egea*, in which the early summer adults are yellow-brown on uns, the diapausing adults are brown (some 1st gen. *P. c-album* adults aestivate and hibernate, while others reproduce to make fall hibernators, then they all reproduce in the next spring). Ssp. ***satyrus*** occurs in Colo., which has yellower uns than other ssp. (such as the very dark ssp. *transcanada* from Nova Scotia etc.).

Habitat valley bottoms near the host on the plains and foothills up to the Canadian Zone. Hostplants in Colorado herb Urticaceae: *Urtica dioica gracilis*; Cannabaceae: *Humulus lupulus* var. *neomexicanus*. Common, but less common than *P. gracilis*.

Eggs green with whitish vertical ribs, laid in columns of up to 7 on host leaf uns. Larvae eat leaves. Older larvae make nests on the underside of leaves by chewing the leaf base slightly esp. the veins (making it droop), drawing down the leaf edges and silking them together, as does *P. comma*. Older larva black, the top of body greenish-yellow (ochre-yellow anteriorly) or cream (white in BC), with weak or strong blackV marks on top except behind head, sometimes a middorsal row of small black dashes, and transverse lines of cream and black in areas between segments at least subdorsally, often orange dashes behind spiracles or an orange L-shaped mark behind and above spiracles, and a pale-yellow or cream lateral band or row of dashes (orange between segments), the BD1-2 & BL1 scoli cream, other scoli darker; head black, with an inverted cream V on front and two short black antlers. Pupa yellowish-gold or tan (yellowish on top sometimes) or light brown or brown, with brown abdominal lines (two dorsal lines, lateral and ventral bands), and gold or silvery spots in the saddle; many dorsal cones on abdomen, a point on top of thorax, and a pointed head. Adults hibernate.

Two flights, L June-E Aug. (this flight is slightly paler), and end of Aug. overwintering to E June. Adults do not migrate.

Adults visit yellow and white and sometimes purple flowers, including *Arctium minus* and *Physocarpus monogynus*. They frequent tree sap, are highly attracted to fruit bait, and visit catkins, mud, moist fungi, dung, sometimes carrion. Adults usually bask with wings spread (dorsal basking), including when they rait. Adults can warm up by shivering the wing muscles.

Males rait to await females, in sunlit clearings mostly in gulches (sometimes at lake or river edges), as they rait on leaves or trunks (once on my shirt) an average of ~1.6m (0.5-3m) above ground, typically on the W-facing (seldom S or SE-facing) side of a wall of trees (*Acer negundo, Alnus, Salix, Populus deltoides monilifera=sargenti*, *Ulmus pumila, Quercus gambelii*, etc.), in the afternoon from ~13:00 (weakly at ~12:20 or a little before) to ~17:00 (near or at dusk). Hibernating adults mate-locate only in spring.

Polygonia progne Black Comma (Gray Comma)

A rare stray to Colorado from eastward. Only one adult has been caught in Colorado, a female I found just N of Indian Peak in the foothills W of Denver May 26, 1998, probably a stray from a larva/pupa brought in from the east on nursery *Ribes*. It has a thin silver unh comma-mark and is dark blackish on uns with little contrast between inner and outer halves (like *P. oreas*), but the uph marginal areas are much blacker than *P. oreas* so the submarginal orangish uph spots are very small. Two black spots present on many *P. oreas* and many other *Polygonia* (the spot at base of upf cell CuA_1, and the spot on middle of uph) are absent in *P. progne*. *P. progne* has smaller upf black spots. It is evidently the sister species to *P. oreas*, as the male gnathos is very thick in both, their hostplants are the same, larvae have nearly identical color patterns, both are generally rare, they both fly slowly, and their ranges are mostly allopatric and overlap just barely in central BC. It has two seasonal forms: **form umbrosa** is the non-hibernating summer generation with very wide black outer part of uph (like *P. interrogationis* and *P. comma*—form umbrosa occurs only in those three species), while the hibernating form has this black band narrow (both have small orangish uph submarginal spots fully immersed in this black area).

Habitat in E U.S. and Canada deciduous and coniferous woods/valley bottoms with the host. Hostplants in E. U.S. bushy Grossulariaceae: *Ribes* (several species of gooseberries and a currant, *R. rotundifolia* preferred in W.Va.) In Pa. they sometimes eat Ericaceae: *Rhododendron nudiflorum*. {I planted ~10 *Ribes* gooseberry bushes in my yard, which usually produce abundant berries, but no *Polygonia*.} The government attempted to eradicate eastern *Ribes* in early 1900s-1930s because they are the alternate host of White Pine Blister Rust that attacks *Pinus strobus*, but luckily many survive to feed *P. progne*. Uncommon throughout its range. A rare import in Colo.

Eggs green, laid singly on host leaves. Larvae eat leaves, and older larvae rest on the underside or on stems, with the front of the body bent sideways, the rear bent up, without a nest. Older larva (photo

Allen et al. 2005, Wagner 2005 p. 121) resembles *P. oreas*, black, top of T2-A2 oranger, with multiple transverse lines of black and orangish on top of body at segment joints, an oblique orangish mark runs forward and down from BD1 scolus, BD2 & BSD scoli are in the middle of orangish irregular tapering downward-pointing crescents, the latter joining cream then orangish crescent pointing upward from cream BL1 scolus (these orangish marks orangish-brown on some larvae), scoli mostly creamy or pale-orangish except BSD scoli blackish and upper scoli blackish on thorax; some larvae blacker with orangish patches on sides, the spines more orangish; prolegs & uns blackish; head blackish with some orangish on front and the usual two black scolus "horns". Pupa usually pinkish-brown with pinkish and greenish stripes and bands and oblique lines, or pupa just dark brown. Cremaster pad evidently yellowish? in poor photo. Adults hibernate.

Two generations eastward, evidently L June-E Aug. (form umbrosa with the black outer part of uph wide), and Sept. overwintering to May (the winter form with the black outer part of uph narrower).

Adults in E U.S. seldom visit flowers, and visit sap, rotting fruit, carrion, dung, and mud. Adults bask dorsally, and can warm up by shivering the wing muscles. Adults (of all *Polygonia* and *Nymphalis*/*Aglais*) roost on twigs with the forewings moved far forward, hiding the antennae between them for camouflage; and they can play dead to avoid predation. Adults fly slower than other *Polygonia* except its sister species *P. oreas*.

Males rait in gulch bottom clearings in afternoon (at least 14:00-16:45 in my few observations, undoubtedly 13:00 to dusk like other *Polygonia*) to await females, as they rait ~1m (maybe 2m mostly) up.

Polygonia oreas **Oreas Comma**

The uns is rather-uniform blackish in all ssp. like *P. progne*, with little difference between inner and outer parts of the unh. *P. oreas* is distinguished from *P. progne* by the much paler outer ¼ of uph where the black border is narrower with larger orangish spots; and the spots near ups bases are larger including the black spot in upf cell CuA_2. The base of upf cell CuA_1 usually has a large black spot but it is absent in some males in Colo.; the middle of uph has an absent to strong black spot. It is the sister species to *progne*, and their ranges are mostly allopatric and overlap just a short distance in central British Columbia. Most *P. oreas* traits are like *progne*: the uniform blackish uns, hostplants, details of larval color pattern, fewer egg ribs, slow flight, rarity, and the thick gnathos on the male genitalia (much thicker than *P. gracilis*). But form umbrosa is absent in *P. oreas*. Adults are rare in nature; I have seen more than one per day only a few times. Two ssp. occur in Colorado: ssp. ***nigrozephyrus*** in the Front Range & S Wyo. (Albany & Carbon Cos. and just S Casper) has the uph submargin like *P. gracilis zephyrus*; ssp. ***satellow*** on the western slope has the uph submargin quite yellowish like *P. satyrus*; 1m1f from the W side of the Sangre de Cristo Mts. look closer to *satellow* on the male but the female is like *nigrozephyrus* so the population is perhaps near-*nigrozephyrus*. *P. oreas* is rare and will surely be recorded in a dozen more counties, including Jackson, Routt, Moffat, Summit, Garfield, Lake, Pitkin, Hinsdale, Dolores, San Miguel, and Custer Cos. It occurs in Archuleta Co., so will probably be found in adjacent New Mex. {The main references on these butterflies are: Scott 1984a J. Res. Lepid. 23:197-210; Scott 1988b J. Lepid. Soc. 42:46-56; Scott in Scott et al. 2006 Papilio (New Series) #12:39-40 & pl. IV}.

Habitat woodland valleys (sometimes gulches) with the host. Hostplants in Colorado bushy Grossulariaceae: *Ribes inerme, leptanthum*, probably other *Ribes* (also assoc. with *R. lacustre*) on W slope. Usually rare, but on the W slope sometimes one can see several in a day.

Eggs green, with ~9-10 vertical ribs (*P. progne* has ~9 also; other *Polygonia* have ~11), laid singly mostly on uns of host leaves. Larvae eat leaves, and rest under leaves or on stems without nests (in Wash. they may rest in a silked nest with leaf sides drawn down and fastened). Older larvae rest in a corkscrew shape for camouflage, with front bent sideways and rear sticking up. Older larva blackish in ground color, with orangish areas on T2-3 & A1-2 versus many small pale-yellow markings on top of

A3-8, with blackish V-marks around middorsal BD1 scoli on A3-8 (these marks broader than those of *P. gracilis*), a larger brown middorsal triangle within each V, scoli BD2 & BSD are in cream marks (mostly orangish in some ssp. *silenus*) running down and forward (and sometimes also backward on oranger *silenus*--those marks similar to the undulating markings on *P. progne*), the two forward marks enclosing a black spot, then there may be a long oblique cream dash, then BL1 scolus is at the rear of a cream crescent that is oranger away from scolus on oranger *silenus* larvae, multiples of black and cream transverse lines run across top at segment junctions, most scoli creamy-tan except the dorsal thoracic scoli darker with pale bases (but most scoli and markings are orangish in photo of ssp. *silenus* in James & Nunnallee 2011, and Calif. ssp. *oreas* is a little orangish, but photo of Ore. near?-*silenus* in Neill 2007 is darker similar to Colo. larvae); underside black; head black, with many tiny orange cones, a large orange W on the front, orange surrounding both black eye patches, and an orange notch between two spiny black horns. Pupa pinkish-tan or sometimes blackish-gray, reddish-brown on top of A2-3, with gold or silver spots in the saddle, abdomen has a brown-edged cream paired middorsal line and tan-edged lateral and midventral bands, an often-greenish band on wing case. The silk cremaster pad is <u>bright pink</u>, an unusual trait. Adults hibernate.

Two generations, L June-E Aug., and L Aug. overwintering to E June.

Adults visit flowers including *Chrysothamnus* (*Ericameria*) *nauseosus* (*Senecio* and *Mentha* in Calif.) and frequent rotting fruit, sap, mud, dung, and carrion. Rotting fruit bait is about the only hope to collect this species. Adults also fly slower than *P. gracilis* and other *Polygonia*. They bask dorsally. They can shiver by closing the wings and vibrating (up to 2mm open at the wingtips) the wing muscles to get warm. They roost with wings closed and fw far forward covering the head and antennae, which makes the wings more closely resemble a leaf and protects the head and antennae. Adults often feign death when handled.

Males rait in small clearings in valley bottoms from afternoon-dusk, as they rait 1-3m up on shrubs/small trees to await females.

Polygonia gracilis zephyrus **Hoary Comma**

The uns is gray (paler than *P. progne* and *P. oreas*), much darker on the inner half than the outer. The uph submarginal spots are in a dark band, unlike *P. satyrus*. On the base of upf cell CuA_1 only a few adults have a black spot, and on middle of uph only a few have a strong black spot; those spots are generally present in *P. satyrus*. In lower-altitude mts. where two generations occur, the summer adults have the uph submargin slightly paler than hibernating adults so the orangish submarginal spots are larger (<u>opposite</u> to the outer part of uph being much darker in summer form umbrosa in *P. interrogationis*, *P. comma*, and *P. progne*). The male gnathos is much more slender than that of *P. progne*/*P. oreas*. Ssp. ***zephyrus*** has inner/outer part of unh less contrasting than ssp. *gracilis* from Canada-NE N.A.

Habitat mountainous areas from foothills up to Subalpine Zone, and sometimes straying well above timberline (but there is no big migration to high altitude like *Aglais milberti*). Hostplants in Colorado bushy Grossulariaceae: *Ribes cereum* (the most common host, which other *Polygonia* evidently do not like probably because it is waxy), *inerme*; possibly eats other *Ribes* including *R. montigenum*, because Colo. has 7 more *Ribes* spp. that could be hostplants. Common.

Eggs green, laid singly on host leaves (usually on the underside and on petioles). Larvae eat leaves and rest on the underside; no nests. Larvae after the 1st-stage have a ventral neck gland which evidently produces noxious chemicals to deter predators such as ants. Older larvae are cryptic as they rest mostly under leaves or on stems, positioned in the "J" shape common to many Nymphalinae (the rear raised, the A3-6 prolegs attached, and the front humped upward (T2-A1 higher, the head down) and that front often bent to the side a little. Older larva black, with many black and cream (orange T2-A2) transverse dorsal lines between segments, orange with orange-red scoli on top of T2-3 and A1-2, cream with cream scoli on top of A3-8 (with sharp dark V-shaped marks on the cream segments, the point of each V obscured by each middorsal BD1 scolus), a black middorsal line on abdomen, a thick undulating orangish lateral row of crescents above a thin straighter ochre lateral line (both contain orange then ochre scoli), the scoli mostly pale or just the dorsal scoli pale; head black, sometimes with an orange inverted V on front, and black spiny horns. Pupa light brown (or creamy gray or tinged with green), gold or silver spots in the saddle, abdomen mottled brown with brown midventral and lateral bands, the usual small cones; cremaster pad orangish-white. Adults hibernate.

Only one generation occurs near timberline (approx. July overwintering to May-June); two occur elsewhere, mostly L June-E Aug. when adults are a bit paler especially on the uph margin, and L Aug. overwintering to L May. Fall adults die in several hours at 0^{o}F in my freezer, so like *Nymphalis* and *Vanessa* they obviously require weeks of gradually colder temperatures to build up their concentration of glycerol/sorbitol to be frost-resistant. Adults hibernate, and overwintering adults mate-locate in spring. Adults evidently hibernate mostly in tree holes and under loose bark (S. Nylin saw a hibernating European *P. c-album* just hanging beneath a twig 0.5 m above ground), etc.

Adults visit yellow and white flowers, sometimes blue and purple and pink ones, including *Chrysothamnus* (*Ericameria*) *nauseosus*, *Ribes cereum*, *Senecio* (*Packera*) *canus* and *Senecio* spp., *Taraxacum officinale*, *Potentilla fruticosa*. They feed on rotting fruit, sap (including that at sapsucker holes), even *Salix* catkins, aphid honeydew, ripe *Rubus deliciosus* berries, urine, dung, carrion, and mud. They often rest upside down on trunks incl. when feeding on sap. They bask with wings mostly spread (dorsal basking), and can warm up by vibrating the wing muscles. Adults fly slightly faster than *Nymphalis antiopa*, and sometimes glide with wings to the side. Six adults strayed ~4 miles from Green Mtn. to my house in Denver. Aug. 3, 1984 I found 8m5f on *Senecio* flowers on Mt. Evans 12,000’, where they evidently strayed (they are rarely found in the alpine zone) possibly from larvae eating *Ribes montigenum* which is common in nearby Subalpine Zone. Adults roost with the forewings far forward, enclosing the antennae (as does *P. comma*, *P. progne*. *P. faunus*, *Nymphalis antiopa*, and their relatives).

Males rait in gulch/valley bottoms to await females, where they rait on bushes, stones, logs, etc. an average of a little less than 1m up (~½-1m); they start raiting at ~11:15-11:30 (raiting strongly by 12:00, but a mating pair was found at 11:30) and rait until ~16:40 (near dusk), based on ~167+ computerized observations. {C. Wiklund found that Sweden *Polygonia c-album* matings occur 11-17 hours after lab daylight [2003, Proc. Roy. Soc. London B 270:1824]—at 60^{o}N latitude}. I saw one male raiting in a small “gulchlike” clearing next to a hilltop. In courtship, the male overtakes the female, and several females were observed to hover and rapidly vibrate laterally-spread wings as the male hovers behind (receptive females would presumably land and be motionless as the male joined). I found a *zephyrus* copulating pair on a *Senecio* flower near a *Salix* carr. Adults probably mate several times as they age.

{*Polygonia* courtship is rarely seen, so here I summarize what is known of *Polygonia c-aureum* courtship in Japan [Endo, K. 1973. Hormonal regulation of mating in the butterfly, *Polygonia c-aureum* (L.). Development, Growth and Differentiation 15:1-10]: When a flying male sees resting individuals of either sex he lands behind a female [due to the female pheromone produced by glands on her abdomen tip--he seldom lands behind males or dead butterflies or females from which scent glands have been removed], then he “explores the female’s abdomen several times with his antennae” [evidently moving his antennae repeatedly to her abdomen as does *Aglais*], and after a few minutes he bends his abdomen toward the female and joins. [Endo did not mention what happens when raiting males spot flying females--presumably the male would overtake the female and they would slow and he would flutter nearby, then he would land behind her then courtship would proceed as Endo described]. Endo found that long photoperiod and warm temperatures cause the corpus allatum to produce juvenile hormone that matures the female ovaries and accessory glands and stimulates the production of the female sex pheromone so those adults quickly mate, whereas short photoperiod/cool temperatures produce diapausing fall-form adults. Soren Nylin (pers. comm.) notes that in European

Polygonia c-album the pair fly away together at dusk into the trees, presumably to mate there in a hidden place. *P. c-album* older females have mated 2-3 times; males can mate up to 5 times.}

Polygonia faunus hylas Green Comma

Identification: the wing margins are very jagged, and the unh is variegated and has green submarginal spots (except in some form silvius females). The uph submarginal orange spots are small and always in a very dark wide border. The black ups spots are large. Males are highly variegated on uns; and everywhere in the range of all *P. faunus* ssp. some females are almost as variegated as males, but other females vary completely to often uniform gray on uns, **form silvius** (=orpheus). Ssp. ***hylas*** (New Mex.-Colo.-S Wyo.) is smaller and the greenish unh spots are very small, compared to other ssp. such as *cenveray* northward which may have two submarginal rows of large silvery-green spots.

Habitat the middle mountains from upper foothills nearly to timberline, mostly in valley bottoms near some water. Hostplants in Colorado usually tree Salicaceae: *Salix bebbiana*, surely more *Salix*; sometimes bushy Grossulariaceae: *Ribes inerme*. Elsewhere *Populus* and Betulaceae: *Betula* and *Alnus* are hosts, and M. Fisher found it associated with *Alnus* in the South Platte Canyon and the San Juan Mts. so that may be another Colo. host; but *Salix* is also preferred in Wash. and E Canada. Usually uncommon, sometimes abundant at higher altitude in late summer.

Eggs green, laid singly on the uns and ups of young host leaves and twigs (also on terminal buds or catkins, James & Nunnallee 2011). Larvae eat leaves, and rest on leaf uns; no nests. Larva black, very similar to *P. gracilis*, with black and white transverse lines across the top in the area between segments, the top of body orangish from T2-3-A2 then cream with some black dashes on A3-A9, several orangish wiggly lines on side, scoli mostly cream (orangish on T2-A2) except BSD scoli dark; head black, with an orange W on the front (at least in Calif. ssp. *rusticus*) and two short black horns. Pupa light brown or dark gray, with gold or silver spots and often an orange flush in the saddle, abdominal tan bands (two dorsal, one lateral, one ventral), two long head horns, and many subdorsal cones; more elongate in shape than other *Polygonia*. Adults hibernate.

One flight, Aug. overwintering to June.

Adults visit flowers of all colors except perhaps pure red, including *Chrysothamnus* (*Ericameria*) *nauseosus, Taraxacum officinale*. Adults frequent tree sap, catkins, rotting fruit, urine, carrion, dung, and mud. Adults bask with wings spread (dorsal basking), and can warm up by shivering the wing muscles.

Males rait in gulches to await females, raiting an average of ~2/3m up (10cm-1m) on bushes, from ~12:34-16:00 (probably near-noon to near-dusk like *P. gracilis*).

Nymphalidae, Nymphalinae, Junoniini

A tribe of a few dozen species mostly throughout the tropics (few in temperate areas such as mid-altitudes in the Andes), especially in Africa, including *Junonia* and *Hypolimnas*.

Junonia coenia (includes *grisea*) Common Buckeye

This rare stray is identified by the large eyespots, and the white area just basal to the large upf eyespot (this eyespot is surrounded with whitish except at the bottom). The front uph eyespot contains a red crescent and is generally larger than the other eyespots. The nudum on the antenna club is brown. A rare stray migrating into Colorado, recorded from all the plains counties and adjacent foothills, and fewer counties on the W slope (Eagle, Mesa, Montrose, La Plata, & Montezuma Cos.) evidently because the San Juan Mts. slow some migrants, and there are fewer observers in W Colo. In warm seasons the unh is tan, but in colder times it becomes reddish (**form rosa**), reportedly due to cold temperature or short photoperiod (K. Smith 1991 J. Res. Lepid. 30: 225-236) but it seems more uncommon than expected from just cold and short days. Form rosa flies mainly in late fall in E U.S.; it is uncommon in Colo. I have found ~40 *coenia* in E Colo. and only three females were very red on uns (caught Aug. 18, E Sept., & E Oct.) and another was less red, while many late-summer Colo. adults have a reddish unh postmedian band which may be a weak version of rosa. The reddish-unh form rosa occurs throughout the range in North America (it occurred in many of my Calif. lab-reared adults reared indoors in warm air also, and in some wild adults caught March-May etc.); in Calif. only the usual tan-unh form hibernates in warm places but is killed by strong freezes. Form *rosa* seems to be more sedentary than the tan-unh form that is usual in Colorado, and redder adults moved shorter distances than tan adults in my Calif. mark-release study (Scott (1975c, 1976b) studied this species in Calif.). Calif. butterflies were named ***J. c. grisea*** (TL S Pasadena, LA Co. Calif.), which has been claimed as a distinct "species" based on mtDNA and a very few nuclear "wingless" bits, but actually there is just widespread polymorphism of mtDNA-CO1 from Calif. to Texas in "*grisea*", *coenia*, and even in *J. zonalis nigrosuffusa* (see figs. 3-4-5 of M. Lalonde & J. Marcus 2018 Systematic Entomology DOI:10.1111/syen.12335) and adults cannot be identified well from most suggested wing pattern traits which work poorly, so the mtDNA is just a minor irrelevant polymorphic variant within *J. coenia* (and "*grisea*" and *coenia* hybridized well for John Hafernik without any reproductive isolation). However, ***grisea*** seems to be a wing-pattern ssp.: Hundreds of adults from Calif.-Ariz.-SW NM and Moab Utah [*grisea* evidently occurs all over SW Colo. also, as similar adults have been found S of the San Juan Mts.] can be called ssp. *grisea* because they are distinguished by a less-marked unh (more uniform tan) with smaller/fewer postmedian ocelli and weak or no unh postmedian darker streak (though the unh coloration is somewhat environmental), whereas ssp. ***coenia*** in E U.S. and most of Colo. mostly has two larger unh postmedian ocelli in a darker postmedian area (however that darker area when present is very often redder in E Colo. suggesting it is partly environmental as a weak version of form rosa). Other ups traits claimed to distinguish *grisea* from *coenia* work poorly (*grisea* ups grayer-brown, uph submarginal orange band narrower), or are useless (fw subapical ocellus smaller less frequent, less upf apical orange). Form rosa adults are equally brick-red on unh in E U.S. and E Colo. *coenia* and Calif. *grisea*. The mtDNA is intermediate in Ariz.-NM, but adults resemble Calif. adults on unh, so Ariz.-NM butterflies can be named *grisea* or near-*grisea*. {Unfortunately mtDNA has failed to help classify many or most visibly-similar butterflies.} *Junonia* butterflies look very similar to several *Precis* species in Old World warm areas, but DNA etc. shows that they are different genera, and our *coenia* belongs to *Junonia*.

Habitat mostly low flat land (generally on valley bottoms if present) often with open dirt and herbs/weeds, mostly in southern U.S. A stray was found at 11,800' on Pikes Peak. Hostplants in Colorado herb Plantaginaceae: *Linaria vulgaris*, in garden *Antirrhinum majus*; elsewhere many species of *Plantago*, which is probably the main hostplant in Colo. because of its abundance (it ate *P. lanceolatum* at my study site beside San Francisco Bay); in Colo. assoc. with Orobanchaceae: *Agalinis tenuifolia*. Elsewhere it often eats *Agalinis*=*Gerardia* & sometimes *Castilleja* in Orobanchaceae, and eats numerous other mostly non-Colo. plants including *Veronica* & sometimes *Penstemon* in Plantaginaceae, Verbenaceae (*Phyla*=*Lippia*, *Verbena*) and Acanthaceae (M. Bowers 1984, J. Chem. Ecol. 10:1567-1577), and *Mimulus* (Phrymaceae). The hostplants contain iridoid glycosides, bitter compounds that evidently make larvae noxious to birds, but pupae and adults are edible; *Euphydryas* also eat nearly the same hostplants with iridoid glycosides and are noxious.

Eggs green with whitish vertical ribs, laid singly mostly on host leaf uns, up to 962/female. Larvae eat leaves (the leaf surface when younger, the whole leaf when older), without nests. Larvae often feed at night. Older larva blackish, with a near-middorsal row of small white or orange dots or dashes, and two lateral rows of larger white spots and dashes with brown between them, and many black scoli (bluish-black dorsally, and with orange around the lateral BSD and BL1 and BSV scoli), prolegs orangish; larva sometimes blacker or paler; head black with orange spot on the front and top and sides orangish, with two short black scoli horns. Larvae rest near the hosts in daytime, then consume them at night. Larvae are evidently warningly colored, as larvae are noxious to birds. Pupa cream usually with reddish-brown blotches, or varying to nearly black with whitish patches (including some small white dorsolateral ones) and grayish wings, some midventral and sublateral brownish bands on abdomen, numerous subdorsal and dorsal tiny brown or reddish cones. Larvae and perhaps some adults overwinter, but only in the south and along the S & C Calif. coast, because there is evidently no diapause.

Three or more flights far southward, found in Colo. May-Oct. but mostly L Aug.-E Oct. (often bred from earlier-season migrants). It evidently cannot survive Colo. freezes, and overwinters only in S U.S. incl. Alabama (a Dec. 1990 freeze killed them in C Calif. except along the coast). In N Florida T. Walker's Malaise screen traps found that adults migrate northward in spring (median date April 23), south-southeastward in E Sept.-E. Nov. (median Oct. 2-5).

Adults visit a variety of flowers of all colors, including *Achillea millefolium, Baccharis salicifolia, Brassica nigra* (favorite), *Centranthus ruber, Cirsium arvense, Eriogonum latifolium, Ranunculus, Wyethia helenoides,* and seldom visit other food sources but occasionally visit rotting fruit, crushed grapes, aphid honeydew, and mud, once reported sucking something from grass inflorescence. Adults bask with wings spread, and their large eyespots serve to scare away inexperienced predators such as young birds. The adult eyespots may also attract bird strikes to the wings rather than the vulnerable body, sparing the butterfly to fly another day. In hot weather they close the wings and extend their legs and lean to minimize their exposure to the sun. Adults live long, an average of ~10 days in nature in my mark-recapture study at Point Richmond, Calif. (Scott 1975c) (but some emigration surely occurred so the actual lifespan may have been ~two weeks or more); in lab lifespan is up to a month (a male 35 days, a female 28); and in lab one female lived 17 days and laid 962 eggs (reared females start laying ~10 days old [surely younger?]).

Mate-location: Males rait all day to await females, generally on bare spots (often on dirt trails) in open valley bottoms, as males rait usually on the ground (sometimes as much as 1.5m up on plants in a sedge marsh), and after investigating a passing object (butterflies, dragonflies, bees, flies, birds, motorcycle, car, etc.) the males turn around, glide back to near the previous spot, land and turn away from the sun with wings spread to bask and rait. Males sometimes flait and glide. In courtship (Scott 1976b), the male overtakes a female flying near (or occasionally spots a moving landed female), and then a receptive virgin female lands and raises her wings, and the male lands behind and moves alongside with wings raised and bends his abdomen laterally to mate. But courtships with less-receptive females are very variable: At that time a less-receptive female may land with wings raised or spread and the male may hover over her (wings mostly spread and moving at small amplitude) then land and the female may flap her wings and the male flutter his (wafting his sweet-sugary-smelling pheromone), and the male may nudge her rear (with his wings slightly raised and antennae pointing backward) to get her to lower her abdomen slightly to permit mating (and to creep under her wings if they are spread, as the male can join if her wings are raised or spread somewhat); the female may flap her wings a little, then they can join. Unreceptive females flutter their wings vigorously (the rejection dance) to repel the male, or raise her abdomen or spread her wings fully so he cannot join (her abdomen must be lowered slightly below horizontal for him to join), or crawl or fly away. Very young males that are courted by older males can repel the unwanted male by fluttering the wings like unreceptive females do. Males and evidently females have different aphrodisiac pheromones, because I observed that males can locate young females by scent from at least 8 cm away and strings of up to four males will pursue a young female. Evidence that females also have a pheromone is that several crippled females who could hop but not fly were mated with spermatophores, and males court virgins much longer than mated females, and males even bend their abdomen with open valvae to try to mate with the female of a mating pair but not with the male. If the mating pair is disturbed, the female flies, the male dangling. Mating averages 27 min. Females usually mate just once (often twice, rarely thrice).

Scott, J. A. 1975c. Movements of *Precis coenia*, a "pseudoterritorial" submigrant. J. Anim. Ecol. 44:843-850.
Scott, J. A. 1976b (“1975”). Variability of courtship of the Buckeye Butterfly, *Precis coenia* (Nymphalidae). J. Res. Lep. 14:142-147.

Junonia zonalis nigrosuffusa Dark Tropical Buckeye

A rare stray to five southern Colo. counties (Montezuma, Baca. Prowers, Kiowa, & Fremont Cos.) from the Mex./S NM/S Ariz. ssp. ***nigrosuffusa***. It resembles *J. coenia*, but *J. zonalis* ssp. have a pale (tan) nudum on the antenna club. And it lacks a white area basal to the lower upf eyespot, the upf pale band anterior to the eyespot is brown, orangish, or orangish-white (it is white in *coenia*), and the ups is blacker in color; and the front uph eyespot usually lacks orange (hybrids with *J. coenia* may have orangish within the black ring--found in one Colorado specimen) and is usually the same size or smaller than the hind upf eyespot. The unh median line is very straight. Hybridization between *J. coenia* and *nigrosuffusa* occurs often in S Ariz., but they mostly do not interbreed because they prefer their own species’ upf postmedian band color, and different pheromones are evidently involved (J. Hafernik) (crosses between most taxa--*nigrosuffusa*, *zonalis*, c*oenia*--produce adults). {DNA etc. study has changed the names of N. America *Junonia* that I used in Scott 1986a: the inland buckeye *J. evarete* is now *J. zonalis*, south Texas has *J. zonalis stemosa*, the coastal Mangrove Buckeye *J. genoveva* is now *J. neildi neildi* in the Caribbean and *J. neildi pacoma* on W Mex. coast, and *J. neildi varia* in S Texas (*J. neildi* ssp. have blackish nudum) (all based mostly on mediocre DNA results).}

Hostplants in Texas/Ariz.: Plantaginaceae (*Stemodia* [which *J. coenia* reject because of the hairy leaves, which *stemosa* larvae burrow through], *Veronica*; Orobanchaceae (*Agalinis*=*Gerardia*); and Phrymaceae (*Mimulus*); for ssp. *zonalis* in Fla. and Antilles Verbenaceae and Acanthaceae. Older *nigrosuffusa* larva darker than *J. coenia*, black with bluish-black scoli bases except BL1 and BSV scoli have reddish-brown bases, a lateral row of red-brown patches, prolegs red-brown; head black with short branched scolus on top in each horn position, sometimes with orangish on top and side (photo in Allen et al. 2005 as “*genoveva*”). *J. zonalis stemosa* larva resembles *J. coenia* but some grayer-black dorsal areas occur. (*J. neildi varia* averages darker larvae & pupae.) Pupa like *J. coenia*, gray-brown to brown with pinkish, whitish, and greenish markings, dorsal cones edged behind with white.

Multiple generations far southward.

Adults visit various flowers. Marked females moved a little farther than males on average. In Costa Rica *J. zonalis* (oranger-upf ssp.) adults emigrate to higher moister elevations in the dry season (P. Opler).

Males rait and often flait all day in valley bottom open areas (often on dirt roads which they choose more often than *J. coenia*), as they rait on low weeds 1/6-1/3m up or on dirt, and glide 1/3-1/2 m up. When two raiting males interact, they reportedly do not fly vertically as *J coenia* males do. In courtship, the male pursues the female, who lands, and the male may nudge her from the rear before they join. Courtship is like *J. coenia*. Unreceptive females flutter the wings, move the abdomen away from the male, or try to escape by flight. Mating lasts 30-45min.

Nymphalidae, Nymphalinae, Melitaeini Checkerspots and Crescents

Melitaeini are several hundred species in North America and Eurasia, and many crescents in the American tropics. Adults are mostly small, and are often tawny, sometimes blackish. Adults usually fly rather slowly. Adults usually rest and flower-feed and bask dorsally, all with the wings spread. Females lay eggs in clusters, and larvae live communally until they hibernate usually about half-grown. Larvae often eat Asteraceae or Plantaginaceae. Branching spines (scoli) are absent on the head, but are present on the body including a middorsal row, and those scoli are often blunt, sometimes long. Pupae are rather simple, but often have small dorsal cones or bumps. Adults often have black ups veins, which helps warm the hemolymph slightly during dorsal basking. The U.S. *Phyciodes* were in a horrible mess, and it took me several decades and rearing 5000+ eggs/larvae to adults and designating and naming a dozen+ lectotypes/neotypes/holotypes etc. in numerous publications to fix that mess of species boundaries and names, and there is still some mess in E U.S. involving *P. diminutor*, and there are more messes among neotropical crescents.

Euphydryas anicia=E. chalcedona anicia Anicia Checkerspot

Distinguished from *E. editha* by the unh median band which has an outer edge of yellowish spots (versus an outer edge red band in most *E. editha*), by larger size, the fw is more pointed, the abdomen often has white subdorsal dots, the male uncus has two long hooks, and the upper prong of the antler on the inside of the male valva is a long spine curved downward to a point. There is great geographic variation among these butterflies, and Colorado *E. anicia* is part of stenchospecies *E. chalcedona*, which also includes *E. colon*. *E. anicia rorina* is also part of this stenchospecies, and is often considered to be conspecific with *E. anicia* (see the next "species" below). I published a survey of the male valva variation in this stenchospecies {Scott, J. 1980 ("1978"). A survey of valvae of *Euphydryas chalcedona*, *E. c. colon*, and *E. c. anicia*. J. Res. Lepid. 17:245-252}, which suggested that there is just one species involved. Then some electrophoresis work by P. Brussard et al. agreed. But it became obvious that some taxa were sympatric with others, and some people wished to divide it into several species. Ssp. ***wecoeut*** occurs in W Colorado from Moffat, Rio Blanco, Garfield, Mesa, Delta, Montrose, Montezuma, La Plata, and Archuleta Cos. (plus SE Utah, SW Wyo., and--very disjunctly--Carbon Co. Montana) in dry open woodland and sagebrush areas mostly at 6000-7500' altitude (generally lower altitude than ssp. *rorina*), E May-E June; adults are orangish on ups with whiter median ups areas and upf postmedian areas. Ssp. ***carmentis*** occurs in SW Colorado from Archuleta to Montezuma, Dolores, San Miguel, Ouray, and ?Hinsdale Cos., in open Ponderosa Pine woodland, M June-M July; adults are mixed mottled orange and whitish on ups with a paler unh that has postmedian spots that look like little corn kernels (orangish with cream caps). Ssp. ***brucei*** occurs throughout the Southern Rockies in upper Subalpine and Alpine Zone meadows and tundra; it is usually small and rather dark blackish, though it varies considerably and some individuals are whitish like ssp. *rorina* or orangish like *eurytion*, yet all of them are blacker on the furry ups wing bases which distinguishes them from other ssp.; *brucei* has one flight mostly July-E Aug. Ssp. ***eurytion*** occurs in grassland areas in middle-altitude Rocky Mountains of Colo. (in open grassy areas from upper foothills to Canadian Zone including South Park), with one flight mostly L June-July, but it flies M-L July on Rabbit Ears Pass, and June-M July near Rosita on the W side of the Wet Mts. and in forest surrounding the Wet Mtn. Valley (including Lapin Creek 9800' Custer Co. and Dutch Flat Custer Co. and Buttermilk Crk. 8800' Custer Co. and Mosca Pass Huerfano Co. 9700'). {*E. a. eurytion* also occurs in Larimer Co. at Laramie River Road L June, Poudre River N fork at Phantom Can. M May; in Jackson Co. (E of Sand Hills Natural Area L July and W of Grizzly Creek Cgd.); in Routt Co. 1-5 mi. W Steamboat Springs and NW of Toponas; in Teller Co. at Cripple Creek; in Rio Grande Co. at Creede; [perhaps just W in Hinsdale Co.]; in adjacent N.M. in Rio Arriba Co. Glenwood Springs and its airport/Glenwood Canyon has many *eurytion/wecoeut* but many look like *rorina* (see *E. anicia rorina* below, which is not a distinct species) and some are intermediate, M May (one June 12). Summit 10,000 in Sierra Madre Range of Carbon Co. Wyo. has *eurytion*, while *rorina* flies near there at low altitude in hills 7 mi. W Encampment. W of Laramie around Centennial Wyo. has *eurytion*. And in June 8, 2019 S. Spomer found whiter *eurytion* larvae producing *eurytion* adults at Pole Mtn. W of Cheyenne Wyo.} Ssp. ***capella*** occurs in the foothills of the Front Range (and perhaps once occurred near Beulah in the foothills of the Wet Mts.), in open areas (mostly open forest), flying L May-M July (mostly June-E July, but June-July near Colorado Springs) (Craig Meadows S of Bailey in Park Co. July 1 has mostly *capella*). The book by Ehrlich & Hanski (2004) has much information about *Euphydryas*.

Habitat the sagebrush and most open mountain habitats throughout the mountains and W Colo. as noted above. Hostplants in Colorado perennial herb Plantaginaceae (*Penstemon*, *Besseya*, *Linaria*) and Orobanchaceae (*Castilleja*): For ssp. *carmentis Penstemon* & *Castilleja*. Ssp. *wecoeut* hostplants *Castilleja chromosa*, *Penstemon retrorsus* (and *Penstemon* in SE Utah). Ssp. *brucei* hostplants *Besseya alpina* (in Sawatch Range, N Gunnison Co., and Hinsdale Co.) (eggs were found on *B. alpina* on six Gunnison Co. peaks, and none were found on *Pedicularis parryi* and *Castilleja sulphurea* and lab larvae lost weight on *C. sulphurea* and gained little on *P. parryi* [M. Cullenward, P. Ehrlich, R. White, C. Holdren 1979 Oecologia 38:1-12]), *Castilleja occidentalis* (Clear Creek Co.). Ssp. *eurytion* hostplants *Besseya plantaginea* all over Kenosha Pass and South Park and Cover Mtn., and occasionally *Castilleja integra* in South Park; in the high meadows in the Wet Mountains the hosts are probably the same (I found one larva on *C. integra*, and *B. plantaginea* is present there and is probably the main host that I did not recognize at the time). Ssp. *eurytion* eats *Besseya wyomingensis* in S Wyo. (S. Spomer). *Penstemon whippleanus* is the host at Rabbit Ears Pass where *eurytion* is common and *B. plantaginea* is absent. Ssp. *capella* hostplants *Penstemon virgatus asagrayi*, *glaber*, (occasionally *secundiflorus*), *Linaria genistifolia dalmatica=macedonica* (populations exploded on this as noted below). These hostplants are closely related and mostly contain iridoid glycosides (mostly catalpol and aucubin), which makes the larvae and adults of all the *Euphydryas* and *Chlosyne* and *Poladryas* that eat those plants poisonous to birds. Ssp. *capella* is usually uncommon except near Golden, but the mid-altitude ssp. are mostly common and sometimes abundant, and alpine *brucei* and other ssp. can be abundant in good colonies.

Eggs yellow, turning reddish-brown later, laid in large clusters mainly on the uns of leaves of sunlit hosts. Young larvae live in a silk nest before winter (I found one *capella* nest covering the little plant like a silk stocking). Larvae eat leaves, sometimes flowers/bracts. Older larvae of the various ssp. show great differences in ground color, but the heart-line is always black, there is always a black line along the spiracles, the BD1 (middorsal) & BSD & BSV scoli are always orangish at least at the base (the other BD2 & BL1 scoli and often most of the prior scoli are black) and the head is always black {J. Scott 2008 Papilio (New Series) #18:34-36}. Ssp. *wecoeut* is mostly black in Colo. (but has some whiter areas in SE Utah), BD1 & BSD & BSV orangish as usual, with small orange spots next to heart-line. Ssp. *brucei* is very black all over, with some white near heart-line. Ssp. *eurytion* is white, sometimes with some black. Ssp. *capella* is white with little black. Pupa white (sometimes whitish-gray), marked with black or brownish spots and many orangish dorsal bumps and orangish lateral abdominal bumps. 3^{rd-} and 4th-stage larvae hibernate, often multiple times; the very strong diapause in all *Euphydryas* makes them very difficult to study, as people try to rear them and they get mostly diapausing larvae, which may feed a little then go back into diapause. Paul Ehrlich and his colleagues endured that torture for more than four decades. Alpine ssp. *brucei* larvae take two or three years to become adults.

Flight time late spring-early summer, depending on the subspecies and population as noted above. Because some larvae reenter diapause, the life cycle occasionally may be two years or more.

Adults of ssp. *brucei* visit whitish and yellow, less often blue and purplish flowers, including *Hymenoxys grandiflora*, *Senecio* spp., and *Silene acaulis* etc. Adults of other *E. anicia* ssp. visit yellow and whitish flowers, sometimes orange or pink, including *Apocynum androsaemifolium* (favorite), *Ceanothus fendleri, Erigeron pinnatisectus, Eriogonum umbellatum, Gaillardia aristata, Helianthus pumilus, Heterotheca villosa, Jamesia americana, Oxytropis sericea, Physocarpus monogynus, Prunus virginiana, Sedum lanceolatum, Senecio spp., Taraxacum officinale*, and often visit mud (*E. chalcedona* in Calif. sometimes visits carrion), sometimes dung. Adults usually keep their wings spread ~90^{o} or almost-fully spread, except at mud, and they bask dorsally. In very hot weather adults may fly down gulch to seek moisture. R. White (1980, J. Lepid. Soc. 34:353-362) found that ssp. *brucei* adults occasionally fly up to 2-3km between Alpine Zone peaks and are able to fly back to their alpine colony if they wander into the forest. Marked adults lived ~4-10 days on average in different mark-recapture studies in nature (R. White same paper). Adults may feign death when handled. They sometimes roost 4m up in a pine tree.

Mate-locating behavior: 1) Ssp. *wecoeut* males sometimes rait on hilltops, but are often found in gulches so perhaps fleek there also. 2) Males of ssp. *brucei* rait all day on hilltops to await females, as they rait on the ground with wings spread in basking pose. At abundant colonies and near the host *brucei* males may also fleek <20cm up, for instance at ½ mi S of Mt. Bross some males raited on a hilltop but most fleeked about the hillside evidently near the hostplant, and near Loveland Pass males both rait on hilltops and fleek about the hillside *Castilleja occidentalis* host. In courtship, the *brucei* male overtakes the female, and the male flutters near her to transfer pheromone while the unreceptive female also flutters to repel him. 3) Ssp. *eurytion* males seem to rait on *Oxytropis* and *Taraxacum* flowers preferably out of the wind behind snow fence, and they also fleek ~1/3m up slowly about the fairly-flat habitat all day to seek females. In courtship, the *eurytion* male overtakes the female and she lands and flutters her wings a little, and the male lands behind and moves alongside her and joins, then they sometimes drop to the ground. Males flutter their wings behind reluctant females to transfer pheromone, and unreceptive females flutter full stroke much more and move away when he tries to join, or she turns her abdomen out of reach. The young female seems to have a pheromone, as a male landed just downwind of where a mating took place a moment before then he flew to the same spot where she had been. Also, F. Odendaal, K. Jones, & F. Stermitz (1989 J. Res. Lepid. 28:1-13) found that males pursue males of other species 3 sec., *eurytion* males 4 sec., mated females 12 sec., and virgins 98 sec. (due to that pheromone). They studied virgins: if she flew near the male (usually) he pursued, she landed and he landed beside her and quickly joined; or he spotted her resting (one female with soft wings was resting near her pupal shell) and he landed "virtually on top" of her and she did not flutter while he joined. Mated females refuse to land (females who previously oviposited are lighter so can fly better), or eventually land (or the male spots a landed mated female) and the females flutter their wings vigorously (the rejection dance) to repel the male. Female *eurytion* mate just once, rarely (7%) twice. Male harassment increases female movement, and male encounters result in increased turning, which produces local aggregations of males (F. Odendall, P. Turchin, F. Stermitz 1989 Oecologia 78:283-288 and 1988 Amer. Nat. 132:735-749). 4) Ssp. *capella* rait on hilltops to await females in the usual uncommon/rare populations in the Front Range foothills, as males rait an average of ~1.1m up (0-3m, on the ground or bushes or pine boughs). But the Eurasian weed *Linaria genistifolia dalmatica* exploded in the foothills W and NW of Denver by 1975 and *capella* liked it and exploded too by 1989 (300 adults were seen some days); in those abundant populations, a few *capella* males rait on hilltops, but most fleek about hillsides near that host. In courtship, the *capella* male overtakes the female, who slows and lands and spreads her wings partway, while the male lands behind and may flutter for an instant to waft his pheromone and spreads his wings ~60° and nudges her abdomen, and if she flies she flies slowly and both land with wings 45° spread and he bends his abdomen to mate. If a (evidently less-receptive) female hovers when the male overtakes her, he flutters behind or below her to waft his pheromone, and if she lands he may hover over her or below her briefly. Unreceptive *capella* females flutter the wings at wide amplitude as a rejection dance to repel him, or try to fly away; if she flutters after they land he may persist and flutter behind or below her then he may bump into her and may vibrate his mostly-spread wings and may flutter them at wide amplitude behind her, and he often bends his abdomen to try to join (usually with his wings spread ~45-90°) and may try to push under her partly-spread wings to try to join. If a mating pair (of *eurytion* & *capella*) is disturbed, the female flies, the male dangling.

{Courtship of *E. chalcedona klotsi* in C Ariz. is presented here for comparison (R. Rutowski & G. Gilchrist 1987 J. Natural History 21:1109-1117): Males fleek and rait widely in C. Ariz. and show little site tenacity (Rutowski, Gilchrist, & B. Terkanian. 1988 J. Insect Behav. 1:277-289 reported that male *klotsi* rait in the morning, and fleek in the afternoon). A male meets a flying virgin female, she lands, he lands behind and faces her and moves beside her and joins, but 25% of virgins crawled or flew a short distance then became quiescent and the male joined. Previously-mated unreceptive females flew away or if they landed they held their wings open and rapidly vibrated their wings until the male departed. Previously-mated females are courted less persistently than virgins evidently because of a pheromone (the 1988 paper just cited). Mating lasts an average of 72 min. (3-7 hours if the male had recently mated); some females mate twice, rarely three times.}

Euphydryas anicia rorina (*E. bernadetta rorina*, *E. chalcedona rorina*)
Bernadetta Checkerspot

Ssp. *bernadetta* also belongs to stenchospecies *E. chalcedona*. It resembles *E. anicia* in the traits listed above for distinguishing *E. anicia* from *E. editha* (the male valva antler is like *E. anicia*), and is distinguished from *E. anicia* by mostly having a whiter ups (including the wider postmedian spots etc.). It does not have the characteristic traits of *E. editha* mentioned in the text for that species. Ssp. *bernadetta* was considered a separate species because it often flies mostly in sympatry/synchrony with *E. anicia* in Montana and (doubtfully) Alberta (S. Kohler & N. Kondla 2006, Papilio [New Series] 12:30) (including the Cypress Hills of Alta. where *bernadetta* flies with *anicia*). Is *bernadetta* a separate species from *anicia* in Colorado?—it evidently isn't. Just one ssp. of *bernadetta* occurs in Colo., ssp. ***rorina*** (which is usually distinguished by a narrower black elongated ring around the orange row of postmedian spots on the outer part of unh--that ring is thicker in ssp. *bernadetta* northward and in *veazieae*); *rorina* could be considered to be conspecific with *E. anicia* because wherever *rorina* occurs in Colo. and S Wyo., there are some orange individual variants that look like *eurytion*; however those oranger variants also occur as a minority in ssp. *veazieae* and related ssp. such as *macyi* in Oregon and nearby states which have also been placed in *E. bernadetta*, so the oranger variants are not concrete proof of a second species. Ssp. *rorina* generally occurs at higher altitude than *E. a. wecoeut*. Ssp. *rorina* occurs in S Wyoming {W of Wheatland in Platte Co., at The Rock in Converse Co., west of Laramie and Sybille Can. etc. in Albany Co., W of Cheyenne (20-25 mi. W etc.) in Laramie and Albany Cos. including Veedauwoo, 7 mi. W Encampment in Carbon Co. M July} and in Colorado it occurs in Larimer Co. (near Virginia Dale and Glacier View Meadows, & the northernmost part of CR80C), Moffat Co. (Diamond Peak [the unh resembles *rorina* here, not ssp. *bernadetta* or *veazieae*], vic. Greystone), Jackson Co. (NW Walden), Eagle Co. (Game Creek, 5 mi. E of Eagle), Grand Co. (widespread, with some orange adults even at TL), Summit Co. (widespread), Garfield Co. (with some *eurytion*, around Glenwood Springs and Basalt near Glenwood Can.), Gunnison Co. (with *eurytion*, at Black Mesa Rd., 9500'), Pitkin Co. (with some *eurytion* variants, at Aspen and Hwy. 82 in Roaring Fork Can. W of Woody Creek), Rio Grande Co. (SW of Creede). In South Park, the *E. anicia eurytion* populations average a little whiter and there are some very-whitish variants that look like the usual whiter ssp. *rorina* (causing South Park butterflies to be named *E. a. carolae*), so the South Park butterflies could be thought to be whiter because they are intergrading toward *rorina*. However, the South Park butterflies have mostly-white larvae like *eurytion* and *capella*, whereas ssp. *rorina* in the Laramie Range W of Cheyenne Wyo. often have blacker larvae (photo of one larva by S. Spomer, versus photo of many more-whitish larvae W of Cheyenne for *eurytion*) with strong black and smaller white bands like ssp. *bernadetta* in W Neb. And *rorina* sometimes has a slightly earlier flight than the reddish *eurytion* (but they often fly together with equally fresh adults), and the Wyo. *rorina* always have some reddish adults among the mostly-whiter adults, so those S Wyo. polymorphic whitish/orangish populations and all the Colorado populations of white butterflies with some orangish phenotypes might be conspecific with *rorina*. S. Spomer observed a whitish male *rorina* mating with an orangish *eurytion*, and both have the same *Besseya wyomingensis* hostplant in S-C Wyo., suggesting they are conspecific. Similarly, in the Cypress Hills of SE Alberta ssp. *bernadetta* can fly with ssp. near *anicia* (similar to *eurytion* in appearance but darker) and visual intermediates occur in large series (the *bernadetta* are a bit more worn in N. Kondla photo suggesting they fly a little earlier, but K. Roever found them equally fresh), so that situation is similar to the *rorina*/*eurytion* situation in S Wyo. (interpretable as just variable populations). But if they are conspecific, why do some trips there result in mainly whitish *rorina*, and other trips result in mostly orange *eurytion*? (evidently random sampling). More work is desired to get older larvae & hostplants of populations across W Colorado to help determine how many species are in Colorado. The oranger "*eurytion*" specimens within the usually-white *E. bernadetta rorina* populations are now considered to be intergrades toward *E. anicia eurytion*, and the whiter variants among South Park orangish *eurytion* are considered intergrades also, and not a second species. So far, no localities have been found in Colorado where two species *E. bernadetta* and *E. anicia* are clearly sympatric without interbreeding. And both seem to occur in S-C Wyo. in the Laramie Range at Pole Mtn./Vedauwoo where S. Spomer found both *eurytion* & *rorina* populations in different years, distinguishable by adults and larvae; Spomer considers them conspecific. Scott (2006, Papilio [New Series] #12:32-35 and 2008, 18:34-36) discussed this situation. In March 2020 I identified 100+ adults John Nordin collected from Albany (some from Carbon) Counties in S-C Wyo., and some from Lone Pine Creek in Larimer Co. Colo., which seem to conclusively prove that they are conspecific, as orange *eurytion* and white *rorina* continuously intergrade at every one of a dozen localities and are obviously all one species *E. anicia*.

Habitat sagebrush valleys and hills and mostly Canadian Zone open woodland in W Larimer Co. and the western slope of Colo. Hostplants in Colorado herb Plantaginaceae: *Penstemon strictus* at Aspen, and associated with Orobanchaceae: *Castilleja flava* in Grand Co. In S-C Wyo. (W of Cheyenne at Veedauwoo/Pole Mtn., adults L May-M July) the host for *rorina* is Plantaginaceae: *Besseya wyomingensis* (S. Spomer), the same host used by ssp. *bernadetta* on Pine Ridge, Nebraska (where larvae often eat *Symphoricarpos occidentalis* [Caprifoliaceae] in spring [S. Spomer 1985 J. Kans. Ent. Soc. 58:566, & 1985 J. Lepid. Soc. 39:55-56]), so that is probably the host in NW Larimer Co. Colo. Moderately common.

Eggs yellow, turning reddish-brown later, laid in large clusters on uns of host leaves. Larvae eat leaves. Young larvae feed in communal webs under leaves. Older larvae (S Wyo.) blackish with tiny white dots, with narrow white middorsal band including a black heart-line, a whitish lateral band includes a black row of tiny black marks along the spiracles, BD1 (middorsal) scoli mostly orange, BSD & BSV scoli orangish at the base (the other BD2 & BL1 scoli black); head black. Older larva of ssp. *macyi* from Alvord Desert Ore. (Neill 2007) is similar. Pupa white, with numerous black markings, and the usual numerous orange cones. Half-grown larvae hibernate.

One flight for *rorina* L May-M July, mostly M June-E July.

Adults visit various flowers including *Senecio* (*Packera*) *canus*, and visit mud.

Males of *rorina* sometimes rait on hilltops in W Colo. including Grand Co. where they rait ~20 cm up on shrubs evidently all day. Male *rorina* rait on hilltops and also occur widely even in gulches when abundant at Diamond Peak in NW Moffat Co. (*E. a. bernadetta* fleeks in gullies/valleys in Neb. and the Bighorn Mts.)

Euphydryas editha **Edith's Checkerspot**

E. editha is identified by the extra narrow orangish band on the outer edge of the unh median cream band (this narrow band is often absent in *E. chalcedona/anicia/bernadetta* or if present it is cream). Also, adults are smaller than *E. anicia/E. bernadetta*, the abdomen generally lacks white subdorsal dots, the fw is usually more rounded, the male uncus has two short blunt projections, and the upper prong of the male valva antler is aimed upward and is wide with two teeth at the tip, not a downward narrow hook as in *E. anicia/ bernadetta*. Two *E. editha* ssp. occur in Colo., mostly on the western slope (on the eastern slope only in Jackson & Larimer Cos.), both are mottled with red, black, and cream spots: ssp. ***lehmani*** =*gunnisonensis* (from Aspen to Ouray Cos., oranger on ups), and ssp. ***hutchinsi*** (=*alebarki*, or perhaps *alebarki* is a weak ssp.) (the rest of northern Colo. W of continental divide plus Jackson & Larimer Cos. on the E slope, & S Wyo., a little darker on ups).

Habitat mostly open hilly sagebrush areas. Ehrlich, P. & I. Hanski, eds. (2004) discuss the biology of *E. editha* and other *Euphydryas* thoroughly. Hostplants in Colorado herb Orobanchaceae: *Castilleja linariifolia* is the main host (a common drought-resistant plant, well-studied in Gunnison Co. by C. Holdren & P. Ehrlich 1982 Oecologia 52:417-423). *C. chromosa* and *Penstemon strictus* (Plantaginaceae) occur there and are eaten in lab but are less drought-resistant so they are not utilized in nature in Colo., even though in Nevada *C. chromosa* is a major host and *C. linariifolia* is not eaten. Adults in Summit & Grand & Larimer Cos. etc. are associated with *C. flava*, in Larimer Co. also assoc. *P. confertus procerus*, and Grand Co. (W Tabernash) adults are assoc. *P. cyathophorus*. Many other Valerianaceae, Plantaginaceae, and Caprifoliaceae hostplants are known elsewhere for other *E. editha* ssp. *Collinsia* (Plantaginaceae) is a common host elsewhere, and *C. parviflora* is widespread in W Colo., but it is not eaten there because it senesces before the butterfly flight period. Calif. ssp. eat *Plantago*, *Pedicularis* (Orobanchaceae), *Collinsia*, and *Castilleja* depending on the colony, and the primary colony hostplants are not simply correlated with the named ssp. The hostplants contain iridoid glycosides and seco-iridoids, which are noxious and are produced by plants to discourage herbivores, but are incorporated by *Euphydryas* into their bodies to poison bird etc. predators. Common.

Eggs greenish-yellow, later turning orangish-brown , laid in clusters averaging 5 or 90 or 247 depending on population and individual variation (average 45 at the famous Jasper Ridge CA colony now extirpated), up to 731 or 1200 eggs per female, laid near base of *C. linariifolia*. Larvae are gregarious in 1st-3rd-stages; 1st-stages usually live in a loose silk nest, 2nd-3rd often on rather than in it. Larvae eat leaves, sometimes flowers, and abundant larvae may eat whole small plants then starve. Different hostplants are eaten before and after hibernation at many sites. Older larva mostly black, heart-line always black, always a black line along the spiracles, the BD1 (middorsal) & BSD & BSV are always orangish at least at the base (the other BD2 & BL1 scoli are black); head always black. Larvae may jerk their heads to the side (singly or several in unison) to deter predators, or regurgitate. Pupa white or gray with black blotches and streaks and many orange dorsal cones, mostly within a sparse web holding together a few blades of slender foliage. 3rd– and 4th-stage larvae hibernate, and postdiapause larvae may reenter diapause. Larvae can burrow into loose soil if starved. Diapausing larvae reportedly have thicker and hairier skins. After diapause (in spring), larvae may disperse up to 10m per day.

One flight L May-June (M June-M July in Gunnison Co.). Because some larvae reenter diapause, the life cycle occasionally may be two years or more. Adults seem to prefer yellow and white flowers, and they visit mud. Adults can commute between valley flowers and ridge hostplants, if they need to: some adults in Calif. flew 1km and back to a creek during a drought (A. Launer, D. Murphy, C. Boggs, J. Bauman, S. Weiss, P. Ehrlich 1993 J. Res. Lepid. 32:45-52). Adults that were marked move an average of less than 25 m or 193m, depending on the population, up to 1.2km. Adults live about a week on average, up to a month in lab. Cows can crush up to 35% of eggs/adults. Adults bask dorsally, with wings spread.

Males rait and occasionally flait on hilltops (if present) all day to seek females, as raiting males rait mostly on the ground with wings spread, and males especially in abundant populations may fleek near the hostplant <20 cm up to find females. In populations in Gunnison Co., males may congregate on hilltops but in abundant years such as 1984 matings occur more often near hostplants and hilltopping lessens mating success, whereas at the same site when the population was uncommon in 1987, most males and females were mating/present on hilltops, proving that natural selection during sparse years maintains hilltopping (P. Ehrlich & D. Wheye, 1984 J. Res. Lepid. 23:143-152, & 1986 Amer. Nat. 127:477-483, & 1988 Amer. Nat. 132:460-461; Wheye & Ehrlich 1985 Ecol. Ent. 10:231-234) (in general, hilltopping benefits butterfly populations mostly when density is low). Newly-emerged females carry a load of mature eggs making them about twice the weight of males, so their slow flight is attractive to males, and fleeking males may find resting females. In courtship of receptive females (mostly from P. Labine 1966. The reproductive biology of the checkerspot butterfly, *Euphydryas editha*. PhD thesis, Stanford Univ.), the male pursues a flying female and they land or he lands beside a resting female, he gets close to her or touches her side if she has closed wings or if sometimes her wings are spread he can often nudge under her hindwings, and they join. Receptive females are passive and accept the male and seldom flutter. Courtship of less-receptive females is more complicated with male hovering and fluttering to transfer pheromone to the female, more like *E. anicia capella*. Unreceptive esp. mated females flutter to repel the male, or they crawl away or fly, or bend the abdomen away from the male. Virgin females evidently have a pheromone attractive to males, who are not attracted to egg-laying females who lack that pheromone (F. Odendaal, P. Ehrlich, F. Thomas [1985 J. Morphology 184:3-22] studied the antenna and suggested there is a close-contact pheromone). Males are equally attracted to mating pairs, and may attempt to mate. Occasionally an older male will grasp a teneral male in the mating position. Females usually mate just once, sometimes two or three times. Mating lasts 61-87 min., or 109 min. or more if the male mated recently. The male inserts a small clear plug into her opening to make it difficult for her to remate. If a mating pair is disturbed, the female flies, the male dangling.

Euphydryas gillettii **Gillett's Checkerspot**

The broad orange submarginal bands identify *E. gillettii*, which is related to European *Euphydryas* species (*E. iduna, cynthia, maturna, intermedia*--the latter even eats *Lonicera*).

This species is not native to Colorado, and was introduced to the tiny town of Gothic in Gunnison Co. by C. Holdren & Paul R. Ehrlich in early July 1977 using ~83 egg masses (they also introduced it to Pioneer Resort in 1979 but that introduction failed), and that colony was tiny for many years but expanded and exploded in numbers in 2002 (when one was found 6.4 km away) after three dry winters in a row allowed larvae to diapause in 4th-stage rather than 2nd stage which evidently allowed many to complete development in one year rather than two; it disappeared from the release site but was still present nearby; its current status is not known to me. This introduced species is not likely to become a pest and is a special precious butterfly that is usually quite uncommon from Wyo. to Alberta, so it should not be overcollected and people who find it might even choose to assist its persistence in Colorado.

Habitat upper Transition to Subalpine Zone moist valley bottoms often in open forest, usually with a nearby small stream, often marshy. Some occupied meadows were created by fire, beavers, grazing, or logging; fire creates meadows that create new colonies. Hostplant in Colorado shrub Caprifoliaceae: *Lonicera involucrata* (also the usual host from Wyo.-Alta.). Other hosts elsewhere in other states are mostly herbs: Caprifoliaceae (*Veronica wormskjoldii* [eaten by a subalpine ecotype in Wind River Mts. Wyo.], shrub *Symphoricarpus albus*, *Lonicera caerulea*), Orobanchaceae (*Castilleja miniata, linariaefolia, Pedicularis bracteosa, groenlandica*), and Valerianaceae (*Valeriana occidentalis*). Most of these hosts except *Lonicera* are eaten as occasional hosts only in spring (and *Plantago* is eaten in lab). It has been uncommon to abundant in Colo.; elsewhere uncommon.

Eggs yellowish-green, turning pinkish-red, laid in clusters averaging 128-146 eggs on sunlit hostplants, mostly on underside of leaves facing southeast to gather morning sun (where eggs develop faster because of the warmth). Larvae eat leaves and leaf buds, and young larvae live in silk webs wrapped around several host leaves and the stem until diapause. Older larva black, a wide middorsal yellow stripe and wide lateral white stripe; scoli and head black. Pupa white with many black spots, and many orange bumps on abdomen and top of thorax. 2nd-, 3rd-, & 4th-stage larvae (perhaps mostly 4th) hibernate in most of range (except subalpine 10,000' & 8400' biennial populations hibernate as 2nd-stage then unfed 5th-stage in Wind River and Beartooth Mts. Wyo.).

One flight, mostly L June-July. Adults fly slowly. Adults visit various flowers esp. *Erigeron peregrinus, Geranium*, *Senecio*, *Aster*, *Agoseris*, and visit mud. Adults feed and oviposit with wings spread. They evidently bask dorsally. They roost singly on conifers at least 3m up.

Males fleek all day high up around conifer treetops near the host in valley bottoms (the subalpine ecotype in Wyo. may fly lower) to find females.

Poladryas minuta **Beardtongue Checkerspot**

Easily identified by the unique unh pattern, including the 2-3 rows of black dashes in the median cream unh band, the very thin row of cream spots on the unh margin at the base of the cream fringe (orange and wider in other similar butterflies) that are capped by wider crescent-shaped cream marginal spots. Ssp. ***arachne*** occurs over most of Colorado, and has wider white unh bands and the unh wing margin is white. Ssp. **near-*minuta*** occurs on the plains of N Texas and NE New Mexico, and along the Raton Mesa complex just N of New Mexico in extreme SE Colo., in Las Animas Co. (at Raton Mesa/Johnson Mesa 2-3 mi. SE Branson 6500-6700', and on the plains area including Horse Creek Can. 30 miles north of there, and Spool Ranch in Gotera Can.), and in Baca Co. (Carrizo Crk., 22 mi. SSW Pritchett). Ssp. near-*minuta* has slightly wider red unh bands and the ups is slightly oranger and the unh has a thin to absent blackish line along the margin at the base of the fringe. {True ssp. *minuta* occurs in central Texas (extirpated at Kerrville and Comfort but still present W of Dallas) and has a definite stronger narrow black line always present along unh margin at the base of the fringe, while ssp. *simador* from NE Mexico has a thick black line on unh margin; actually there is a cline from *simador* to *minuta* to near-*minuta* to *arachne* to the Calif. ssp. *monache* which has very wide white unh bands.} Larvae also are clinal (the NE New Mex. near-*minuta* larvae are light orange just like the F1 *minuta*X*arachne* larvae I reared).} I reared C Texas *minuta* darker-orange larvae and released the females in front of *arachne* males on Green Mtn. just W of Denver and they readily mated naturally and I reared many F1 and some backcross adults, which thoroughly proved that there is no mating barrier or prezygotic or postzygotic reproductive isolation and *arachne* is just a ssp. of *minuta* (Scott 1974d, 2016c; and J. Scott 2006 Papilio [New Series] 12:35-36), and they are interbreeding along the Colo.-NM border. {Note that ssp. *nympha* does not occur in Ariz. and the type was mislabeled from there, it only occurs in Mexico incl. Sonora and W Chihuahua.}

Habitat open wooded areas or grassland, on the upper plains and foothills to the upper Canadian Zone. Ssp. near-*minuta* prefers little limestone mesas. Hostplants in Colorado thin-leaved green herb Plantaginaceae: only *Penstemon*: for ssp. *arachne* in the Colorado mts. *P. virgatus asa-grayi* (*P. barbatus torreyi* was a misidentification of *P. virgatus*), *glaber*=*alpinus*, *harringtoni*, *cyathophorus*, (the tough-leafed *P. virens* is rejected, and the glaucous [thick grayish-green leaves] *P. secundiflorus* is usually rejected although the latter may be a host sometimes when young and green [many records of this were misidentified *P. virgatus*], and the glaucous *P. osterhoutii* is rejected); *P. albidus* is evidently a hostplant for *arachne* on the C Colorado plains. Ssp. near-*minuta* feeds on *P. jamesi* and *P. albidus* in NE New Mexico and eats *P. albidus* and *P. ambiguus* in N Texas (and surely eats *P. albidus* in Colo.) {*P. cobaea* is the *minuta* host in central Texas.} These plants have iridoid glycosides, and ssp. *arachne* larvae are involved in Müllerian mimicry with larvae of *Euphydryas anicia eurytion* and *E. a. capella* and the Geometrid moth *Meris alticola* (Scott 2016c). Usually uncommon, but abundant in some places.

Eggs pale yellow. Females start ovipositing at 1 to 4 days old, and lay an average of ~38 eggs per cluster on the underside of young leaves of *Penstemon* plants without inflorescences. Young larvae are gregarious, without nests. Larvae eat leaves. Older larvae of all ssp. have all body scoli black, except the BD2 scoli are always orange except some have small black tips; head brownish-orange. Larvae of the ssp. differ mainly in body ground color: ssp. *arachne* (ssp. *monache* similar in Calif.) larva ground color white, with black middorsal band, a wide black band above spiracles, body dark-brown below spiracles (mottled with gray between the appendages); head brownish-orange, with black around the eyes and a brown bell-shaped spot on the front. Ssp. *minuta* larva ground color all orange (lighter-orange for ssp. near-*minuta*), with a trace of a black middorsal band on thorax, scoli black except BD2 scoli all orange (black tips on anterior BD2 scoli); head like that of *arachne*, but flanges on the "bell" usually smaller or absent. Larval ground color is evidently inherited quantitatively, so the hybrids and backcrosses between the ssp. that I reared have intermediate color patterns (thus F1 *arachne* [from W Denver] X *minuta* [from W of Dallas] had lighter-orange ground color matching the ground color of near-*minuta* from the Raton Mesa area of Colo.-New Mexico border [photo of Allen et al. 2005] whereas ssp. *minuta* larvae from W Dallas (photo in Scott 2006 paper cited above and in Scott 2016c) are darker-orange, and backcrosses to *arachne* were mostly whitish near *arachne*). Pupa white, with black patches and rows of orange dorsal bumps. 3rd-stage larvae hibernate; some C Texas larvae diapause even in spring and those individuals may have just one generation.

Ssp. *arachne* has several flights June-Aug. (sometimes L May and E Sept.) in a continuous population with no apparent way to pick out the ~several separate generations, which might suggest that larvae diapause for irregular lengths of time and decide to feed and grow at random times thus producing random emergence of adults. Ssp. near-*minuta* flies from L April to M-L May, through June-Aug. to L Aug.-E Sept. in ~three probably-continuous flights (the extinct C Tex. Kerrville *minuta* population flew at least Jan.-Sept., and some individuals may have just one early gen.).

Adults usually visit yellow flowers, sometimes white, orange, pink, blue or purple, including *Heterotheca villosa, Sedum lanceolatum, Senecio* spp.; they often feed on yellow Asteraceae, but do <u>not</u> visit *Penstemon*! perhaps because the proboscis is too short. Strangely, they evidently do not visit mud. Adults rest and bask with wings spread fully, and seem to close them only when roosting or in cold weather. Both sexes become cataleptic (play dead) for a few sec. after handling. Males lived an average of at least 5 days during my mark-recapture study (some emigration occurred so the lifespan was probably more like 7+ days). Marked adults averaged ~100m movements, and traveled up to 470m along a ridge at Cripple Creek, Teller Co. Colo., where Scott (1974d) studied the biology of ssp. *arachne*.

Mate-locating and mating of *arachne* (mate-location/mating of ssp. near-*minuta* and ssp. *minuta* is very similar to that of *arachne*): Males rait mostly in morning to find females, as they rait with wings spread on bare spots of ground or rocks on hilltops/ridgetops almost all day (sometimes as late as 15:12 in my notebooks) but they rait especially in the morning (from 08:00-11:30), and seldom fleek in morning, while in the afternoon (esp. after ~13:00) they seem to mate-locate gradually less often and often fleek on hillsides and they visit flowers more often. The species is unusual by gradually changing from raiting in morning to flower/feeding and some fleeking in the afternoon. In the simplest successful courtships (a ratio of about one of six of them), when a female comes near a male, he pursues, she lands and he lands behind the quiescent female and bends his abdomen to mate. Four other elements may occur: <u>Male hovering</u> usually occurs (but seldom occurs if the female is quiescent and accepting), and consists of the male rapidly beating his widely-spread wings at small amplitude a few cm above and downwind of the female for a few seconds, then he lands behind her; if she flies crawls or flutters during courtship the male may hover before alighting again. <u>Male fluttering</u> occurs rarely, and is similar to male hovering but the male is on the ground/substrate so the wings are above the horizontal, moved slower, and with greater amplitude; male hovering/fluttering evidently transfers a pheromone to the female. <u>Male nudging</u> consists of the male holding his wings about 40^o above horizontal and antennae directed backward and pushing his head under her spread hindwing, evidently positioning him beside her so his abdomen can bend laterally to mate (if her wings are closed he immediately crawls along her and attempts coupling—most females raise her wings prior to coupling but sometimes males mated by nudging under her spread wings). The male usually keeps his wings 40-60^o above horizontal even when it would appear advantageous to raise them to get closer to her. Male hovering and fluttering and nudging serve to assist mating with less-receptive females. <u>Female fluttering</u> consists of landed females holding wings ~40^o above horizontal and fluttering them slightly or more vigorously to repel males; unreceptive virgin females discourage males by fluttering their wings (a rejection dance), crawling away, flying a short distance (occasionally high in the air), or occasionally lifting the abdomen 30^o so the male cannot couple, and they usually keep wings spread, but the males often overcome moderate female unreceptivity by persistent hovering, nudging, and attempted coupling over several minutes and then the female raises her wings and positions her abdomen properly (horizontal to just below) and they mate. A stereotyped vertical rejection flight is used by unreceptive mated females, rarely by virgins: she flies slowly vertically ~3 m (2-4m), then rapidly returns to the ground, and the male follows her upward but frequently cannot follow her as she zooms downward and away because of the visual confusion with clutter on the ground; this dance resembles the vertical encounters between two males, which may also discourage the pursuing male. Strangely, when joining with the female, my records show the male bent his abdomen right 15 times, left only 6 times. Mating lasts an average of 26 minutes (15-49, N=20), unless the male mated the previous day (~74 minutes) or mated within the previous hour (9-11 hours). Virgins mate their first or second, sometimes third day (my released females mated at ages of one hour to 2 days), and females mate just once, rarely twice, while males can mate at least five times; the male inserts a small clear plug into her opening to make it difficult for her to remate. Virgins fly to ridgetops in the morning before 12:00. On hilltops/ridgetops, 14 of 31 females collected were virgin (no spermatophores), while only 2 of 24 were virgin 15m or more away on hillsides and flats. 39 mating pairs were seen (6 ssp. *arachne*, 1 ssp. near-*minuta*, the others F1 or backcross *arachne* X *minuta* mated in nature using wild *arachne* males), including ~35 successful courtships of virgin females of *arachne* and near-*minuta* (many using *minuta* and hybrid females released in front of wild *arachne* males in nature), and numerous other courtships. If a mating pair is startled, the female flies, the male dangling.

Scott, J. 1974d. Adult behavior and population biology of *Poladryas minuta*, and the relationship of the Texas and Colorado populations. Pan Pacific Ent. 50:9-22.

Scott, J. 2016c. *Meris alticola* (Geometridae), a poisonous Müllerian mimic moth, and its co-mimic moths and *Euphydryas* and *Poladryas* butterflies (Nymphalidae). News of Lepidopterists' Society 58:100-101.

***Chlosyne leanira* ssp. Leanira Checkerspot (for ssp. *alma*=*flavodorsalis*), Fulvia Checkerspot (for ssp. *fulvia*.)**

Easily identified by the cream unh with black veins, and the postmedian unh row of black spots that looks like a chain. Two ssp. occur in Colo.: Ssp. ***fulvia*** occupies most of Colorado including the E slope and plains and S of the San Juan Mts.; adults lack black unh postbasal blotches, and the ups is orangish, or blackish on many (males average blacker than females, esp. on ups wing bases), and the labial palpi are blackish on top and mostly whitish on bottom (with the tawny chitin-colored exoskeleton of the palp showing through narrow scales a little). Note that the ups blackish/orangish coloration does NOT differ from spring to late summer, contrary to reports. Ssp. ***alma***=*flavodorsalis* occupies Delta and Mesa Cos. in W-C Colorado, and SE Utah; the ups is oranger than *fulvia* (the blackish mostly limited to the basal 1/3), the unh has some black postbasal marks, and the labial palpi are mostly orange and slightly blackish on top, mostly orange with some whitish basally on bottom. (The name *flavodorsalis* was given to E Utah-W-C Colo. butterflies that are very similar to ssp. *alma* from NW Ariz., and *alma* is very similar to *basinensis* from W Utah-Nevada, thus all three names are very similar so I treat them as synonyms of the oldest name *alma*; some adults from W-C Colo. that I reared have stronger unh postbasal marks, but the non-reared wild adults differ little.)

{The ssp. in North America were divided into two species *C. leanira* (including *alma*) and *C. fulvia* by M. Smith & J.Brock (1988 Bull. Allyn Mus. #118) but are obviously just one species. Their conspecificity was explained in more detail by Scott in Scott et al. [2006. *Chlosyne leanira*/*fulvia* classification. Papilio (New Series) #12:37]. The butterflies show step-cline variation in nine adult and older larval traits: 1) older larval ground color is orange in Cal. *leanira* & Nev. *alma*, yellowish-orange in W Colo. *flavodorsalis* & S Utah *pariaensis*, orangish-yellow in S and C Colo. *fulvia*, and yellow in Ariz. *fulvia* (and S Ariz. *C. cyneas*), so the midpoint of the cline is C Colo. 2) The black larval bands are very wide in Baja Cal., quite wide in S Calif. *wrighti*, narrower elsewhere (except very wide on a photo of *coronado*), so the midpoints of variation are N of Los Angeles and maybe somewhere in E Ariz. {Note added in 2022: *coronado* is darker on ups, and its DNA suggests it is a separate species, maybe with *pariaensis*.} 3) The black subdorsal band of larvae contains many white dots in Calif. *wrighti* and *leanira* but not in other ssp. {some white dots in *C. cyneas*}, so the midpoint of variation is approx. the W edge of the Mojave Desert in Calif. 4) The older larval head is black in *wrighti* and *leanira* and *alma*, reddish brown in C Colo. *fulvia* (and *C. cyneas*), orange in S Utah & Ariz. *fulvia*, demonstrating a cline with midpoint in C Colo. 5) The ups adult color is black in coastal Ore. syn. *oregonensis* & C Calif. *leanira*, a bit redder in Sierra Nevada foothills *daviesi*, even redder in S Calif. *wrighti*, blackish to red on the W edge of the Mojave Desert "cerrita", reddish in Nev.-W Colo. *alma* & *flavodorsalis*, intermediate *alma*X*fulvia* in *pariaensis*, and blackish in males and reddish in females in *fulvia* in C Colo.-New Mex.-Ariz., a little blacker in SE Ariz. *coronado* (then blacker again in S Ariz. *C. cyneas*), so this trait has <u>three</u> midpoints (at W edge Mojave Desert, at *pariaensis*, & S Ariz.). 6) The unh has black postbasal unh marks in *wrighti*, *leanira*, and *alma=flavodorsalis*, and lacks them in *pariaensis* & *fulvia* & S Ariz. *coronado* & *cyneas*). 7) The palpi are orange-tipped in *wrighti*, *leanira*, and *alma=flavodorsalis*, blackish on top and mostly whitish on bottom in *pariaensis* & *fulvia* & S Ariz. *coronado* & *cyneas*, so the midpoint is the four-corners area for those two traits. Two more traits are added here: 8) Antenna club is mostly orange in ssp. *leanira* & syn. *oregonensis* and *daviesi* and many *alma*, mostly black in the others including "*flavodorsalis*" and *fulvia* and *coronado*, so the midpoint is ~Utah. 9) The color of unf veins esp. the vein closing the unf discal cell: that vein is usually narrowly black in *fulvia* and *alma* varieties (*=flavodorsalis & =basinensis*), is present but often weak on "cerrita" and *wrighti* and averages absent or weak on *daviesi* and *leanira* (and on Mex.-Ariz. *C. cyneas*), so the midpoint is the Calif. Sierra Nevada (ignoring *C. cyneas*). These step-clines indicate gene flow from one end to the other, and most of the traits show a different point where the traits change halfway, clearly indicating that there is no chosen point in the transect where one species becomes another. Smith & Brock ignored all these traits except a few adult traits, so their treatment is wrong. The ssp. *pariaensis* in S Utah is actually considerably intermediate between Smith & Brock's *leanira* and *fulvia* species, as its hostplant and single generation are like *alma*, ups wing color is intermediate, and postbasal unh marks & palpi are like *fulvia*. Also, R. Bailowitz & H. Brodkin's book (2007, Finding Butt. in Ariz., p. 25) reported *fulvia*/*leanira* intergrades occur in N Ariz. (Hack Can. NE of Mt. Trumbull, 24 mi. SW of pavement). And SW Colo. *fulvia* sometimes have some unh postbasal markings (M. Fisher), suggesting a little intermediacy toward *alma=flavodorsalis*. These butterflies have no sympatry of distinct species, they just have obvious intergradation. Except maybe? *coronado* is a separate DNA species.}

Habitat open pinyon/juniper/sagebrush etc. woodland below the Canadian Zone (~5500-7500') for ssp. *alma*; for ssp. *fulvia* hills on the plains and hills in pinyon/juniper open woodland, preferably on limestone or calcareous soil; *fulvia* colonies seem to occur most often on bad soils such as gypsum (the sulfurous filler in sheetrock), and I found a colony in the Arkansas Canyon by going to the mapped location of a gypsum quarry. Ssp. *fulvia* ranges up into the Canadian Zone in Colo. in Park and Teller Counties etc. and in Custer Co. in the Wet Mtn. Valley and the high grassland near Rosita on the W side of the Wet Mtns., where there is just one flight in July (I caught a stray at 12349' hilltopping on top of Greenhorn Mtn. in the Wet Mts.). It is very rare W of Denver, where I caught an adult on Mt. Zion July 6, 1977, and found a larva on Green Mtn. Aug. 12 1977; that was the last gasp as they were exterminated by encroaching development around Denver and I never found them there again, but recently it has been found just SE of Boulder in a small remnant of degraded prairie, where it may not last long; it is evidently extirpated in areas with extensive development, as natural prairie is mostly gone now near cities. Hostplants in Colorado herb Orobanchaceae: *Castilleja integra* for ssp. *fulvia* in most of its range and even on the plains next to the mountains, *C. sessilifolia* for *fulvia* eastward on the plains (and in Neb. and Kansas); *C. chromosa* for ssp. *alma*. Uncommon to sometimes abundant.

Eggs pale lemon-yellow, turning orange, laid in clusters on the underside of lower green host leaves. Young larvae eat leaves and perhaps sometimes eat inflorescences and are gregarious in a loose web; older larvae eat the inflorescence. Older larva ochre-yellow for Colo. *fulvia* [Scott 1968 J. Lepid. Soc. 22:237-240], yellow-orange for Colo. *alma*, with black middorsal and lateral lines and a black subdorsal band, scoli all black; head reddish-brown in Colo. Larvae (and adults) vary in clinal fashion in a roughly clockwise gradient as noted above from S Calif. to C. Calif. E to Colorado then S to Ariz. Larvae sequester iridoid glycosides (mostly catalpol and aucubin) from the hostplants, making larvae and adults poisonous to birds (E. Mead et al. 1993 [J. Chemical Ecology 19:1155-1166] found the chemicals from *C. integra*). Pupa white, with numerous black bars and dots and orange between adjacent black spots. Late 3rd–stage larvae hibernate.

Flight period for ssp. *fulvia* evidently about three generations at low altitude, May-E June, end of June-July, M Aug.-E Sept., just one generation July at high alt. in Wet Mts. There are three generations every year at low alt., not one; these generations are equally colored on ups, as males tend to be blacker on ups (esp. the wing bases) while females are oranger, though both vary considerably. Ssp. *alma*=*flavodorsalis* has just one flight May-E June.

Adults prefer yellow and white flowers, and probably visit mud.

Males rait and often flait all day mostly on hilltops to await females, as they rait mostly on the ground with wings spread, or fly only 5 cm above the grass. Ssp. *alma* has the same behavior: males rait and sometimes flait on ridgetops/hilltops all day to await females, as they rait mostly on the ground. At high density males fleek more widely in the habitat. They usually fly rather fast. If a mating pair is startled, the female flies, the male dangling.

Chlosyne nycteis drusius **Silvery Checkerspot**

Identified by the large white spot in cell M_3 of unh margin (with brown in cell M_2 beside it), the unh median band of round cream spots with brown rims, and the wide black upf and uph margins. The uph has a row of submarginal black spots (some are black ocelli with white center) in the orange band, like *C. gorgone* (absent in most *Chlosyne*). Ssp. ***drusius*** occurs in most of the Colorado mountains (south to NM and Arizona) generally above the lowest foothills (but I once found a stray very near the plains along Van Bibber Creek in Jefferson Co.), and has darker less-tawny ups coloration. In NW Colo. W of the continental divide adults have more tawny coloration and look like ***drusius*****X*****nycteis*** (ssp. *nycteis* in E N.A. has even more tawny area on ups), and those intermediate populations are also reported from the Black Hills in S.D.

Habitat streamsides in the upper foothills and lower Canadian Zone. Hostplants in E U.S. are many genera of herb Asteraceae, but in the Rocky Mts. including Colorado and Ariz.-N.M. only the Asteraceae herb *Rudbeckia laciniata* var. *ampla* is eaten, a tall 1m plant which grows along streamsides and moist gulch bottoms. Uncommon to common.

Eggs whitish-green when young, laid in clusters averaging 121 eggs on underside of host leaves. Larvae eat leaves. Young larvae gregarious, without nests. Older larva in Colo. brownish-black with tiny white dots, two lateral rows of pale-orangish dashes (in ssp. *nycteis* both may be consolidated into a single wide cream-and-orange lateral stripe), and many black scoli, prolegs orange-brown; head black. Pupae variable, white with blackish spots and brownish streaks, or greenish-yellow, pinkish-brown, gray-brown, or nearly black, a dark lateral band on A5-8; many small orange dorsal cones (edged in front with brown). 4th-stage larvae hibernate in a special reddish-brown skin, as in *C. gorgone*.

One flight June-July (mostly M June-M July). Adults visit whitish/yellow flowers especially of its hostplant *R. laciniata* var. *ampla*, also including *Apocynum androsaemifolium, Rudbeckia hirta, Senecio triangularis*, and adults occasionally visit mud and carrion. Adults are dorsal baskers or body baskers.

Males fleek all day ~1/2-1m above ground along little creeks/gulch bottoms near the host to seek females; rarely a male raits in a gulch bottom; I have seen some males fleeking on a N-facing slope (evidently near the host). In courtship, the male encounters the female in flight and they slow down and land or he spots a resting female, he lands behind and if she were receptive she would probably just be quiescent and he would simply mate; but if unreceptive the female flutters her widely-spread wings to repel him whereupon he flies in stereotyped loops ~10 cm in diameter over her (up and down, rarely sideways) then lands behind her with wings partly- spread or mostly-spread (~45-180°), and may then flutter behind her, he may bend his abdomen to attempt to mate and may spread his wings 45° and nudge under her partly-spread wings to try to join. The male's loops over her are somewhat variable: they are nearly always vertical, up and to the side then back and down, sort of like two crescents, and are about 10 cm in diameter (8-15 cm), the loops vary from circular to more irregular (somewhat triangular sometimes, sometimes a spiraling loop), he usually does 2-4 loops over her, sometimes 6 or 9, once 40 loops in 5 min., each loop takes about 1 sec., and he often lands for a few seconds between each loop. Once a male merely hovered over a fluttering female then left without doing loops. Unreceptive females flutter her wings at wide amplitude to repel the male. If a mating pair is startled, the female flies, the male dangling.

Chlosyne gorgone Gorgone Checkerspot

Identified by the zigzag median unh band of white cones, and the creamy submarginal crescents on uph. It is one of very few butterfly species that is mostly found just on the Great Plains, though its range extends somewhat beyond the Great Plains to the SW and SE (it colonized as far as Ontario, New York, Penn., Utah, and Idaho etc. but died out in most of the areas beyond the Great Plains, except it is still common in W Colorado and N New Mex.). Adults recently found in Georgia resemble Missouri and Colo. specimens, so the name *carlota* is evidently a synonym of *gorgone*. I have not noticed change in darkness with altitude in Colo. *C. gorgone*, thus there are no valid ssp.

Habitat plains and open areas in lower mountains (up to the lower Canadian Zone). On the plains it is found in weedy cultivated areas as well as diverse prairie. Hostplants in Colorado herb Asteraceae: *Helianthus pumilus* (usual host in mountains), *petiolaris, annuus, Cyclachaena "Iva" xanthifolia, Ambrosia trifida, Xanthium pennsylvanicum* var. *strumarium, Viguiera multiflora, Rudbeckia hirta*. The hostplants are often *Helianthus* spp. (sunflowers) which are common in the Great Plains, the stronghold of the species. Today whole cultivated fields of *Helianthus ~annuus* sunflowers only 1m tall have huge 20cm flower heads with big commercial sunflower seeds, but the sunflowers usually eaten by *C. gorgone* have tiny 1-5cm heads that Goldfinches and other finches love to eat the maturing seeds, and imported Fox Squirrels drag the heads down or cut them off and haul the heads up a tree to eat the seeds. Common, sometimes abundant.

Eggs pale-green when young, laid in clusters of ~150 eggs under host leaves. Larvae eat leaves, and feed gregariously under the leaf when young, without nests. Older larvae have three genetic forms differing in body color, but the scoli and head are always black in all forms: **form bicolor** is the usual intermediate mostly-dark form, with a middorsal black line, wide subdorsal and sublateral black bands containing many whitish dots, usually with yellow-orange or orange-red between the bands at least at the middorsal and lateral scoli bases. **Form nigra** has narrow yellow lines (rather than orangish bands) next to the black middorsal line and laterally, and black lateral mottling between the very wide black bands. The uncommon **form rufa** larva is all orange except for the black scoli. Form rufa is due to a dominant gene R that prevents the other forms from appearing. If two recessive r genes are present, form bicolor is dominant to the recessive form nigra due to genes at a different chromosome region. (The more-tropical species *Chlosyne lacinia* has the same forms with the same inheritance, S. Gorodenski 1969 Genet. Research, Cambridge 14:333-336.) Pupa from rufa larva cream with fine reddish mottling; from nigra larva blackish-brown due to fine blackish mottling; from bicolor larva the pupa is intermediate; all these pupae have a row of pale dots across the wings and many small dorsal conelike bumps on the abdomen. 4th-stage larvae hibernate, in a special reddish-brown skin.

About three flights on the plains, perhaps mostly L April-M June, L June-July, and M Aug.-M Sept., higher in the mountains perhaps just one main flight M May-M July (with some M Aug. records).

Adults visit yellow and less often white flowers, seldom bluish or light reddish, including *Allium textile*, *Barbarea orthoceras*, *Heterotheca villosa*, *Physocarpus monogynus*, *Prunus virginiana*, *Senecio* (*Packera*) spp. incl. *canus* & *fendleri* (favorite), *Taraxacum officinale*, *Verbesina encelioides*, often visit dung, and very often visit mud. Adults sometimes fly down-gulch evidently to seek mud/moisture/flowers. I once found 3 dead males beside dog dung, perhaps killed by some de-worming chemical present in the dung. Adults bask with wings spread (dorsal basking or body basking).

Males rait and sometimes flait all day on hilltops to await females, and are found primarily there at low density as they mostly rait on the ground or on very low ~10cm vegetation; but males also fleek on hillsides etc. and at high density (one day I saw ~1000 adults) most or all males fleek everywhere including hillsides (the males fleeking about hillsides and gulches chase females etc. there). And once I saw a male rait on *Ceanothus fendleri* on a slope among pines and chase a small *Oarisma garita* and a large *Argynnis*. The *C. gorgone* range is centered about the Great Plains, where fleeking is useful on flat land. In courtship, the male pursues the female and she lands with wings closed (or he spots her on a flower) and he may make several <u>loops</u> over her then he lands and closes his wings and bends his abdomen to join. If she is quiescent (even with 60^o-spread wings) he lands and after fluttering a little he bends his abdomen to try to mate. But if the female flutters (or sometimes vibrates at low amplitude) her widely-spread wings after landing (her <u>rejection dance</u>), that triggers the male to perform stereotyped <u>vertical loops</u> above her, then if she keeps fluttering he occasionally flutters behind her but usually departs. His loops are nearly-always vertical and are mostly elliptical-oval in shape (sometimes irregular, rarely corkscrew-like) ~10cm in height (extremes 8-15cm), performed just above her usually 2-5 times but rarely just once or sometimes 8, 10, 12, 15, or 20 times, and he sometimes <u>hovers</u> over her a little just before he does the loops. Unreceptive females flutter her wings (sometimes vibrate them, meaning fluttering at small amplitude) while they are spread an average of 135^o apart (100-180^o, N=23; 135^o is the usual spread as drawn in my notebooks, as 11 of the 23 look like 135^o) in her stereotyped rejection dance, and she may fly, or drop; one female disappeared high in the air and one female did several vertical flights then rapid zoomed down to near the ground to try to escape the male. If the mating pair is disturbed, the female flies, the male dangling (24 copulating pairs were found).

Chlosyne lacinia adjutrix Sunflower Patch

It is mostly black, with tiny white postmedian unh and unf dots. A photo of *lacinia* was taken at Lamar in Prowers Co. in extreme SE Colo. Aug. 18, 2007, a stray from SE NM or S Tex. (ssp. ***adjutrix***, which usually has orangish/orange-brown median bands) or from S NM-Ariz. (ssp. *crocale*, which usually has white [sometimes orangish] median bands). More were found in Prowers Co. Oct. 12, 2007, July 7 2015, July 14-17 and Sept. 26 2018. Most strays to Colo. are probably ssp. *adjutrix*, which is the ssp. W. Field (1938, A Manual of the Butterflies and Skippers of Kansas, Bull. #12 of Dept. Entomology Univ. Kansas) determined from the butterflies straying N to Kansas. Adults rarely stray as far as Minn.

Habitat open areas or open woods southward. Hostplants southward numerous mostly-herb Asteraceae, including *Helianthus*. A rare stray in Colo. but it may breed in late summer in extreme SE Colo.

Eggs pale-greenish-yellow, turning reddish, laid in clusters averaging 139-155 (up to 1,169 per female), laid on leaf uns. Larvae eat mostly leaves, without nests. Older larva mostly orange-red (form **rufa**), or black with white dots and red bands (form **bicolor**), or mostly black (form **nigra**), all with black spines; head black. Form rufa is caused by a dominant gene R, but if the recessive gene r is present, form bicolor is dominant to the recessive form nigra due to other genes B and b at another chromosome locus (the same forms are found in *C. gorgone*). (S. Gorodenski 2013 [News Lep. Soc. 55:142-149] details genetics and early stages.) Pupa nearly black, or white with black markings, or mostly white. Larvae make a special extra-thick cuticle at the molt into 4th-stage hibernation (3rd-stage sometimes hibernate, rarely 5th).

Many flights most of the year in S Tex. Adults visit mostly yellow and white flowers, and also feed on dung, carrion, and mud.

Males fleek near the hosts (sometimes on hilltops, where they sometimes rait), all day to find females. Females usually mate after 1-2 days of age. Unreceptive females raise the abdomen so a courting male cannot join, and of course have other behaviors to reject males.

Chlosyne whitneyi damoetas Rockslide Checkerspot

Identified by the Alpine/upper Subalpine Zone talus habitat, and the greasy ups appearance. The ups and uns are darker than *C. sterope* and *C. palla*, and the dusky median unh band is more often split into two near-equal-width bands than those species. Ssp. ***damoetas*** is genetically darker on ups (darker even on my lab-raised adults); large series show that the percentage of very blackish females is about the same throughout Colorado. Ssp. *damoetas* is an obvious ssp. of the other Alpine rockslide *Chlosyne* including Sierra Nevada Calif. *C. w. whitneyi*, and differs from it and Alberta/BC ssp. *altalus* by having a more rounded fw margin and darker ups with often blackish females (ssp. *altalus* and *whitneyi* have an indented fw margin, and ssp. *whitneyi* has upf bands more continuous, and its females are paler than the others, often cream on ups). (Ssp. *windriver* in Wind River Mts. Wyo. [near it in N Utah] is like *altalus* but has the postmedian area of upf less black.)

Habitat Alpine and upper Subalpine Zone talus slopes. Most colonies are above timberline, but where talus extends down barely into the Subalpine Zone *damoetas* flies there also. Hostplant in Colorado herb Asteraceae: *Erigeron leiomeris*. This blue-flowered mat plant inhabits nooks in alpine/subalpine rockslides/cliffs. Uncommon, occasionally locally common.

Eggs pale green when laid in large clusters on leaf uns. An ovipositing female spread her wings widely and fluttered them a little as she crawled on the hostplant *Erigeron leiomeris* and finally found a place to lay her eggs. Larvae eat leaves. Young larvae feed gregariously but make no silk nests. Older larva black, covered with cream dots, brown on underside, heart-line black, the orange crescents on each side of middorsal scoli form two orange dorsal stripes (or surround the scoli in ssp. *altalus* & *whitneyi*), and the orange crescentic bars on the ventral base of the BSD scoli and the small orangish bars at ventral base of BL1 scoli form two orangish lateral stripes with cream dots frequent between them; scoli and head black. Pupa tan, shaded in front with black, a bluish-white tint on abdomen, five dorsal rows of orange bumps on abdomen, a lateral row of orange dots on abdomen which also has lateral black dots and black spiracles; wings of tawny *whitneyi* pupa have several brown streaks. Half-grown larvae (~3rd-[perhaps also 4th]-stage) hibernate under rocks, and each year some of them manage to find a hostplant and become adults, so they are multiannual and some or all take several years or more to become adults (because all alpine butterflies are at least biennial so they may hibernate as 2nd stage also), which may be useful to survive high-snowfall or bad-weather years. Larvae from Utah-Wyo.-Mont. diapaused as large 3rd-4th and sometimes large 2nd-stage (Wolfe et al. 2010); their larvae mostly diapaused and each year few went on to produce adults.

One flight L July-E Aug. (sometimes M Aug.) {E-M Aug. for ssp. *windriver* in Wind River Mts. Wyo.}.

Adults visit yellow, bluish, and sometimes pinkish or white flowers, including *Arnica rydbergii*, *Erigeron leiomeris, E. pinnatisectus, E. pygmaeus*, *Senecio fremontii* var. *blitoides*, *Senecio* spp., *Silene acaulis*, and adults probably visit mud occasionally. Adults bask with wings spread. Like most butterflies, females fly slower than males.

Males rait and often flait all day in rocky chutes and nooks on talus slopes, especially those low on the talus where it levels out and ends (rocky swales, in other words), and when abundant males also fleek about the talus where hostplants and larvae are concentrated, as they rait on rocks and fly only ~5-10cm above the rocks (*C. w. windriver* is similar). Once a raiting male even chased an *Erebia magdalena*, a much larger and blacker butterfly. In courtship, the male overtakes a flying female and both may hover with him behind (receptive females would presumably land and remain quiescent while the male lands and joins); unreceptive females flutter her wings at wide amplitude, while the male may hover over a landed fluttering female or may land and flutter behind her and attempt to join. The female has an attractant pheromone, as Maurice Howard saw males hovering over one spot of talus and started pulling up rocks and found a female under the rock there. If a mating pair is startled, the female flies, the male dangling.

Chlosyne sterope Sagebrush Checkerspot

This sp. is identified by the pale unh bands being dull-white, rather than yellowish in *C. palla* and dusky-cream in *C. whitneyi*. There are two ssp. in Colorado: Ssp. ***acastus*** occurs in the San Luis Valley and the western slope, and is rather evenly light orangish on ups (with paler uph margins than *C. palla* for instance). Ssp. ***arkanyon*** (Arkansas Canyon in southern Chaffee and northwestern Fremont Cos.) is blacker on ups than ssp. *acastus* and the black markings on unh are enlarged. This species was known as *C. acastus*, but Washington *C. sterope* has proven to be conspecific (*sterope* is similar to ssp. or synonym *dorothyi* which was named in *C. acastus*) and is an older name, so the species must be called *C. sterope*. (Washington lepidopterists should submit a petition to ICZN to preserve the name *acastus*. Currently they and others do the mythical ostrich [bury head in sand] and just pretend that the name *sterope* does not exist.)

Habitat Upper Sonoran to Transition Zone gulches in open (often pinyon/juniper) woodland & sagebrush for ssp. *acastus*, gulches in open brush or pine woods for *arkanyon*. Hostplants in Colorado Asteraceae: for ssp. *acastus* the herb *Aster* (now *Herrickia*) *glaucodes*=*Eucephalus glaucus* in Eagle Co. (and in Bighorn Mts. Wyo.), and probably the shrubs *Chrysothamnus viscidiflorus* and possibly *Chrysothamnus* (*Ericameria*) *nauseosus* in most of W Colo.; for *arkanyon C. viscidiflorus* and sometimes *C.* (*E.*) *nauseosus* {J. Scott 2014. Early stages of *Chlosyne sterope arkanyon.* Papilio (New Series) #22:30-32}. *C. viscidiflorus* is easily recognized by its corkscrew leaves. Often common (*arkanyon* is seldom common).

Eggs pale green, laid in large clusters of up to 150 on uns of host leaves, mostly near the base of the plants. Young larvae gregarious, without silk nest. Older larva black, covered with hundreds of tiny yellow-cream dots, heart-band black (containing BD1 scoli) edged by a whitish stripe made of tiny yellow-cream dots, a band of pale-yellow or cream dots or stripe below BSD scoli (weak brownish-orange clasps the bottom of those BSD scoli), a narrower pale-yellow or cream line runs along lower edge of BL1 scoli and weak brownish-orange surrounds base of those BL1 scoli); the long scoli black; a ventral neck gland repels ants etc.; head black. Larvae are blacker with less orangish than *C. palla* but both species are somewhat variable. Scoli are longer than those of *Phyciodes batesii*. Pupa blackish-brown (blackish with white mottling in Wash. photo), with fine tan mottling, with 3 rows of orange-tipped and cream- and black-edged small cones over body except the blackish wings and underside, numerous brown dots, a postmedian row of cream dots on wing cases, ssp. *acastus* may have a brown lateral stripe on abdomen. 3rd-stage larvae have a strong diapause.

One flight L April-M June for ssp. *acastus*, L May-June for *arkanyon*.

Adults visit flowers including *Erysimum asperum*, *Sisymbrium linifolium*, and visit mud. Adults surely bask dorsally. They may roost communally on shrubs esp. in canyon bottoms (James & Nunnallee 2011).

Males mate-locate all day, as they often rait in gulch bottoms/dry washes close to the ground on rocks/bushes etc., but at high density most fleek along gulch bottoms and (for *arkanyon*) fleek especially on a hillside around the host and flowers where they evidently try to find newly-emerged females by scent; males fly only ~10 cm above ground. Unreceptive females flutter strongly to repel the male, who may hover over or flutter behind her to transfer his pheromone.

Chlosyne palla Northern Checkerspot

The pale unh bands are yellowish or cream, separating it from *C. sterope* and *C. whitneyi* which have dull–white or dusky-white bands, the ups is darker than *C. sterope acastus*, and *C. palla* does not occur in the alpine zone as does *C. whitneyi*. And *C. palla* overlaps the range of *C. sterope acastus* in Colo. only at middle altitudes on the W slope. Ssp. ***calydon*** occurs in the Front Range, while ssp. ***flavula*** (much less orange, and more cream areas on unh) occurs on the western slope (Grand Co. adults are near-*flavula*).

Habitat the Transition Zone foothills to Canadian Zone mountains. It mostly flies at higher altitude and is mostly allopatric to *C. sterope acastus*, though both fly near Basalt in Eagle Co. and in Glenwood Canyon and other middle altitude places on the western slope. Hostplants in Colorado herb Asteraceae: for *calydon Erigeron speciosus var. macranthus* at least in the Front Range (and probably W Colo.), sometimes *Aster* (*Symphyotrichum*) *spathulatum=occidentalis*. For *flavula Aster* (*Eucephalus*) *engelmannii* in Utah [which is common over NW Colo. S to Gunnison & Mesa Cos.]. Usually uncommon in the Front Range, *flavula* more common on the W slope.

Eggs pale green when laid, laid in clusters on the uns of host leaves. Larvae eat leaves. Young larvae gregarious on leaf uns, without a nest or sometimes with a slight silk nest (diapausing larvae make a weak silked nest). Older larva black with thousands of white dots making larva look paler, heart-line black edged by a row of white dots (orange beside abdominal BD1 scoli), orange below BSD scoli interrupting a white band there, and a narrow white line touching the bottom of BL1 scoli (BC larva has orange BL1 bases also, Guppy & Shepard 2001 photo); the long scoli and head are black. Pupae tanish-white with a few black dots in BC, (variable in other states, pale tan to brown, or gray to mostly black), in Colo. white with numerous black streaks on wing and side of abdomen and black tiny spots, many orangish-rear black-front cones with orange tips scattered over top. Half-grown (3^{rd} stage) larvae hibernate.

One flight June-M July (sometimes L July) for *calydon*, M May-July for *flavula*.

Adults visit yellow and white flowers, seldom bluish or pinkish, including *Erigeron speciosus, Rudbeckia hirta, Senecio* spp., and occasionally visit mud and dung. Marked adults of *flavula* from Gunnison Co. Colo. moved an average of 477m between captures, up to 1.6km (R. Schrier, M. Cullenward, P. Ehrlich, & R. White 1976 Oecologia 25:279-289); adults evidently lived less than a week.

Males mostly rait and sometimes flait all day in valley bottoms, generally on small flat areas of the valley bottom such as a little flat terrace/bench or even a flat dirt road, as they usually rait on vegetation an average of 78cm up (extremes ~40-150cm, N=17), and flait roughly ½ m up. Several times raiting males flew a little spy circle 2m above ground before landing again. Males also fleek about hostplant concentrations (usually on a NE- or N-facing slope near the top of foothills topography) to try to find virgin females. In courtship, the male overtakes the female, and she may hover then fly then land, and the male may hover over her; on flowers, unreceptive females flutter strongly to repel the male while the male behind her may flutter evidently to transfer pheromone. (As usual, the receptive female would probably just land and remain quiescent and accept the male.) (In courtship of Calif. *C. palla*, the male overtakes the female, and if she is unreceptive she may flutter in a bobbing fashion and he flutters/hovers near, she lands and flutters her outspread wings and lifts her abdomen slightly to reject the male, while the male flutters over her; courtship is presumed to be like

C. whitneyi, so males will flutter behind unreceptive females also, and receptive females would not flutter and would accept the male.)

Phyciodes (*Anthanassa*) *texana texana* Texan Crescent

A rare stray, identified by the indented outer fw margin, and the black ups with some weak reddish basal and postbasal spots and some small white spots including a straight row of white postmedian uph spots. A rare stray to Colorado from Texas/Mexico, known from eight counties in eastern Colorado including near Coaldale in the Arkansas Canyon, and one from my back yard in Lakewood; many records in E Colo. in 2005, including one 11,800' on Pikes Peak. It very rarely strays as far as North Dakota.

Habitat open areas and desert far southward. Hostplants southward many genera of herb/bushy Acanthaceae (a plant family absent in Colo.) including *Dicliptera*, *Ruellia*, *Anisacanthus*, *Justicia* {G. Ross 2002 [Holarctic Lepid. 9(1-2):1-31] details ~30 hostplants and early stages and biology in La.}. A very rare stray.

Eggs pale yellowish, laid in clusters of 1-145 on the uns of young host leaves (photos of egg larva pupa in Bright & Ogard 2010, larva in Tveten & Tveten 1996). Larvae eat leaves. Young larvae may drop on a silk line and hang til danger passes. Older larva brown, the heart-band dark-brown, a row of cream dashes nearly merges with white band along BD2 scoli, then a wide dark-brown band, several ochre lateral bands incl. a lateral cream band with orange-brown bases of the cream BL1 scoli, the upper 3 rows of scoli dark-brown (BSV scoli greenish-cream); head black, frontoclypeus light-brown. Pupa light-brown with many long cones with orangish bases, a weak transverse ridge runs across A4. Evidently does not survive strong freezes.

It flies most of the year far southward, and Mar.-Nov. in Ariz., strays at least L June-July in Colo.

Adults visit especially yellow and white flowers. They often feed on blue-green-algae mud "microbiota crusts" in La. They fly low to the ground, and often glide like other *Phyciodes*. Adults roost on leaf ups.

Males usually rait (and sometimes flait) all day 1/3-1m above ground, mainly in gulches and dry stream beds. In courtship, the male may spot her on a flower and flutter next to her, or he overtakes the flying female and they spiral about each other, she lands and he loops (~10cm diameter) behind & above her, if receptive she may vibrate her wings and arch her abdomen up (very receptive females would presumably just remain quiescent), he lands beside her and closes his wings and nudges under her wings and curves his abdoment to mate. Unreceptive females flutter their wings and fly upward (a male meeting another male often spirals upward as much as 10-12m); in my observation, if unreceptive she flutters her mostly-spread wings a few times/sec. and the male flies around her in a vertical loop and lands behind, then this loop & landing was repeated 7X. Mating lasts <1-2 hours.

Phyciodes graphica vesta Vesta Crescent

The wings are mottled orange like most *Phyciodes*, but are easily identified by the unf submarginal chain of black circles. A rare stray to Colorado (and Nebraska), with records all over the eastern half of the state from a dozen counties, even just east of the continental divide in the Canadian Zone. The winter **form marcia** has a darker unh.

Habitat open woodland/prairie/deserts in Ariz.-Mex., often near waterholes in arid areas. Hostplants herb Acanthaceae (*Siphonoglossa*, *Dychoriste*) southward, but those plants are absent in Colo. A very rare stray.

Eggs laid in clusters under host leaves, which larvae eat.

Flight period March-Nov. in S Arizona, Colo. strays found June-Sept.

Males fleek ~1/3m above ground all day, often on flats, to find females.

Phyciodes mylitta **Thistle Crescent (Mylitta Crescent)**

P. mylitta is orangish on ups without whiter bands, and resembles *P. pallida* but is smaller and lacks the black median spot near the rear of unf/upf (or it is very small), and the unh markings are a little weaker. The upf outer margin is slightly concave. Ssp. ***arizonensis*** in most of Colo. is larger and a little darker-spotted (the spot near rear of unf a little larger) than ssp. ***mylitta*** from Calif. to Montana-BC.-N Utah-Wyo. and evidently the NW tip of Colo. Remarkably, *P.mylitta* has recently expanded its range into Colorado due to global warming and the human spread of Canada thistle (*Cirsium arvense*) and other weedy thistles (probably including *Carduus*--a known host elsewhere and now common thoughout Colorado—and *Onopordum* which is rapidly spreading in Colo. [a road grader introduced it to the Mt. Lindo ridge above Tinytown]). I found *mylitta* in E Custer Co. in 1993 & 1998, and M. Fisher notes that it was found in Baca Co. in 1993, El Paso Co. in 2000, Elbert and Douglas Cos. by 2001, Boulder Co. in 2005, Fremont & Mesa Cos. by 2007, and it expanded up the Arkansas Canyon to Chaffee Co. where I found it in 2013. In California, the great species *P. orseis orseis* once lived in the central Coast Range at San Francisco and Napa/Sonoma Counties etc., and *P. mylitta mylitta* may have exterminated it there after humans spread hostplant weedy thistles (some *Cirsium* spp., *Carduus*, *Cynara*, *Onopordum*, *Silybum* etc.) so *P. mylitta* may soon have some deleterious effect on Front Range *P. pallida*.

Habitat the plains and foothills into the Transition Zone. Hostplants herb Asteraceae (tribe Cynareae) elsewhere, mostly *Cirsium* (*C. arvense* is surely a host in Colo., and adults possibly eat *Onopordum* and *Carduus* also in Colo.). In N New Mex. *Cirsium vulgare* & C. *undulatum* evidently are hosts. Common where established.

Eggs pale yellowish-green, laid in large clusters on host leaf undersides (40-270 averaging 142 in Wash.). Early stages were reported by Scott (1976c). Larvae eat leaves. Young larvae gregarious, sometimes in a small silk-web nest. Older larva maroon-brown to black with many pale dots, underside brown, with two middorsal cream lines and two cream lateral lines (the upper band may be weak) with brown band between them; scoli black, except BL1 and BSV scoli orangish; head black, with a cream subdorsal stripe (rarely a cream spot below it) and rarely a cream crescent above the eyes. Pupa mottled brown to ashy gray with the usual crest across A4 and small dorsal cones with orange-brown fronts, and the usual *Phyciodes* weak lateral and sublateral blackish abdominal bands. Unfed 4^{th}-stage larvae hibernate.

About three flights per year in lowlands at least May-E June, July-Aug., and Sept.-Oct. (probably the same in SW Colo. E Apr.-May and at least July-Aug.).

Adults visit whitish and yellowish flowers at least.

Males rait and fleek in gulch bottoms/roadside ditches/watercress patches etc. all day, as they rait ~½(usually)-1m up and fleek ~1/3 up; in flat California agricultural fields etc. they usually fleek near the hostplants. If a mating pair is startled, the female flies, the male dangling.

Phyciodes pallida **Pale Crescent**

Similar to *P. mylitta*, but larger, usually with a small to large median black spot on rear of upf and unf (usually very small or absent in *mylitta*), the uns markings stronger overall, and the unh submarginal spots of females more often silvery-white without much brown. Ssp. ***pallida*** occurs on the east slope of Colo. and in the higher western slope (such as Eagle Co.) and the Laramie Range in Wyo. In Glenwood Canyon and Mesa Co. and lowland W Colo. ssp. ***barnesi*** (type locality Glenwood Springs, Colo.) is much paler on ups with fewer black markings, yet the larvae are much darker. The dark larvae also predominate in *P. pallida* ssp. westward to Oregon-Washington but adults from those states resemble ssp. *pallida*; to solve this problem I evidently will have to name the Ore.-Wash. butterflies with dark larvae and ssp. *pallida*-like adults as a new ssp.; they can be called “dark-larva *pallida*” for the time being.

Habitat the foothills and western low-altitude canyons, in Upper Sonoran and Transition Zones. Hostplants in Colorado herb Asteraceae: *Cirsium*, usually *Cirsium ochrocentrum* and sometimes *C. undulatum* for ssp. *pallida*, *C. neomexicanum* for ssp. *barnesi* (*C. arizonicum* is eaten in Utah and could be eaten in Colo.). The hostplants are biennial (live two years): the first year they sprawl out on the ground with young tender leaves the females oviposit beneath and larvae eat and hide beneath, and the second year those plants provide food for older larvae then grow a tall stalk with flowers then become tough and die. Moderately common.

Eggs pale yellowish-green, laid in large clusters (54-120 averaging 89, James & Nunnallee 2011) on uns of leaves of first-year young biennial hostplants. Early stages were reported by Scott (1976c). Larvae eat leaves, with no nests for the gregarious young larvae (or sometimes very-weakly-silked "nests" in a fold of leaf, James & Nunnallee 2011) which hatch and feed gregariously on leaf uns (they sometimes mine the leaf in Wash.), while 3rd-4th-stage larvae usually rest on leaf uppersides and eat craters in the leaf, and coil up and drop off if disturbed (all *Phyciodes* older larvae drop like this). Older larvae of all *P. pallida* ssp. are distinguished from all other *Phyciodes* by having BD2 scoli <u>completely surrounded</u> by orange which touches BD1 scoli (in other species the orange is only anterior and posterior to BD2 and only within the subdorsal cream band). Ssp. *pallida* older larva varies in color from mostly cream to mostly ochre, with orange also below BSD scoli and orange around bases of BL1 scoli, a black middorsal line, a wide cream or ochre-cream area contains BD2 scoli on its lower side, a wide grayish-black dorsolateral band, a weak cream line just above black spiracles, a wide blackish band contains spiracles, a cream lateral band touches bottom of BL1 scoli; scoli black except BL1 and BSV scoli creamy-tan; head black, with a cream subdorsal stripe on each temple and a cream crescent above the eyes. Ssp. *barnesi*/dark-larva ssp. (W Colo.-Ariz.-larva similar in BC; Wash. photo in James & Nunnallee 2011; Ore. larva fig. by Neill 2007 is too black and is probably *P. mylitta*) older larva much blacker than ssp. *pallida*: larva black, with a white-edged black middorsal band between BD1 scoli, a variable interrupted cream subdorsal band between BD2 scoli, a wide black-brown band includes BSD scoli, lower edge of those scoli narrowly orange-tan (or orange, or absent), an interrupted creamy line just above spiracles, a brown or black wide band encloses spiracles and has more cream dots than usual, a cream lateral band touches ventral edge of BL1 scoli which are surrounded by an orange-tan or orange or absent ring, underside brown; scoli like ssp. *pallida*; head black with subdorsal vertical cream dash on temple, and most heads have cream crescent above eyes. Pupa mottled light brown like other *Phyciodes*, with tiny dorsal cones. Unfed 4th-stage larvae (sometimes 3rd stage in Wash.) hibernate.

One flight L May-E July (sometimes M-L July or rarely into Aug.).

Adults visit mostly yellow flowers, seldom white/blue/violet, such as *Barbarea orthoceras*, *Heterotheca villosa*, *Rudbeckia hirta*, *Sedum lanceolatum*, and *Solidago altissima* "*canadensis*", and visit mud. Adults bask with wings mostly spread. An adult strayed 1 mile from the foothills to Green Mtn. west of Denver.

Males rait and sometimes flait in gulch bottoms all day, as they rait an average of 83 cm above ground (extremes 10-100 [once 300]cm, N=26). Sometimes males fleek up on S-facing hillsides near abundant *Cirsium ochrocentrum* hostplants. In courtship, the male overtakes the female and they slow down then land (the male probably hovers over landed females sometimes), when an unreceptive female flutters her wings full-stroke to try to repel the male, while the male may flutter behind her with wings widely spread but often fluttered at small amplitude to transfer pheromone and he tries to bend his abdomen to join, and he may fly a 10-cm wide loop over her then land again (I saw this loop only once, so it is probably not usual behavior). Unreceptive females do that fluttering rejection dance and fly away. (As usual in butterflies, receptive females would likely be quiescent and the male would display minimal hovering/fluttering and mating would quickly ensue.)

***Phyciodes tharos* Pearl Crescent**

P. tharos is usually a little smaller than *P. cocyta* (males 14-16mm fw length, females 16-18), and most often has a black line across the large uph orange postmedian area, the uph submarginal cream crescents are usually more conspicuous, the unh marginal patch of males averages narrower and often darker (usually with brown crescent), and females are always mostly orange (melanic-upf females are common in *P. cocyta*, uncommon in *tharos*). {Note that in the *P. tharos* group (*P. tharos, P. cocyta, P. diminutor*, & *P. batesii*), the unf triangular subapical spot along the costa contains much black, whereas it is just tawny/russet with little or no black in *P. pulchella*. The orangish submarginal spot in upf cell CuA_2 has a little black dot within it in most *P. tharos* [and *P. cocyta* and *P. diminutor* and a few *P. batesii* and some *P. phaon*], which is lacking in most other *Phyciodes* including nearly all *P. pulchella*.} Two subspecies occur in Colorado. On the plains and adjacent lower foothills, in open valley bottoms generally in meadowy or somewhat moist areas, *ssp.* ***orantain*** has the antenna nudum (scaleless area on the club) mostly orange, and has about three generations, the first L Apr.-E June, plus two merged flights L June-Sept. (sometimes M Oct.). It is sympatric with *P. cocyta* in many lower foothills canyons from Larimer, Boulder, Jefferson, Custer, Pueblo and Las Animas Counties; it usually isn't common in those canyons, but is present and flies from M May to Sept. there. Careful attention to size and wing pattern elements is needed to identify those. The second ssp. ***riocolorado*** occurs in valley bottoms all along the lower Colorado River (from Mesa and surely Garfield Co. to as high as Eagle and Pitkin Cos.) and Gunnison River (Delta Co. and as high as Montrose Co.) in western Colorado; it is smaller and has more orange area on ups and has a black nudum on a more-oval antenna club (the club on ssp. *orantain* and *P. cocyta* and *P. batesii* is more elliptical). It occurs in weedy areas along rivers and in irrigated canals pastures and fields, and flies [May]-E June, plus two merged generations July-M Sept. at least. In all *P. tharos* ssp., the spring **form marcia** has the unh mottled with whitish marks; it is produced by short photoperiod acting on the 3rd-stage larva. Scott (esp. 1994a, 1998, 2006b, also 1994e, 1976, 2014) revised *Phyciodes*, by rearing 5000 adults and studying immatures and adults and hostplants and genitalia etc. and designating a dozen neotypes/ holotypes/ lectotypes and naming a dozen ssp.; those butterflies were in a horrible taxonomic mess.

Habitat moist valley bottoms on the plains into Transition Zone foothill valleys just above the plains; moist river areas and irrigated fields in W-C Colo. Hostplants in Colorado herb Asteraceae: *Aster* (now *Symphyotrichum*) *ericoides* (mostly var. *falcatus*, sometimes var. *ericoides*), *lanceolatus hesperius* for ssp. *orantain*. (Most *Aster* have been split into the genus *Symphyotrichum* as part of the rampant splitting that has afflicted all butterflies and other animals and plants.) In NW Nebraska it sometimes uses *A. laevis*. Hostplant for ssp. *riocolorado*: *A.* (*S.*) *lanceolatus hesperius*. Ernest Williams and recent students (all unpublished) found that the minus "high" enantiomer of the sesquiterpene germacrene D promotes oviposition and larval feeding (on lab *A. lanceolatus*, *simplex*, *novae-angliae*, *novi-belgii*), whereas atractylone is repellent (lab larvae lose weight on *Aster umbellatus* which lacks germacrene D). Common eastward on the plains, uncommon near and in the foothills; *riocolorado* is sometimes common.

Eggs pale green, laid in large clusters (averaging ~62 eggs) on uns of host leaves. Young larvae are gregarious, and eat the underside of host leaves (older larvae eat leaves from the edge). 1st- and 2nd-stage larvae only sometimes make a moderate silk web on the hatched eggs/leaf uns and larvae do not live beneath the web. 4th-5th-stage larvae are mostly solitary and feed at night and rest in litter by day. Older larva usually brown, usually <u>a little paler</u> above the subdorsal cream band than below, a middorsal darker heart-band edged by a lighter-brown line, a subdorsal cream line containing BD2 scoli, the side of body lighter-brown with a lateral cream band, BD1 & BD2 & BSD scoli dark with <u>conspicuous cream tips</u>, BL1 & BSV scoli creamy-tan or orangish-tan, a small orangish patch below BD1 & BSD scoli, and orangish in front of and behind BD2 and all around BL1; head black with a triangular white area on frontoclypeus plus the usual vertical cream band on each temple and cream crescent over eyes. Pupa <u>usually orangish-brown</u>, some creamier-brown, with weak to fairly-strong wing streaks, a brown-edged crest across top of A4, and large ridges and cones, otherwise with the usual *Phyciodes* pattern. Unfed 4th-stage larvae hibernate.

Three generations for ssp. *orantain*, L Apr.-E June plus two merged flights L June-Sept. (sometimes M Oct.). Ssp. *riocolorado* similar, [May]-E June, plus two merged generations at least M July-M Sept.

Adults visit all colors of flowers except perhaps pure red, including *Asclepias* spp., *Aster ericoides, A. laevis, A. lanceolatus hesperius, Astragalus gracilis, Bidens cernua, Cirsium arvense, Euphorbia* "*Agaloma*" *marginata, Helianthus annuus, H. tuberosus, Heterotheca canescens, Medicago sativa, Senecio ~spartioides, Solidago* (*Euthamia*) *occidentalis, Solidago altissima "canadensis", Verbena hastata*, and sometimes visit mud, urine, dung, and carrion. Adults can glide with wings spread to the side, and like other *Phyciodes* both sexes normally fly with wings straight out to the side and flapping them little. Adults bask with wings spread (dorsal basking). They roost on the ground or on a dead willow 2m up, and on numerous plants in between those heights.

Males fleek all day about the habitat to seek females, especially in low spots in valley bottoms such as gulch bottoms or along creeks and moist meadowy swales or near the hostplant, as they fly ~20-30cm up (or ~1/4 to 1/3 m above vegetation). Rarely a male will rait in a gulch a little. In courtship (Scott 1986c), the male overtakes the female or spots her on a flower, they slow and he may hover over the female before landing, they land and she spreads her wings fairly widely spread (~100-120^o) and raises her abdomen ~20^o(seldom 30^o) and the male merely moves alongside with wings slightly spread and joins. But if the female is temporarily less receptive (fluttering) and requires persuasion, the male sometimes hovers over her a little and he may flutter his wings a little just before/while landing, and after landing he often flutters his wings strongly at wide amplitude for a few seconds even 3-4x and for several minutes, then if the male is successful he joins generally while spreading his wings only 20^o-open (wingtips ~5mm apart) and bending his abdomen (the female generally keeps her wings spread fairly widely such as 110^o, which does not impede his joining). Often near a landed female that moves, he opens his wings ~90-110^o spread--once 130^o--and moves his forewings forward a little (a male forewing display) and sometimes vibrates them with small ~1mm amplitude for a few seconds often while facing the female (evidently to transmit pheromone) then he tries to join. Completely unreceptive females (that fail to mate) flutter their widely-spread wings (averaging ~139^o spread apart, extremes 110-160^o, N=22) strongly (the female rejection dance) to try to repel the male, and she may fly vertically up to 6m to escape, or crawl or turn or fly away or drop down into the vegetation, or sometimes raise her abdomen ~40-45^o so he cannot join; an unreceptive female on a flower may close her wings to avoid detection when a male flies over. C. Oliver found that lab males of *P. tharos tharos* and *P. batesii batesii* would not attempt to grasp the abdomen of females of the other species, indicating that the female pheromones are different in those species; the female pheromone is evidently in the abdomen, because he found among *P. tharos* that if he grasped the female's wings with forceps and stroked her abdomen onto a lab male's antenna the male would be more likely to mate. If a mating pair is startled, the female flies, the male dangling. Mating lasts only 28-36 min. or sometimes 45 min. if the male has evidently not recently mated, or up to several hours if he evidently mated recently.

Phyciodes cocyta selenis (=*pascoensis*=*morpheus*) Northern Crescent

P. cocyta is a mountains species, and usually flies at higher altitude than *P. tharos* and has just one flight {they overlap only in the lowest foothills (near the plains) where *P. tharos* is uncommon}. It is usually a little larger than *P. tharos* (males 16-18 fw length, females 17-20), and usually lacks a black line across the large uph orange middle postmedian area (except some females), the uph submarginal cream crescents are usually weak so the dark margin appears wider, the antenna club is often a little more elongate in shape (this club has an orange nudum [scaleless area] but so does *P. tharos orantain* on the eastern ½ of Colo. which also has a somewhat-elliptical antenna club), the unh marginal patch of males averages thicker, and females often have a melanic upf (melanic upf females are rare in *tharos*) and often have a slightly-paler (more creamy) upf postmedian band. Form marcia does not occur in *P. cocyta*. {Note that in the *P. tharos* group of *tharos, cocyta, diminutor,* & *batesii,* the unf triangular subapical spot along the costa usually contains much black, whereas it is just russet mostly without black in *P. pulchella*. In the *tharos*-group including many *P. cocyta* the orangish submarginal spot in upf cell CuA_2 often has a little black dot within it, which is present in *P. tharos* but lacking in most other *Phyciodes* including *P. pulchella*, except some *P. phaon*.} The eastern slope has ordinary ssp. **selenis**. On the western slope, adults (the ***Aster foliaceus* variety of ssp. *selenis***) tend to have the upf postmedian band often a little paler (slightly more creamy), more closely resembling *P. batesii anasazi* in that trait (that partial similarity might have arisen from introgression, or from similar selection pressures due to a similar environment), but *P. cocyta* has the black uph border usually wider, and the unh brown marginal patch is usually large and the crescent is usually brown instead of yellow or cream. On the western slope, look for the conspicuous bluish-gray-green *Aster glaucodes* plants—if they are absent, then *P. batesii* is not present and your butterflies must be *P. cocyta*.

Habitat moist gulch bottoms and fairly-open N-facing slopes in the foothills and Canadian Zone. Hostplants in Colorado green herb Asteraceae: *Aster* (now *Symphyotrichum*) *laevis* var. *geyeri* on the E slope, *A.* (*Symphyotrichum*) *foliaceus* on the W slope. In the lab some Wash. *Erigeron* species are acceptable (James & Dunnallee 2011), but so far they have not been found to be hosts in nature. {It does not eat *Aster* "*Herrickia*" "*Eurybia*" *glauca*, contrary to James & Nunnallee (2011) and Warren (2005) who misinterpreted my Colo. data, and Mike Fisher in Butt. Colo. figured pure *P. batesii anasazi* adults sympatric with *cocyta* in Eagle Co.} Common.

Eggs pale green, laid in large clusters (averaging 49 eggs in Colo., but up to 700 per female lifetime) on uns of host leaves. Young larvae are gregarious, and eat the underside of host leaves. About half the families of 1st- and 2nd-stage larvae make a moderate or strong silk web on the hatched eggs/leaf uns but larvae rarely live beneath it. 4th-5th-stage larvae are mostly solitary and feed at night and rest in litter by day. Older larva brown, usually <u>just as dark</u> above the subdorsal cream band as below, a middorsal heart-band edged by a light-brown line, a cream line between BD2 scoli, a weak cream line between BSD scoli, the side of body lighter-brown with a lateral cream band, BD1 & BD2 & BSD scoli dark with <u>conspicuous cream tips</u>, BL1 & BSV scoli usually orangish-tan, a small orangish patch below BD1 & BSD scoli, and orangish in front of and behind BD2 and all around BL1; head black with a triangular white area on frontoclypeus plus the usual vertical cream band on each temple and cream crescent over eyes. Pupa <u>quite creamy</u> color in half the pupae, some light-orange-brown, few dark-brown (like one from Blue Mts. area Wash. shown by James & Nunnallee 2011), usually with strong or moderate dark wing streaks, a brown-edged crest across top of A4, (abdomen has some subdorsal brown spots and lateroventral and supraventral and midventral brown lines in Wash. as usual in *Phyciodes*) and large ridges and cones, otherwise with the usual *Phyciodes* pattern. Unfed 4th-stage larvae hibernate.

One flight M June-L July (sometimes E June).

Adults visit flowers of nearly all colors especially yellow, including *Apocynum androsaemifolium* (favorite), *Erigeron speciosus, Eriogonum umbellatum, Heterotheca villosa, Rudbeckia hirta, Senecio* (*Packera*) *fendleri, Senecio* spp., and visit mud, and in E N.A. visit urine and carrion. Both sexes normally fly with wings straight out and moving them little, and they often glide between flaps. Adults bask dorsally (with wings spread). One adult strayed 1km+ from the main foothills to Green Mtn. in Jefferson Co.

Males fleek all day, in lush gulch bottoms and valley bottoms mostly, and about concentrations of the hostplants (mostly N-facing wooded slopes in the Colorado foothills, or open oak or aspeny woodland etc. in other higher mountain areas), as they fly ~20-30 cm above ground or less above vegetation. In courtship (Scott 1986c), which is like *P. tharos,* the male overtakes the female, they land, and the male flutters behind her to transmit pheromone, and they join. The female and male may hover with the male behind before she lands, and the male often hovers over and often flutters behind a landed female. Males occasionally fly randomly over and around a landed female (like *P. pulchella camillus*--I never saw the precise loops displayed by *Chlosyne gorgone*). (So far I have not seen the male forewing display done sometimes by *P. tharos* and *P. pulchella*, in which the male moves his widely-spread forewings forward near the female and occasionally flutters his wings a bit, but this display may rarely occur.) Temporarily-unreceptive females may flutter after landing and she may raise her abdomen, but after he flutters behind her she may become receptive so she does not flutter as they join (they both have wings spread somewhat, the female spread more, the male less, as in *P. tharos*). Unreceptive females flutter her wings while they are spread ~110-135^{o} (the rejection dance) to repel the male (unreceptive females flutter to repel him if he hovers over them) and raise her abdomen 45^{o} so he cannot join, or jerk her abdomen away if his abdomen touches it, or often drop down into the vegetation, or crawl or fly away or fly high in the air to escape, and if she is on a flower and a male flies over she closes her wings to avoid detection. If a mating pair is startled, the female flies, the male dangling.

Phyciodes batesii anasazi Canyon Crescent (Bates' Crescent for entire species' range)

P. batesii anasazi flies in western lowland Colorado, including the pinyon/juniper zone where *P. cocyta* is mostly absent (they fly together in the lower Montane Zone), and always occurs with abundant *Aster glaucodes* (an easily recognized bluish-gray-green aster that often grows in huge clusters—learn how to recognize that abundant aster, which frequently grows in clusters so large they can be spotted from 100m away). It can be confused with *P. cocyta* because both have orange nudum on the antenna club; and it usually has the upf postmedian band a little paler than the rest of the wing (W slope *cocyta* often have that band paler also). These features distinguish ***anasazi*** from *cocyta*: the unf black patch on tornus is generally larger (except in some adults in higher-altitude populations where it is sympatric with *cocyta*), the unf posterior median black spot is usually larger, the uph submarginal creamy crescent-spots are more extensively developed, the uph margin is generally a bit narrower than *P. cocyta* so the area of orange on uph actually averages <u>larger</u> than *P. cocyta*, the unh brown marginal patch has a yellow or cream crescent in 2/3 of adults and brown in 1/3 (versus usually absent in the brown patch on *P. cocyta* and *P. tharos*), and females are never melanic on upf (often melanic in *cocyta*). Form marcia does not occur in *P. batesii*. {The triangular subapical patch on the unf costa is mostly black in *P. batesii* ssp. [and *P. tharos* & *P. cocyta* & *P. diminutor*], tawny with little or no black in *P. pulchella*. The orangish submarginal spot in upf cell CuA_2 has a little black dot within it in most *P. tharos* and *P. cocyta* and some *P. phaon*, but that black dot is seldom visible in *P. batesii* ssp. because it is engulfed by the black tornus patch.} Brown et al. (1957, Colorado Butterflies p. 88 top) illustrated a male as "*batesii*" from Loveland Pass Road 10,200 ft., Clear Creek Co. Colo. July 26, 1934, Dr. L. E. Chadwick (which is along Clear Creek and the current I-70 at the base of Herman Gulch [which is 3 mi. NE Eisenhower Tunnel and 3 mi WSW Bakerville]) which actually seems to be a melanic aberration of *P. cocyta*; *Aster glaucodes* is common at and near Georgetown 9 miles to the east (on E/SE-facing lower slopes), one of the few spots it occurs on the E slope, but *batesii* does not occur there.

Habitat the canyons of W-C and SW Colorado (found S of Douglas Pass in Garfield Co., and probable in Dinosaur Nat. Mon.) in the lower mountains generally below the Canadian Zone, with the host *Aster glaucodes*. (The population at the W end of Rocky Mtn. Nat. Park is *cocyta* not *anasazi*, as most adults resemble *cocyta*.) Hostplant in Colorado herb Asteraceae: *Aster* (now *Herrickia*, recently *Eurybia* and *Eucephalus*) *glaucodes=glauca=glaucus*. This gray-green aster often grows in huge swards, mostly on sliding dirt above a gulch bottom, and is the only host of *P. batesii* in Colo.-W Wyo. [including *P. b. apsaalooke*]-Utah-Ariz.-New Mex. Males fleek near the host on sliding dirt near/at gulch bottoms (in W Nebraska-NE Wyo. ssp. *lakota* uses *Aster laevis* as host so males fleek in gulch bottoms and near the host on N-facing slopes). *P. b. anasazi* occurs with *P. cocyta* where their hosts overlap, in Eagle Co. and Glenwood Can. etc., and some introgression may have occurred at least in Eagle Co. but they remain distinct species (I reared one near *cocyta*, but Mike Fisher later collected and illustrated pure *anasazi* at that locality near Minturn) and *P. cocyta* eats *Aster foliaceus* there (the oranger coloration of *P. b. anasazi* throughout its range even in the Grand Canyon may have originated from introgression with *P. cocyta*, although *anasazi* is a little oranger than *cocyta* on uph, and no current introgression is known in most of its range.). Adults fly a little <u>slower</u> than *P. tharos/P. cocyta/P. pulchella*, and *P. batesii* ssp. seem to be more adapted than other *Phyciodes* to having local populations on high concentrations of the hostplant. Thus *P. batesii* often occurs in <u>little colonies</u>, which evidently makes them more vulnerable to extinction (from New York south to Virginia no colonies are left, evidently mostly because of forest overgrowth and habitat destruction and perhaps the spread of weedy *P. tharos tharos* and its parasitoids). Western *P. b. anasazi* is doing well in canyonlands unsuited to development, and evidently there are endless millions flying in the rugged canyonlands throughout SW Colo. and S Utah and the Grand Canyon area and Chuska Mts. of Ariz.-NM. Common, especially in local colonies which can be abundant.

Eggs pale green, laid in large clusters (averaging ~80 based on counts of eggs and 1st-stage larvae, reflecting the large size of hostplant populations) on uns of host leaves. Young larvae are gregarious, and eat the underside of host leaves. 1st- and 2nd-stage larvae <u>always make a moderate or strong silk web</u> on the hatched eggs/leaf uns like other *P. batesii* ssp., but all *P. batesii* ssp. larvae are on top of web and rarely occur beneath that web. 4th-5th-stage larvae are mostly solitary and feed at night and rest in litter by day. Older larva usually blackish to dark-brown, usually just as dark above the subdorsal cream band as below it, a middorsal dark heart-band edged by a light-brown line, a subdorsal cream band containing BD2 scoli, the side of body lighter-brown with a lateral cream band, BD1 & BD2 & BSD <u>scoli dark with blackish tips</u> (some cream-tipped), BL1 & BSV scoli usually tan or orangish-tan, a small orangish patch below BD1 & BSD scoli, and orangish in front of and behind BD2 and all around BL1; head black, <u>only 1/3 of larvae have a triangular white area on frontoclypeus</u>, plus the usual vertical cream band on each temple and cream crescent over eyes. Pupa usually orangish-tan or cream-tan, with weak or moderate dark wing streaks, a brown-edged crest across top of A4, the <u>ridges and cones usually smaller</u> than *tharos/cocyta*, cremaster very rugose (more than *tharos/cocyta*), otherwise with the usual *Phyciodes* pattern including dorsolateral, lateroventral, supraventral, and midventral browner spot-lines on abdomen. Unfed 4th-stage larvae hibernate.

One flight L June-M July.

Adults visit flowers of most colors (yellow, white, blue, purple, violet) except perhaps red, including *Aster glaucodes, Cirsium arvense, Medicago sativa, Rudbeckia laciniata*, and sometimes visit carrion and mud. Adults fly a little <u>slower</u> than *P. tharos/P. cocyta/P. pulchella*, and they can glide for a bit interspersed with their flaps when they fly. Adults bask with wings spread (dorsal basking). Adults often roost on *Quercus gambelii* tops.

Males fleek all day about valley/gulch bottoms and about the hostplant on lower slopes (often on sliding dirt near/at gulch bottoms), as they fleek ~20-30cm above ground or ~15cm above vegetation. In courtship, the male overtakes the female and they land, and the male may flutter his wings behind her and may nudge under her wings (if they are spread) to attempt to bend abdomen and join, while unreceptive females flutter and raise the abdomen to repel the male (courtship is surely like *P. tharos/P. cocyta*).

***Phyciodes pulchella camillus* (=*P. pratensis*=*P.campestris*) Field Crescent**

P. pulchella is identified throughout Colorado and North America by the color of the approximately-triangular subapical patch along the front margin of unf, which is orangish or brown in color without black (rarely a little) (it generally has extensive black in *P. tharos*/*cocyta*/*batesii*). And our ssp. ***camillus*** has a yellow unf discal cell bar, which is absent in *P. tharos/P. cocyta/P. batesii*. Also, the unf black spots are small. The uph median band is orangish-yellow, whereas it is orange in other *Phyciodes*. The unh brown marginal patch contains a yellow crescent. Adults are small and the ups is blackish with a paler creamy upf median band and a moderate to strong pale uph submarginal line. **Form marcia** flies in early spring, and has much white mottling on unh. {The orangish submarginal spot in upf cell CuA_2 has a little black dot within it in many *P. tharos* and *P. cocyta* and *P. diminutor* and some *P. phaon*, but that dot is rare on *P. pulchella*.}

Habitat open areas everywhere from the plains to Canadian Zone (sometimes into lower Subalpine Zone). Hostplant in Colorado herb Asteraceae: *Aster* (now *Symphyotrichum*) *porteri, ericoides* (vars. *falcatus, ericoides*), *A.* (*chilensis*) *ascendens, lanceolatus hesperius, foliaceus* (incl. var. *apricus*), *Dieteria* ("*Machaeranthera*") *canescens, D.* ("*M.*") *bigelovii* var. *bigelovii=pattersonii*. In N New Mex. it is sometimes assoc. with *Aster* (now *Symphyotrichum*) *fendleri*. In lab several *Erigeron* species are eaten, so perhaps an *Erigeron* might be eaten in nature but none have been found so far (they are evidently unattractive to ovipositing females). Common.

Eggs yellowish-greenish-cream, laid in clusters averaging ~62 (up to 235) on leaf underside. Young larvae gregarious and make a silk web on the hatched eggs/leaf uns, but seldom live beneath it. James & Nunnallee (2011) found that Wash. young larvae often spun enough silk on their leaf or between two leaves for them to consider it a nest and observed some larvae living within the nest [I have not found larvae living within the silk nest]. Older larva dark-brown, which is just as dark above cream subdorsal band as below, a middorsal dark heart band edged by lighter-brown, a cream subdorsal line containing BD2 scoli, the side of body lighter-brown with a cream lateral band, BD1 & BD2 & BSD scoli dark with <u>dark tips</u>, some orangish next to BSD scoli and a weak whitish line between them, BL1 & BSV scoli orangish to brown with brownish-orange around BL1 scoli; head black, with <u>frontoclypeus all black</u>, the usual vertical cream stripe on temple and sometimes a cream crescent over eyes. Pupa most often orangish-brown but many varying to brown or orangish- or creamy-brown, usually with weak streaks on wings, a brown-edged crest across top of A4, <u>ridges and cones very small</u>. Unfed 4th-stage larvae hibernate (there are 5 stages, not 6).

Evidently three flights on the plains and lower foothills, May-M June, then several coalesced flights ~L June-M Oct.). Higher in the mts. there are mostly two flights end of May-start of July, and M July-E Sept. (evidently one flight L June-M Aug. at the highest subalpine altitude).

Adults visit all flower colors including yellow, white, and blue-purple, except perhaps red, including *Allium textile, Antennaria parvifolia, Aster ascendens, A. ericoides* and var. *falcatus, A. lanceolatus hesperius, A. porteri* (favorite), *Barbarea orthoceras, Chrysothamnus nauseosus, Erigeron pumilus, Erigeron spp., Heterotheca villosa, Dieteria* "*Machaeranthera*" *bigelovii=pattersonii, Medicago sativa, Senecio spp.,* and they often visit mud, sometimes dung. *P. pulchella* flies a little faster than *P. tharos*/*P. cocyta*, and often glides between wing flaps like other *Phyciodes*. Adults bask with wings spread, and they usually also keep their wings spread when feeding. One adult roosted on a Pinyon Pine tree.

Males fleek all day about the habitat, especially in valley bottoms/moist meadows etc., and also on slopes etc. wherever the hostplant grows, as males fleek only ~5-20cm above ground/vegetation (males almost never rait: I briefly saw one resting male chase a passing *Cercyonis pegala*, and once a male on a flower chased a passing male). In courtship (Scott 1986c), the male overtakes the female if she is flying or spots her on a flower, they land and he may flutter or vibrate his nearly-closed wings and then flutter his mostly-spread wings then he mostly closes his wings (~20^{o}-spread) and bends his abdomen to join if she is quiescent (they can join even when she has her wings fairly wide open or closed but join most readily when his wings are open little). The male very often hovers over a landed female (he usually hovers if she flutters when he comes near), and in doing so often flies an irregular ramble over her (usually he flies back-and-forth over her which sometimes looks like a zigzag or an irregular oval, or there may be several-cm up-and-down elements to it that occasionally are increased to make a vertical 7-8cm diameter loop accidentally approximating the stereotyped loops of *Chlosyne gorgone*). After landing behind a landed less-receptive female (who may flutter with wide amplitude to repel him) he often flutters (seldom vibrates widely-spread wings) behind her to transfer pheromone then he nearly closes his wings (20º-spread, once 60º) and crawls beside her and bends his abdomen to try to join. Sometimes the male does a male forewing display like *P. tharos* by spreading his wings widely as usual but moving his forewings forward (while doing this only 1 of 7 males flicked his wings slightly), which never seemed to work to get the female to mate. Unreceptive females flutter at wide amplitude (averaging 124º-spread wings [extremes 60-160º, N=37]--several times she vibrated at small amplitude with wings widely spread) to repel the male, or she raises her abdomen 45º so he cannot join, or she drops down or crawls or flies away or flies vertically ~3m to try to escape. If a mated pair is startled, the female flies, the male dangling. Many females of *P. cocyta* were released near *P. p. camillus* males to study courtship, but no completed matings were obtained as the males and females did not like each other, so they just ignored each other or displayed rejection behavior--obviously they have different pheromones.

Phyciodes picta picta **Painted Crescent**

P. picta looks like *P. pulchella camillus* on ups (but with paler uph postmedian band) and resembles *P. phaon* somewhat, but the unh (and unf tip) is yellow-cream in males and cream in females. The spring **form marcia** has a few additional markings on unh. (Ssp. *canace* from S Ariz. has oranger females, and does not occur in Colo.)

Habitat open dry alkaline valley bottoms, roadsides, and weedy areas on plains and lower mountains. It often occurs on gypum-rich soils. It occurs in the Wet Mts. foothills and the Arkansas Canyon in southern Colorado as well as the plains, but stays on the plains in N Colo. Hostplants in Colorado herb Convolvulaceae: *Convolvulus arvensis* (the imported horribly-invasive Bindweed, yet it is the favorite host); and herb Asteraceae: *Rayjacksonia* (formerly *Machaeranthera* and *Haplopappus*) *annua=phyllocephala* (the original native host, at Fort Morgan etc.). Lab larvae eat *Aster* (*Symphyotrichum*) but prefer bindweed, but the butterfly unfortunately refuses to populate town lawns and gardens and cultivated fields where Bindweed control is desperately needed (larvae evidently need something such as dried cow pies etc. to rest beneath in daytime). Texas lab larvae even ate Acanthaceae. Uncommon, sometimes common esp. in S Colo.

Eggs pale yellow-green, laid in clusters of ~50-100 on uns of host leaves. Larvae eat leaves; no nests. Older larva yellowish-brown, a darker brown heart-band, a cream subdorsal line along BD2 scoli (with a brown line above it), a band of red-brown spots in cream surroundings just below spiracles, and a cream lateral stripe, a brown band between BSD scoli, scoli reddish-brown; head brown, with a cream stripe on vertex and a cream crescent above the eyes (these cream areas may be brownish), frontoclypeus brown, distinguished from other *Phyciodes* by <u>cream stripe along the adfrontal sulcus</u> of the head. Pupa smooth, many creamy, many orangish-tan, a few dark-brown, wings weakly mottled (paler pupae have only small discal cell spot, darker pupae have moderate brown streak from that spot to margin). 2^{nd}- to 4^{th} (probably mostly 4^{th})-stage larvae hibernate.

About three flights, M May-June then several coalesced flights July-M Sept.

Adults evidently visit flowers of all colors, including *Heterotheca villosa* and *Medicago sativa*, and presumably also visit mud.

Males fleek all day mainly on flat open land such as near streams, vacant fields, beside railroad tracks, etc., as they consistently fly only ~5cm above ground/vegetation. In courtship, males may fly over a landed female and fly around her, while unreceptive females flutter widely-spread wings to repel the male (courtship is presumably similar to that of *P. tharos* and males surely hover/flutter near unreceptive females). Fleeking males can find very fresh females and mate with them before they fly much. If a mating pair is startled, the female flies, the male dangling.

Phyciodes phaon jalapeno **Phaon Crescent**

Resembles *P. picta* with a contrasting cream upf postmedian band, but has much more orange on the upf and unf submarginal area than *picta*. The fw has a thick black median band and a whitish postmedian band, then a submarginal band of orange spots; the unh is yellowish-cream, with narrow brown lines on females. Evidently a semi-migratory rare stray, found so far in four plains counties (Logan, El Paso, Kiowa, Prowers Cos.), but there are 6 county records in Neb. and many over most of C and E Kansas, so maybe the strays are from there rather than from the south. {Ssp. ***jalapeno*** (Ariz. & SW U.S.) differs from SE U.S. ssp. *phaon* by having the ups median band cream, instead of orangish-yellow in ssp. *phaon*; the band is intermediate in Travis Co. Tex.} The winter **form marcia** has a darker unh, due to short photoperiod.

Habitat moist open areas along ponds/gulches/streams. Hostplants herb Verbenaceae elsewhere: *Phyla=Lippia* spp. (two species including a known host *P. lanceolata* occur on the Colo. plains; *P. cuneifolia* occurs just S of Green Mtn. in Jefferson Co., but not the butterfly). A rare stray.

Eggs pale green or cream, laid in clusters up to ~100 on host leaf uns. Larvae eat leaves, without nests. Older larva dark-brown (brown dorsally) with tiny white dots, a blackish middorsal line edged by tawny, a cream-tan subdorsal band containing the orange bases of BD2 scoli is above a broad area of brown and blackish twinned dashes, a tan mottled band along the spiracles, and a cream lateral line edged beneath by a blackish line; the scoli brown except BL1 & BSV scoli ochre; head blackish-brown, with white patches like those of *P. picta* but enlarged and joined and the front of head white on drawings of evidently *jalapeno* by Charles Dammers (J. Comstock 1929 Bull. So. Cal. Acad. Sci. 28:22) but somewhat less white in photo of Fla. *phaon* in Minno et al. (2005) & Wagner (2005) (the front view of head is not shown on known photos). Pupa tan, or brown, a lateral brown line on A4-9, mottled with cream and black, a transverse crest across A4, with many tiny brown dorsal bumps. Perhaps no diapause stage.

Many flights all year in Mex. & Tex., at least June (and probably to Sept.) in Colo. Adults visit flowers such as asters and other small Asteraceae, and visit mud.

Males fleek all day only ~5cm above ground/vegetation, mostly on flats near the larval hosts (W. Texas, Scott 1976a). If a mated pair is startled, the female flies, the male dangling.

Lycaenidae Small Butterflies, Gossamerwings

Lycaenidae is a large family of ~6652 species distributed worldwide, most of them small. The eyes of adults are indented near the antennae. The male forelegs are slightly to moderately smaller than the hind four legs and have fused tips without claws, while female forelegs are nearly full size and have claws. Most Lycaenidae are rather local, but a few species migrate. Most species rest with the wings closed. Larvae usually eat dicotyledon plants, and many eat flower buds rather than leaves. The larvae of most are rather sluglike, less so in Riodininae in which some are not much differently shaped than other butterflies. The larval hairs can be short (most Lycaeninae) to long (most Riodininae). A tropical larva has hairs with noxious chemicals (*Teratoneura*, H. Eltringham) that are unknown in Colorado. Lycaenidae have a spatulate fleshy terminal lobe on older larval prolegs (except *Apodemia*), and the crochets are usually arranged in several rows medial to that fleshy lobe; the lobe evidently helps stick the larva to smooth surfaces. The older larvae have a prothoracic shield. Some species of both Riodininae and Lycaeninae are tended by ants for the honeydew the larva produces from honey glands, and pore-structures and eversible glands in both subfamilies produce pheromones used during the relationship with ants. All or nearly all Lycaenidae older larvae have perforated cupolas=lenticles, which are tiny circular sclerites consisting of a ring around an area of tiny pores that usually produce pheromone chemicals that appease ants by mimicing brood pheromones of those ants. Some Lycaenidae have a middorsal honey gland (on A7 in Eumaeina and Polyommatini, on A8 in some foreign Riodininae including *Theope* and *Lemonias caliginea*="*Anatole rossi"*), which produce sugars (mostly sucrose, often glucose etc.) and some amino acids (mostly leucine, plus others) to feed the attendant ants and bribe them to keep them from eating the larva. And some Lycaenidae have subdorsal eversible tentacles (on A8 in many foreign tribes and genera and most U.S. Polyommatini, on T3 in foreign Riodininae [*Lemonias*]) which evidently produce a pheromone mimicing the alarm pheromone of ants to alert the ants to protect the larvae from other predators such as Ladybird Beetles or Reduviid bugs or wasp/fly parasitoids etc. Mature larvae were well-studied in California by Ballmer & Pratt (1988), who detail the setae etc. and provide keys and photos. They note that most Lycaenidae (including Riodininae) older larvae and pupae have dendritic setae (long flexible setae with terminal branches) which function in (and are correlated with) myrmecophily, and are concentrated near lenticles and may disseminate chemicals; and those dendritic setae seem important in *Lycaena*, which lack the honey gland and eversible tubercles and yet are associated with ants (Ballmer & Platt 1991). Fiedler (1991) and Pierce (1995) review myrmecophilous and carnivorous Lycaenidae; some Lycaenini are carnivorous (such as *Feniseca*, Miletini), as are some Riodininae (such as *Setabis*, Nymphidiini). Larvae of Lycaenidae (and Papilionidae) evidently do not have the ventral neck gland that is present in other butterflies (Hesperiidae, Pieridae, Nymphalidae) and produces a chemical to repel predators such as ants; instead, numerous Lycaenidae trick and bribe ants with pheromones and honey to repel predators. Pupae usually are attached by a silk girdle, and often by a cremaster which is sometimes absent in various species. The pupae are stout or usually pill-like (ellipsoidal) with abdomen segments that are nearly immovable, but some pupae make very faint sounds (called “stridulation”, mostly inaudible to humans) evidently to attract ants: in numerous species of Riodininae and Lycaeninae tiny ribs (stridulating plates) and pegs (the “file”, usually on adjacent areas with numerous tiny teeth) between the overlapping abdominal segments (dorsally between A5-6, sometimes also between A4-5) (Downey, 1966) produce faint squeaks when the segments move; those sounds may be used during relationships with ants. Very faint sounds were recorded in pupae of Colorado species of the major groups of Lycaeninae: in *Strymon melinus*, *Lycaena hyllus*, and *Everes comynas* (Downey & Allyn 1978). Adult Lycaenidae (Riodininae and Lycaeninae) can see all colors from ultraviolet to red, and have red610 rhodopsin detectors that let them see red (G. Bernard 1978 Science 203:1125-1127).

Lycaenidae, Riodininae Metalmarks

Colorado has only two Riodininae, *Apodemia mormo* and *A. nais*, out of ~1501 species worldwide, mostly in the American tropics (a few elsewhere) where adults are amazingly diverse and beautiful. Some people raise them to a family Riodinidae, but they are obviously just a subfamily of Lycaenidae based on their relationship with ants and morphology and DNA etc. (all the DNA phenograms of Heikkila et al. 2011 prove that). The male foreleg is less than half the length of the other legs, and its first segment (coxa) extends like a spine beyond the joint with the rest of the leg. Only one small group of Riodininae (the genera *Helicopis*, *Sarota*, *Anteros*) has a “false head” on hw consisting of a long tail and eyespot; they move the hindwing(s) independently to fool a bird into attacking at that spot rather than the real body (the two hindwings are not moved alternately as they are in the “hindwing rubbing” of Lycaeninae, R. Robbins 1985 J. Lepid. Soc. 39:224-225). Riodininae larvae have five larval stages (often more in *Calephelis* farther south than Colorado), versus only four in most Lycaeninae (including all Colorado Lycaeninae except *Callophrys gryneus* and *C. spinetorum* which have 5-7, Ballmer & Pratt 1988). Older Riodininae larvae are less sluglike than Lycaeninae, and have slightly wider heads about half the width of the body, and the wider head cannot be retracted into the thorax, unlike most Lycaeninae. Riodininae larvae mostly eat plants, though some have other foods. Omnivorous neotropical *Setabis* larvae mostly eat ant-tended Hemiptera such as Membracidae treehoppers and Coccidae scale insects and sometimes eat ant-tended Coccinellidae & Jassidae, and sometimes eat cacao fruits and extra-floral nectaries of *Inga* plants (in lab they may also eat *Pheidole* ant larvae/pupae as they are assoc. with those ants) (L. Augusto Kaminski, L. Dias Lima 2019, J. Lepid. Soc. 73:279-281). Older larvae of Colorado Riodininae lack honey glands and eversible tubercles which some other Lycaenidae use in their relationship with ants, and our *Apodemia* lack a close relationship with ants, whereas some other Riodininae elsewhere have honey glands and eversible tubercles etc. to communicate with ants: *Lemonias caliginea=Anatole rossi* has an eversible honey gland on A8, a dorsolateral eversible tubercle/hair pencil on T3 wafting pheromone, and strange vibratory papillae on T1 (ants palpate all those with their antennae and imbibe the honey); *Menander* has the honey gland and small versions of the other two organs; *Theope* spp. has a lateral tentacle nectary organ on A8 producing sugar, and a cluster of giant balloon setae on T1 that waft pheromone from numerous perforated cupolas=lenticles (on T1-2-3 and sometimes A1) to communicate with *Azteca* ants. In another tropical species *Adelotypa annulifera*, larvae and adults with red-circle ant-like patterns on their wing uns consume the nectar produced by spiky bamboo shoot tips, while being protected by the red ants who drink the same bamboo nectar and also consume honeydew produced by the larval anus and two ~A8 nectar glands, and larvae and pupae are mottled-red-brown for camouflage among the ants (P. Torres 2016 J. Lepid. Soc. 70:130-138). Older larvae of Riodininae have a prothoracic shield with some long setae extending over the neck or head, unlike Lycaeninae, and the body setae are mostly on large plates called verrucae and usually some or most of the setae are very long (longer than the head width). The A1 spiracle of American Riodininae larvae is placed anteriorly and ventrally compared to the other spiracles, unlike Lycaeninae which have them all in a row. Pupae are a little less rounded than Lycaeninae, and are mostly attached by silk girdle and cremaster. Pupae of *Lemonias* have dorsolateral ant-attracting organs on T3 and produce sounds from the movable abdominal intersegmental areas behind the wings, which keep ants attending (G. Ross found that ants shepherd the larvae like little cows into holes covered by day at the base of the *Croton repens* host, and the larvae feed at night protected from predators and parasitoids by ants, in Veracruz, Mex.). Some tropical species have oddly-shaped eggs like stacked pies, etc.

Apodemia mormo **Mormon Metalmark**

Distinctively patterned by white spots on the brown unh, and much orange on the basal 2/3 of unf. Adults have greenish-gray eyes. Ssp. ***mormo*** in W and SW Colo. and the S end of the San Luis Valley has reddish on upf, almost none on uph. Ssp. ***pueblo*** is in the northern San Luis Valley and common in SE Colo. but is absent near Denver and rare in N Colo. in Poudre Can. and S St. Vrain Can.; it resembles ssp. *mormo* but has a reddish uph postmedian band. This band varies somewhat and the Arkansas Canyon and plains populations are similar and differ little in series. At Del Norte and west of La Garita on the W side of the San Luis Valley, ssp. *pueblo* and ssp. *mormo* seem to intergrade, and both phenotypes and many intermediates occur (Scott 2017). In southern Las Animas Co. along the NM border (a male 6 mi. N Raton, and 2m4f N of Folsom in Union Co. NM, all in CSUC collection in Fort Collins), the butterflies evidently have just one generation so are ssp. *pueblo*, but the uph has more orangish, matching ssp. *mejicanus* from central NM as far north as the Sandia Mts., but it will take many more specimens from Colorado to conclude that ssp. *mejicanus* occurs in Colorado. Supposedly the mtDNA indicates that populations E of the continental divide are quite different from populations farther west to Calif.-Wash. etc., but this area includes ssp. *pueblo* in Colo. and ssp. *mormo* in N Wyo.-Sask., and mtDNA offers little help in interpreting geographic variation in *A. mormo*.

Habitat for ssp. *mormo* mostly Upper Sonoran-Transition Zone in open pinyon/juniper etc. woodland. Habitat for ssp. *pueblo* little mesas with scattered junipers on the plains, and lower mountains open pinyon/juniper etc. (Ponderosa Pine in Larimer Co.) woodland. Hostplants herbaceous Polygonaceae: for ssp. *pueblo Eriogonum jamesii* var. *jamesii* in S Colo., but associated with *E. umbellatum* in Boulder Co. & along the Cache la Poudre River in Larimer Co. & in Laramie Co. Wyo. In W Colo. ssp. *mormo* is associated with *Eriogonum corymbosum* var. *orbiculatum, E. microthecum* var. *foliosum* (also in S San Luis Valley), *leptocladon*, and *lonchophyllum* var. *lonchophyllum* (it is assoc. with 10 *Eriogonum* in Utah). (Ray Stanford found ssp. *mormo* adults on *E. brevicaule* near Thermopolis Wyo.) Throughout its range *A. mormo* chooses more species of

Eriogonum than *Euphilotes* which are often locally restricted to just one sp. Uncommon, sometimes common.

Eggs light-pinkish-purple, later turning deep violet, in Colo. & Wash. whitish with a pink cast, laid singly or in clusters of 2-4, for ssp. *pueblo* on inflorescences mostly on bracts below the calyx, elsewhere on inflorescence or drying leaves or stems. Older larvae live in a nest of leaves silked together. Older larva violet-brown, with near-middorsal, supralateral, and sublateral rows of black cactus-spines-like mounds (verrucae) on each side (each plate has many dark spines with a long white seta in the center, the lateral setae much longer), the topmost plate much the largest, around the bases of those three rows of plates is respectively cream or orange, little or no cream, and (widest) yellowish-cream (these cream patches orange in Utah, yellow in Wash. photo); head black. There may be 4-5 larval stages. Pupa mottled brown or violety-brown, with dark spots on abdomen, top of thorax & wings very dark, often with near-middorsal, dorsolateral, and lateral yellow spots around clusters of setae. Immatures poorly known in Colo. Eggs hibernate in Wash. (James & Nunnallee 2011) and Ore.? (Neill 2007) and perhaps in Colo. In C Calif. (Shapiro 2007) the eggs hatch in the lowland Calif. winter but larvae do not feed until new growth appears on the host in early spring. In S Calif. (G. Ballmer & G. Pratt 1988, p. 32), hibernation occurs as eggs for some populations, or 1st-stage larvae, or partly-grown larvae.

One flight Aug.-E Sept. (seldom M July).

Adults prefer white (sometimes yellow) flowers, especially *Eriogonum*, sometimes *Heterotheca villosa* or various white flowers. Adults wave their opened wings while on flowers. They possibly visit mud. Adults fly erratically and not very fast, like hairstreaks, unlike blues. Adults bask and rest with wings mostly spread. Adults roosted on *Quercus gambelii* and *Cercocarpus montanus* bushes and a small 1m *Pinus edulis* tree. Marked males lived average ~9 days in Calif., females ~11 days, and adults moved up to 617m (R. Arnold, J. Powell).

Males of ssp. *mormo* rait at least 10:40-15:30 on bases of slopes, esp. in gulches. Males of ssp. *pueblo* rait and often flait mostly in depressions such as tiny sloping gullies cutting into hillsides and depressions at the base of slopes, as they rait on the ground or on *Eriogonum* or other low plants ~0-50cm up. Ssp. *pueblo* males rait and chase from 11:00-15:00, the same time as ssp. *mormo*; before that they mainly feed on the larval host flowers. I observed only one courtship, as unreceptive female and male fluttered near the ground. In Calif. ssp. *langei*, raiting males pursue passing females, they land, the male flutters near her and may nudge her, she may flutter a little then becomes quiescent and they join; adults were active 10:00-16:00, and mating pairs were found from 13:00-16:00 (R. Arnold). In Calif. ssp. *virgulti*, if a mating pair is startled, the female flies, the male dangling.

Scott, J. A. 2017. *Apodemia* "*mormo*"-group variation, especially in New Mexico, Colorado, and in Sonora, Mexico (Riodininae, Lycaenidae). Papilio (New Series) #26:33-39.

Apodemia nais nais Coppermark (Nais Metalmark)

Easily identified on the unh, which resembles *Lycaena hyllus* somewhat, whereas the ups resembles a checkerspot (Melitaeini). Adults have light green eyes.

Habitat the lower mountains below the Canadian Zone, especially very open Ponderosa Pine forest or treeless hills with numerous *Ceanothus fendleri*. Hostplant in Colorado bushy Rhamnaceae: *Ceanothus fendleri* low bushes. (Females did not lay eggs on *Prunus virginiana* var. *melanocarpa* in my lab, even though W. H. Edwards managed to rear Ariz. larvae on *Prunus*, and *Prunus havardii* is the host for W Tex. ssp. *chisosensis*.) Usually uncommon.

Eggs greenish-white, laid singly on host leaves (upper or underside) or stems or inflorescences. Larvae eat leaves and probably fruits. Older larvae live in a nest of leaves silked together. Larva light-purplish (greenish ventrally), with a middorsal purple heart-line edged by tiny white spots, a wide cream subdorsal band along the lower edge of topmost BD scoli, and three rows of "scoli"-like-verrucae on each side containing many shorter black setae and a few long white setae, the BSD and BL1 "scoli" on purplish orange-tipped bumps; head black, lighter above, hairy. Pupa gray-brown (dark greenish on abdomen, the eye orange) with several gray-brown lines and a silk girdle, covered with white hair except on wing cases. Half-grown to nearly-mature larvae hibernate, under fallen leaves etc.

One flight M June-E Aug. but usually L June-July.

Adults prefer the white flowers of its hostplant *Ceanothus fendleri*, and often visit *Apocynum androsaemifolium* and various yellow and white flowers, and often visit mud. Adults have an erratic nonlinear flight. Adults usually bask and feed with wings spread.

Males mate-locate by raiting in preferred topographic sites, and by fleeking about the hostplant: Males rait and sometimes flait from ~08:50-14:30 in dry little-vegetation swales, including small clearings/depressions, especially steep little dirt clearings near gulch bottoms or clearings at the bases of slopes, or in little hillside swales (sometimes between pine trees and a slope) or old steep dirt roads simulating swales, as males rait on plants ~15-30cm up. Raiting behavior was seen throughout the day including as early as 08:50 and a courtship at 09:00, and frequent 09:15-10:30-rest of day on dry S-facing hillsides. I saw many males feeding on *Ceanothus fendleri* flowers and fleeking about them and often chasing. In a courtship on the hostplant, the male held his wings ~70º spread from each other and flicked them behind a female whose wings were spread somewhat (~60º) also, as he pursued the ovipositing female 4x.

Lycaenidae, Lycaeninae Coppers, Hairstreaks, Blues

Lycaeninae is a very large subfamily with ~5151 species worldwide. The male foreleg is somewhat smaller than the rear legs but not as small as in Riodininae, while female forelegs are nearly the same as the other legs. A peculiar behavior called "hindwing rubbing" is displayed by adults of some Lycaeninae tribes (the coppers=Lycaenini, hairstreaks=Eumaeini & Theclini, and blues=Polyommatini), in which the wings are fully closed (raised) and the hindwings move forward and back several mm, the left moving one way while the right moves the other way (various other mostly SE-Asia tribes of Lycaeninae lack this behavior). This behavior helps to direct a predator's (birds etc.) attention to the rear of the hindwing where there is often an eyelike spot and sometimes even a tail which simulate a head and antennae, in the hope that the bird will peck at the hindwing tornus rather than the real head and the butterfly can then escape. But many Lycaeninae in those three tribes lack the eyspot and tail and nevertheless still do "hindwing rubbing" evidently because that behavior evolved in the ancestor of those three tribes of Lycaeninae and is still in their DNA. The % of species having a false head with eyespots decreases with latitude from the tropics, so halfway to the poles only ~half the species have the false eyespots. Eggs are incredibly variable in sculpturing of the shell (see photos of Downey & Allyn 1981, 1984). Most Lycaeninae have just 4 larval stages. Older larvae of Lycaeninae are sluglike in shape with thick skins, and usually have small heads (except for various foreign species such as *Feniseca* and *Eumaeus*) that can be retracted into the thorax to keep ants from grabbing them, and extended into the hostplant to mine the food. Older larvae of many species—perhaps the majority—are tended by ants, and larvae of Eumaeina and Polyommatini produce honeydew from a honeydew gland on A7 to bribe the ants not to attack. Some Lycaeninae have "dew patches" on top of T2 (G. Clark, C. Dickson 1956, Lepid. News 10:37-43). And nearly all Lycaeninae have perforated cupolas=lenticles which produce a pheromone mimicing the brood pheromone of attendant ants, to prevent the ants from attacking. Larvae of nearly all Polyommatini have eversible tubercles on A8 that may have long hairs and waft a pheromone mimicing the alarm pheromone of attending ants. In Europe the larvae of some species (*Maculinea*) are carried into ant nests where the larvae eat ant larvae, but none of those are known in Colorado. Some larvae of *Lycaena rubidus* have been found in ant nests below the hostplant. Pupae are rounded like deer pellets, attached by silk girdle and cremaster.

Lycaenidae, Lycaeninae, Lycaenini Coppers

Coppers are named because many species have a copper-like brassy upperside, at least on males, although some species are brown, reddish, yellow, or even blue. Lycaenini contains about 50 species worldwide, mostly in Eurasia and North America. Adults have a rather thick thorax, and flight is stronger than most blues but is fluttery, not as erratic as the flight of hairstreaks. Adults do not migrate and are rather local. Most species rait to find females, but Colorado *L. heteronea* fleeks like blues (Polyommatini) and its wings are blue like them. Eggs hibernate in all North American species, except for two (*Lycaena phlaeas* and *L. cupreus*) that are related to Eurasian *Lycaena* and hibernate as half-grown larvae like those Eurasian species. Larvae often eat Polygonaceae plants, and are sluglike like most other Lycaeninae. Three other species eat *Vaccinium*. Lycaenini older larvae have only four larval stages. Older Lycaenini larvae have “mushroom” setae shaped like a bush. Older larvae lack honey glands and eversible tubercles, yet some species have relationships with ants evidently using their pheromone-producing perforated cupolas=lenticles, and four *Lycaena* (*xanthoides*, *x. editha*, *rubidus*, *heteronea*) have dendritic setae that are important in relationships with ants. Pupae are pill-like (ellipsoidal) like most other Lycaeninae, attached by cremaster and silk girdle. Adults bask dorsally (by spreading wings).

Lycaena cupreus snowi Lustrous Copper

Easily identified by the brassy upf and uph (females may be yellower) and the gray unh, and the Alpine Zone talus habitat of ssp. ***snowi***. Other *Lycaena* species with the ups orangish or orange-brown have a black submedian spot in upf cell CuA_2, which is missing in *L. cupreus*. The unh submarginal orange band is very narrow. Interestingly, in neighboring states incl. Wind River Mts. and NW Wyo.-Utah, the Alpine Zone is occupied by *L. phlaeas arctodon,* and *L. c. artemisia* (shiny reddish-orange on ups with larger spots, unh creamy-gray, intermediate to the reddish Calif.-Ore. ssp. *cupreus*) occupies lower altitude often in sagebrush habitat and seldom up to timberline, including Wind River Mts. and Jackson Hole in Wyo.

Habitat Alpine Zone talus slopes, and talus that extends barely down into the Subalpine Zone. Hostplant in Colorado herb Polygonaceae: *Oxyria digyna* (ssp. *artemisia* elsewhere eats *Rumex paucifolius* & *acetosella*). Uncommon.

Eggs greenish-white, soon turning white, with gigantic craters over egg (each about 1/8 the width of egg, photo in James & Nunnallee 2011), laid singly mostly on rocks near the host. Larvae eat leaves, without nests. Older larva green with indistinct markings: a slightly darker heart-band edged by yellowish, a row(s) of weak yellowish dorsolateral dashes, a lateral yellowish band; BC larva (Guppy & Shepard 2001 photo) dark-green with darker heart-band. Older larva ssp. *artemisia* in Utah light-green, sometimes reddish, or with variable dorsal & lateral red stripes or dashes. All *Lycaena* larvae lack a honey gland and eversible tubercles (Ballmer & Pratt 1988 p. 34). The older larval setae of ssp. *snowi* are longer than those of Calif. ssp. *cupreus,* and are long like *L. phlaeas*. Pupa brown; in S BC (Guppy & Shepard 2001 photo) mottled brownish-green, wings tan, with numerous black specks and abdomen has lateral brownish band. Half-grown larvae hibernate below-timberline (3rd-stage in Calif. ssp. *cupreus* [Ballmer & Pratt 1988] and probably *artemisia*, out of 4 stages). But Alpine Zone *snowi* are surely biennial, so evidently L2 and L4 hibernate (James & Nunnallee 2011).

One flight July-Aug. mostly M July-E Aug.

Adults visit yellow flowers almost exclusively, rarely white or purple, including Asteraceae *Senecio* (*Packera*) *crocatus=dimorphophyllus, S. fremontii* var. *blitoides* (favorite), and *Geum rossii turbinatum*. I have not seen them on mud. Adults fly fairly fast, almost as fast as *L. phlaeas*. Adults bask dorsally with wings spread. Adults crawl into spaces between talus rocks when it becomes cloudy, and no doubt roost there.

Males rait and often flait all day in little gulchlike depressions in talus slopes to seek females, as they rait mostly on large rocks and fly only ~10 cm up in part to avoid strong winds. Males chase after other *L. cupreus*, and sometimes chase *Colias meadii* and *Chlosyne whitneyi*, perhaps because both are orangish similar to *L. cupreus*. Males share the same rockslide hollow mate-locating spots with *Chlosyne whitneyi* and *Erebia magdalena*, though *E. magdalena* requires only larger nooks while the others rait in small to large nooks. In courtship, the male overtakes the female and she may hover with him hovering below, after landing an unreceptive female flutters her wings, and the male behind also flutters to transfer pheromone and bends his abdomen to try to mate when both have closed wings. Unreceptive females flutter strongly and crawl away etc.

Lycaena phlaeas hypophlaeas Small Copper (American Copper)

Identified by having the unh mostly gray with an orange marginal band, the uph mainly gray-brown and the upf mostly orange. The unh apex lacks the black dashes next to the margin that are present in *L. cupreus*. Small blue dots may occur just inside the uph marginal orange band (form **caeruleopunctata**). Ssp. ***hypophlaeas***=*americana* is a rare stray from low-altitude E U.S. to Colorado (2 specimens from El Paso Co. perhaps transported in hay, plus records from Prowers Co. Colo., and strays to Colfax Co. NM, Laramie Co. Wyo., & SE Mont.). {*L. p. arctodon* occurs on Alpine Zone talus in Wind River Mts. of Wyo. but high-altitude *L. phlaeas* populations are unknown in Colorado, though they occur in S and NE Utah.} Ssp. *hypophlaeas* has been hypothesized to have been introduced from Europe to North America, where larvae prefer *Rumex acetosella* which also was introduced to N.A. earlier from Europe. But E U.S. butterflies were given different ssp. names *hypophlaeas* and *americana* for the logical reason that they differ from European butterflies. Most of Europe has ssp. *phlaeas* with brown unh and a definite little hw tail, and Lapland in Scandinavia has ssp. *polaris* with gray unh and minimal tail and has a brassy ups like the arctic/alpine North American ssp. So that theory is bogus, unless there is someplace in northern Europe such as southern Scandinavia that might have adults with gray-unh and no tail and orange non-brassy upf similar to *hypophlaeas* (ssp. from India and Japan have gray unh but differ in other ways). Scandinavian adults I have seen have gray to light-brown unh and have almost no tail or a definite tail and usually have a toothed hw margin, and many have blue uph spots, so they match poorly with ssp. *hypophlaeas*; and *Polygonum* is a Norway host.

Habitat weedy fields usually with *Rumex acetosella* in E U.S. Hostplants in E U.S. herb Polygonaceae: *Rumex acetosella*, *crispus*. In Wyo. ssp. *arctodon* host *Rumex acetosa* and assoc. *Oxyria digyna* (the host in Utah). A rare stray to Colo.

Eggs greenish-white, soon turning white, the shell formed of gigantic hexagonal craters, laid singly on uns of host leaves or on stems. About 150 eggs are laid in a lifetime in Japan. Larvae eat leaves (young larvae eat just the underside) at night, without nests, resting on lower petioles or litter by day. Older larva just solid green or yellowish green; or light-bluish-green or green with pinkish lateral area that may enclose a creamy line, and reddish heart-band; or larva red with yellowish laterally; or in *arctodon* and Calif. *L. p. shields* (Ballmer & Pratt 1988 photo) whitish-green sometimes with a dusky pinkish heart-line and sometimes with red dorsal dashes and a red lateral stripe; in *L. p. arethusa* from Yukon (Guppy & Shepard 2001 photo) dark-green with pink dorsal stripe and pink sides. European larvae may be just green, but often have reddish heart-band and reddish lateral band, with many black setae. *Lycaena* older larvae have tiny "mushroom" setae. Pupa light brown or reddish or gray, sometimes tinged with yellowish-green, with many small dark dots and specks, some weak browner streaks on wings between the veins, attached by silk girdle and cremaster. Half-grown larvae hibernate evidently 3rd stage (out of 5 stages) for Calif. Alpine Zone *shields* larvae reared in cool [natural] shorter-day lab, but larvae reared in warm longer-day lab may have only 4 stages [G. Ballmer & G. Pratt 1989 J. Lepid. Soc. 43:59-65]); the diapause is triggered by short photoperiod and low temperature as usual among butterflies. However alpine ssp. *arctodon* and ssp. *shields* and ssp. *arethusa* in W U.S.-Canada surely hibernate twice, as younger (L2?) and old larvae.

Several generations in E U.S., May-Sept. for the rare strays to Colo.

Adults visit flowers of all colors, and visit mud. They usually body bask with wings half-open and head usually facing away from the sun (they sometimes bask laterally) (they seldom do hindwing rubbing while basking), and M. Douglas (Douglas & Douglas 2005) notes that they keep their head up while basking, unlike many other lycaenids.

Males of ssp. *hypophlaeas* in E. U.S. evidently rait all day, raiting on ~1/3-1/2m plants often in low weedy places where *Rumex acetosella* grows. Ssp. *arctodon* raits evidently all day on flowery rocky slopes including talus, especially in nooks or on trails at the base of such slopes, where the host grows. Adults have a faster more erratic flight than *L. cupreus snowi*. Courtship was studied in Japan and Europe (Y. Suzuki 1978 Trans. Lepid. Soc. Japan 29:129-138; Y. Suzuki 1976 Kontyu, Tokyo 44:193-204; J. Y. Ide 2014 Eur. J. Entomology 111:417-420 and references there): Males rait all day ~07:30-16:30 to await females, sometimes on flowers, and flait/fleek sometimes in the sunny warmer part of the day (males spend <5% of their time in flight). Males fly and approach rapidly-fluttering passerbys coming within ~1m, and ignore very-different passerbys such as *Pieris rapae*, as they try to determine the species identity of passerbys and continue to pursue only other *L. phlaeas*, then if both are *L. phlaeas* males the pursued male may shortly land (the raiting male occasionally tried to mate with the other male as if it were a female), or the raiting male may terminate the pursuit after up to 10m or if the passerby flies high into the air, or the passerby may engage in mutual pursuit with the result that both fly rapidly in a circle for a while then one leaves or lands. In courtship, the male pursues the female and flies closely around her then they land (or he spots a landed female) and he attempts to mate and crawls after her with wings half open and fluttering for ~40 sec. and the female accepts the male and they join. Unreceptive females close their wings when the male is near so he won't notice her (the male is attracted to the reddish ups, and is attracted to her uns when he comes near), but if noticed females ignore the male or walk or fly away, or turn face-to-face, or flutter (the rejection dance) until the male flies away, or she may fly high to try to escape. Mating lasts 16-17min. Females mate when 2-3-4 days old [surely they wish to mate sooner than later], then become unreceptive (they rarely mate more than once). If a mating pair is startled, the female usually flies, the male dangling. Males can distinguish females from males when approaching <15 cm away, and in Europe P. Douwes (1976, Entomol. Germ. 2:232-241) suggests that females (at least virgin females) have a pheromone attractive to courting males.

Lycaena helloides helloides **Purplish Copper**

The unh is orangish tinted. Both sexes have an orange marginal hw band, while males are mostly brown on ups and females are mostly orange esp. on upf. *L. helloides* differs from *L. florus* by having more orange (males usually have about 4 lunules on uph margin, and females are generally 80% orange on upf), and the unh is usually paler. And *L. helloides* has two or more generations (versus just one in *L. florus*) and mostly flies at lower altitude (including the plains and the main valley bottoms on the W slope) than *L. florus*, but they range very near each other at many places in Colorado such as the lower Front Range and upper Wet Mts. (*helloides* occurs on the Wet Mtn. Valley eastward up to Rosita 9000', its highest occurrence in Colo.) and the Yampa River, and both fly together at Steamboat Springs. The two species range very near each other at the edge of the San Luis Valley, and in SW Colo. *L. helloides* occurs at Gunnison in the Gunnison basin. *L. helloides* is nearly sympatric with and overlaps the range of *L. florus* in Jefferson County, where the former occurs into the foothills at Coal Creek Can., Indian Gulch W of Golden, at Mother Cabrini Shrine, 1 mi. E of Genesee Park 7500', Tinytown, Deer Creek Can., Indian Creek Cgd., & in Douglas Co. at Jarre Can. and Deckers, and *L. florus* occurs (or occurred) as low as Critchell ~7760'. The palest (largest amount of upf orange) populations in Colorado are on the floor of the San Luis Valley, but they aren't quite different enough to name as a distinct subspecies. Ssp. **helloides** occurs all over W North America (including the Ruby Mts. of NE Nev.), except for a darker unnamed ssp. in S BC.

Habitat streamsides, valley bottom meadows, and lake margins, from the plains up through the Canadian Zone. Hostplants in Colorado herb Polygonaceae: *Rumex crispus, triangulivalvis, fueginus, Polygonum* (*Persicaria*) *amphibium coccineum* (at Barr Lake in late summer, frequently nearly a million butterflies fly on *P. a. coccineum* on emerging lake margins), *pensylvanicum, lapathifolium* var. *incarnatum*. Usually uncommon elsewhere, sometimes common.

Egg pale greenish-white, turning white, laid singly and haphazardly in litter at the base of the host. The *helloides* egg is finely-sculptured like *L. florus*, but usually has a wider sunken micropyle area on top. Larvae eat leaves, without nests. Older larva light- or yellowish-green, a middorsal green band, edged by a cream or yellowish-green line beside it, three undulating weak paler dorsolateral lines, a cream lateral band (these bands may be weak). Pupae variable, dark red, creamy-red, reddish-tan, or reddish-yellow in different individuals, with middorsal and subdorsal tan to blackish bands, often with blackish mottling and browner wings on the redder pupae; pupa attached by cremaster and silk girdle. Eggs hibernate.

About three flights on the plains, M May-M June, M July-M Aug., and L Aug.-Oct. Two flights at higher altitudes L May-June and L July-E Sept.

Adults visit whitish and yellow, sometimes purple/violet and pink flowers, including *Aster ericoides, A. lanceolatus hesperius, Bidens cernua, B. frondosa* (favorite), *Dieteria=Machaeranthera canescens & D.=M. bigelovii=pattersonii, Polygonum* (*Persicaria*) *amphibium coccineum* (favorite). I have not seen it on mud (probably because its habitat is moist), and in Calif. A. Shapiro notes it seldom or never visits mud. Adults bask dorsally with wings spread at least partway. Adults roost on *Rumex* stalks and various other tall plants.

Males mate-locate all day, as they rait ~1/2m up on plants in valley/gulch bottoms/creeksides/lake shores etc. near or on hostplants, and they flait/fleek almost as often (in high-density populations they usually fleek) about the hostplants. In a completed courtship, the male overtook the female and both landed, she fluttered full stroke as she was not very receptive, the male behind her vibrated his open wings 80-100°-spread and bent his abdomen to try to join, then she flew and they landed and she became more receptive as she kept her wings closed then and afterward and he vibrated his 80°-spread wings, she flew again and they landed and he vibrated his 45°-spread wings and finally joined after attempting to join 5X on both sides of her. Near a female the courting male holds his wings fairly-widely open (45° up to 100° or 120° spread) and flutters them at small amplitude (vibrates them) or at much wider amplitude, evidently to transfer pheromone to her, and while beside her he may creep under her partly-spread wings (while his wings are leaning away from her yet spread apart 30° and motionless or sometimes vibrating) and bend his abdomen to try to join. Receptive females would remain quiescent, while unreceptive females flutter her usually-widely-spread wings at wide amplitude or small amplitude to repel the male, or she crawls away or moves if his abdomen touches her, or she flies high in the air to try to escape. The male may hover and flutter over a fluttering unreceptive female. During mating the male's valvae are together beneath her abdomen, so male and female remain attached together mostly because of the positioning of his uncus/gnathos. If a mating pair is disturbed, the female flies, the male dangling.

Lycaena florus Florus Copper

L. florus usually has less orange than *L. helloides* (males have 0 to sometimes as many as 4 orange lunules on uph, and females have no orange to 80% orange on upf), and the unh is usually a little darker. *L. florus* mostly flies at higher altitude than *helloides*, and its hostplant is nearly always *Vaccinium*, only rarely Polygonaceae. And *L. florus* always has just one generation. Much new research has been done {in Papilio (New Series), 2008 #18:39-55 + pls II, V + figs. 2-10, which included egg morphology by D. Wright, chaetotaxy by Wright and J. Scott, life history and taxonomy by J. Scott; also Papilio (New Series) 2014 #22:63-64 more life history}. That research proved that *L. florus* is a separate species from *L. helloides,* in a group of species (including *L. nivalis* and *L. mariposa*) which all have small cells on the egg shell with less prominent ridges, while *L. dorcas* is a very distinct species in a separate species group (including *L. epixanthe* and *L. hyllus*) which has a very different coarsely-sculptured egg with nearly twice the cell size with prominent points on the ridge intersections. (*L. dorcas* also has different egg and hostplants and wing pattern etc. from *L. florus*). Two ssp. occur in Colorado: Ssp. ***florus*** occurs in N Colorado south to the northern ~1/3 of the Sawatch Range, and averages 1.9 orange lunules on the male uph margin, and the female upf averages ~1/3 orange (varying from no orange to mostly orange); ssp. *florus* also occurs in Alberta-BC. Ssp. ***sangremar*** occurs in the Sangre de Cristo Mts. and averages nearly 2.6 lunules on males in S Colo. (3.1 in that range in NM) and the female upf averages ~1/2 orange; the San Juan Mts. has near-*sangremar* with an average of 2.4 lunules, females ~1/2 orange, while southern Sawatch Range adults evidently intergrade northward to ssp. *florus*. The name *castro* was sometimes applied to this species, but its lectotype was from an inadequately-labeled series containing both species, and the International Commission of Zoological Nomenclature (case 3450) designated a neotype of *castro* using a specimen of *L. helloides* from near my house in Lakewood CO, so *castro* is now a synonym of *helloides*. {Other ssp. occur in W U.S.: ssp. *caldera* with almost no orange from the Yellowstone area and N Utah and SE Idaho and the Jarbidge Mts. of NE Nev.; ssp. *megaloceras* with cream females from the Bighorn Mts. Wyo. to C Mont. mts.; ssp. *arcticus* from Yukon which is somewhat similar to *sangremar*; and *dospassosi* from N.B. based on its remarkable similarity to *megaloceras* in adult phenotype. Obviously *L. florus* populations have been isolated enough to develop numerous different ssp., while *L. helloides* was able to spread widely at lower altitude and has little geographic variation.

Habitat Canadian-Subalpine Zone openings in coniferous forest in valley bottoms and slopes (on N-facing slopes and adjacent gulch at lowest altitude) with abundant *Vaccinium myrtillus* and *V. scoparium* growing thickly among/near the trees. It occurs (or occurred) as low as 7760' at Critchell in Jefferson Co. on the N-facing slope (and streamside below) of a mountain covered with *Vaccinium myrtillus*. It occurs very near *L. helloides* at numerous places in Colorado including the near-lower Front Range, the upper Wet Mts., along the W edge of the Sangre de Cristo Mts./San Luis Valley floor, in SW Colo., and both occur in and near Steamboat Springs. Hostplants in Colorado herbs, nearly always Ericaceae: *Vaccinium myrtillus oreophilum, scoparium,* less often *cespitosum*; rarely Polygonaceae: *Rumex acetosella, densiflorus, triangulivalvis, Polygonum douglasii, aviculare, Oxyria digyna*. I spent numerous days trying to find hostplants of *L. florus* in Colorado, back when many people thought it was related to *L. dorcas* (*L. d. michuron* eats *Potentilla fruticosa* in Michigan, Ontario, Quebec, Maine etc., and *L. dorcas dorcas* eats the red-flowered *P. palustris* from Manitoba to BC), and I never saw females oviposit on *P. fruticosa* (they only feed on the yellow flowers) and had difficulty getting ovipositions/eggs, but eventually saw a few females oviposit on Polygonaceae (*Polygonum aviculare, P. douglasii*, and *Rumex acetosella* mostly on gopher diggings, plus I found a few eggs at *Rumex densiflorus* and *R. triangulivalvis* and *Oxyria digyna*), proving that they do use Polygonaceae as hostplants sometimes. But later Clyde Gillette found that *L. florus caldera* eats 3 sp. of *Vaccinium* in Wyoming/Idaho/Utah, so I watched females near *Vaccinium* and soon found many ovipositions in a short time and learned that *L. florus* always associates with *Vaccinium scoparium* (especially near timberline) and *V. myrtillus oreophilum* (mostly at the lower altitudinal range down to the Canadian Zone) and almost always eats those (it sometimes eats *V. cespitosum* which occurs farther from trees), and Polygonaceae are rare at most *L. florus* sites. Thus *Vaccinium* is the main hostplant and Polygonaceae is seldom eaten. Common.

Egg greenish-white, quickly turning white, sculptured like *L. helloides* but sunken micropyle crater much smaller, laid singly on *Vaccinium* lower stems or on litter under the occasional Polygonaceae host. The egg of *florus* is like *L. helloides*, except for the micropyle area; both species (and *L. mariposa* and *L. nivalis*) have eggs that are much more finely-scultured than the coarsely-sculptured egg of *L. dorcas* (and *L. epixanthe* and *L. hyllus*) that have comparatively few bumps (at each ridge intersection). Larvae eat leaves, without nests. Larvae and pupae are similar to *L. helloides*. Older larva green or light green, a green middorsal band, edged by a cream line, an undulating weaker cream dorsolateral line and a weaker line of dashes below that, lateral ridge cream or yellowish-cream, these lines/bands fairly weak. Pupa green or pale green with middorsal irregular blackish band and various blackish subdorsal dots and sublateral and ventral bands of black spots, wings & head & mouthparts usually green but sometimes mostly black. Eggs hibernate, and timberline populations are surely biennial so probably hibernate as older larvae.

One flight, mostly July-E Aug. at lowest altitudes, L July-Aug. near timberline.

Adults visit yellow, bluish, whitish, sometimes purple etc. flowers, including *Achillea millefolium "lanulosa", Anaphalis margaritacea, Erigeron ~speciosus, E. ursinus, Haplopappus* (*Oreochrysum*) *parryi, Heterotheca pumila, Potentilla fruticosa, P. pulcherrima, Rudbeckia hirta, Senecio atratus*. I have not seen it on mud. Adults bask with the wings spread partway (dorsal basking). Some adults roost with wings closed on *Pinus contorta* and *Picea engelmanni* leaves. I once saw a male flying perfectly well even though one hindwing was completely missing; he proved that the butterfly forewing is more important than the hindwing in flight (and Diptera flies of course fly well with just large forewings--their hindwings reduced to tiny "halteres" consisting of a rod with a vibrating blob at the end that functions as a gyroscope--and at the opposite extreme tiny Strepsiptera insects fly well with just giant triangular membranous hindwings).

Males mate-locate by usually flaiting and often raiting all day to find females, usually near the hostplant at flowery spots in small hillside swales or gulch/valley bottoms. Males flait by flying ~15 cm above ground or just above flowers to seek females, and they often rait there (~40% of the time or less) by resting ~10-40 cm up on flowers or other plants to await females. In a completed courtship, the male found a flower-feeding female and after landing he fluttered with wide amplitude ~10X/sec. behind her, and she was somewhat unreceptive so she also fluttered widely ~10X/sec., then she flew back and forth 1m twice with the male behind and then they landed and fluttered again and he joined. The courting male flutters his widely-spread wings to transfer pheromone to her: he flutters them fast or sometimes slowly, or just vibrates the mostly-spread wings (sometimes he flutters mostly closed wings, or just flicks near-vertical wings about once/sec.). Very receptive females would be quiescent and accept the male, while unreceptive females flutter their wings fast ~5x/sec. or slower, usually widely-spread or sometimes just 0-30^o-spread, or she may just vibrate her widely (~140^o)-spread wings to repel the male. If a mating pair is startled, the female flies, the male dangling.

Lycaena nivalis browni **Lilac-bordered Copper**

Identified by the light-yellow unh, with a lilac (pale-pinkish-violet) flush on the outer third. *L. nivalis* males have the ups paler-brown than *L. florus* and *L. helloides* (which have brown ups), and the black ups spots are a little weaker. Females vary from solid brown on upf to half pale-yellow. The Colo. ssp. ***browni*** has a yellowish unh with the lilac color only on the outer ~1/3 of the wing (versus the outer ½ in Calif. ssp. *nivalis* and Warner Mts. Calif. ssp. *warnermontana*). Some adults throughout the range of *L. nivalis* (and in all ssp.) have beautiful bright deep-yellow wing undersides (ssp. *bichroma* from NW Calif. and the Cascade Mts. of Ore. was even named for those colors), with a lilac sheen over that outer part, while others vary to dull-yellowish-tan with lilac sheen, for some unknown reason (perhaps we should consider the bright-yellow uns adults a distinct **yellow form**, they are so strikingly different, and those yellow adults do not characterize the ssp.). It occurs mostly on the western slope in Colo., barely spilling over onto the eastern slope within several km of the continental divide in Boulder, Gilpin, and Clear Creek Cos. *L. nivalis* is usually uncommon or scarce; I have never found it common.

Habitat upper Canadian and lower Subalpine Zone mostly open valley bottoms and terraces (in sagebrush on the W slope). Hostplant in Colorado herb Polygonaceae: *Polygonum douglasii*. Uncommon.

Eggs pale bluish-white, turning white, laid singly at or near the base of the host (in Wash. females can oviposit where the host senesced and disappeared earlier). Larvae eat leaves, without nests. Larva pale green or green, with a reddish or pink heart-band, edged by a weak or strong cream line, several rows of dorsolateral faint creamier somewhat-oblique dashes, a weak paler line between spiracles, and a weak or strong red-above-cream band along lateral ridge, the lines stronger-developed in Wash. (James & Nunnallee 2011 photos), often weak in Calif. (Warner Mts. Calif. photo in Guppy & Shepard 2001 just green with pink heart-band). Pupa pale straw-yellow, with brown spots and tiny trumpet-shaped hairs, a red middorsal line edged by cream in Wash. Eggs hibernate.

One flight L June-E Aug. (rarely M Aug.), mostly July.

Adults visit whitish and yellow flowers, and occasionally visit mud. Adults bask with wings spread.

Males rait all day in valley bottoms in dry shallow usually-bare depressions just above a creek or low spot, such as a shallow (1/2-2/3m deep, 2-4m broad) hollow with just a few small herbs, or a shallow depression on an abandoned slightly-inclined dirt road next to the valley bottom, or wide bare low spots of a valley-bottom trail, or a gentle roadside ditch or gravel swale (these sites were found to be raiting sites in multiple Colorado localities, one locality in Wyoming, and many in the Sierras and Siskiyou Mts. of California). After a raiting male chases some moving butterfly etc., he usually flies (flaits) about the spot ~30 sec. then lands again. One male raited for 8 days at the same inclined-bare dirt road spot, and others stayed in one raiting spot all day.

Lycaena hyllus=thoe Bronze Copper

Easily identified, the unh mostly white with marginal orange band, the unf mostly orange. Males and females differ greatly on upf, the male mostly reddish-brown, female mostly orange. This butterfly was known as *L. thoe* for 138 years, then F. M. Brown and W. D. Field discovered that *L. hyllus* was an older name for it; if they had petitioned the ICZN to preserve the name *thoe* we would still have that fine name.

Habitat moist valley bottoms and lake edges on the plains and lower mountains. Hostplants in Colorado herb Polygonaceae: *Rumex crispus, Polygonum* (*Persicaria*) *amphibium coccineum*. In late summer thousands or a million adults can fly around the edge of shrinking reservoirs on the plains (Julesburg Res., Barr Lake, etc., and in Minn.) on *P. a. coccineum*, because eggs and larvae laid then can survive submergence as the water level rises during the winter-spring (whereas *L. dione* larvae evidently cannot survive submergence). *L. hyllus* has been greatly expanding its range in western N. Amer. (Utah, Idaho, BC, etc.) in recent decades, perhaps because of the spread of *Rumex crispus* along roadsides, and it has now expanded into the San Luis Valley (several sites in the San Juan Mts. in Conejos County up to 8200' altitude). Usually uncommon, but abundant at those lakes.

Eggs dull green, soon turning white, laid on litter below host, unless the hosts grow in water in which case eggs are laid on dead leaves still attached to the plant (Bright & Ogard 2010 state eggs are on uns of leaves, along stems, and sometimes on seed heads, evidently above wet ground). Larvae eat leaves, sometimes buds & flowers, without nests. Older larva yellowish-green or green, with darker-green heart-band, next to it a yellower-green stripe blending downward into green (sometimes blending down as far as the side), occasionally several rows of weak paler/dark oblique dorsolateral dashes, lateral ridge slightly paler. Pupa green or tan or light yellowish-brown, with numerous small brown or reddish-brown dots incl. several rows on abdomen, a middorsal darker abdomen band, some red-brown streaks between outer wing veins, sometimes brownish on top of thorax. Eggs hibernate.

Two generations on the plains, M June-July, and Aug.-E Sept. (sometimes E Oct.), but one flight M July-L Aug. in the Wet Mtn. Valley (and presumably for the recent SW San Luis Valley population).

Adults visit yellow or whitish, sometimes purple/violet/blue or pink, flowers (on all colors in Ohio), including *Asclepias speciosa, Bidens frondosa, Polygonum* (*Persicaria*) *amphibium coccineum*. They probably visit mud. Adults body bask, dorsal bask with wings spread, and sometimes lateral bask. Adults can disperse 1km.

Males rait all day in valley bottoms/gulches/meadows to await females, as they rait ~60 cm up (once 2.5 m up) on plants, and males sometimes fleek about the host (especially at high density at the lake margins) to seek females. In courtship, the male may hover around the female or flutter behind a female in air, and flutter after landing beside her, to transfer pheromone, and the male may nudge beneath her wings to try to mate; receptive females surely would remain quiescent and accept the male, while unreceptive females flutter widely to repel him, and keep her wings spread so he cannot join. Males have been seen landing on pupae attached to leaves, suggesting a female pheromone. Courtship is probably similar to *L. helloides*/*L. florus* etc.

Lycaena heteronea Blue Copper

The unh is white (with or without black spots) and the ups is blue with darker veins (males) or brown (females), distinguishing it from other *Lycaena*. *L. rubidus* is similar on uns but has orange ups in males and many females. Female *L. heteronea* lack an orange uph border or rarely have a tan border or a weakly-orange border, whereas female *L. rubidus* always have an orange uph border; questionable female *heteronea* with a weakly-orange uph border always have weak blue scales tinting the ups wing bases, whereas *rubidus* females have the ups bases brown or orangish and never have a bluish tint. Two ssp. occur in Colo. On the western slope and in Subalpine Zone just E of the continental divide, ssp. ***heteronea*** has few or no unh blackish spots (*klotsi* appears to be a synonym, as ssp. *heteronea* everywhere in N. Amer. generally varies from few to no spots). On the east slope at lower altitude (from S Colo. to the Snowy Range of S-C Wyo.) ssp. ***gravenotata*** has many blackish unh spots {a similar blackish-spotted butterfly occurs on E side of Cascade Mts. from NW Calif.-N Oregon, which can share the *gravenotata* name because the primitive condition in *Lycaena* is an uns full of black spots, so the weak-spot ssp. *heteronea* butterflies diverged from the primitive spotted butterflies to become a second weakly-spotted kind}. Most females are brown on ups, but rare females (**form clara**) are all powdery-blue on ups except for the costal part of upf; those females occur very rarely everywhere but seem most frequent in high-altitude populations of ssp. *heteronea* on both sides of the continental divide where roughly 2% of females are mostly blue. *L. heteronea* has the same hostplants and coloration and Colorado mate-locating behavior as various blues (Polyommatini), an extraordinary convergence, which perhaps improves the functioning of mate-locating behavior if the colors and pheromones allow *L. heteronea* males to avoid wasting time investigating other males and *L. rubidus* and various blues.

Habitat open brush/forest/sagebrush from the upper foothills to the lower Canadian Zone, plus the upper Transition to Subalpine Zone for ssp. *heteronea*. Hostplants in Colorado herb Polygonaceae: for ssp. *heteronea Eriogonum subalpinum* and *E. umbellatum* { Bernard & Remington (1991) also reported oviposition on *E. subalpinum* and *E. umbellatum*, presumably in Gunnison Co.}, and assoc. *E. umbellatum* var. *porteri* (Wolfe et al. 2010 reported *E. racemosum* and *E. corymbosum*, probably in Utah) (Austin & Leary 2008 reported *E. heracleoides* & *E. microthecum* in Nev., which may be hosts in W Colo.). Colo. hosts for ssp. *gravenotata*: *E. umbellatum* var. *umbellatum, E. jamesii, E. flavum*. Usually uncommon.

Egg light-green, turning white, laid singly on bracts under the host umbels. Larvae eat young leaves, without nests, but they are tended by ants. Older larva light-green or grayish-green, a pair of middorsal thin creamy lines, next to them a wider row of strong cream crescentic dashes, a strong or weaker row of cream sinuous marks below that, then several weak vague cream sinuous rows above the lateral weak cream or stronger yellowish band; these markings are often or usually weak, the lateral band the strongest. Pupa light green (greenish-gray or green on wing cases), with grayish-white mottling, a darker middorsal line, a pale lateral stripe, and greenish subdorsal spots; photo in Guppy & Shepard (2001) just mottled creamy-green with some dark dots, wing veins a bit paler; attached by silk girdle and cremaster. Eggs hibernate.

One flight M July-Aug. in S Colorado on *Eriogonum jamesii*; L June-E Aug. in the Front Range foothills on *E. umbellatum* and *E. flavum*; mostly July-E Aug. at middle altitudes mostly on *Eriogonum umbellatum*; and L July-Aug. just below timberline often on *E. subalpinum*. These flights are influenced by the hostplant flowering times, and have the common connection of flying L July everywhere.

Adults visit yellow (esp. the hostplant) and whitish flowers, sometimes blue/purple/violet or pink, including *Chrysothamnus* (*Ericameria*) *nauseosus, Cirsium arvense* (favorite), *Erigeron ursinus, Eriogonum flavum, E. subalpinum, E. umbellatum, Heterotheca pumila, H. villosa, Senecio atratus, Solidago altissima "canadensis", S. missouriensis*, and often visit mud. Adults bask with wings spread. They roost on top of bushes ~1-3m up, such as *Quercus gambelii* and *Cercocarpus montanus* top. In the Subalpine Zone I saw numerous ssp. *heteronea* adults roosting/basking with wings spread on 1.5m-tall *Sambucus microbotrys* tops, and as the large leaves cool in cloudy conditions they fold upward enclosing the butterfly and hiding it (both leaf and wings-closed colder butterfly have pale undersides), evidently providing simultaneous protection and warmth and camouflage.

Males fleek all day ~15-30cm up over the hostplants to seek females, on hillsides etc. regardless of topography, and sometimes rait especially on host flowers or sagebrush ~15-70cm up. Males have a strong rather fast flight, and in their bright blue color and size and speed they seem to outperform the "blues" (Polyommatini). The blue color perhaps allows males to ignore the many blue males of *L. heteronea* and various blues (Polyommatini) that waste their time while they search for the brown females. I saw mostly fleeking and occasional raiting in Colorado including the Front Range ssp. *gravenotata* and Clear Creek Co. ssp. *heteronea*; similarly, Bernard & Remington (1991) saw some resting males chasing other males (raiting behavior, evidently at Crested Butte, Gunnison Co. Colo. for *L. h. heteronea*), and stated that "newly hatched females attract males by wind-carried pheromones, not visual signals. Flying males [fleeking evidently] arrive, display their wing colors, and attempt to copulate, but the female accepts only a male with the conspecific [blue] coloration." (In contrast, in N California [A. Shapiro, C. Palm, K. Wcislo 1981 J. Res. Lepid. 18:105] and in S Calif. ssp. *clara*, males are reported to mostly rait. Shapiro [2007] reports that they rait on vegetation usually at about waist height in N Calif.) In courtship of less-receptive females, the landed male spreads his wings widely (~70^o-usually 90^o-spread, sometimes nearly closed) and flicks them a few times or in very short bursts every second or so, or he sometimes flutters them ~10-100^o spread, all to transfer his pheromone, and he may butt her a little or paw her with his forelegs, and he bends his abdomen to attempt to mate. Unreceptive females flutter some (I saw fewer vigorously-fluttering females repelling males than in other *Lycaena*) and crawl and turn away to avoid the male. During mating, the valvae fit under a greenish scaleless area below her dark lamella (*Lycaena* valvae do not clasp the lower abdomen as most butterflies do). If a mating pair is startled, the male flies (as does *L. rubidus* and unlike most *Lycaena*), the female dangling. Color vision of *Lycaena heteronea* and *L. rubidus* (Behr) was studied by Bernard & Remington (1991) and Sison-Mangus et al. (2006). Both species have optical receptors peaking at ultraviolet-360nm, blue-437nm, green-500nm, and yellow-red-568nm, the latter useful for detecting reddish butterflies and hostplants (the same wavelength used in human red-light cone detectors). The upper part of their eyes have some different optical receptors than the bottom part of their eyes, and the two species differ somewhat in their receptors. *L. heteronea* females require blue males, while *L. rubidus* females require orange-red males. But males evidently do not care about whether their females are brown or colored on upperside (female *L. rubidus* especially vary from brown to orange-red, *L. heteronea* brown to rarely blue) and females usually keep their wings closed anyway, so evidently males are attracted to female pheromones.

Lycaena rubidus **Ruddy Copper**

The uns is mostly white as in *L. heteronea*, but the male ups is orange and the female ups is brown to orange, the female always has an orange uph border which is absent or rarely weak in *heteronea* females (the female ups bases are brown or orangish, never faintly bluish-tinted as in all *L. heteronea* females). The subspecies of *L. rubidus* are rather weak, and most are useless. In Colo. the low altitude populations mostly have orangish ups females (ssp. ***rubidus***), while the high-altitude mountain pops. usually have brown ups females (ssp. ***sirius***), but there is great variation so these are not very good subspecies and could be treated as just **orange and brown female forms**.

Habitat open mostly moist valley bottoms on the plains and mountains including Canadian and sometimes Subalpine Zone. Hostplants in Colorado herb Polygonaceae: *Rumex triangulivalvis, densiflorus, occidentalis, crispus, Polygonum douglasii, Oxyria digyna*. Assoc. *R. venosus* on NE plains. Common.

Egg greenish-white soon turning white, laid singly in litter at or near base of the host. Larvae eat leaves, without nests, but they are tended by ants and hide in litter, and may be inside ant nests; Wolfe et al. (2010) note that larvae require loose understory (plant debris or gravel), and larvae may be 4-5" below the surface and 7-8" away from host stem, and 92 larvae were found under one small plant (probably in Utah). Older larvae green with darker heart-band and faint subdorsal and lateral creamy lines; or reddish-brown, with a dark-red-brown middorsal band (edged by yellow dashes), a faint yellowish row of dashes below that, and maybe a faint lateral creamy line. Pupa tan with numerous tiny reddish-brown spots all over, attached by crochets and a silk girdle. Eggs hibernate.

One flight July-Aug. (mostly M July-M Aug.), but L June-E Aug. on the plains and foothills.

Adults visit yellow, whitish, sometimes bluish/violet/purple or pink, flowers, including *Achillea millefolium "lanulosa", Cirsium arvense, Erigeron elatior, E. ursinus, Heterotheca villosa*, *Potentilla fruticosa*. Adults bask dorsally with wings spread.

Males rait all day on plants in dry gullies or along streams/gulch bottoms, or along trails through fields, as they rait ~1/2m up to await females; males seldom flait about flowers in valley bottoms to find females. In courtship, the male overtakes the female and may hover behind her as she flutters/hovers, then they land, when unreceptive females flutter (sometimes full-stroke) or may vibrate her wings at small amplitude (1/4" or 30^o spread) to repel the male, while the male flicks his wings (~0-70^o open ~1-2X/second) or sometimes flutters to transmit pheromone, and attempts to join. (Receptive females presumably remain quiescent and accept the male.) Unreceptive females may also raise her abdomen or turn away to reject him. For studies on optical receptors, see *L. heteronea*. When a mating pair was startled, the male flew like *L. heteronea*, the female dangling.

Lycaena dione **Gray Copper (Dione Copper)**

Identified by the brownish-gray ups (except females also have cream to orange upf spots), the uns creamy-gray with small black dots (not the brown spots with tan centers on *L. xanthoides*), and a long red marginal band on both uph and unh. It is a distinct species from *L. xanthoides* (both *L. dione* and *L. x. vurali* are or were sympatric and synchronic just upstream from Curtis Gulch Cgd., at the confluence of LaBonte Creek & Bear Creek, Laramie Mts. Wyo., R. Hardesty & D. Groothuis).

Habitat moist valley bottoms on the plains, and it sometimes ranges <1 km into the foothills. They often occur in disturbed places that are doomed to development. Recently in Colorado I have not found them often, and they are becoming rather scarce in colonies and numbers. In the eastern Great Plains they occur in tallgrass prairie remnants and pastures. It is absent at big reservoirs such as Barr Lake (where *L. helloides* and *L. hyllus* are common), and disappeared at a similar lake-now-reservoir in BC (Guppy & Shepard 2001), evidently because larvae—not eggs--cannot withstand flooding of

Polygonum (*Persicaria*) *amphibium coccineum*); Shapiro (2007) reports that Calif. *L. xanthoides* eggs can survive 3 months underwater, but larvae drown. Hostplants in Colorado large herb Polygonaceae: *Rumex crispus, triangulivalvis, occidentalis*. Increasingly uncommon.

Eggs greenish-white, turning white, laid singly in litter on or near the base of the host. Larvae eat leaves, without nests; young larvae feed by day but older larvae feed at night and hide in litter by day. Larvae are tended by ants. Older *dione* larva (Borkin 1993 has photos) green, a reddish-brown heart-band (dark-green or red in BC) edged slightly by paler color, a weak creamy sinuous subdorsal line, and faint paler tiny area above side. (Calif. *L. xanthoides* similar, green with maroon heart-band edged by yellowish.) Pupa tan (slightly orangish-tan on top of thorax), with tiny blackish specks on wings and thorax, and large blackish areas on front and covering much of top of abdomen where spiracles appear as pale points. Eggs hibernate.

One flight L June-July (rarely 6 June and L Aug.).

Adults visit purple, blue/violet, pink, or whitish flowers, seldom yellow, including *Asclepias speciosa*, *Cirsium arvense*; perhaps they sometimes visit mud. Adults bask by spreading the wings partly (body basking) or mostly (dorsal basking) and facing away from the sun. Adults live less than 2 weeks.

Males rait all day in gulch/valley bottoms to await females, as they rait ~1m up; sometimes males rait/flait over flowers. In courtship, the male pursues the female and they land, and the male flutters beside her (he sometimes spreads his wings ~70^{o} and vibrates them in bursts ~one burst/sec.) very close to her and bends his abdomen to try to join (no completed courtships were seen). Unreceptive females flutter her wings at wide amplitude ~10x/sec. or turn away or raise her abdomen 30^{o} to prevent him from joining. {Courtship of *L. xanthoides nigromaculata* is given below at *L. x. vurali*.}

Borkin, S. 1993. Investigating the Great Copper [*L. dione*]. Milwaukee Public Museum. LORE 43:16-19.

Lycaena xanthoides vurali **(=*montana*, =*L. editha montana*)**
Great Copper (includes Edith's Copper)

This butterfly is much smaller than *L. dione*, and occurs in the higher mts. Males of *L. xanthoides* ssp. are brownish-gray on ups like *L. dione* (females often have much cream patches on upf but some are dark with little cream); the uns is tan with large brown spots that have tan centers, unlike the solid black dots of *L. dione*; the uph and unh have an orange marginal band in both sexes, shorter and thinner than *L. dione* on unh, and the hw has a short little tail. Ssp. ***vurali*** in the Rocky Mts. has much larger unh spots than *L. x. editha* from Calif.-Ore. {Those two ssp. have been considered to be a separate species from *L. xanthoides* which has even smaller unh spots, but *xanthoides*X*editha* intergrade in a large area of N Calif.-SW Ore. and in middle altitudes on both sides of the Sierra Nevada Mts. (including Mather on W side of Sierra Nevada and Silver Can. & Sherwin Summit on the E side Sierra Nevada). That intergradation cannot be denied, and was reported by Scott (1981a) from Dunsmuir in CA and thoroughly discussed by Scott {Papilio (New Series) 14:35-36 (2006), & 19:58 & 19:77 (2008)} which references Warren (2005--Warren reported widespread intergradation in SW Oregon and also references a computer-grinding study by G. Pratt et al. that badly misinterpreted the data). One report suggests that both *xanthoides* and *editha* adults occur uncommonly at South Fork of Bishop Creek Calif. (K. Davenport 2004, Yosemite Butterflies, Taxonomic Report of International Lepid. Survey 5:20-21 & 61 [color plates K. Davenport, N. Kondla, C. Grisham, C. Howard Grisham, 2007, 5(2):1-83.]), where one or both may be mostly strays (*xanthoides* is replaced by *editha* above ~3200' in the Sierra Nevada, Shapiro 2007; one stray *editha* is known from the lower-altitude Mather area also). Those intermediates in Siskiyou Co. CA were named *pseudonexa* J. Emmel & Pratt. Additionally the ssp. *L. x. nigromaculata* from N Calif. is rather intermediate between S Calif. *L. x. xanthoides* and the "*pseudonexa*" intermediates [suggesting there are too many names for all that intergradation]. And the change from *editha* to *vurali* obviously continues the cline of enlarged spot size.}

Habitat open moist valley bottoms mostly in Canadian Zone, often with bushes such as *Potentilla fruticos*a or away from shrub willows. Hostplants in Colorado small herb Polygonaceae: *Rumex acetosella, Polygonum douglasii*. Uncommon.

Eggs greenish-white with coarse polygonal-ridge sculpturing, turning white, laid singly in litter at or near base of the host. Larvae eat leaves (mostly the uns). Older larvae tended by ants, without nests. Older Wash. larvae green, with a dark-red middorsal band edged by a bit of yellowish-green (James & Nunnallee 2011). Pupa yellowish-tan (orangish-tan on abdomen), wings greenish-tan, with numerous brown specks all over. Eggs hibernate.

One flight July-E Aug.

Adults visit yellow or whitish flowers, often blue and sometimes pink, including *Achillea millefolium "lanulosa", Anaphalis margaritacea, Chrysothamnus* (*Ericameria*) *nauseosus, Erigeron ursinus*. (W Ore. near-ssp. *xanthoides* feed on nectar and the sticky resin of *Grindelia* flowers.) I have not seen it on mud. Adults bask with wings spread.

Males rait all day in swales/depressions/trails/gullies/valley bottoms, as they rait on vegetation ~10-40cm up to await females. In courtship, the male flutters with wings mostly spread behind the unreceptive female, who flutters (fluttering her 30^{o}-spread wings in the one observation) to repel him. When a mating pair of ssp. *editha* was startled, the male flew, the female dangling.

{Courtship of Calif. *L. xanthoides nigromaculata* (Scott & Opler 1975) is useful here to supplement: In courtship, the male pursues a passing female, he often hovers behind a hovering female or over the landed female beating his wings with wide amplitude ~7x/sec., then they land, when he often flicks his partly-spread wings with small amplitude rapidly a short time, and attempts to join. Receptive females land and are quiescent as the male joins, whereas unreceptive females flutter their wings with wide amplitude ~5-10x/sec. (the "rejection dance") until the male departs, and unreceptive females raise the abdomen so the male cannot join. Females mate once, seldom twice. Average lifespan was 9 days for males, 14 for females, at a vacant lot in Berkeley, Calif. where Paul A. Opler did a mark-recapture study of *L. x. nigromaculata* and there was evidently little emigration (Scott & Opler 1975).}

Scott, J. A. 1981a ("1979[1980]"). Geographic variation in *Lycaena xanthoides*. J. Res. Lepid. 18:50-59.

Lycaena arota virginiensis **Tailed Copper**

Easily identified by the hw tails and the unique unh pattern. Males are mostly brown on ups; females are mostly orange and black with a large triangular black spot on middle of upf. Ssp. ***virginiensis*** from Nevada looks about the same as the butterflies named *schellbachi* from Arizona (both have unh more brown & male unf more orange than Calif.-Ore. ssp. *arota*), so I use the older name *virginiensis* in Colo.

Habitat the lowest foothills up to the middle of the Canadian Zone, in brushy or open woodland canyons. Hostplants in Colorado bushy Grossulariaceae: *Ribes leptanthum*, sometimes assoc. *R. inerme*. *R. leptanthum* is the primary host throughout Colorado, and the *L. arota* range ends just a short distance north of the limit of *leptanthum* in the Front Range (*Ribes inerme* and *R. cereum* etc. occur northward but are evidently not desirable hostplants): *R. leptanthum* ranges north to the Platte Canyon area and Deer Creek, and *arota* occurs northward at Deer Creek and strays rarely north to Tinytown where I found only one adult and *R. leptanthum* is absent and *R. inerme* is scarce. Often common in S Colo.

Eggs white, with ~13 vertical ribs between which is ~15 ladderlike horizontal steps, laid singly on twigs, dead leaves, etc., on or under the host. Oviposition occurs inside bushes of *Ribes leptanthum* (in the middle to near the bottom), on smooth tan twigs or bark of the branches, occasionally on dead leaves of another plant species under the bush (they are safe from humans inside the 1m or larger thorny bush, which is heavily armed with thorns that break off inside your skin then irritate). Larvae eat leaves, without nests. Older larva green, with a white line near the top that turns into more-lateral slightly-crescentic dashes on T2-3 and A7-8, a weak cream line above spiracles, and a white or yellowish lateral band edged above by dark-green (these dorsal and lateral bands are more frequent in S Calif. than N Calif.). Pupa blackish-brown or mottled tan or yellow-brown, the larval lines faint, several dorsolateral rows of small dark dots. Eggs hibernate.

One flight July-E Sept., mostly M July-M Aug. Scott (1974f) studied the species thoroughly.

Adults prefer white and yellow flowers, and occasionally visit blue/purple/pink ones, including *Apocynum androsaemifolium, Aster porteri, Chrysothamnus* (*Ericameria*) *nauseosus, Clematis ligusticifolia, Erigeron elatior, Erigeron speciosus, Eriogonum jamesii, Heterotheca villosa, Melilotus albus, Pericome caudata* (favorite), *Rudbeckia laciniata ampla, Solidago* (*Euthamia*) *occidentalis* (favorite), often visit ripe *Rubus deliciosus* berries, and visit mud. They seem to pollinate the yellow flowers of *Hymenoxys richardsonii*. In my mark-recapture study (Scott 1974f) adults were rather sedentary (some can move several hundred meters but mostly stay near attractive flower patches), and in a very hot year average lifespan was only 4 days because of the heat and predation by ambush bugs and robberflies. They bask dorsally by holding the wings ~120^o apart, usually facing away from the sun. Adults evidently roost on tree/bush branches. Adults "rub their hindwings together" to draw a bird's attention to the antenna-like tail in the hope the bird will peck at the wing tip rather than the body; they rub when basking, but seldom when feeding.

Males rait, on branches of shrubs and trees 1-2m above ground (extremes 1/5-2.5m up—A. Shapiro notes males often rait 3m up in Calif.), in small clearings (~3-5m in diameter) surrounded by tall trees or steep hills or both (these favored mate-locating clearings are most often in valley bottoms, sometimes on hillsides or ridgetops). They rait (and court and mate) only in morning, from ~07:15-11:00, and gradually stop between 11:00-12:00, and seldom rait after 12:00 (in the afternoon they visit flowers or rest on bushes). Raiting males discriminate well, so most objects they pursue are other *L. arota*. In courtship, the female is pursued by the male who flies ~15cm below her for a short distance, and the female lands on a branch with the male behind. The male then opens his wings 90-120^o apart (usually 120^o) and vibrates them at only 1-2mm amplitude (sometimes only 1-2 times/sec. or up to ~10 times/sec.) to transfer pheromone (some males did not vibrate their wings at all) and the male crawls alongside and joins. Receptive virgins can be quiescent during mating (in which case the male seldom vibrates his wings), while unreceptive females flap their wings almost full stroke ~10 or more times/sec. for ~2-5 sec. after landing to repel the male, and females fly away (often high up). Females mate just once (rarely twice), on their first or second day. If a mating pair is startled, the male or the female flies, the partner dangling.

Scott, J. A. 1974f. Population biology and adult behavior of *Lycaena arota* (Lycaenidae). J. Lepid. Soc. 28:64-72.

Lycaenidae, Lycaeninae, Theclini Hairstreaks

There are more than 2000 species of Theclini worldwide, more than 1400 in America especially in the tropics. Hairstreaks are so called because many have hairlike stripes on the underside of the wings (they also often have hairlike tails). Many hairstreaks are beautiful, and can be blue/violet on upperside or green on underside. Hairstreaks usually have thick muscular thoraxes and can fly fast, but their flight is usually erratic (not unidirectional) and they usually do not fly far and quickly stop. They usually rait to find females, but some species fleek. Many hairstreak species mate only late in the day. Larvae have just 4 stages (except *Callophrys gryneus* and *C. spinetorum*). Older larvae lack eversible tubercles on A8, but most of them have honey glands (except *Hypaurotis*) on A7 and evidently all of them have perforated cupolas=lenticles, and many species have close relationships with attendant ants.

Larvae are usually sluglike like Lycaenini and Polyommatini. Pupae are mostly ellipsoidal like other Lycaeninae, attached by silk girdle and cremaster. Eggs generally hibernate in species with shrub or tree hostplants, whereas pupae generally hibernate in species with herbaceous or succulent hostplants.

Lycaenidae, Lycaeninae, Theclini, Theclina Hairstreaks

Most Theclina species occur in Eurasia. Theclina adults have 11 forewing veins. U.S. Theclina adults visit sap and mud, but not flowers. The only Colorado species—*Hypaurotis crysalus*—basks dorsally by spreading the wings. The older larvae have only four larval stages. Colo. Theclina older larvae lack honey glands and lack eversible tubercles, yet some species elsewhere in the world—none in Colorado--have relationships with ants evidently using their perforated cupolas=lenticles to produce pheromones to communicate with the ants.

Hypaurotis crysalus Colorado Hairstreak

The violet ups and wing pattern are unique. Ssp. ***crysalus*** is in most of Colo. including SW Colo. Ssp. ***citima*X*crysalus*** (uns a little whiter, and the ups orange spots smaller though not as small as those from Wasatch Mts. Utah *citima* which has much less orange plus a whiter uns) occurs in NW Colorado and south of the San Juan Mts., and intergrades with ssp. *crysalus* just N of the San Juan Mts.

Habitat the *Quercus gambelii* zone from the foothills barely into the Canadian Zone. Hostplant in Colorado small-tree Fagaceae: *Quercus gambelii* in most of Colo., and probably also var. *undulata* (which represents *Q. gambelii* X *Q. grisea*) on the Mesa de Maya near New Mexico. Adults are rather sedentary, and seldom fly more than 5m away from an oak grove to new distant groves (disturbed adults may fly erratically away from a grove ~2/3m above ground but generally gradually turn and head back to the oak grove). In the Front Range they occur about as far north as the N limit of *Q. gambelii* W of Denver (rarely at the removed ski lift on slope SW Mt. Vernon Canyon). Females move a little more unidirectionally than males. Average lifespan is 5 days for males and 9 for females but they can live up to 17 and 21 days based on my mark-recapture study (Scott, 1974g). Common where the host is abundant.

Eggs light green (pale bluish-greenish-white) when laid, turning white ½ hour later, turning cryptic brown after a week, covered with hundreds of long blunt-tipped spikes, micropyle a small indentation. Eggs laid in *Q. gambelii* bark crevices, incl. crevices in leaf buds or on twigs at junction of leaf petiole. Larvae live on uns of leaves, without nests, eating new growth & older leaves. Older Colo. larva light green, a pair of yellowish-cream middorsal bands flare apart a little on thorax, two faint creamy oblique undulating subdorsal dashes on each segment, a slightly-darker-green undulating band above the tan spiracles, a cream band on lateral ridge (all the creamy bands/lines look pinkish on a [mis-colored] photo of S Ariz. larva in Allen et al. [2005] but text says just pale not pink), gray-green beneath when mature, body covered with pale short hairs; head brown. Pupa becomes light-orange-brown with abdomen paler-orange-brown, a middorsal brown band edged by creamy-green on abdomen, many black spots and streaks; attached by silk girdle over ~A2 and by cremaster. Eggs hibernate.

One flight mostly M July-Aug. (rarely the end of June and start of Sept.), (records M-L June-and sometimes July south of the San Juan Mts.).

Adults never feed on flowers (the proboscis is short) and feed only on host oak sap (on seeping knobs including where a leaf fell off, and sap from new acorns, or exudation from insect galls [such as a *Callirhytis* pip gall on *Quercus rugosa* in another state]), and imbibe raindrops on leaves and the moisture in wet sand/mud. *Quercus gambelii* often grows in thick monocultures where there are few flowers to drink, so they have evolved behaviors that reduce desiccation: the males fleek even in clouds and in light rain and just rest during prolonged sunny periods, they fleek in late afternoon-early evening when rain is more frequent, the females bask often with wings spread in cloudy and late-day conditions and males are attracted to the uv/violet display of basking females, and they fly in July-

August to benefit from the monsoon rains at that time. Adults bask dorsally by spreading the wings (usually flat, often halfway open, seldom slightly open=body basking) and moving the forewings forward slightly and orienting the wings somewhat perpendicular to the sun while facing any direction (even downward) but most often facing away from the sun. Resting adults do "hindwing rubbing" to display the unh eyespot, and ~8% of adults have eyespot-area chunks torn from both hw, which at least sometimes might have been a result of a bird pecking at the eyespot.

Mate-locating behavior: Males fleek erratically ~10-15cm over the canopy of the hostplant *Quercus gambelii* from about 14:20-18:10 (more often in cloudy periods--even slight rain--during this time) (courtships were seen mostly 15:00-17:30), as males make flights of 10m or more about the canopy to search for females; they fleek more often over the oaks in gully bottoms than on hillsides so are a little more common there. Males sometimes rait by resting on the oak canopy and flying up to investigate a passerby (usually a male). When the male spots a basking female using the uv-violet reflection on her ups wings, he lands beside her, or he pursues a flying female and both land on a *Quercus gambelii* leaf. The male crawls alongside the female, who closes her wings, and he courts by rapidly flicking his wings which are held above the body and rapidly opened and closed (~6mm between wing tips at the widest opening, the amplitude decreases at each wing beat to only ~1-2mm at the last beat) about 5-10 times during a burst lasting ~¼ to 1/3 sec.; this burst is repeated up to 2-3 times per sec. The male flicks his wings in this manner for several seconds, then bends his abdomen to join. Receptive females accept the male, while unreceptive females fly, crawl, or turn away, and elevate the abdomen if the male makes contact with it. My experiments (pinning fresh or oven-dried adults [with orange spots or removed orange spots] to oak leaves in various wing positions) showed that males are first attracted to females because of the uv/violet reflection from the ups of basking and flying females, while the orange spots are ignored (note that Utah ssp. *citima* butterflies mostly lack the orange spots), and females evidently have a pheromone that induces a male coming within 10-20 cm to court and bend his abdomen to try to mate (fleeking males approach and chase other males, but in my experiments males seldom land beside posed males and do not bend their abdomen to oven-dried females, compared to posed fresh females that elicit the full male courtship flicking and abdomen-bending behaviors [Scott, 1974g]). The uv/violet color of males—which covers more area on the ups of males than females--may induce the females to land, and his wing flicking evidently transfers a male pheromone to her to induce her to accept him. Females usually mate once, sometimes twice, rarely thrice. If the mating pair is disturbed the female flies while the male dangles below.

Scott, J. A. 1974g. The interaction of behavior, population biology, and environment in *Hypaurotis crysalus* (Lepidoptera). Amer. Midl. Nat. 91:383-394.

Lycaenidae, Lycaeninae, Theclini, Eumaeina Hairstreaks

All Colorado hairstreaks belong to Eumaeina, except for *Hypaurotis*. About 1400 Eumaeina species occur in the American tropics, many of them incredibly beautiful, and many are rarely found, probably because they spend most of their time on forest canopy. Eumaeina adults have only 10 forewing veins. Eumaeini adults visit flowers, unlike Theclina. Adults usually bask laterally (wings closed and left or right side perpendicular to the sun). Adult hairstreaks often have the hw tornus twisted a little, to help that area look like a head and antenna to fool predators such as lizards into grabbing the tornus instead of the real head (hindwing rubbing moves that tornus to encourage pecking at the tornus rather than the body). Eumaeina older larvae have only four larval stages (except *Callophrys gryneus* and *C. spinetorum* which have 5-7, Ballmer & Pratt 1988); they often associate with ants, and they have honey glands (except *Erora* from Ariz.-Mexico lack the honey glands) on A7 which produce honey to bribe ants not to attack, but they lack eversible tubercles (present on A8 in Polyommatini). Many species use those larval honey glands and their pheromone-producing perforated cupolas=lenticles during relationships with ants. Larvae are generally sluglike (*Eumaeus* from the Caribbean and Florida are less sluglike), and pupae are ellipsoidal, attached by silk girdle and cremaster.

Atlides halesus halesus **Great Blue Hairstreak (Great "Purple" Hairstreak).**

Easily identified by the blue ups, and the black uns which has red spots near the body and greenish-silver spots near the long tails. Ssp. ***halesus*** occurs in Colorado; Scott {2008, Papilio (New Series)#18:55} corrected the mistaken characters and ranges regarding the ssp. of *A. halesus* (*corcorani* is a synonym, and the only other valid ssp. is the Fla. ssp. *dolichos*=*juanita* with longer tails).

Habitat mostly Pinyon/juniper woodland. Hostplant in Colorado tree-parasite Viscaceae: mostly *Phoradendron juniperinum* growing mostly on *Juniperus osteosperma*=*utahensis* and perhaps sometimes on *J. scopulorum* (which also occurs on the W slope in W Colo., but *J. monosperma* does not according to W. Weber [Flora of Colorado by J. Ackerfield evidently wrongly maps the resinous-cone *monosperma* from W Colo.]). Usually uncommon. The host occurs in Garfield Co. so the butterfly should occur there also.

Eggs green, laid singly scattered on the host. Larvae prefer younger non-woody parts (young larvae prefer flowers and tender leaves, older larvae eat leaves), and are not associated with ants. Older larva solid green without markings except for a small diamond-shaped bluish-white prothoracic shield (with dark line through it) outlined in black, although some larvae have traces of a darker middorsal line or traces of small paler dorsolateral clouds; evidently covered with short whitish or tawny hair. Pupa brown, often heavily mottled with black, with scattered yellow-orange hair except on wing cases. When handled, pupae make faint squeaks. Pupae hibernate, at the base of the tree or under loose bark.

Several flights April-M May and L June-July-Aug.

Adults mostly visit whitish flowers, including *Apocynum, Asclepias, Baccharis, Bidens, Chrysothamnus, Eriogonum, Fendlera rupicola, Melilotus albus, Prunus, Rhus, Senecio, Solidago*, etc., sometimes visit aphid honeydew, and visit mud. Adults fly down-valley to seek flowers and mud (Scott 1973d).

Males rait on treetops on hilltops, as they arrive about noon and leave at dusk (12:00-19:30, mostly13:00-18:00) (thus males depart latest in June; my observations were only during part of the flight 13:50-17:40) (males quit raiting early on cool days of course). Raiting males rest 1-3m above ground on outer tips of Palo Verde hilltop bushes in the S Ariz. desert (Alcock 1983, who reported hearing wings meeting when one male investigates another), but rait on top of 3-5m+ *Quercus* and *Pinus edulis* and *Juniperus* hilltop trees in SE Ariz. & Colo. (in hot weather they rait on the shaded E and N parts of the top).

Alcock , J. 1983. Territoriality by hilltopping males of the great purple hairstreak, *Atlides halesus* (Lepidoptera, Lycaenidae): convergent evolution with a pompilid wasp. Behavioral Ecology & Sociobiology 13:57-62.

Satyrium fuliginosum semiluna **Sooty Hairstreak**

Identified by the rounded fw, the sooty-brown ups, and the dingy-brownish-cream uns with a few somewhat-fuzzy postmedian and postbasal spots. They resemble another *Lupinus*-feeding butterfly *Plebejus icarioides* in appearance, fleeking behavior, hostplant use, and habitat, an unexplained example of convergence. The best identification feature is the black spot at the end of the unf discal cell, which is weak in *S. fuliginosum*, solid black in *icarioides*. Splitters have tried to divide this species and treat ssp. ***semiluna*** as a species (the uns of *semiluna* is much paler than the brown-uns ssp. *fuliginosum*), but Eric Rundquist (2012 thesis Univ. Calif., Davis) found that it intergrades with the NW Calif. ssp. *fuliginosum* in a narrow zone with polymorphic intergrading phenotypes (at Mt.

Lincoln, Placer Co. Calif. etc.) where *semiluna* genes introgress into *fuliginosum*, and across this region and the hybrid zone, males of both ssp. actually prefer to mate with *semiluna* females experimentally released there in nature! The stigma of *semiluna* was lost in ssp. *fuliginosum*, which is evidently harmfully inbred. In their coloration (dark upperside and whitish spotted underside) and their *Lupinus* hostplants and habitat, *S. fuliginosum* resembles blues (Polyommatini) and adults resemble females of the *Lupinus*-feeder *Plebejus icarioides* as noted above, which is amazing but is evidently not a case of mimicry because eating *Lupinus* evidently does not make the adult butterflies distasteful to birds (currently neither species is thought to be poisonous to predators), so the creamy underside evidently serves as camouflage on *Artemisia tridentata* sagebrush.

Habitat sagebrush hills mostly in the Canadian Zone. They seem to occur mostly near ridgetops on the less-windy side (usually the E or SE). Hostplant in Colorado herb Fabaceae: *Lupinus polyphyllus* var. *prunophilus*, and associated with *L. caudatus*. Wolfe et al. (2010) list *Lupinus sericeus*, *argenteus* as hosts, probably in Utah. Uncommon.

Eggs pale whitish-bluish-green with a tinge of tan, becoming tan, laid mostly in small clusters (of two eggs in my three records) in holes in the soil next to hostplant stems. I did not notice much glue on eggs, whereas in low-altitude shrub-steppe populations in Wash. James & Nunnallee (2011) observed them covered with transparent cement. Larvae are strongly associated with ants (medium-sized red ants in Grand Co.), and evidently feed at night and stay in litter holes near the host stem by day (ants may even make these litter holes sometimes, and there may be 3-4 larvae in a hole, Wolfe et al. 2010). Older Calif. larva (Ballmer & Pratt 1988 fig. 74a, Guppy & Shepard 2001) green, heart-line slightly darker, a white band of slightly oblique dashes away from the middorsal area, then several rows of oblique narrow weaker white dashes in the dorsolateral area, the body slightly-browner-green above a lateral white ridge (all the whitish markings are edged by dark-green); a dark shield on top of T1; the recessed head brown. In Wash. mature larvae are green as in Calif., or pinkish with the same white marks (and adding a narrow middorsal whitish line) (James & Nunnallee 2011). Pupa in Calif. milky-green, or shiny reddish-brown with the wings & side of thorax yellower-greenish. Eggs hibernate.

One flight mostly L June-M July (seldom M June and L July, rarely E Aug.)

Adults visit yellow and sometimes whitish flowers, including *Arnica mollis, Eriogonum subalpinum, E. umbellatum, Tetradymia canescens*; they probably visit mud. Adults bask laterally. They use their middle leg to clean the antenna on that side of the body. Adults are rather sluggish.

Males mate-locate evidently all day by fleeking and raiting: males usually rest on shrubs but frequently fleek by flying fast and erratically (often back and forth) about the canopy of *Lupinus* hostplants and bushes to seek females, but they fly only ~3-15m before they land on sagebrush (*Artemisia*) or *Purshia* etc.; sometimes they pursue passerbys such as *Cercyonis oetus* etc. from those spots so they evidently rait sometimes also. More observations are needed. Females fly erratically also. No courtships were seen.

Satyrium behrii Orange Hairstreak (Behr's Hairstreak)

Easily identified by the orange ups and the broad brown borders on anterior edge of upf. The uns is brownish-gray. Ssp. ***crossi*** east of the continental divide (including San Luis Valley) is larger, and darker on unh. Ssp. ***behrii*** on the W slope is smaller and paler (whiter-gray) on outer part of unh.

Habitat mostly foothills chaparral and mid-elevation (Canadian Zone) sagebrush. Hostplant in Colorado shrub Rosaceae: *Cercocarpus montanus* for ssp. *crossi*, *Purshia tridentata* (assoc. for ssp. *behrii* in W Colo., and the confirmed host west to Calif.). Common.

Eggs greenish-white, turning white, laid singly on host twigs (seldom on leaves). The eggs of *Satyrium* species are mostly very different (Downey & Allyn 1981, 1984). Young larvae mine out buds, when half-grown+ eat leaves, without nests. Older larva green (sometimes brownish elsewhere), with a middorsal line of white dashes, then a green band, then a row of short whitish (yellow in Calif.)

dashes, a dorsolateral row of oblique long white lens-shaped white dashes (edged on each side by dark-green) (in Calif. the yellowish and oblique dashes form a triangular area with darker interior on each segment), then two rows of weak or stronger whitish shorter oblique dashes, and a lateral row of cream or yellow dashes edged above by light-brown and edged below by dark green, another row of narrow whitish dashes edged by dark-green above legs/prolegs; body covered with short yellowish hair (photos in Ballmer & Pratt 1988 & Allen et al. 2005). Colo. larvae unknown. Pupa light tan or reddish-tan with mottling of tiny & larger dark-brown blotches (less mottled on A5-9). Eggs hibernate.

One flight mostly L June-July (rarely M June, E Aug.), L May-M June in Archuleta-La Plata Cos., mostly July in Wet Mtn. Valley and San Luis Valley.

Adults usually visit whitish and yellow flowers, sometimes purple or pink, including *Apocynum androsaemifolium, Asclepias speciosa, Ceanothus fendleri, Eriogonum flavum, E. umbellatum, Tetradymia canescens*, and occasionally visit mud. They bask laterally. Adults do "hindwing rubbing" even though they have no tails or eyespot, as this behavior is evidently genetically present in all Lycaeninae (coppers, hairstreaks, blues) that I have seen. Some adults roosted on *Quercus gambelii*.

Males rait all day on top of shrubs or small trees on hilltops, as they usually rait on *Juniperus, Cercocarpus montanus, Pinus edulis,* or *P. ponderosa* trees etc. up to 2.5m above ground on the hilltop. During raiting the male's raiting site varies depending on physical and weather conditions: if there is just one giant tree on the hilltop, they rait on the side of it 2.5m up.; or males rait only on top of a little 30 cm bush if that is the highest plant on a bedrock hill; in hot weather they rait on the shady side of the bush/tree, or they may rait on the windless side in strong winds. In courtship, the male lands behind the female and vibrates his wings ~30^o apart and bends his abdomen to attempt to join. If two males meet they often twirl around each other, and sometimes have a vertical encounter.

Satyrium liparops aliparops **Striped Hairsteak**

The white lines and bands are wide apart on the dark uns, and the bluish unh spot is capped with orange. (There are three white dashes in unh cell 1A+2A and cell 3A, versus 2 in *S. calanus*.) Males have the usual stigma on upf near the front, plus an extra small scent pad (stigma) on upf between the bases of veins M_3 and CuA_1. Ssp. ***aliparops*** from Colo. to Manitoba has weaker uns lines, and variable amount of ups orange (from none to much) compared to other ssp. in E U.S.

Habitat brushy areas with *Prunus* and *Quercus* etc. from the upper plains (near the foothills, and a few places on the NE Colorado plains) to lower Canadian Zone. Hostplants in Colorado tree and shrub Rosaceae: *Prunus virginiana* var. *melanocarpa*, *americana*, *Prunus* horticultural var. "*cistena*", *Crataegus succulenta* (*macrantha*) var. *occidentalis*. Perhaps *Amelanchier alnifolia* and *Quercus gambelii* and others may be eaten in Colo., because in E U.S. those genera and many other small trees/shrubs are sometimes eaten. Uncommon.

Eggs dull dark brownish-red with numerous long sharp spines, laid singly on hostplant twigs (sometimes stems or buds), mostly on crevices or joints of the twigs. Larvae eat buds, flowers/fruits, sometimes leaves, preferring the fruits of some plants; no nests. Older larva green, with a near-middorsal yellowish line (farther from top on A7-9), several rows of yellowish long oblique dorsolateral dashes, a yellowish lateral line; some larvae just green with weak markings (some yellowish beside darker heart-band, weak paler oblique lines, and whitish spiracles). Larva resembles the least-marked form of *S. calanus*. Pupa dull yellowish-brown or dark reddish-brown, with brown markings, a brown middorsal band, and a dark ventral abdominal line. Eggs hibernate.

One flight L June-E Aug. (mostly July).

Adults visit whitish flowers, sometimes purple or pink or yellow ones, including *Apocynum androsaemifolium*, *cannabinum*, *Asclepias*, *Clematis ligusticifolia*, *Monarda fistulosa*, *Solidago ~altissima* "*~canadensis*", *Solidago ~missouriensis*, and sometimes visit aphid honeydew, and dew from leaves; I have not seen them on mud. Adults are lateral baskers. They do “hindwing rubbing” like other Lycaeninae.

In the Front Range foothills, males rait all day in gulch bottoms to await females, as they rait ~1-4m up (average 2.3m up, n=9) on bushes/tree limbs. On a ridge in Routt Co. Colo. with mostly just *Quercus gambelii* bushes, the males rait in lanes/nooks/little clearings on the gentle slopes and even on the ridgetop, as they rait 30-150 cm up, evidently all day. Raiting males seem to prefer to investigate darker passerbys, and seldom chase yellow or orange ones. In courtship, the male pursues and lands behind the female, and vibrates/flicks his wings rapidly while spreading them a variable individual-average amount (his wings vary from closed to 50^o to 70^o to 130^o spread on average) as he tries to join, while unreceptive females crawl away or jump to a lower leaf or flutter some (receptive females would presumably remain quiescent and accept the male). A courting male seemed to locate a female from 30 cm away through the oak by using her pheromone.

Satyrium calanus **Banded Hairstreak**

The unh lacks an orange-red cap on top of the bluish spot (in cell CuA_2), the postmedian unf bands are much narrower than *S. liparops* (and the white edgeing on the postmedian band is thicker distally than basally). The orange-red cap in unh cell CuA_1 is usually as thick as or thicker than the black spot beyond it. Ssp. ***falacer***=*godarti* occurs in most of Colo., and has a blackish unh. Ssp. ***albidus*** occurs in NW Colo. and in the NW part of the Gunnison Basin, and has the uns much paler (brown) than ssp. *falacer*; the palest ones are in the Yampa River drainage of Colo. and adjacent Carbon Co. Wyo., where many vary continuously from brown to grayish-white on uns (the predominantly-whitish uns adults are form **heathii**, which may constitute ¼ of the population); ssp. *albidus* is paler presumably for better camouflage when they land on sagebrush.

Habitat the *Quercus gambelii* zone and some upper plains sites with just *Prunus*. Hostplants in Colorado shrubs & small-tree Fagaceae: *Quercus gambelii*; sometimes assoc. *Prunus virginiana* var. *melanocarpa* (Rosaceae). The main hostplant is evidently *Q. gambelii* which grows naturally in the Front Range only north to Red Rocks just W of Denver (rare plants are scattered in gulches northward to W of Boulder) (on the W slope it grows commonly north into Carbon Co. Wyoming). A few adults were found at the one large *Q. gambelii* clump in Tucker Gulch NW of Golden, and one or a few adults were found at five sites in Jefferson Co. where no *Quercus* occurs (in Lakewood at McIntyre Gulch just E of Kipling Ave. assoc. *Prunus virginiana*, Green Mtn., Chimney Gulch at base of Mt. Zion, Indian Gulch, Wheatridge [all four sites have *Prunus virginiana* and *P. americana*]), and M. Fisher found one in a thicket of *P. virginiana* in E Douglas Co., so this seems to be good evidence that *Prunus virginiana* var. *melanocarpa* is an alternate host (*P. americana* may be proven to be another alternate) (there are many more alternate hosts in E U.S. such as *Castanea*, *Carya*, *Juglans* etc.). Uncommon in the northern Front Range, more common in S and W Colo.

Eggs pale green, turning pinkish, laid on host twigs & branches esp. on buds. Larvae eat catkins/buds then young leaves, without nests. Larvae are evidently nocturnal feeders. Older larva in Colo. (5 seen) bright yellowish-green, a yellow-cream line away from middorsal axis is thicker and whitish on top of thorax, a row of slightly-oblique dashes on T2-A9, dorsolateral area has oblique yellow-cream dashes, lateral ridge is yellow or yellow-cream (edged by darker-green except cream on rear). In E U.S. ssp. *falacer* (photos at Allen et al. 2005, Allen 1997, Wagner 2005, Minno et al. 2005, Bright & Ogard 2010, Tveten & Tveten 1996) older larvae are incredibly variable, often grass-green, with a wide middorsal area (which is dark-brown on top of T2-A1 [this patch may be edged by white] then is not darker [but some larvae have four perfume-bottle marks with brown then pinkish edges on top of A3-6] then is narrower and brownish on A7-9), with two rows of weak oblique dorsolateral cream dashes (some larvae have brown between these two dashes), a lateral cream or pinkish band; or some larvae light pinkish-brown with the same markings including heavy blackish-brown markings on top of same dark places on front and rear (and cream lines beside middorsal blackish on T2-3), and reddish staple-marks on top of A2-5 and brown between adjacent oblique markings on A2-5, a pinkish-edged lateral cream band (sometimes topped with black blotches on A2 & A7-9); a larva reddish with the two blackish areas and nearby dorsal white line and lateral white band and weak oblique dorsolateral dashes; some larvae are hickory-twig brown; other larvae are pinkish-gray with cream bands/lines; other larvae are whitish with white subdorsal lines and oblique lines and lateral line of pure white and dark-green instead of brown on top of T2-A1 and A7-9; and other larvae are plain pale-green with the longitudinal then oblique then lateral creamier markings without the two dark patches on top; body densely white-hairy; head green or greenish-brown. Pupa brown (reddish-brown on abdomen, slightly-reddish-brown on thorax, mostly covered with fine brown or blackish mottling, the middorsal band darker and is two spots on A2; attached by silk girdle over A1-2 and cremaster. Eggs hibernate.

One flight mostly L June-July (seldom to L Aug.-E Sept.) in the foothills, mostly M July-M Aug. at higher altitudes (Arkansas Canyon-Wet Mtn. Valley-San Luis Valley), mostly July for ssp. *albidus*.

Adults visit yellow and whitish flowers, sometimes pink or purple, including *Apocynum androsaemifolium*, *Asclepias*, *Cirsium arvense*, *Rudbeckia hirta*, *R. laciniata*, *Solidago ~altissima "~canadensis*"; they sometimes imbibe sap from *Quercus gambelii* acorns. Clench (1955) found that Mich. adults greatly preferred white flowers esp. *Melilotus albus*, often *Asclepias syriaca*, *Apocynum cannabinum*, *Erigeron* etc., and greatly preferred the white *M. alba* to the yellow *M. officinalis*. Adults are lateral baskers.

Males rait all day to await females, often in gullies, or in little clearings amid bushes/small trees (such clearings were mostly seen amid *Q. gambelii* in Colorado), as they rait on plants 4cm to 2m up (average 0.9m up, N=11), all day (my limited observations were mostly in morning 07:00-11:30, then very few to 12:30 and as late as 14:00, but Opler [Opler & Krizek 1984] reported that *S. calanus falacer* mate-locates all day "Males perch on shrubs or low tree branches on hilltops or in forest glades during most daylight hours [07:30-18:00 hr]. Their interactions with other males are particularly strong in early morning and late afternoon."). R. Robbins (2001 News Lepid. Soc. 43:73-74) wrote that males rait about the crowns of oak and hickory trees near the E coast mostly from dawn to 09:30 "but a very few males perch until late in the day". No courtships were seen. Male ssp. *albidus* rait by choosing a prominent point of the oak bushes jutting out into a clearing (unlike S. *liparops* which chooses nooks) or lane, all over slopes but often on ridgetops, as they rait on jutting-out branches 0.3-2m (usually ~1m) up.

Clench, H. 1955. Some observations on the habits of *Strymon falacer* (Lyc.). Lepid. News 9:105-117 (his observations of males and females found near woods and during the daylight hours were unfortunately done without considering mate-locating behavior).

Satyrium saepium saepium Buckthorn Hairstreak (Hedgerow Hairstreak)

Identified by the unique uniform metallic-reddish-brown ups. The uns is brown, without a red cap on the blue unh spot. Taxonomists seem to have gone berserk on this species, as they have named seven completely-worthless synonyms as "subspecies" of *saepium* which are all identical to ssp. ***saepium***, and the only two different valid ssp. are ssp. *latalinea* from SW Utah-Inyo Co. CA (white edge on unh band, longer tails) and ssp. *caligulosum* from SLO Co. CA (darker basal 2/3 of unh).

Habitat brushy chaparral and open pine areas in the lower mountains (Upper Sonoran and Transition Zones). Hostplant in Colorado bushy Rhamnaceae: *Ceanothus fendleri*. Wolfe et al. (2010) list *Ceanothus velutinus* as a host, perhaps in Utah, and it is assoc. with that in Nev. (Austin & Leary 2008), so it is probably a host in NW Colo. Common.

Eggs greenish-white, laid singly on smooth sides of thin host stems (sometimes on buds in other states). Larvae eat leaves and sometimes flower buds, without nests. Older larva resembles *S. sylvinus*, whitish-green (frosted due to thousands of whitish setae), with a dark-edged creamy line near the middorsal area that jogs laterally a bit on A7-8, 2 ½ rows of weak or stronger whitish long oblique dorsolateral dashes, and a whitish or yellow lateral stripe from T2-A10 (dorsally edged with darker green esp. on rear). Pupa brown (orange-brown on abdomen) (James & Nunnallee 2011 photo), in Wash. (Guppy & Shepard 2001 photo) with irregular small blackish mottling over top. Eggs hibernate.

One flight L June-E Sept. (mostly July-Aug.).

Adults visit whitish and yellow flowers, occasionally pink and purple/blue, including *Achillea millefolium "lanulosa", Apocynum androsaemifolium, Aster laevis & porteri, Ceanothus fendleri, Cirsium arvense, Eriogonum flavum, E. umbellatum, Heterotheca villosa, Monarda fistulosa, Potentilla fruticosa, Solidago altissima "canadensis", S. missouriensis*. Adults sometimes visit mud. Adults fly down-valley to seek flowers and mud (Scott 1973d). Adults do "hindwing rubbing" as usual in Lycaenidae, even though there is no conspicuous eyespot on unh, although there is a tiny tail.

Males rait all day on ridgetops and hilltops, as they rait ~1m above ground (average 89cm, extremes 20cm-2m, N=36) on large rocks or small shrubs or low tree branches to await females. In a population explosion males will rait on shrubs as far as 30m from the hilltop, and in another pop. explosion in Colusa Co. Calif. I noticed that some males also rait on the side of shrubs facing the hillside, in addition to hilltops. Males will also rait on flowers even while feeding, but can feed within 2cm of a female without noticing her. Males may court on hillside *Ceanothus fendleri* also. In courtship, the male overtakes the female, and they land, the male flicks/flutters his wings rapidly 0-30°- or 0-45°-spread to transfer pheromone from his stigma, (then receptive females would presumably remain quiescent and accept him), when unreceptive females can drop down into a bush to escape him and surely would do other rejection behaviors. In mating, both of his valvae are inserted into her ostium bursae (this is typical of many hairstreaks). If a mating pair is disturbed, the male usually flies, about as often the female, the partner dangling.

Satyrium californica California Hairstreak

The uns is brownish (*S. sylvinus* is much whiter in Colo.), the uph orange spots are generally smeared, and there are many submarginal unh orange crescents, plus a thin red crescent capping the bluish spot (*S. acadica* has just one sharper orange spot on uph and a grayer uns and only occurs on the Colo. plains). *S. californica* occurs only in the mountains or very near (on the plains I found some 2 mi. E Eldorado Springs in Boulder Co. and along Cherry Creek in south Denver). The butterflies in most of Colo. are the shade of uns brown of Calif. ssp. *californica*, but are larger and have a little more orange along unh margin, so the weak ssp. ***helenae*** could be used for them (the TL is Jefferson Co. Colo. in the Front Range) (most of the ssp. in *S. californica* are weak, including ssp. *obscurafacies* from Snake Range Nevada which has very slightly smaller uns black spots, and ssp. *cygnus* from Storey Co. Nev. which may be a bit grayer-brown on uns). Ssp. ***wapiti*** is distinctive with quite small orange uph spots and occurs in the Elk Mts. and West Elk Mts. near Aspen and in the North Fork valley of the Gunnison River up to ~9000 feet (it intergrades wih *helenae* in Grand Co. to Routt Co. etc. in NW Colo.).

Habitat brushy areas in the lower mountains (Upper Sonoran and Transition Zones). Hostplants in Colorado shrub Rosaceae: *Cercocarpus montanus* (the most common host on the E slope), *Prunus virginiana* var. *melanocarpa, Amelanchier alnifolia* (oviposition by ssp. *wapiti*), *Purshia tridentata* (the most common host on the W slope), *Holodiscus dumosus*. Assoc. *Salix exigua* (Salicaceae) in Denver, Eagle, Delta Cos., and adults are often found with *Quercus gambelii* in NW Colo. Also, *Quercus* (Fagaceae) and *Ceanothus* (Rhamnaceae) are hosts in Calif., and Austin & Leary (2008) notes assoc. with *Ceanothus velutinus* commonly in Nev. Wolfe et al. (2010) list *Amelanchier utahensis, Ceanothus velutinus*, and *Prunus virginiana* as hosts found by Jack Harry in Utah. (*Eriogonum* is an error.) Uncommon in the Front Range, common in W Colo.

Eggs whitish-green, becoming slightly-grayish white, laid mostly in clusters of 1-6 (average 3.7) mostly in depressions (holes, crevices, depressed scars, under bark, sometimes on bark or base of petioles) on the hostplant twigs/small branches, the eggs covered with a copious thin clear glue secreted by the female that forms a "glue window" protecting the eggs. Larvae eat tender young foliage, mostly at night, without nests, often associated with ants. Older larva (Calif. & Wash., Allen et al. 2005, James & Nunnallee 2011, Ballmer & Pratt 1988, Neill 2007) reddish-brown (the dorsolateral areas grayish-tinted on one photo), on each segment is a middorsal large patch (resembling a cream-crusted black hamburger bun clasping a middorsal bluish-slate burger), the intersegmental subdorsal rear edge of all body segments orangish, several white oblique long dorsolateral dashes on each segment (each rising forward), cream dashes above the spiracles, and a cream lateral ridge, covered with ~1mm dark hair; prothorax black on top, numerous long hairs. Pupa reddish-brown or dark-brown mottled with small reddish-brown splotches, with brown wing cases and underside, all covered with sparse white setae. Eggs hibernate.

One flight June-E Aug. (mostly L June-July), July for ssp. *wapiti*.

Adults visit whitish and yellow flowers, sometimes pink and purple, including *Apocynum androsaemifolium, Ceanothus fendleri, Cirsium arvense, Eriogonum subalpinum, Holodiscus dumosus, Rudbeckia laciniata, Solidago altissima "canadensis", Tetradymia canescens*, and often visit mud. Adults bask laterally.

Males rait and occasionally flait on top of 1.5-3m trees (sometimes on a 6m *Quercus* tree in Calif.) and shrubs mostly on ridgetops and hilltops, from ~12:50 to dusk in Colo. and Calif. (Shapiro 2007 notes that Calif. males show peak mate-locating behavior [raiting] from 16:00-16:30). Some raiting and courtship was seen on a flowering *Aesculus californica* tree on a hillside in Calif.; *S. californica* and *S. auretorum* seemed to choose different trees at one Calif. site. No courtships were seen.

Satyrium acadica Acadian Hairstreak (Northern Willow Hairstreak)

Identified by the single uph orange spot, the numerous orange submarginal unh spots, and an orange crescent capping the blue unh spot. It occurs on the plains, and comes within several km of the mountains in Boulder (just S of Boulder), Jefferson Co. (W side of Lakewood and Wheatridge), and Fremont Co. (just E Canon City).

Habitat streamsides and irrigation ditches/roadside ditches on the plains where *Salix exigua* grows. Hostplant in Colorado small-tree Salicaceae: *Salix exigua* (additional *Salix* are hosts in E U.S.). Usually uncommon.

Eggs purplish-brown when laid, becoming tan within 8 hours, then tan-white, laid in clusters (of 1, 1, 3, 3, 6) preferably in holes (one was laid in the crotch at base of two leaves when the female could not find a hole) in twigs/branches of *S. exigua*, and covered by a "glue window" of copious thin clear glue secreted by the female; the holes are made usually by the departure of some wood-boring insect, sometimes by a branch breaking off. Larvae eat leaves, without nests. They are associated with ants. Older larva green, with twin white middorsal bands blended laterally into yellower-green color above the first of two oblique white dorsolateral lines on each segment (the upper oblique line nearly joins the lower oblique line on the segment behind), a white lateral band. Pupa yellowish-brown, with small darker brown spots, a dark ventral stripe on abdomen, and dark dorsal and lateral bands. Eggs hibernate.

One flight mostly July-E Aug.

Adults visit pink, white, and less-often purple-violet flowers, including *Asclepias speciosa, Cirsium arvense, Melilotus albus*. Adults bask laterally.

Males rait (and seldom flait) on small *Salix exigua* or other plants an average of 78cm above ground (extremes 61cm-1.5m, N=16), especially on low plants growing out from a *Salix* grove (up to 3-4m away from the grove), from ~13:20-13:50 to dusk. In courtship, the raiting male pursues a passing female and they land, he vibrates his wings from closed to 30^o-spread ~5-10X to waft his pheromone while her wings are closed, and the male crawled around a grass stem pursuing her for ~4 sec. and then joined. If a mating pair is disturbed, the female usually flies, sometimes the male, the partner dangling. Mating pairs may remain joined overnight until the next late morning, when I found them but did not find raiting males in morning {R. Robbins [2001 News Lepid. Soc. 43:74] [repeated by Opler & Krizek 1984] wrote that on E coast it has "mating territories" from dawn to 09:00 (which I think is dubious as those mating pairs were probably joined the previous evening) then 18:00 to dusk (they mate-locate much longer than that) (also, *S. liparops* & *S. caryaevorus* & *S. edwardsii* rait only after 09:00).}

Satyrium sylvinus mostly *putnami* Sylvan Hairstreak, Western Willow Hairstreak

Identified by the lack of an orange crescent capping the bluish unh spot (it rarely has a small bit of orangish there). Also, the unh is whitish and has just one or a few orange spots. Ssp. ***putnami*** occurs in most of Colo., and has a grayish-white uns. But some lowland sagebrush populations in Moffat Co. are a little whiter on uns, evidently a **whiter variety** better? camouflaged on the sage, and this whiter var. ranges more widely in the "Great Basin" even in Washington (James & Nunnallee 2011). *S. sylvinus* occurs with *S. acadica* on the plains of Fremont Co. (just E of Canon City) without interbreeding.

Habitat creeksides and irrigation ditches on the western edge of the plains (just E of the Wet Mts. and in the Black Forest E of the Front Range) and lower altitudes in Upper Sonoran Zone to lower edge of Canadian Zone in the mountains and W Colo. (on the floor of the San Luis Valley also). Hostplants in Colorado small-tree Salicaceae: *Salix exigua*. *S. exigua* grows along irrigation ditches and creeks etc., which may have aided its recent spread on the eastern slope. I found it in 1968 in the northern Wet Mountain Valley, and in 1970 commonly along the Arkansas Canyon and around Canon City (where it flies with *S. acadica*), then by 1990 it spread north to Douglas Co. creeksides then evidently to Jefferson Co., and it occurs in Las Animas Co. Common.

Eggs pale greenish-white, laid singly or several together in crotches, or in cracks or holes or other imperfections on host stems, and she often glues a glue window over the eggs. Larvae eat leaves, without nests. Older larva light-green, with a white line near top that wanders farther from the very top anteriorly then comes a little closer on T2, 2 ½ rows of weak oblique cream dorsolateral sinuous narrow dashes on each segment, a cream or yellowish dark-edged band on lateral ridge. Pupa pale olive-green mottled with dark green, the abdomen pale greenish-brown with brown dorsal mottling; or pupa reddish-tan-brown with a middorsal row of brown spots, and mottling of numerous tiny brown spots on abdomen and top of thorax. Eggs hibernate, and can survive immersion in flood waters for several weeks according to A. Shapiro.

One flight July-Aug. (mostly L July-E Aug.) on the western slope, July-E Aug. on the eastern slope (evidently M July-M Aug. in San Luis Valley).

Adults visit all colors of flowers (pink, white, yellow, purplish-blue) except perhaps pure red, including *Apocynum*, *Asclepias speciosa, Cirsium arvense, Clematis ligusticifolia*, *Rudbeckia laciniata*, and sometimes visit mud. Adults bask laterally.

Males rait (and sometimes flait) on patches of the *Salix exigua* hostplant or sometimes other plants, especially where the patch convexly protrudes several m out into an open area, as males rait an average of ~1.1m (61-200cm, N=4) above ground on small *Salix* or sometimes other plants on or next to the *Salix* patch. They rait from ~09:45 (not earlier) to ~17:45 (in Calif. Shapiro 2007 reported them raiting on twig tips of the hostplant *Salix* at least in mid to late afternoon.) In courtship, the male pursues a flying female, she lands and the male may hover over her briefly then land, when courtship is presumed to be like that of other *Satyrium*. If a mating pair is startled, the female flies and perhaps the male also, the partner dangling.

Satyrium titus Coral Hairstreak

Identified by the long row of unh marginal spots colored like Italian coral used in jewelry. The upf often has orangish diffuse areas, esp. on females. Ssp. ***immaculosus*X*watsoni*** with small black uns dots occurs in most of Colorado (ssp. *watsoni* in most of E U.S. has somewhat larger uns black dots), while ssp. ***immaculosus*** with even smaller to nearly-absent black uns dots occurs in W-C and NW Colorado to Nev.-Wash.-Mont.

Habitat open areas esp. in valley bottoms with some *Prunus*, and nearby hilltops, from the plains to the middle Canadian Zone. Hostplants in Colorado shrub Rosaceae: *Prunus virginiana* var. *melanocarpa*, *americana*. Uncommon, sometimes moderately common.

Eggs pale green, turning ochre-white. The female crawls down the trunk and lays usually in clusters (my ovipositions were 1, 2, 5 eggs) on debris (twigs/rock/dirt etc.) at base of hostplant trunks. Larvae eat young leaves and flower buds/fruits at night, and rest hidden at the plant base during the day (no silk nests); larvae associated with ants, which reportedly may carry the larvae from detritus at the hostplant base to flowers and fruits at night (Douglas & Douglas 2005). Older larva green or dull yellowish-green with weak L-shaped (fish-shaped in Calif.) subdorsal creamy marks, a dark-green middorsal heart-line, a large brown shield and a little reddish on top of T1, with red areas (sometimes bordered with whitish spots) on top of T2 and most of T3, and red top of A6, and red on all of A7-10 (A6-7 sometimes dull-yellow laterally). Pupa pale brown, with numerous black dots and fine dark mottling especially on abdomen, including a middorsal row of dark dots on abdomen. {Emmel Minno & Drummond (1992) and Allen et al. (2005) etc. have photos of larvae/pupae.} Eggs hibernate.

One long flight M June-start of Sept. (mostly L June-M Aug.). It is not known why the flight period is so long; maybe the ant-associated feeding is temporally less reliable/unpredictable?

Adults visit yellow and white flowers, and less often purple/pink/blue/orange, including *Asclepias speciosa* (in E U.S. they love orange *A. tuberosa*), *Ceanothus fendleri, Eriogonum flavum, E. umbellatum, Solidago altissima "canadensis", Solidago ~missouriensis*, and sometimes visit mud and carrion. Adults bask laterally.

Males rait on hilltops, where males rait on bushes (sometimes weeds, rocks, or small juniper trees etc. if bushes are absent) averaging 52 cm above ground (10-200 cm, usually 20-60 cm, n=25) (on flat land they rait on small trees/bushes), from ~10:00 (sometimes as early as 09:00-09:15) to 16:00 (they genetically do not rait in very early morning even in warm temperatures). In courtship, the male overtakes the passing female and they land, the male multiply flicks his wings from closed to 30º-spread to waft his pheromone and attempts to join, but unreceptive females fly etc., to try to escape. Mating pairs sometimes remained joined overnight. If a mating pair is startled, the female flies, and perhaps sometimes the male, the partner dangling.

Satyrium favonius autolycus **Northern Oak Hairstreak**

This butterfly resembles *Strymon* by having a white postmedian uns line and the uns lacks a postbasal dash (sometimes weak), but the uns is brown, the unh postmedian line forms a W near the eyespot, the uph has several (or one in NE U.S.) orange marginal spots, the upf usually has orangish central patches, the unh has marginal orange spots like *Satyrium californica* (including an orange cap on the blue spot), and the male upf stigma is large and gray (it is black in *Strymon*). Found only in SE Colo., in E Las Animas and Baca Cos. near the New Mexico border. Butterflies from there and adjacent NM look like Texas ssp. ***autolycus***, so I treat the name *viola* (type locality Folsom, Union Co. NM) as a synonym.

Habitat the *Quercus gambelii* introgression zone (*Q. gambelii* in SE Colo. near the NM border often has leaves that are not lobed, which are hybrids with *Q. grisea* called *Quercus* "*undulata*"). Hostplant in Colorado small-tree Fagaceae: assoc. *Quercus gambelii* (vars. *gambelii*, *undulata*=*gambelii*X*Q. grisea*). (*Quercus turbinella* with spiny leaves occurs in Las Animas Co. but not in Baca Co., and has not been found with the butterfly yet.) Common.

Eggs laid singly on host twigs esp. crooks or scars, esp. on twigs that will produce male catkins (S. Gifford & P. Opler 1983 J. Lepid. Soc. 37:97-105). Young larvae eat male catkins/pollen, older larvae also eat buds & leaves, without nests. Older larva basically pale unstriped green, except for slightly-darker heart-band (photo Tveten & Tveten 1996 from Houston Texas), though ssp. *favonius* eastward reported as unstriped green to pinkish; most ssp. have a weak paler line near heart-band and some weak oblique dorsolateral dashes and a weak or stronger paler lateral line (Bright & Ogard 2010 fig. Ala. larva pupa) (Ariz. ssp. *ilavia* has the near-middorsal and lateral lines cream and sometimes edged by reddish, the body covered with tawny short hair). Pupa pale-brown (or dark-brown with A1-3 top tan), slightly mottled with black, with a lateral row of black dots. Eggs hibernate.

One flight end M June-E July (sometimes E June).

Adults seem to prefer whitish flowers (they visit *Melilotus albus, Malva*?, *and Apocynum*), and also visit honeydew and galls.

Males rait on hilltops on juniper trees etc. at least late in the day 14:10 (David Wagner, pers. comm.) and one observation in Okla., and M. Douglas notes that they rait higher up on plants than other *Satyrium*. (*S. favonius ilavia* raits on hilltop junipers and sometimes on its Ariz. host *Quercus turbinella* from 11:00-15:00 [B. Beck 2017 News Lepid. Soc. 59:141-143]).

***Satyrium* (*Phaeostrymon*) *alcestis* Soapberry Hairstreak**

Identified by the white median dash on the middle of unf and unh, by the solid-brown ups, and the wide forewing (apex not elongated). It has many red unh marginal spots. It occurs only in the extreme SE corner of Colorado, in several small canyons of the Raton Mesa-Mesa de Maya-Black Mesa system of mesas that extend from Raton Pass all the way eastward into Kansas/Oklahoma, then occurs southward into Texas Ariz. Mex.

Habitat valley bottoms with the host trees in mesas of extreme SE Colo. Hostplant in Colorado tree Sapindaceae: *Sapindus saponaria* var. *drummondii*, the only host throughout the range. Abundant near and on the host when I found it.

Eggs laid singly on host twigs. Larvae eat leaves esp. of new growth, without nests. Older larva green, the heart-band dark-green edged by a cream band that becomes farther from its twin anteriorly and is absent on T1 (which has a pale rectangular spot), a weak subdorsal row of cream zigzag dashes, a row of weak cream dashes just above white spiracles, and a cream lateral band. Pupa jade-green. Eggs hibernate.

One flight M June-E July.

Adults feed on various flowers including those of the host tree, on *Salix* catkins, and probably on mud.

Males fleek just above the canopy of the *Sapindus* larval host tree, often during cloudy, windy, or rainy weather (as does *Hypaurotis crysalus* which has an almost identical mate-locating system). Fleeking occurs from ~14:00 to about 18:00 or probably dusk. Both sexes are on those trees during the mating period, whereas in the morning males are mainly at flowers and mostly only females are found on the hostplant trees.

***Callophrys dumetorum* (includes *apama* and *affinis*)**
Green Hairstreak (Bramble Hairstreak)

Identified by the green unh without tails, like *C. sheridanii*, but *C. dumetorum* is larger (mostly 12-15mm fw length vs. 10-13 in *sheridanii*), the ups and unf often has orange (the ups at least slightly-reddish-tinted brown in males, red-brown in females, while the unf is orangish on the E slope of Colo., whereas the ups is just gray and unf is just green and brownish-gray in *sheridanii*), the white unh line is almost never straight, and adults fly somewhat later in spring. Two ssp. occur in Colo. Ssp. ***homoperplexa*** on the E slope has zero to many median unh spots (rarely a complete kinked unh line), a more grass-green unh with browner fringes, and a mostly russet unf. In SW Colorado, the butterflies look like *homoperplexa* but probably average slightly more unh spots because ssp. *apama* somewhat southward into NM has a complete postmedian kinked line on unh. Ssp. ***affinis*** occurs on the western slope in NW Colorado (in Pitkin, Eagle, Grand, Summit Counties northwestward, and southward to the

Gunnison River Basin), and has few or no uns white spots, the unh is light-bluish-green (to better match the sagebrush) with whitish fringes, and the unf has a smaller (or nonexistent) area of light russet or brownish-gray coloration. These two ssp. intergrade in Colo. near the continental divide in the eastern Gunnison Basin at the W end of Saguache Co. (M. Fisher), and intergrade in Jackson and northern Larimer and Weld Cos., and in SE Wyoming (southern Carbon, Albany, and Laramie Cos.) and W Nebraska (Pine Bluffs in Banner and Cheyenne Cos.) (G. Gorelick 2005). {*C. dumetorum dumetorum*=*perplexa* and *C. dumetorum affinis* are conspecific as detailed by Scott & Justice (1992). Reports claiming that paper mislabeled specimens to reach that conclusion are ridiculous because only one specimen was misidentified [the female from Fort Simcoe misidentified as *oregonensis*, because only *C. sheridanii* and "*affinis*" *washingtonia* occur there]. Ssp. *washingtonia* is actually intermediate between ssp. *affinis* and *C. d. oregonensis* and adults can often not be separated from *oregonensis* as the photos of Gorelick [2018] show; both *washingtonia* and *oregonensis* have the unf rear russet in color and *washingtonia* females have a tawny ups tint and the two are very similar; and Gorelick [2018] wrote that he mislabeled some ssp. *dumetorum* and *washingtonia* from numerous counties as paratypes of his name *oregonensis*; those two range near each other but are nowhere sympatric. Ssp. *dumetorum* mostly resembles Colo. *homoperplexa*, and eats two very different hosts *Lotus* and *Eriogonum* as does *homoperplexa* [*Ceanothus* & *Eriogonum*], so it's no surprise *dumetorum* and *affinis*/*homoperplexa*/*apama* are conspecific.}

Habitat of *homoperplexa* is open areas in the foothills to middle of the Canadian Zone. Habitat of *affinis* is sagebrush, mostly in Canadian Zone. Hostplants of *homoperplexa* in Colorado bushy Rhamnaceae: *Ceanothus fendleri*, *herbaceus;* herb Polygonaceae: *Eriogonum umbellatum* var. *umbellatum*, *E. alatum* {2 mi. E Wilkerson Pass in Park Co., J. Harry 2005 J. Lepid. Soc. 59:191-2; also a larva on *E. alatum* in Sandoval Co. NM, S. Cary 2000 Lepid. News 42 (suppl. S1):24)}; and assoc. *E. flavum* (the host for *homoperplexa*X*affinis* in S-C & SE Wyo.). Hostplants for *affinis* in Colo. Polygonaceae: *Eriogonum umbellatum*, *E. subalpinum* (the only *Eriogonum* at some sites), elsewhere *E. racemosum*. *Ceanothus fendleri* and *E. alatum* plants become abundant after wildfires, when the butterflies can be abundant. Common on the E slope, uncommon for ssp. *affinis*.

Eggs pale bluish-green, not varying and similar to *C. sheridanii*, laid singly on host flower buds, occasionally on young leaves. Larvae eat flowers and young fruits, occasionally leaves, without nests. Older larvae of *homoperplexa* vary from green to red, but all have conspicuous subdorsal ridges edged medially by dark green or red, and a lateral pale band edged above by dark green or red: 1) green larvae have subdorsal ridges pink (cream edged by reddish), a pale-green oblique subdorsal dash on each segment, lateral ridge pinkish-cream; 2) mature larva green, middorsal band reddish-tan, subdorsal ridges red, lateral ridge red, an oblique dark-red subdorsal dash; 3) mature larva red, a middorsal row of reddish patches, beside that a row of large red dashes each atop an oblique pink or pinkish-cream dash extending ventroposterad of anterior end of each subdorsal ridge (or the subdorsal ridges just edged medially by dark-red), area between subdorsal & lateral ridges reddish-green on A3-6, a dark-red line just above red or creamy lateral ridge; 4) mature larva all red, except a cream lateral line, a cream subdorsal oblique dash. {Ssp. *apama* in S Ariz. is similar, varying from light-green to green, to green with cream marks and middorsal and lateral red, to mostly to nearly-all red, all with weak middorsal paler line and subdorsal ridge paler and connected to the paler oblique marks, and the lateral rim is paler topped with darker spots [B. Beck 2019 News Lepid. Soc. 61:140-143].} Larva (ssp. *affinis*) olive-green with red marks (a large subdorsal triangular ridge on each segment is cream with red top, a strong cream lateral band has a reddish area on top middle of each segment—see Gorelick 2005 photo p.193) (larva in photo of Wolfe et al. 2010 has the same markings but is mostly reddish on dark-green ground color); or *affinis* larva grass-green or deep red, both extremes with whitish subdorsal and lateral lines and subdorsal ridges; larva of near-*affinis* [*C. d. washingtonia*] (James & Nunnallee 2011) green with just a yellowish spot on the top of each subdorsal low ridge and a lateral yellow band, but other larvae have each subdorsal very low ridge topped with red above a whitish lateral base, and a lateral band of red-above-white dashes. Pupae of *homoperplexa* vary also, pinkish-cream or ochre-red or dark-red or red-brown, the wings vary from green to tan to dark red-brown, with some tiny middorsal and subdorsal abdominal black spots, etc. Pupa of Wash. *washingtonia*: wings/thorax/head greenish-brown, abdomen reddish-brown with small black spots and blackish heart-band. The pupa of related *C. rubi* in Europe has a stridulating file structure between A5-6 that produces faint sounds. Pupae hibernate.

One flight for *homoperplexa* M April-M Aug. (a long flight period perhaps including some adults of a partial second generation), but mostly L May-E July in the foothills and M June-July at higher altitudes. One flight for *affinis* mostly June.

Adult *homoperplexa* generally visit yellow and white flowers, including *Ceanothus fendleri, Eriogonum umbellatum* & *subalpinum, Harbouria trachypleura, Prunus americana, Senecio* (*Packera*) *fendleri,* and sometimes visit mud. Adults do “hindwing rubbing” despite the lack of an eyespot. Adults bask laterally. Several adults roosted in the upper boughs of a small Douglasfir tree and on a *Quercus gambelii* branch. Adults seem to be rather local, as my marked adults moved little; a marked adult lived at least 19 days in nature (18 days in California *dumetorum*, Shields 1967).

Males of *homoperplexa* rait all day in gulch/swale bottoms (often at narrow spots of the main gulch, and often in smaller “gullies” such as hillside trails or hillside roadcuts/road ditches, or between a horizontal row of bushes {rarely small pines} and the hillside, or hillside hollows or swales near the hostplant) to await females, as the male raits an average of 32 cm above ground on grass stems or other plants etc. or sometimes on the ground (extremes 0-67cm up, N=15) (this average may shrink if many males I recorded raiting on a hillside “road” were just resting on the ground). Even at high density, males still rait and do not flait or fleek, unlike *Erynnis pacuvius* and *E. martialis* which also have *Ceanothus fendleri* hostplants and occur with *C. d. homoperplexa*. Male *affinis* rait all day on ridgetops and hilltops, as they rest on small shrubs ~1/2-1m up especially on sagebrush to await females. Adults have a fast and somewhat jerky flight. In *homoperplexa* courtship, the male overtakes a passing female, they land and the male either keeps his wings closed or vibrates/flutters his widely-spread wings to waft pheromone to the quiescent closed-wings female, then he curves his abdomen to mate. (Unreceptive females were not seen to flutter to repel the male, but perhaps they do that.) If the mating pair is disturbed, the female usually flies (sometimes the male), the partner dangling. Mating lasts at least 30 min.

{Mate-locating/mating behavior of California *Callophrys dumetorum dumetorum=perplexa* is included here for comparison with *C. dumetorum homoperplexa*: Males rait and occasionally flait all day, on hilltops if available nearby, or near the hostplants, as they rait on small shrubs or other objects mostly roughly ~1/2m above ground. In courtship (including completed courtships observed by Shields 1967 and Gorelick 1971 in S & N Calif.) the female flies near the male (onto a big or tiny hilltop) and the raiting male overtakes her and may hover behind her, they land and she may quiver her partly-opened wings but most receptive females are quiescent, and the male usually vibrates (sometimes flutters) his wings near her to transfer pheromone, and moves beside and slightly behind her and curves his abdomen to join. Females often mate twice.} {In Europe *Callophrys rubi* is very similar to *C. dumetorum*, and I found that males at Ventimiglia Italy and Toledo Spain rait all day in gulch bottoms ~1.5m up on bushes to await females, just like Colo. *homoperplexa*.}

{The names of many of these butterflies were thrown into chaos when the types of *viridis* and the older name *dumetorum* were found to be the same taxon, so I and six other people got the ICZN (case 3524) to restore the name *dumetorum* to the same taxon as *perplexa*, so the correct restored names are *C. dumetorum=perplexa* and *C. sheridanii viridis* (not *dumetorum*).}

Gorelick, G. A. 1971. A biosystematic study of two species of *Callophrys* (*Callophrys*) in California. J. Lepid. Soc. 25: suppl. 2:1-41.

Gorelick, G. A. 2005. A review of *Callophrys affinis* (W. H. Edwards), with descriptions of two new subspecies from New Mexico and Mexico. J. Lepid. Soc. 59:181-199
Scott, J. A., & J. A. Justice 1982 ["1981"]. Intergradation between *Callophrys dumetorum oregonensis* and *C.dumetorum affinis* in northwestern U.S. (Lycaenidae). J. Res. Lepid. 20:81-85.

Callophrys sheridanii Little Green Hairstreak (Sheridan's Hairsteak)

Distinguished by small size (~10-13mm fw length), the always-gray ups, the unh grass-green to grayish-green, and the unf having just a little brownish (not the extensive russet of *C. dumetorum homoperplexa*), and the white unh line which is well developed and straight except in W Colo. ssp. *paradoxa*. It usually flies earlier in the season than *C. dumetorum*, and males rait in swales. Three ssp. occur in Colorado. Ssp. near ***neoperplexa*** evidently occurs in extreme NW Moffat Co. Colo. (based on very few specimens), and has a narrow unh stripe. Ssp. ***sheridanii*** occurs in the Canadian Zone on the western slope and the Canadian Zone down to the foothills in the Front Range, and has a wide comparatively-straight white stripe on the dark-green unh. Ssp. ***paradoxa*** from lowland desert canyons of W Colo. near Utah and New Mex. has a little less green on unf than ssp. *sheridanii* (the rear of unf is grayish-brown) and the front areas of unf and the whole unh average grayer-green (dark-green to grayish-green), and the unh spot row is narrow and more kinked and the spots vary from absent to a complete row. Ssp. *paradoxa* is obviously a ssp. of *C. sheridanii*, because in Colorado ssp. *sheridanii* is widespread in the Canadian Zone on the western slope, and intermediate populations occur at lower altitude in the lower mountains all over W Colorado: near Parachute in Garfield Co. on *E. corymbosum*, Chico Creek near Egnar in San Miguel Co., and several sites in Mesa Verde Nat. Park--see photos of those in J. Scott 2017 Papilio (New Series) #26 p. 49 and M. Fisher & J. Scott 2008 Papilio (New Series) #18:pl IV. The intermediates have a narrow unh band varying from complete to just a few spots and the band varies from straight to kinked. Sometimes adults of ssp. *sheridanii* have white postbasal unh spots, which are small and uncommon on low-altitude adults, but on the W slope from about Grand County to Gunnison County a third or more of specimens may have those white postbasal spots or even bars. The origin of those spots is a puzzle (maybe ancient introgression from *C. gryneus gryneus*).

Habitat open grassy slopes (with or without some brush or some trees) for ssp. *sheridanii*, lowland desert canyons of SW Colo. for ssp. *paradoxa*. Hostplants in Colorado herb Polygonaceae: *Eriogonum umbellatum* var. *umbellatum* & *E. subalpinum* for ssp. *sheridanii*, *E. corymbosum* for ssp. *paradoxa*. Wolfe et al. (2010) list *Eriogonum heracleoides*, *racemosum*, *corymbosum*, *umbellatum, brevicaule* for ssp. *neoperplexa*, probably in Utah. Common.

Eggs light green, laid singly on ups or uns of young leaves or leaf buds of the hostplant. Larvae eat leaves (younger larvae eat pits etc. in top of leaves, older larvae eat more of leaf), without nests. Older larva of Colo. ssp. *sheridanii* green, a faint cream or yellowish middorsal line, a line of white subdorsal dashes and a strong or weak cream lateral band; prothoracic shield tan (or pinkish in Utah); or larva light olive-green, with cream middorsal line, with pink patches above and more sparsely below the cream subdorsal dashes (in NW Wyo. the reddish above and below meet, making a band of alternating red and cream along the body, photo at Allen et al. 2005), with weak creamy oblique dashes below those markings, and pink patches above the lateral cream dashes; in Grand Co. Colo. L3 seem to have more reddish markings than L4. Ssp. *paradoxa* older larva (photo in Scott 1986a and here) green or pale-pinkish-green, with pale-yellow markings including a yellowish line beside the middorsal darker-green line, yellowish curved oblique subdorsal dashes, a yellowish lateral line; similar to ssp. *comstocki*. {Calif. ssp. *viridis* ["*dumetorum*" photo of Ballmer & Platt 1988] yellowish-green with a small amount of pink or red [a little red above subdorsal cream-triangle ridges and small red spots above & below lateral cream band], or whitish with extensive red, a subdorsal cream line with dots of red, a lateral creamier line, with a creamier oblique dash on each subdorsal ridge. Other *viridis* mostly green with cream oblique subdorsal dashes and cream lateral band. Calif. ssp. *pseudodumetorum*

[“Coastal Bramble Hairstreak” photo of Allen et al. 2005] yellowish-green with a red spot above each subdorsal cream ridge and a red spot on both sides of each cream oblique subdorsal dash, and red above & a bit below lateral cream dashes. Other *pseudodumetorum* larvae mostly green with cream lateral band, or mostly reddish. Ssp. *newcomeri* green with weak markings in photo of Neill (2007).} Pupa medium brown, sometimes slightly-greenish brown on thorax and wings, the abdomen a little oranger with middorsal brownish band (*paradoxa* pupa pale orange-brown to reddish-brown) with fine dark mottling (less mottling on the darker wings); in litter. Pupae hibernate.

One flight everywhere, in spring: ssp. *sheridanii* flies L March-May in the Front Range foothills (mostly M Apr.-M May--a few misguided adults emerge in M June and M July) and flies end of April-E June in the Canadian Zone; ssp. *neoperplexa* flies mostly May; ssp. *paradoxa* M April-M May.

Adults prefer yellow and white flowers, including *Cerastium arvense strictum, Claytonia rosea, Noccaea fendleri =Thlaspi montanum, Lesquerella montana*; it probably visits mud.

Males of ssp. *sheridanii* rait (and flait a little) all day, most often in hillside depressions/ swales/ nooks near the hostplant (sometimes in gulch bottoms) to await females, as they rait on vegetation ~10-20cm up. In courtship, the male overtakes the female, they land, and the male flicks his wings to transfer pheromone. Males of ssp. *paradoxa* rait in gulch bottoms all day, on narrow flat spots before a steep place in the gully, as they rait ~30-60cm up on vegetation (mostly dead twigs, seldom on live leaves and rarely on the ground) to await females.

Callophrys gryneus siva Juniper Hairstreak

Identified by the hw tail and green unh, which on the Colo. ssp. ***siva*** has a fairly-straight white postmedian band and no white postbasal bars (ssp. *gryneus* eastward has a kinked band and white postbasal unh bars).

Habitat Upper Sonoran to Transition Zone woodland or brushland with juniper trees. Hostplants in Colorado small tree Cupressaceae: assoc. *Juniperus scopulorum* on E slope, and other *Juniperus* are probable hosts and are known hosts elsewhere (*J. monosperma* in S-C & SE Colo., *J. osteosperma* in W Colo. [a host in Utah], *J. scopulorum* throughout the state). Moderately common.

Eggs pale green, the tiny ridges whiter, micropyle pit dark-green, laid singly on host foliage tips (esp. on new growth) and on blossoming twigs. Larvae eat foliage tips (young larvae mine holes in ups of needles, older larvae eat entire needles), without nests. Larvae of Calif. ssp. (*nelsoni* and *muiri*) feed mostly in daytime. Older larva green, with a white middorsal line that disappears posteriorly, large J-shaped white or yellow subdorsal marks (the top crossbars of the J’s much thicker), and a lateral row of white or light-yellow dashes. Pupa mottled dark brown. Pupae hibernate.

Evidently two flights mostly L April-May and M June-July on the plains of SE Colo., and evidently mostly L Apr.-May and M June-E Aug. in lowland SW Colo. But just one flight June-M July in the Front Range and at higher altitudes throughout Colorado including the Arkansas Canyon and San Luis Valley.

Adults usually visit yellow or white flowers, sometimes pink etc., including *Apocynum androsaemifolium, Ceanothus fendleri, Chrysothamnus* (*Ericameria*) *nauseosus, Oreocarya suffruticosa, Eriogonum umbellatum, Jamesia americana, Senecio* (*Packera*) *fendleri*, sometimes visit aphid honeydew, and often visit mud. Adults bask laterally.

Males rait all day on the top and upper sides (often 2/3 of the way to the top) of *Juniperus scopulorum* trees, often flying around the trees, more often on a ridge (often sloping) than in a valley. Males of ssp. *siva* & *gryneus* rait an average of ~2-4 m up on junipers, preferring taller trees. They are reluctant to leave the tree. Courtship was not seen.

Callophrys spinetorum spinetorum Blue Mistletoe Hairstreak

Identified by the steel-blue ups and the reddish-brown uns with white postmedian line.

Habitat conifer woodlands from foothills to Canadian Zone. Hostplant in Colorado Viscaceae (juniper-like parasites on conifer trees): *Arceuthobium americanum* on *Pinus contorta*, *A. vaginatum cryptopodum* on *Pinus ponderosa*, and surely *A. divaricatum* on *Pinus edulis* (known host in Utah) and *A. cyanocarpum* on *Pinus flexilis*. It is rarely seen, probably because most adults are in the treetops.

Egg light-green with dark-green sunken micropyle area, laid singly on the host in crevices etc. Larvae eat all external parts (shoots, developing fruits, esp. terminal buds), without nests. Older larva tremendously variable, green or yellow-olive or ochre-yellow in ground color, sometimes with dark-reddish, changing color in about 2 days to match the hostplant color (S Ore. larva cream & brown in Guppy & Shepard 2001 photo, greenish-brown on Neill 2007 photo) (Ariz. larva may be greener or greenish-brown, or golden brown on Allen et al. 2005 photo), with a greenish or gray middorsal band (sometimes waxy–orangish on A2-6), with a subdorsal row of large clam-shaped conelike protrusions on each segment [largest on T2-A6, except always atrophied on A1], those protrusions commonly colored like "socks" [except on A1] with cream edge and tawny sock interiors, and below the oblique lower edge of each clam-sock is an oblique black or brown or dark reddish trypanosome-shaped dash (on a greenish Calif. larva on photo of Ballmer & Pratt 1988 the protrusions consist of orangish triangles filling the cream-edged sock [except on A1 where it is replaced by a black oblique streak]) (on a very-green Wash. larva [James & Nunnallee 2011 photo] the top rear of the triangular clam has a reddish-brown spot) (Ariz. larva completely golden-yellow with white markings and the protrusions have cream socklike markings with golden sock interiors) (Ore. larvae on Neill 2007 and Guppy & Shepard 2001 photo have protrusion socks red with white oblique border); all the larvae have white stripe on the lateral ridge (topped by a usually-strong brown or black spot at rear of each segment) (a Pierce Co. Wash. larva on Guppy & Shepard photo has cream flaring up from that lateral cream band) (a greener Wash. larva has this stripe weak and the blotches are blackish); the neck shield reddish with an olive bar. Pupa dark chestnut-brown (wing cases & head slightly greenish) or dark-brown, mottled with tiny black marks esp. dorsally, with short dark setae. Pupae hibernate.

One flight May-June in most of Colo., but M–June-July at the highest altitude. In lowland SW Colo. there are two generations April-May and July-E Aug. (In N New Mex. two generations L March to start of Aug.)

Adults visit mostly numerous whitish and yellow flowers, sometimes visit *Salix* catkins, and often visit mud. Some adults were seen to fly down a gulch evidently looking for water, as *C. johnsoni* does in California (Scott 1973d). Flight is fast, and if scared they zoom up into the tree canopy. An adult strayed miles from the foothills to Green Mtn. west of Denver.

Males rait all day on top of prominent trees (pinyon pines, junipers, spruces, etc.), especially on hilltops, as they often rait 2-4 to many meters up (probably at least 10m up, too high to see). At one hilltop there were no trees so males raited on a plant 15 cm above ground and several females came too; and males raited 1.8-2.5m up on smaller trees on another hilltop. Hilltopping was noted in Colo. and Calif. by O. Shields (1965 J. Res. Lepid. 4:240).

Callophrys mcfarlandi Beargrass Hairstreak

Easily identified by the white line that forms a loop around the outer part of unh.

Habitat Upper Sonoran Zone mostly open grassland (often hilly), with abundant hostplant. In Colorado inhabits only Gotera & Cobert Canyons on Mesa de Maya, on Willard Louden's ranch near Branson in Las Animas County, the only place in the state where the *Nolina* host occurs—most of the range is in E New Mexico, West Texas, and Coahuila. Hostplant bush Asparagaceae (was Agavaceae, "Ruscaceae"): *Nolina texana greenei* in New Mexico (*greenei* is hostplant also in E NM and W Tex., *N. t. texana* the host in Coahuila). Common.

Eggs laid singly on hostplant flower stalks. Larvae eat flowers/fruits, without nests, associated with ants. Young larvae bore into flower stems. Older larva ground color (beside the creamy markings noted below) tan (Allen et al. 2005) or dark maroon, sometimes pink or light green, with or without creamy markings (a cream middorsal line, 7-8 semicircular crescents whose midpoints cross middorsal line and curve backward, a row of subdorsal dashes within those semicircular crescents, a pale [often pale yellowish-green] wide band encloses spiracles, a pale lateral line between two rows of darker dashes). Pupa unreported. Pupae hibernate.

Evidently a flight southward in NM end of Feb.-May (some in June), and a second flight July-Aug. that is perhaps partial. In Colorado they may fly April-June when the host blooms.

Adults often visit the whitish hostplant flowers.

Males evidently rait on the hostplant throughout the habitat, probably all day, based on very few observations. Adults are rather local, and spend most of their time parked on *Nolina* inflorescences and flowers.

Callophrys fotis fotis Desert Elfin

Identified by the whitish-gray outer half of unh, the gray ups of both sexes, and the desert habitat. Recently found in Mesa and Montezuma Cos. Colo., and Chuska Mts. NM. Colo. populations are evidently ssp. ***fotis*** which has some slight ups orangish (present in some females), compared to the S Nev. weak ssp. or synonym *mojavensis* with less orangish. Intermediates with *C. augustinus* are reported from Mesa Co. Colo., Carbon Co. Utah, and the Providence Mts. Calif. (I have not seen them to be sure, doubtful).

Habitat low-altitude Upper Sonoran Zone desert brushy areas mostly on hillsides (the host grows on sandstone rimrock). Hostplant in Colorado shrub Rosaceae: *Purshia stansburiana* ="*Cowania mexicana*". Moderately common.

Eggs laid singly on host inflorescences; larvae eat flower buds, flowers, and young fruits. Older larva dark-green or light yellow-green, 50% of larvae lack markings while the others have triangular cream folds near the very top that have weakly-brownish-red caps, and a lateral slightly-reddish-tinted lateral band. Pupa brown, sometimes with slight green shading. Pupae hibernate.

One flight April-E May.

Adults enjoy *Rhus* flowers.

Males evidently rait ~90-150cm up often on *Juniperus* or other bushes including the host, in gulch or ravine bottoms (M. Fisher), but *C. fotis* is not strictly a "gulcher" (Ray E. Stanford pers. comm.), probably all day.

Callophrys mossii schryveri Stonecrop Elfin

Identified on unh by the whitish postmedian area beyond the white jagged line, and the red-brown fused blobs along the margin, which has a narrow undulating white line inside the checkered fringe. The ups is brown in males, orange-brown in females.

Habitat open forest or brushy areas in the Transition Zone foothills. Hostplant in Colorado herb Crassulaceae: *Sedum lanceolatum*. Females occur mostly on north-facing slopes near the hostplants. Usually uncommon.

Eggs pale bluish-green, turning white just before hatching, laid singly, mainly on the uns of basal host leaves. Young larvae are green and eat leaves, older larvae prefer flowers and fruits; no nests. Older larva mostly pinkish with white markings, all but the reddest larvae usually marked with a wide red middorsal band, a long oblique subdorsal dash of white above narrow red edging on each segment, and a creamy lateral line below another reddish band (lateral reddish band weak on mostly-green Wash. larva of James & Nunnallee 2011, but they also show a redder larva with white heart- band edged by red, then white J-shaped crescents edged by red, and a lateral paler band edged above by red). Many older larvae are entirely scarlet (esp. in California ssp.) often with a weak pink middorsal line, a white oblique subdorsal dash on each segment; or larva pink, or reddish with a greenish undertone, or yellowish. An Ore.? full-grown larva is pale-green with a row of small white-above-red dorsolateral dashes (photo Neill 2007). In BC (photo Guppy & Shepard 2001), young larvae on *Sedum* flowers are yellow, and older larvae on pink-tinged leaves are pale pink. Pupa medium-brown in Colo. (in Wash. orangish-brown but brownish-orange on abdomen, with numerous tiny black specks and several dorsolateral rows of black spots on abdomen). Pupae hibernate.

One flight L March-May (most common M Apr.-M May).

Adults visit white and yellow flowers, but rather seldom, on *Prunus americana* etc.; I saw a Calif. ssp. *windi* on mud. Calif. populations are often very local, and adults live an average of 7 days in males, 8 in females, and the maximum movement was 250m (R. Arnold). Colorado populations seem to be less local.

Males rait all day in gullies, in fairly open level sunny spots next to a sunlit bank of the gulch, as they rait on bushes or sometimes rocks ~20-33cm or more above ground. Sometimes they rait on top of a shrub on a hillside. In courtship, the male overtakes the female and they hover (remaining courtship might be like *Callophrys augustinus*) (in Calif., the male pursues the female, they land, flutter, and nudge slightly, then they join). If a mating pair is startled, the female or the male flies, the partner dangling.

Callophrys augustinus Brown Elfin

Identified on unh, by the uniform red-brown along the margin (beyond the row of weak brown dots), and the lighter brown postmedian area beyond the dark inner half of unh. Colorado has two subspecies: ssp. ***augustinus*** in most of the state has the unh basal half blackish-brown, much darker than the outer part; ssp. ***iroides***=*annetteae* from SW Colorado has the unh basal half lighter (brown), less contrasting with the paler red-brown outer half. Females have the ups oranger-brown than males, which have little orangish.

Habitat of ssp. *augustinus* open woodland such as *Pinus ponderosa* or *Pseudotsuga menziesii* containing abundant hostplant, from foothills to Canadian Zone. Habitat of ssp. *iroides* low-altitude brushland and open pine woodland in the Transition Zone lower mts. Hostplants in Colorado are woody prostrate or bushy Ericaceae: *Arctostaphylos uva-ursi adenotricha* for both ssp.; perhaps *A. patula* bushes could be eaten by ssp. *iroides* in W-C Colo. although the range of the plant is smaller than the butterfly in W Colo. For *iroides*, *Ceanothus velutinus*, *Purshia tridentata*, *Cercocarpus montanus*, *Eriogonum umbellatum*, and *Prunus virginiana* are eaten in Utah (Jack Harry), and Wolfe et al. (2010) also list *C. velutinus*, *P. tridentata*, *A. uva-ursi*, and *P. virginiana* as hosts in Utah, so those could be hosts in SW Colo. And *iroides* in California eats many dozen hosts of many families, including various *Arctostaphylos* and other Ericaceae and *Ceanothus* and even *Chlorogalum* (Liliaceae). Uncommon to common.

Eggs pale bluish-green, turning pale yellow-green and finally white, laid singly at the base of host flower pedicels. Larvae eat flowers and fruits (older larvae and starving young ones also eat leaves), without nests. Older larva of ssp. *augustinus* from W.Va. (Allen et al. 2005) green or yellowish-green with a weak darker heart-line with some red diffuse dots nearby, yellow oblique marks below the red dots, some paler green subdorsal crescents (some NJ larvae lack yellow marks); or (Bright & Ogard 2010) green with paler J-marks then weak paler crescents and a paler lateral band; Ont. *augustinus* green with weak middorsal yellowish line, a yellowish crescent on each segment attached below to a narrow yellow comma, weak yellowish supralateral dashes and a yellow lateral band; Fla. larva green with lateral cream line and weak dorsal markings. Pupa brown, spiracles orangish. Ssp. *iroides* larva (Utah, Calif.) olive-green to light green (T1-2 & A8-9 washed with creamy), with white subdorsal triangles (with a small red spot above each triangle, those triangles entirely white with just a small red streak in the A1 triangle), and a lateral abdominal band of white dashes (each with a weak reddish-brown spot above and below). {A Burnaby BC larva (Guppy & Shepard 2001 photo) supposedly "*iroides*" is green with weak subdorsal cream line and weak cream oblique dashes and bright red subdorsal spot on ~A5 (like W.Va. larva) and no subdorsal protrusions, but possibly? may not be *iroides*, because the Calif. *iroides* larva (Ballmer & Platt 1988) looks more like *C. spinetorum* and

Satyrium behrii with large triangular subdorsal cones.} Red subdorsal dots occur in both *C. augustinus* ssp., including present on W. Va. photo of Allen et al. (2005) and N.J. photo of Guppy & Shepard (2001) but missing on Ala. *augustinus* photo of Bright & Ogard (2010). Pupa light brown speckled with black, with dark heart-shaped blotches about spiracles, and middorsal, dorsolateral, and sublateral rows of dark round spots. Pupae hibernate.

One flight L April-M June rarely into July (mostly M May-E June) for ssp. *augustinus*.   One flight L Apr.-M May for ssp. *iroides* in SW Colo.

Adults usually visit white/yellow flowers, including *Arctostaphylos uva-ursi* and many others, and visit mud. Adults fly down-valley to seek moisture and flowers (Scott 1973d). Flight is erratic but not very fast. Adults bask laterally. Adults do "hindwing rubbing" despite the lack of an eyespot or tail.

Males of ssp. *augustinus* rait all day in little sunlit clearings to await females, mostly on hilltops or ridgetops and slopes near the ridgetop/hilltop, seldom lower on hillsides and rarely in little clearings near or on valley bottoms (my records show locations of their raiting clearings: hilltops 18x, ridgetops 11x, near a ridgetop/hilltop 16x, hillside 12x, saddle 3x, near valley bottom 2x, valley bottom 1x), as raiting males rait an average of 31cm above ground (0-67cm, N=39) on low plants at the clearing (most often on prostrate *A. uva-ursi* hostplant, almost as often 1/3-1/2 m up on low *Juniperus communis* bushes, often on miscellaneous small plants [*Quercus*, *Cercocarpus montanus*, tiny Douglasfir or Ponderosa Pine], rarely on grass or the ground). *C. augustinus* and *C. polios* divide up the habitat to avoid mate-locating interference: *C. polios* raits in swales mostly on valley bottoms, whereas the little *C. augustinus* clearings on slopes are not depressed swales. In courtship, the male may hover near the female, they land, then he fluttered/vibrated his wings from 30-110^{o} spread for several seconds 5 cm from the female, then hovered about the area evidently to try to find her, then flew after an *Erynnis*. If a mating pair is startled, the female flies (and perhaps the male sometimes), the partner dangling. Males of Calif. *iroides* rait all day on fairly-prominent shrubs or tiny trees at the edge of a little clearing on a sloping hillside, as they rait evidently ½-1m above ground, higher up than *C. a. augustinus* (*C. a. iroides* lives in bushy chaparral habitat, and most of its hostplants are bushes). In *iroides* courtship (Powell, 1964, 1968, on a 1m bushy *Citrus* tree in a hillside clearing in Calif.), the male overtakes a passing female, they may hover near each other then land, and the male rapidly vibrates his wings at small amplitude beside her to waft pheromone, while the female spreads her wings slightly, and the male joins. Mating lasts 1.5 to up to 8.5 hours and often lasts after dark. Powell found mated pairs only after 15:00, but I found one at 11:10 in Marin Co. CA. (and A. Shapiro noted raiting in late morning onward, and ssp. *iroides* as well as *augustinus* mate-locates all day [Scott 1976a]). One male mated 5 times. A male in Powell's study lived 16 days.

Powell, J. A. 1964. Mating behavior of *Incisalia iroides* (Bdv.) (Lepidoptera: Lycaenidae). Pan-Pacific Entomologist 40:100.

Powell, J. A. 1968. A study of area occupation and mating behavior in *Incisalia iroides* (Lepidoptera: Lycaenidae). Journal of the New York Entomological Society 76:47-57.

Kinnikinnik Lore

The Southern Rocky Mountains in Colorado and S Wyo. and N New Mex. are very old. They rose high about three times, due to apparent weakness in the crumbled crust at that spot. The last rise was less than 15mya [million years ago] to the present, forming our current high mountains. The earliest two rises were worn down by erosion: by the late Eocene an earlier rise of the Front Range was worn down to a rather flat "late Eocene Surface" (discovered by my father Glenn R. Scott and other geologists), and remnants of that surface are still evident today atop the foothills (above Poudre Canyon west of Fort Collins and west of Boulder and on Lookout Mountain west of Denver and near Deckers and along the Rampart Range Road, etc.).

These Eocene Surface remnants have abundant Ponderosa Pines and some Douglasfir and a thick understory of kinnikinnik *A. uva-ursi*, and *C. augustinus* and *C. polios* are abundant on many such places, and I spent many days studying them along the Rampart Range Road in early spring. I always keep a lookout for orange overwintered *A. uva-ursi* berries on the plants, because winter temperature extremes of freezing and thawing make those berries sweeter and much tastier than the bland fall berries, so they make a great snack. Native americans picked them and mixed them with dried meat for their pemmican.

***Callophrys polios* Hoary Elfin**

Identified by the gray outer part of unh beyond a browner-gray area with brown dots, the gray margin of unf, and a very dark inner half of unh. The name *obscurus* has been used as the ssp. of Colorado butterflies, which may differ a bit by having slightly less orange on the uph of females, but that isn't a conspicuous difference because both sexes are brown on ups and few females from Colo. and N.J. have some red-brown near uph margin, so I consider it a synonym of *polios*.

Habitat foothills to Canadian Zone open forest of *Pinus ponderosa* and *Pseudotsuga menziesii* (sometimes *P. contorta* at highest altitude, but it generally grows too thick) with abundant hostplant. Common on the Rampart Range and the hills around Deckers, and the hills in much of Larimer Co. Hostplant in Colorado prostrate shrubby Ericaceae: *Arctostaphylos uva-ursi adenotricha*. Common.

Eggs whitish-green, turning greenish-white, laid singly on or near the base of elongate leaf buds (rarely on flower pedicels) of the host. Larvae evidently prefer to eat young leaves (they eat different parts of the host than *C. augustinus*). Older larva bright or dark green with short tawny setae (photos Allen et al. 2005, Wagner 2005), with a pale-green middorsal stripe, several rows of weak paler oblique dashes on the flanks, and a light-green or yellowish lateral line (the strongest marking--the other markings are weak), a weak paler sublateral row of dashes, a white star-shaped area on top of T1; an Ore. larva [Guppy & Shepard 2001] just plain dull-olive-green. Pupa brown, abdomen reddish-brown with darker heart-band, a row of black subdorsal dots, spiracles yellowish. Pupae hibernate.

One flight M April-M June or rarely into July (mostly May).

Adults prefer the white flowers of its hostplant *Arctostaphylos uva-ursi* (they feed upside down on those flowers), and visit others including *Barbarea orthoceras*, visit *Salix* catkins, and also imbibe mud. Adults bask laterally.

Males rait all day near the hostplant usually in sunlit gulch/valley bottoms and swales (including trails or dirt roads in those places), sometimes in the lower part of swales on hillsides (rarely a swale near a hilltop), as males rait usually on the hostplant or sometimes on the ground, an average of ~11 cm up (mostly due to the low height of *Arctostaphylos uva-ursi*; N=12). They sometimes meet raiting *C. augustinus* males on slopes near valley bottoms. Males sometimes fly in a zigzag pattern (hairstreaks in general fly somewhat fast and a little erratically). A male and female may fly about each other briefly before landing; otherwise courtship was not seen.

***Callophrys eryphon eryphon* Western Pine Elfin**

Easily recognized by the unh pattern. That pattern is similar to that on *C. niphon* which rarely is inadvertently transported into Colo., but *eryphon* has russet cones (in cell CuA_1 especially) and ovals along the unh margin beyond the black zigzag submarginal line (in *C. niphon*, the unh margin has gray spots beyond a russet line).

Habitat mostly *Pinus ponderosa* open woodland, from the foothills up into the Canadian Zone. Hostplants in Colorado tree Pinaceae: *Pinus ponderosa* var. *scopulorum*, *P. edulis*, and *P. contorta*. It can colonize planted pines (*Pinus radiata* around San Francisco, J. Powell 1997 J. Lepid. Soc. 51:176-179), but has not colonized Denver. Common.

Eggs pale green, turning white, laid singly on new-growth branch tips at the base of soft young needles. Young larvae bore into the base of young needles and male catkins then can eat whole young needles, and they and evidently even older larvae refuse old leaves. Older larva dark green, with a strong white subdorsal band, a slightly-paler green area just above spiracles, sometimes a weaker diffuse whitish dorsolateral band, and a strong white lateral band. Pupa slightly-reddish brown, wings darker, with dark dorsal spots. Pupae hibernate.

One flight with extremes M April-M July, but mostly M May-June in the foothills and June at higher altitude.

Adults mostly visit white/yellow flowers, including *Arctostaphylos uva-ursi, Barbarea orthoceras, Oreocarya suffruticosa, Euphorbia esula, Harbouria trachypleura, Prunus americana, P. virginiana, Rhus americana*, *Salix* catkins, *Senecio* (*Packera*) *canus*, and visit mud. Adults are lateral baskers. Adults often fly erratically, like other hairstreaks.

Males rait all day in gulch bottoms to await females, as they rait an average of 1.4m up (½-1.8m, n=31) on small trees (*Pinus ponderosa* most often, sometimes Douglasfir) or less often on dicotyledon bushes such as *Salix* etc.; males rait much higher above ground than other *Callophrys*. Courtship was not seen.

Callophrys niphon niphon **Eastern Pine Elfin**

Not a native, and some Colo. records were possibly errors. Very similar to *C. eryphon*, but the unh margin has gray marginal spots with a line of russet-brown dashes running along the upper part of those gray spots (those marginal markings are just a row of russet cones/ovals in *eryphon*); basal to those spots the black postmedian line is more jagged because the black submarginal triangles are shorter in cells M_3 and CuA_1 and thus look longer in cells M_{1-2} & CuA_2 (that black line is more uniformly zigzag in *eryphon*). A brown spot is present and easily visible in middle of unf discal cell in ssp. *niphon*, usually present but mostly somewhat obscured with brown basal coloring in *C. niphon clarki* (from E Canada), usually absent or often present but obscured in *C. eryphon*. A specimen in Carnegie Museum labeled Starr Ranch 6500' (on E face of Cheyenne Mtn. just S of Colorado Springs) May 21, 1932 by F. M. Brown may have come off a transported tree such as a pupa attached to a Christmas tree, because the nearest wild *niphon* is in E Okla., and the specimen seems to have just one brown bar in unf discal cell which is characteristic of ssp. *clarki* from Canada rather than ssp. *niphon* from most of U.S. with two bars, and H. K. Clench thought it was similar to specimens from Manitoba. {*C. niphon* naturally ranges west to C and N Alberta on *Pinus banksiana*, and *C. eryphon* occurs in the Alberta mts. on *P. contorta latifolia*, and specimens from that meeting area are reported to be atypical [hybrids?].} There are also two dubious records from Bristol and Holly in Prowers County of SE Colo. Transport of (probably Christmas) trees has evidently transported *C. eryphon* from western to eastern N. Amer. (Maine, Michigan, Ontario, etc.), because many of the records of *eryphon* in E N.A. are recent, so that transport may sometimes transport *C. niphon* to Colorado. {*C. eryphon* also expanded its range to the southern San Francisco Bay area in Calif.} That transport has produced vague reports of intergrading populations of *niphon*X*eryphon* in E North America including SE Canada, so maybe they do hybridize often, but there has been no scientific study of those reports.

Habitat coniferous forest in E U.S., northward into Subalpine Zone in E Canada. Hostplants tree Pinaceae: in E North America more than eight species of *Pinus*, seldom *Picea*. A rare import.

Eggs pale green, turning whiter, laid singly on new growth of young plants. Young larvae bore through the sheath of young needles and match the red-brown color; older larvae eat the leaf tip to the base. Older larva green, with a narrow weaker or strong white middorsal line, a strong white subdorsal band (sometimes yellowish or orangish in the middle of segments), a wide diffuse-margined supralateral whitish band (in Bright & Ogard 2010 & Allen 1997 book photos), a strong white or yellowish or weak pale-green lateral band. Pupa slightly-reddish black, or dark mottled brown, the abdomen blackish on top. Pupae hibernate.

One flight in E U.S.: Mar.-April in south, May-M June in north. Adults sip flower nectar and mud.

Adults visit mostly whitish flowers, sometimes yellow or pink, and sometimes visit mud. They bask laterally.

Males rait on sunlit pines up to 20m up (Opler & Krizek 1984), at least 11:30-18:30 [probably early morning also on warm days].

Strymon melinus melinus Gray Hairstreak

Easily identified by the blackish ups and light gray uns, with no postbasal unh markings. The abdomen of males is orange, but only in summer; in spring and on females it is gray and black. Colorado has ssp. ***melinus***=*franki*, and the only other different valid ssp. are the darker-uns ssp. *atrofasciata*=*setonia* from Washington and BC, and an unnamed ssp. from S Florida (Key Largo and Broward Co.) with a larger unh red spot and longer tails.

Habitat everywhere up to the middle of Canadian Zone, but there are few records above the foothills and major river canyons. This species is mostly a lowland butterfly, but I found one in a willow carr on an alpine pass. Hostplants in Colorado flowers/fruits of many herbs or sometimes shrubs in numerous plant families (especially Fabaceae); it is our most polyphagous butterfly: *Astragalus bisulcatus, parryi, laxmannii* (=*adsurgens*) var. *robustior, Glycyrrhiza lepidota, Lupinus argenteus, Psoralidium tenuiflorum, Medicago sativa, Phaseolus vulgaris, Malva neglecta, Eriogonum effusum, lonchophyllum, alatum, Rumex triangulivalvis, Verbascum thapsus, Mentzelia multiflora, nuda, Mentzelia* sp., *Croton texensis, Physalis* (*virginiana* var.) *longifolia, Jamesia americana, Verbesina encelioides*. Usually uncommon in Colo., sometimes common.

Eggs light grass-green, laid singly mostly on flower buds. Larvae feed on flower buds-flowers-fruits, rarely young leaves, without nests (sometimes they bore into green bean pods), and are usually tended by ants. Older larva very variable in Colo. (even on one hostplant), cream, pale-yellow, yellow, green, tan, maroon, pink, or crimson, with various green or yellow or white or reddish marks (paler heart-band edged by darker band, mostly reddish or pale oblique dorsolateral dashes, lateral cream or yellow or pinkish dashes edged by green or tan or reddish). (Larvae are reportedly much less variable in Texas, mainly green.) Pupa brownish (often reddish-brown), or cream with some scattered brownish subdorsal "spray painting", sometimes abdomen has middorsal markings and rows of dorsolateral black dots, head & wings may be brownish, covered by long tawny hairs. Pupae hibernate.

Three flights, evidently L April-May (sometimes E June), and two (sometimes three) merged generations L June-Oct. (sometimes M June); perhaps four generations in extreme SE Colo.

Adults visit flowers of all colors, even red, including *Apocynum androsaemifolium, Aster ericoides, A. laevis, A. porteri, Astragalus, Bidens cernua, Ceanothus fendleri, Chrysothamnus* (*Ericameria*) *nauseosus* (favorite), *Cirsium arvense, Eriogonum flavum, E. umbellatum, Gutierrezia sarothrae, Heterotheca villosa, Liatris punctata, Linaria vulgaris, Medicago sativa* (favorite), *Melilotus spp., Polygonum* (*Persicaria*) *amphibium coccineum, Psoralidium tenuiflorum, Trifolium repens*, sometimes visit aphid honeydew, and often imbibe mud. Adults sometimes bask laterally (Douglas & Douglas 2005), sometimes body bask, and often bask dorsally—unlike most hairstreaks--by spreading the wings ~60-115^{o} (in observations by me, H. Clench, and Tveten & Tveten 1996). They do hindwing rubbing like other Lycaeninae. Adults have a fast and very jerky flight. Marked adults lived up to 27 days, but most live far less (lab adults average 9-10 days). Adults roost on their tall raiting plants or on plants as low as 1m up.

Males rait and often flait mostly in afternoon to dusk, on hilltops when available, to await females, as males rait high up on prominent trees or bushes and trees averaging 2.2m above ground (extremes 5cm-6m, n=83; they prefer to rait several meters or more up). They often fly around the tree/bush (flaiting), and I once saw about 15? males flying around a lone *Pinus ponderosa* tree on a ridgetop. If there are no trees/bushes on a hilltop, they will rait on low grass or *Yucca* or other 10 cm plants, and once several males fluttered about next to me as they thought I was a tree. On flat land they rait on prominent trees (5 males on a lone *Salix amygdaloides* tree for instance, or on a lone *Ulmus pumila*, or once on my truck hood at a site with no bushes/trees). They rait mostly in afternoon, but occasionally start in morning as early as 10:15-11:30, then raiting increases to a maximum about 13:00 and stays vigorous until dusk or cold as late as 19:00 (my hourly records of raiting from 08:00-19:00 were 3, 1, 7, 14, 27, 45, 59, 27, 10, 2, 3, 1--my few records late in the day were lower because of clouds and rain and my departure rather than due to lessened raiting desire). In S Ariz., males rait on paloverde trees on ridges in afternoon 13:30-17:00 (usually 14:30-16:00) in Feb.-Mar. but ending later ~19:00 by June. At high density, raiting was abandoned and most males flaited about the paloverde trees {J. Alcock & K. Oneill 1986 J. Zool. London (A) 209:105-113.}. In courtship, the male overtakes the female, they land, and the male flutters near her to transfer pheromone (no completed courtships were seen—receptive females would evidently remain quiescent and accept the male). If a mating pair is startled, the male flies, the partner dangling.

Ministrymon leda Mesquite Ministreak (Leda Ministreak)

A rare stray to Colo., recorded from La Plata, Boulder, and Jefferson Cos., all in E July. A small hairstreak with sky-blue over much of ups esp. basally, the uns grizzled-gray with weak postbasal dashes on unf and unh, and postmedian bands on unf (brown) and unh (red) , and an orange unh eyespot. In fall and sometimes in spring, **form ines** has the postmedian bands black, edged inwardly by smoky.

A native in S Arizona, where its host is Fabaceae tree: *Prosopis glandulosa* var. *torreyana*; M Fisher found adults emerging from pupae in litter under an Ariz. *Prosopis* tree. A rare stray.

Scott (1986a) gives a brief description of immatures. Older larva olive-green with white red-edged crescents near top that clasp some creamy wrench-end middorsal marks, a lateral row of white reddish-topped dashes. Pupa pale olive-brown (abdomen light brown), with black blotches and dots.

Multiple flights April-Nov. in S Ariz.

Adults visit whitish, often yellow, sometimes pink flowers, including *Baccharis*, sometimes *Ceanothus fendleri*, and sometimes visit catkins.

Males rait on treetops (on the top or near the top of junipers or oaks etc.) preferably on hilltops (once on lake-edge shrubs), at least from 13:30-19:00 when observations were made in Ariz. (perhaps earlier in the day also). They have a fluttery straight-line flight, and may fly about the tree awhile (flaiting) before landing.

Ministrymon "*Tmolus*" *azia* Gray Ministreak

This rare stray vaguely resembles *Strymon melinus* but is similar to *M. leda*, being very small (7-10mm fw length) with gray-tan ups (often with some whitish hw suffusion especially on females), the uns pale-gray with orange postmedian bands (no postbasal bands, unlike *M. leda*) and a small red unh eyespot. A very rare stray to Colo., with records in Boulder in July16, 1957 and July 26, 1975, evidently specimens artificially transported.

Hostplants various herb/tree Fabaceae southward, such as *Mimosa*. Females laid singly on flower buds, and larvae eat flower buds. A rare stray.

Minno et al. (2005) illustrates the larva from Fla., which is light green with numerous subdorsal long conical projections with a red nail-mark on each projection, some weak red dashes on the rest of the bumpy body, and a cream lateral line. Pupa tan with darker specks. Scott (1986a) provides a few more details on the species.

Calycopis cecrops cecrops Red-banded Hairstreak

A very rare stray to Colo., one found in Denver (presumably not ssp. *isobeon*), and one photo at Lamar in Prowers Co. June 25, 2005. Characterized by the red unh postmedian bands (wide on unh, narrower on unf), small weak brown postbasal dashes on unf and unh, the large black unh eyespot with narrower orange cap beside a blue spot on the tornus, and the silvery blue on part of ups. Ssp. ***isobeon*** from S Tex.-Mex. (& maybe Colo.) has narrower red bands and smaller black eyespot, and intergrades with SE U.S. ssp. ***cecrops*** at Houston and S Tex.

The strange larvae mostly eat decaying leaves of deciduous plants (mostly bushes or trees, sometimes herbs) on the ground fallen from *Rhus, Myrica, Quercus, Croton* and no doubt others. Ssp. *isobeon* eats dead/moldy leaves, fruits & seeds on the ground, poison ivy, bread crumbs, dead insects, fellow larvae, hair follicles, etc., evidently just about anything organic. Eggs white, turning tan, laid singly on uns of dead leaves etc. at the base of bushes & herbs. Older ssp. *cecrops* larva dull blackish-brown; or pinkish-brownish (Allen et al. 2005); or olive-green with bluish-green dorsal stripe; or (Bright & Ogard 2010) dirt brown with darker heart-band and subdorsal line of brown squares. Pupa light-brown with black blotches and abdominal bands.

Elsewhere adults visit flowers of *Rhus*, *Ceanothus*, and mud. They have a fast erratic flight. Multiple generations April-Oct. in E U.S., flies all year in Fla. Males probably rait on trees & shrubs, and are most active in late afternoon (Tveten & Tveten 1996).

Lycaenidae, Lycaeninae, Polyommatini Blues

There are maybe ~400 species of Polyommatini throughout Eurasia and North and South America, which are called Blues because males are blue on ups in most species, while females are often blue but more often are mostly brown; a few species have brown males and females (Calif. *Plebejus neurona*, and E. U.S. *Celastrina nigra*, for instance). The blue on males seems to be a signaling system: in most species the females evidently require a blue male for a mate (and may also require the proper male pheromone), while males seldom care about whether the female is blue or brown and evidently use female pheromones for choosing the right species (as an example see *Plebejus atrapraetextus*, below). Males evidently also use the blue color of other males during mate-location to avoid the bothersome waste of time and energy of trying to mate with other males. Most species fleek to find females, but some species (more than previously thought, including *Cupido*, *Plebejus melissa* group, and sometimes *Leptotes*) definitely rait to find females. Males usually have small weak thoraxes and flutter weakly without turning much (although some such as *Leptotes* and *Euphilotes* fly more swiftly), yet a few Polyommatini species are migratory, due to genetic programming. Adults do “hindwing rubbing” like other Lycaeninae, even though most species lack the eyespot and tail that is supposed to attract the bird’s peck to that spot rather than the body; their hindwing rubbing is evidently a legacy of genetic heritage. Adults rest and roost with the wings closed; *Euphilotes* roost with wings closed, head downward. They generally bask dorsally, except *Euphilotes* always bask laterally. Larvae have only four larval stages. Older larvae are sluglike and have very small heads which can be retracted into the thorax or extended into the hostplant to mine the food. Older larvae generally have stellate chalazae (setae that are branched at base). Polyommatini are usually associated with ants, and older larvae have honey glands on A7 which produce honey to bribe ants (except *Plebejus podarce* and presumably *P. glandon* lack them), and have eversible tubercles on A8 (except *Plebejus podarce*/*P. glandon*) which produce a chemical mimicing the alarm pheromone of attendant ants to induce the ants to protect them from other predators. Perforated cupolas=lenticles (a tiny circular chitinous rim enclosing numerous pores in the center that waft pheromone, Ballmer & Pratt 1988) on the larval body evidently produce a chemical mimicing the brood pheromone of attendant ants. {The European *Maculinea rebeli* has taken the relationship with ants to a new height (F. Barbero et al. Science 323:782-785): young *M. rebeli* larvae eat *Gentiana cruciata* plants then final stages are carried by ants into the ant nest, where queen *Myrmica schencki* ants make sounds to get food etc. from worker ants, and *M. rebeli* larvae & pupae mimic those sounds and secrete a chemical that makes ants regurgitate food for the larvae.} The prothoracic shield of older larvae is not pigmented and is apparently less-sclerotized, unlike the Lycaenini and hairstreaks. Pupae are ellipsoidal like most Lycaeninae, generally attached by a silk girdle and cremaster.

Zizula cyna **Tiny Blue**

A tiny butterfly with narrow wings, blue ups, whitish uns with submarginal cones, and rounded black uns spots. A very rare migrant, 3 specimens caught Gold Can. Road, W of Colorado Springs, El Paso Co. Colo., July 2, 2006 (Samuel A. Johnson). Subtropical, ranging S to Colombia, straying N also to N Texas and S Ariz. Flies all year in Mex., at least Mar.-Sept. in Texas. Scott (1986a) illustrates it.

Brephidium exilis exilis **Pygmy Blue**

This tiny butterfly is identified by the row of four large black and blue unh marginal spots (maybe resembling a wolf spider to scare predators?), without a red submarginal band. They are so small they are hard to see. Evidently migratory, flying as far north as Neb. and Idaho.

Habitat low-altitude weedy places mostly in valley bottoms, especially alkaline sites. Hostplants in Colorado herb and shrub Amaranthaceae (Chenopodiaceae): in Colorado associated with *Salsola tragus=australis=*"*kali*" and *Atriplex canescens* (Wolfe et al. 2010 note both are hosts, probably in Utah). In Montrose assoc. with *Halogeton glomeratus* commonly (M. Fisher) which is surely a host, less often *Suaeda nigra=moquinii*, *A. canescens*, and *Chenopodium*. *Sesuvium verrucosum* is a host in Utah and occurs in S Colo. so could be a host in Colo. In Nevada they oviposit at least on all those Amaranthaceae and more (Austin & Leary 2008): *Allenrolfia occidentalis*, *Atriplex canescens*, *lentiformis*, *Bassia hyssopifolia*, *Chenopodium album*: *Halogeton glomeratus*, *Kochia scoparia* [common in Colo.], *Salsola tragus*, *Suaeda nigra=moquinii*, *calceoliformis*.) {*Amaranthus* is an error.} Many of its hosts are foreign weeds. Common southward.

Eggs pale bluish-green, turning white, laid singly everywhere on the hostplant but most often on flower buds, often on buds, sometimes on leaf ups. Larvae eat flowers, fruits, leaves, and stems, without nests; they are tended by ants. Older larvae variable: half of them reddish (granular bluish-green only on side and rear) with dark reddish middorsal area next to cream crescents that clasp reddish patches, then a mottled green dorsolateral area, and a lateral reddish band edged below by a line of cream dashes; or green with a rosy or dark-green middorsal band (sometimes edged by whitish crescents) and sometimes a rosy lateral band (Allen et al. 2005 photo); or yellowish-green with a yellowish-white (pinkish tinged) middorsal band and a yellow lateral band; or green with a dark-green heart-band edged by a white line; or solid dark green (Ballmer & Platt 1988 photo) (resembling the SE U.S. ssp. *pseudofea*, which intergrades with *exilis* in Nueces Co. Tex.); all larvae appear granular because of thousands of short cream setae; the tiny head dull brown. Pupae variable, usually light yellowish-brown with yellowish wing cases, a weak brown middorsal line, brown spots on the wings, and brown subdorsal dots on abdomen; or pupa brownish-yellow, or solid pale green, or yellow-white with a reddish head. Pupae make faint squeaks. K. Coolidge reported pupal hibernation, but A. Shapiro suggests they die in winter and do not diapause and adults reappear in spring in C Calif. due to immigration (1987 J. Res. Lepid. 26:255).

Evidently three or four potential flights E May-Oct. (most common M July-Oct.), but the species is thought to be semi-migratory thus spreading north during the year. However, the butterflies have a weak slowly-fluttering flight which M. Fisher describes as "rolling" along, and are so tiny that they are hard to see and are very easy to miss, so one wonders how such a weak tiny species could be migratory—do they just escape notice? If they migrate, do they fly high and use winds to carry them north? (normally they fly low). I have not seen any migrate. They are more common in SE and SW Colorado so possibly often overwinter there, but are scarce near Denver, though sometimes I found them fairly common in Sept. below Barr Lake where an alfalfa field was abandoned and became a *Salsola tragus* weed monoculture.

Adults visit small flowers apparently of most colors from white to yellow to violet or blue-violet, including *Chrysothamnus* (*Ericameria*) *nauseosus*, *Senecio*, and *Aster laevis*. I have not seen them on mud. Adults bask dorsally or laterally. They often rest on vertical twigs with wings together and one side facing up.

Males fleek (evidently all day) about the hostplants, mostly on flat land, to seek females, as they fly weakly among and several cm from the hostplant branches, and between hostplants they fly only ~5cm above ground. They land often.

Leptotes marina **Striped Blue**

The zebra-striped tan & white uns is diagnostic. Males are blue on ups, females brown & white. Adults evidently migrate to Colorado and most records are July-Sept., though I have never seen adults actually migrate (do they migrate high in the air?).

Habitat the lowlands (plains to Canadian Zone, seldom higher) mostly in valley bottoms, in alfalfa fields or wherever legumes grow. Hostplants in Colorado mostly-herb Fabaceae: *Medicago sativa, Dalea purpurea*, and M. Fisher noted them assoc. with small *Robinia neomexicana* trees along the Highline Canal in Denver. Some Nev. hosts (Austin & Leary 2008) may also be used in Colo.: *Lupinus argenteus*, *Melilotus alba*, *officinalis*, *Mimosa*. Many hostplants southward including shrub and tree Fabaceae (including *Medicago sativa*, *Astragalus*, *Dalea*, *Glycyrrhiza*, *Lathyrus*, *Lotus*). Uncommon.

Eggs pale green, turning white, laid singly on host flower buds. Larvae eat flowers and fruits, rarely leaves, without nests, attended by ants. Older larva very variable, light green or brown or partly pinkish or reddish-brown, with dark bands and diagonal stripes; a reddish-brown larva has cream ground color with heart-band reddish-brown, then each segment has a cream molar-shaped mark edged below by a brown diagonal, then by a patch of reddish-brown patches or blobs, then cream, then underside brownish; a mostly-green larva has r-shaped subdorsal whitish marks and a lateral line of whitish check-marks. Pupa pale ochre-brown, with pale-gray wing cases and brown spots and a brown supraspiracular abdominal band; attached by silk girdle & cremaster. Evidently no diapause (hibernation) stage.

There may be three or rarely four flights L April-Oct. for adults that migrate to Colo. early in SE Colo., but the flights merge in the records and cannot be extracted; adults are most common from July onward. It flies all year in S Texas and migrates as far as S South Dakota.

Adults visit flowers that are whitish, yellow, orange, pinkish, and purple-violet, including *Medicago sativa*, *Melilotus albus*, and very often visit mud. They do "hindwing rubbing". Adults fly erratically and fast, much more erratically than other blues and faster than *Plebejus melissa*, but not as erratically as *Lampides boeticus* in Hawaii.

Males mate-locate all day to find females, mostly in valley bottoms or gulch bottoms, mostly by fleeking but often (contrary to Scott 1976a) by raiting. Males rait in little grassy clearings among valley bottom vegetation, sometimes in *Polygonum* (*Persicaria*) sloughs or bare gulch bottoms, where they rait ~40cm-1.5m up on plant twigs/stems and chase passerbys, and males flait there also. M. Fisher noticed males flaiting and raiting near the tops of the highest individuals of small *Robinia neomexicana* trees to find females. They also fleek over vegetation, so they primarily fleek in habitats with no little clearings or gulch bottoms. At Wheatridge there is a little ~10m wide clearing of grass (2/3-m tall *Calamagrostis canadensis* etc.) surrounded by 3m riparian bushes/trees (of *Salix*, *Populus*, *Prunus americana*), and males rait there about every year, and fly out to meet passing butterflies such as an occasional fleeking *L. marina* male, then they flait around for a while and rait again. Vertical encounters 5m or 8m up in the air happen between males sometimes, usually when two fleeking males meet. If a mating pair is disturbed, the male flew in six pairs, the female in five, the partner dangling. Courtship was not seen.

Cupido "*Everes*" *comyntas comyntas* **Eastern Tailed Blue**

A small species, the ups is blue on males and brown on females (except spring females are bluer, **form meinersi**), the uns whitish-tan with numerous black spots. *C. comyntas* differs from *C. amyntula* by having an orange spot(s) above the tail on uph, and larger orange spots on unh, the fw margin is more rounded, and the male uncus in dorsal view is concave with a point in the middle (drawing in Scott 1986a).

Habitat moist gulch/valley bottoms on the plains and sometimes barely into foothills gulches. Uncommon in Colorado. M. Fisher (Butterflies of Colorado) wrote that it may be just an immigrant to the state, and A. Shapiro describes it as "dispersive" in California where the hosts senesce and it has to move to find new hosts. But it is recorded from nearly all the counties E of the continental divide, and I found it at 18+ locations (mostly on the plains, but at three sites in little foothills gulches in Tucker Gulch and N of Idledale in Jefferson Co. and Hardscrabble Can. in Custer Co.) and found it fairly common at some sites (a gulch N of Idledale in the foothills W of Denver, and on little creeksides E of Colorado Springs, SW of Green Mountain E of Morrison, at Wheatridge, and Barr Lake), and I found ovipositions and larvae. Therefore it is evidently a native at least eastward on most of the plains, but is evidently not well-adapted to the arid Colorado shortgrass prairie climate so local small populations along the Front Range seem to be ephemeral and often disappear. There is no evidence anywhere in its range that it is a migratory species, so it would seem that it is a native species in Colorado. Hostplants in Colo. herb Fabaceae: *Trifolium repens* (ovip. in Jefferson, Elbert, and El Paso Cos.) and *T. fragiferum* (larva reared, Barr Lake), 15+ genera of Fabaceae elsewhere. Uncommon, sometimes locally common, evidently more common near Neb. & Kansas.

Eggs whitish-green with white ridges, laid singly on host flowers, sometimes on young leaves. Larvae eat flower buds and fruits, seldom leaves, without nests. My older larva in Colo. maroon with lighter bands and a slight frosting of pale points, a middorsal dark-brown band, two bands of slightly-oblique gray dashes on each segment (a gray anterior area below lowest oblique), a gray lateral band. Other larvae in E U.S. are similar; or are green with weak yellower-green beside the middorsal area and the subdorsal dashes are weak yellowish and there may be a yellowish lateral band (sometimes pinkish laterally incl. over lateral band in Calif. on Guppy & Shepard 2001 photo); some larvae in E U.S. usually dark green with dark green or brownish middorsal stripe, several rows of weak brownish or dark-green oblique subdorsal dashes, and a whitish lateral line often edged by reddish; or larva red-brown sometimes with green stripes; or larva violet-brown; or yellow-brown. *Cupido* (*Everes*) larvae have eversible tubercles and evidently are assoc. with ants. Pupa in Colo. has wings translucent light olive-green, abdomen tan, top of thorax greenish-brown, a brown middorsal band, a black subdorsal dash on A1-A2, a brown subdorsal spot on A3-7; E U.S. pupae vary from pale or dark green with middorsal green or blackish stripe and black oblique dashes on side of abdomen, or pupa whitish. Nearly-mature last-stage larvae hibernate, sometimes within the host pods.

Several flights L May-M June and ~two merged flights July-M Sept. (Oct.). Fewer of the records are for the first generation than the next ~two generations, which would suggest to some people that it is not a native to Colorado, but the same paucity of first gen. records also occurs in Pennsylvania (L April-M June) where it is clearly a native (Monroe & Wright 2017), although in Ohio the first generation has more records (Iftner et al. 1992).

Adults visit all colors of flowers, mostly short flowers often Asteraceae, including *Medicago lupulina*, *M. sativa*, *Melilotus albus*, *Oxalis stricta*, *Trifolium repens*. They often imbibe mud, and once fed on the blood of a chicken. Adults body bask/dorsal bask with the wings spread 45-120^{o} (M. Douglas, in Douglas & Douglas 2005). They do "hindwing rubbing" and have an eyespot and tail to help misdirect a bird's peck.

Males mate-locate all day low in the vegetation near the hostplants: males fleek most of the time, but some were seen raiting. Adults have a faster and more direct flight than *Hemiargus isola*.

Courtship was not seen. If a mating pair is startled, the female flew in six cases, the male once, the partner dangling.

Some Colorado records for C. comyntas: 2 mi. N Idledale, Jeff. Co. CO 21viii77 1f mounted, 11m3f papered, JAS. Lakewood, Jeff. Co. CO 1ix60 1m JAS. Green Mtn., gulch near Indiana Ave., Jeff. Co. CO 20ix88 1m mounted; 20ix77 1m papered; all JAS. Denver, Holly St. X Cherry Crk., Denver Co. CO 11vii73 1f JAS. Leyden Gulch, Jeff. Co. CO 5ix97 1m papered JAS. Chimney Gulch, Jeff. Co. CO 28vi78 1m papered JAS. Red Rocks, Jeff. Co. CO 12viii77 1m papered JAS. Tucker Gulch, Jeff. Co. Colo. 1m wreck caught in 4th July count ~1980? and counted but thrown out JAS. 1 mi. S Mt. Tom, Jeff. Co. CO 12vii81 1f papered JAS. Wheatridge, Jeff. Co. CO 11ix91 1f papered; 28vii92 1m papered; 5ix96 1m papered; all JAS. Boulder, Boulder Co. CO 17viii60 1m1f JAS. Barr Lake, Adams Co. CO larva found *Trifolium fragiferum* 28ix87, reared 1f emgd. 22x87; 2ix98 1m mounted, 2m2f papered; 2ix87 1m papered; 27viii88 1f papered; 23viii89 1m papered; all JAS. Briggsdale, Weld Co. CO 14vi77 1f JAS. Timnath, Larimer Co. CO 28viii73 4m papered JAS. Horsetooth Mtn. Park, Larimer Co. CO 18vi88 P. Opler 1f CSUC. 8 km NNE Nunn, Central Plains Experiment Station, Weld Co. CO 27viii76 1m papered JAS. Horse Creek, Elbert Co. CO 5ix72 9m1f JAS. Comanche Creek E of Kiowa, Elbert Co. CO 11viii78 6m papered JAS. 7.7 mi. E Jct. 24 & 94, El Paso Co. CO 9ix71 4m1f, 6ix71 4m2f, JAS. 0.5 mi. E Smith Crk. Cgd., Custer Co. CO 5vii73 JAS 1f. Wetmore, S edge, Custer Co. CO 13ix71 3m2f JAS. 3 mi. N Wetmore, Pueblo Co. CO 2vii70 1f JAS. E of Walsenburg, Huerfano Co. CO 1ix96 1f papered JAS. Bonny Rec. Area, Yuma Co. CO 8vii72 1f RES CSUC, same 1vii72 1m RES CSUC.

Cupido* "*Everes*" *amyntula **Western Tailed Blue**

C. amyntula resembles *C. comyntas*, but is usually larger, has less (smaller) of an orange hw spot (usually none on uph of males, a smaller one on females) than *C. comyntas*, the fw is more pointed (fw margin less rounded), and females have more ups blue. The male uncus is convex with a point (see Scott 1986a drawing). This is a mountains species in Colo., whereas *C. comyntas* usually occurs on the plains and sometimes occurs just a few km into the mountains. There are two ssp. in Colorado: ssp. ***amyntula*** from the western slope has smaller uns blackish spots; ssp. ***valeriae*** from the eastern slope (and S.D. to N.M.) has a full set of larger uns spots. *C. amyntula* is clearly a separate species from *C. comyntas*.

Habitat open areas including woodland from foothills to Canadian Zone. Hostplants in Colorado herb Fabaceae: *Lathyrus lanszwertii* var. *leucanthus, polymorphus incanus, eucosmus, Vicia americana, Astragalus flexuosus*, *Oxytropis lambertii*. In Nev. they eat *Vicia americana* and 7 sp. of *Astragalus* (Austin & Leary 2008). *Trifolium* is dubious as a host. Most Colo. hosts have tendrils (*Lathyrus* and *Vicia*), although *A. flexuosus* without tendrils is very popular. Common.

Eggs pale green with white ridges, laid singly on host flowers and young pods or the pedicel of flowers (sometimes on stems, seldom on leaves). Larvae eat flowers, fruits, and young leaves, without nests, but young larvae burrow into flower buds until they outgrow the bud (Wolfe et al. 2010), and S Calif. older larvae live inside pods and seal up the entrance hole with silk. Larvae are tended by ants, and external-feeding larvae in N Calif. (and surely in Colo.) have eversible tubercles to produce honeydew to bribe ants, whereas the S. Calif. larvae that live inside *Astragalus* pods have non-eversible tubercles (Ballmer & Pratt 1988, p. 50, 66) evidently because ants seldom get inside those pods. Older larva light reddish with weak darker-reddish heart-band, several subdorsal rows of cream crescents edged below by darker reddish, a reddish lateral band; or larva greenish-straw with red heart-band, pink or red oblique dashes, and a pink lateral ridge; or larva solid green with a darker middorsal line, often with weak cream oblique subdorsal dashes and a cream lateral stripe; covered with short whitish hair; head black. In Calif. Ballmer & Pratt (1988) found that they differ in details of older larval setae (the non-bushy dorsal setae on A7-8 are erect and straight or weakly bent in *amyntula*, mostly moderately to strongly bent in *comyntas*), but some populations in N Calif. and along the Sierra Nevada of Calif. are intermediate. Pupa pale-tan, sometimes brown or greenish-gray or olive-white, with a dark-brown middorsal band and subdorsal blackish spots, sometimes (Wash., James & Nunnallee 2011) mottled all over with tiny brown markings, and wing veins paler because free of mottling. Nearly-mature last-stage larvae hibernate.

The number of flights in the foothills is difficult to determine, because abundant continuous records from L April-July evidently represent a mixture of one generation and two generations, then records are few during Aug.-M Sept. indicating a partial 2nd-3rd flight. At higher altitudes only one flight occurs mostly L June-E Aug. (extremes E June-L Aug.). On Green Mtn. W of Denver records are mostly May-E June and the later generation is evidently absent because that "green" mtn. often dries out and turns tawny in summer.

Adults visit white, sometime yellow or purplish or pinkish flowers, including *Astragalus flexuosus, Lathyrus lanszwertii* var. *leucanthus, Sedum lanceolatum*. They also visit urine, dung, manure, and often imbibe mud. Adults bask by spreading the wings somewhat (body basking & dorsal basking). They do "hindwing rubbing." Adults roost on low vegetation and *Quercus gambelii* bushes, with forewings moved back between hindwings and antennae out.

Males rait all day to await females, as they rait just above the ground (3-30cm up) in gulch bottoms, valley bottoms, and swales; they sometimes flait there. Also, males sometimes (as little as ~10% of the time) fleek elsewhere in the habitat (about the understory of *Quercus gambelii* etc.) to seek females. In courtship, the male pursues the female and they land, the male may hover and flutter over the female, and may flutter behind the female; no completed courtships were seen. During mating the valvae grasp the underside of the female's abdomen, unlike hairstreaks. If a mating pair is disturbed, the females flew in five cases, the males flew in three, the partner dangling.

Celastrina neglecta **Summer Azure**

Identification features are the very-whitish uns, the white almost-uncheckered wing fringes, the frequent whitish streaks on male ups and whitish areas on female ups, the flight from June to Sept., and its presumed range on the far-eastern Colorado plains. Adults are difficult to distinguish from *C. humulus*, so hostplant association must be used. So far, it is confidently-identified only from the far eastern plains (caught in Sedgwick Co. in E July, in Baca Co. Sept. 8, & Logan & Prowers Cos.). The female "*neglecta*" illustrated by M. Fisher in his Butterflies of Colorado from Wheatridge in Denver Aug. 6 I think is a late *C. humulus* which occurs there commonly earlier in June on *Humulus*. Questionable specimens include four specimens I caught (from Lakewood in Denver July 16 1m & July 28 1f; from Little Fountain Creek in El Paso Co. Aug. 9 1f; 4 mi. S Beulah in foothills of Wet Mts. Pueblo Co. Aug. 4 1m; and I saw a *Celastrina* on the Univ. of Denver campus May 27; M. Fisher caught one at Littleton in Denver Aug. 13; and Marc Epstein found several in El Dorado Can. in Boulder Co. Aug. 14, probably *C. humulus*), and others were caught in Jefferson, El Paso, and Douglas Co. in 1999--all of those fit the flight time of *C. neglecta* but were rare when caught and most are probably late-emerging *C. humulus* (possibly rare *C. lucia sidara*? but it usually has more uns spots), because there are no known *C. neglecta* <u>populations</u> there and the only known white-*Celastrina* there in those areas is *C. humulus*. But *Cornus sericea* bushes with *C. neglecta* larvae may have been imported into Denver (where cultivated *C. sericea* bushes are very common) and other plains towns. But to prove the presence of *C. neglecta* on the western Great Plains would require proof of <u>actual populations</u>, such as finding many larvae on *C. sericea* in Denver. Currently any specimens from far E and SE Colorado such as Baca Co. would be considered to be *C. neglecta*, based on educated guess.

{It should be noted here that a species currently called *Celastrina echo cinerea* occurs in Ariz./New Mexico and apparently occurs as far north as the Chuska Mts. in NW NM/NE Ariz., and the Carrizo Mts. just N of the Chuska Mts. in San Juan Co. NM, and the Sangre de Cristo Mts. just S of Colorado [see Scott 2017, Papilio (New Series) #26:51-54]. So perhaps it might occur in extreme S Colorado. It has just black dots on unh, has no lucia or marginata or lucimargina forms, and is whiter with little fringe checkering, and thus resembles *C. neglecta* and *C. humulus*, so there is a problem in identifying them but those latter two are not known from far S Colo. Typical *cinerea* and Calif. *echo* have more violety ups that is most noticeable on males, and some of the presumed *C. echo cinerea* Carrizo Mts. NM males fig. by Scott 2017 seem to have darker ups blue than the Chuska Mts. *lumarco*, so *cinerea* may come close to Colorado. I also identified *cinerea* from Mora and San Miguel Cos. in the Sangre de Cristo Mts. of NM. based on few specimens, and *C. lucia sidara* occurs in NM south to San Miguel, Taos, and Rio Arriba Cos. If *C. echo cinerea* occurs in Colo., it might eat hostplants *echo* uses in Nevada (Rosaceae: *Holodiscus*, *Peraphylum ramosissimum*, *Petrophyton caespitosum*; Austin & Leary 2008) or Utah (*Eriogonum racemosum*, Wolfe et al. 2010). Currently any whitish butterflies found in SW Colo. might be considered to be *C. echo cinerea* because *C. humulus* currently is known only on the E slope south to S of Colorado Springs and *C. neglecta* is only definitely known from extreme E Colo. and evidently the NE tip of NM. A Calif. *echo* larva (Ballmer & Platt 1988 photo) is dark-green with massive subdorsal cream crescents and massive lateral white vertical hooks all inwardly edged by black (and a pinkish-tan Calif. larva in Guppy & Shepard 2001 has similar massive creamy marks clasping black markings plus a purplish heart-band), but larvae vary and are often whitish pale pink or pale green, and the upper segment A1 usually has a dark-green, pink, or brownish transverse "bar" [present on many *Celastrina*]. On Wash. *echo* (James & Nunnallee 2011 photo) the subdorsal cream crescents or zigzag marks has a small red edge on top [crescents sometimes have slightly reddish centers] and dark-green below, while lateral cream vertical marks occur only on some larvae and most have a lateral line of cream dashes with attached red areas on top and bottom of each dash, while some larvae lack creamy or red lateral marks. A presumed *echo* larva from Portland Ore. (Neill 2007) is cream with diffuse reddish-brown heart band, a dark A8 middorsal patch, subdorsal dark spots below the white crescents, the same A1 large dark spot, lateral band whiter. An *echo* larva from Lake Wenatchee Wash. is light-green with purplish heart band and cream subdorsal triangles/crescents and purplish dots above lateral cream line.}

Habitat evidently streamsides with the hostplants, and on the host in towns in Iowa etc. Hostplants in Colorado shrub Cornaceae: *Cornus* (*Swida*) *sericea sericea*=*stolonifera* (oviposition in Washington Co. Colo., and the host in Neb., Iowa, Minn., and assoc. in SE S.D.). Ovip. on C*ornus drummondii* in the middle of Okla. Numerous other plants with clusters of flower buds are also used in E U.S., including *Prunus virginiana* fingerlike leaf galls in S Minn. Common eastward.

Eggs pale green with white ridges, laid singly on host flower buds. Larvae eat flower buds and fruits, inserting their small head into the buds to mine out the food as Lycaeninae do, without nests. Larvae are tended by ants. Older larva (S Minn.) green with greenish-cream shrimplike markings beside heart-band, and a lateral band of cream dashes (a S.D. larva similar, Marrone 2002 photo); or a whiter version of the same; or greenish olive-brown with brownish irregular heart-band, a lot of brown on rear, lateral ridge pinkish-cream. Larvae have the pattern less sharp than *C. lucia sidara*. Older larvae in Penn./W.Va. variable, some are uniform grayish-cream with creamy lateral band; others are dark red with weak line of whiter dashes beside heart-band, white oblique subdorsal dashes, and a lateral white band. The heart-band seems less sharp esp. on A7-10 than *C. humulus*. Pupa paler than *C. humulus*: a dark heart-band and dorsolateral dark band, thorax and wings translucent-appearing grayish-tan, abdomen pinkish-ochre-tan, with various blackish and brown spots and mottling. S Minn. pupae are much paler than *C. lucia sidara*. Pupae hibernate.

Several flights in S Minn.-Iowa-S.D.-Neb.-E Wyo., the 1st flight in June, and a 2nd/3rd from L July-E Sept., so Colo. flights should be similar to those.

Adults eastward usually visit white flowers, sometimes yellow or purplish ones, including *Cornus sericea, Melilotus officinalis, Rhus glabra, Trifolium repens* (favorite), *Ceanothus*, and often visit mud, sometimes urine. Other *Celastrina* also prefer whitish flowers. Adults body bask & dorsal bask. Adults sometimes fly far, and evidently can fly farther than other *Celastrina*, based on their distribution near the hosts NE of Colo.

Males in Iowa and S Minnesota fleek (probably all day though my records are only 11:40-19:30) about the canopy of the hostplant *Cornus sericea* and nearby deciduous trees especially *Aesculus glabra* (which might have served as a hostplant earlier in mid May), as they fly near the ground to 4m up (usually ~1.5-3m up, extremes 40cm-8m up). In courtship, the male and female may both flutter widely (the female's fluttering evidently an attempt to repel the male).

Celastrina lucia sidara Front Range Azure

This ssp. ***sidara*** on the eastern slope of Colo. (and N NM and S Wyo.) is identified by its usually darker (grayish) uns with conspicuous narrow/small black markings, its mostly earlier flight, its habitat usually on or next to N-facing wooded slopes with *Jamesia americana*, the fringes are a little checkered, and the ups is blue (not violety). The uns usually has just dark-brown small spots and dashes and zigzags, but about 2% of adults have a small to rarely larger blotch in the middle of unh (form lucia). Some adults are a little paler on uns (more weakly marked), and the extremes may be difficult to distinguish from *C. humulus*. Some people treat *sidara* as a ssp. of *C. echo* (based on no evidence), but I treat *sidara* as a ssp. of *C. lucia*, because my lab rearings of it produced only the gray-uns spotted *sidara* adults and not the whitish-uns adults typical of the other two species, and I found some late-emerging adults in the foothills like *sidara*, and the ups seems to be less violety blue than *C. echo*. Genetic and rearing studies of other eastern U.S. *Celastrina* species (starting with W. H. Edwards in the late 1800s) has shown that the large-unh-brown-patch **form lucia** and the darker-unh-margin **form marginata** (and the combination, **form lucimargina**) are mostly genetic, and some species are evidently genetically fixed for those darker markings and darker uns grayer color. The checkered wing fringe also seems to be mostly genetic. However the extent of strong versus weak black unh markings and the ground color may be partly due to temperature/ photoperiod, because Schmidt and Layberry (2016) found that *C. lucia* "auctorum" in S Ontario can have a 2nd generation (E-L July, versus E-L May for the 1st gen.) which has the usual stronger marginal and the frequently-darker central unh blackish markings a little less dark than the 1st gen., and the uns is a little less gray (slightly whiter) in the 2nd gen. also (*C. lucia* in Ont. has checkered wing fringes, whereas *C. neglecta* there has just white fringes.) Also, *C. lucia sidara* may be sympatric with *C. echo cinerea* in the Sangre de Cristo Mts. and elsewhere in N New Mex., where *sidara* flies in May, whereas *cinerea* flies in L Aug.-M Sept. and presumably also in June [J. Scott 2017 Papilio (New Series) #26:51-54].

Habitat the mountains from the foothills to Canadian Zone, mostly on N-facing open-wooded slopes (with *Pseudotsuga menziesii* and often aspen trees) from the ridge to adjacent gulch bottom. Hostplants in Colorado shrub Hydrangeaceae: almost always *Jamesia americana* (a shrub that grows on N-facing open semi-shaded wooded slopes and along the adjacent semi-shaded gulch bottom). The following mostly-shrub hosts are eaten much less often: Rosaceae: *Holodiscus dumosus* sometimes (a frequent host W of Colorado Springs), *Prunus virginiana* var. *melanocarpa* rarely, *Physocarpus monogynus* rarely; Cornaceae: *Cornus* (*Swida*) *sericea* occasionally; bushy Rhamnaceae: *Ceanothus fendleri* rarely; vine Cannabaceae: *Humulus lupulus* var. *neomexicanus* rarely. Common.

Eggs pale bluish-green, becoming greenish-white, laid on host flower buds. Larvae eat flower buds-fruits, and are tended by ants (I found *Camponotus modoc, Formica podzolica, F. neorufibarbis*, and *Tapinoma sessile* on larvae). Older larvae variable in Colo. (Scott & Wright 1998), usually some shade of green, sometimes overall color red-purple with pink lines; or larva brown & white; green, maroon, & creamy; brown, white, green; green with brownish middorsal, mottled green or yellow-green; in general, the ground color usually green or some shade of green (seldom red-purple), middorsal band dark-red purple to usually maroon or brown or tan or dark-green; subdorsal and obliques pink to white & maroon to brownish-cream and pale to mostly greenish & green to seldom gray & creamy-gray; lateral band rarely pink to tan-white to usually greenish-cream or seldom yellow-green or rarely creamy-gray; edge of laterals seldom red-purple or pale-maroon-brown or tan and mostly greenish & rarely gray. S Ont. *lucia* larvae also variable, green, or green with those same reddish and dark-green and cream markings, the subdorsal mark on A1 darker green or reddish. Pupa ochre, head and top of thorax mottled dark-brown, middorsal dark-brown band on thorax and abdomen, different-shaped black subdorsal spots, (as emergence nears, the eyes and proboscis tip turn black before the rest in all *Celastrina*). The *sidara* pupae are darker on top of thorax than *C. humulus*, contrasting with paler (ochre) abdomen and wings. Pupae hibernate.

One flight mostly L April-M June in the foothills, L May-M July at higher altitude. Worn *sidara* fly with fresh *C. humulus* along the mountain front; in late springs such as 1991 & 1995 their flights overlap by several weeks.

Adults visit only yellow and white flowers, including *Arctostaphylos uva-ursi, Barbarea orthoceras, Jamesia americana, Prunus virginiana,* and feed on *Salix* catkins, on honeydew, on *Conium maculatum* umbels, on wet rotting wood, manure, and often visit mud. Adults bask by spreading the wings somewhat.

Males fleek all day mostly over the canopy of shrubs and low trees (often over the hostplant *Jamesia americana*) on N-facing slopes from the gulch to near the ridgetop, as they fly ~1-2m up. In courtship, the male pursues the female and both may fly in zigzag fashion for ~5m (evidently the female's attempt to escape the male), she lands and he may hover over her, then unreceptive females vibrate her ~130^o-spread wings to repel the male; no completed courtships were seen. If a mated pair is startled, the male flies at least often, the partner dangling. {A male pheromone--lavender lactone and delta-decalactone--is in Eurasian *C. argiolus* [Murtazina 2014]; American species are unstudied.}

Schmidt, B., R. Layberry. 2016. What Azure blues occur in Canada? A re-assessment of *Celastrina* Tutt species (Lepid., Lycaenidae). ZooKeys 584:135-164 (includes *C. lucia* larval photos).

Celastrina lucia lumarco **Lumarco Azure**

Nearly all adults of this W-slope Colo. ssp. ***lumarco*** have a dark marginal marginata area on unh, and nearly half have a large to giant brown lucia patch in middle of unh, much larger than other *Celastrina*, except some in NW Neb.-NW Wyo.-N Mont.-C Wash. have large dark unh markings and may belong to near-*lumarco*, such as the colony at Cowiche Can., Yakima Co. Wash. described by James & Nunnallee [2011] which also eats *Cornus sericea* and often has a large unh lucia-patch; and near-*lumarco* may? occur in the Black Hills of SD where Marrone 2002 describes and illustrates a male uns like *lumarco*. The uns is grayish like *C. lucia sidara*, and the fringes are very checkered. The ups is regular blue (not violety as is *echo*). Easily distinguished because other *Celastrina* do not occur with it, except southward in the Chuska Mts. of AZ/NM where the whitish *C. echo cinerea* evidently also flies with it in May but has several generations (May, L July probably to E Sept.) [Scott, J. A. 2017. *Celastrina lucia lumarco* in the Chuska Mountains, and other *Celastrina* in New Mexico (Lycaenidae). Papilio (New Series) #26: 51-54.].

Habitat the lower mountains up to the Canadian Zone on the western slope of Colo. Hostplants in Colorado shrub Cornaceae: *Cornus* (*Swida*) *sericea* is the hostplant in Glenwood Canyon (Garfield Co.), where *Amelanchier alnifolia* and *Prunus virginiana* var. *melanocarpa* are not eaten. Rhamnaceae: *Ceanothus velutinus* is used in Grand Co. Colo. (A. Warren), where the population may have intergraded with *C. l. sidara* somewhat based on adults. T. Emmel, M. Minno, & B. Drummond 1992 Florissant Butt. also list *C. velutinus* as a hostplant, evidently for *lumarco* because *C. velutinus* occurs only in NW Colo., not near Florissant). Common.

Eggs white with numerous tiny projections, laid singly on host flower buds. Larvae eat flower buds and fruits. Older larva (Glenwood Can.) cream, the middorsal band consisting of purple areas concentrated on the posterior of each segment, below that a cream triangle/crescent on each segment (on paler-green L3 larvae this is divided into a creamy dash above an oblique dorsolateral dash), which is behind a subdorsal olive-green mark that looks like a floppy boot with top flopped laterally (the toes connected middorsally on A1 & A7 & sometimes A6), large cream vertical dashes attached at bottom to lateral cream line. Many *lumarco* larvae look similar to some *echo* larvae. (Cowiche Can. Wash. larvae are often green with a cream lateral band, but some larvae are whitish and most larvae also have a subdorsal row of oblique yellowish dashes.) Pupa tan (wings slightly greener), top of thorax brown, a slight browner middorsal band on abdomen, a blackish subdorsal blotch on A1, irregular black smaller splotches on A4-6. Pupae hibernate.

One flight most often M May-E June, extremes L April-E July.

Adults visit various flowers including *Ribes inerme*, *Cornus sericea*, and *Prunus virginiana*, and spend much of their time imbibing mud.

Males fleek all day ~2m above ground about the canopy of the hostplant *Cornus sericea* and nearby bushes to seek females.

Celastrina humulus **Hops Azure**

This species occurs along the Front Range mountain front, and has the unh mostly whitish like *C. neglecta*, and has the wing fringes uncheckered on hw and weakly so on fw like *C. neglecta*, but occurs on hops (on lupines in one small area) and flies mostly in June. The unh varies continuously from very whitish with little pattern, to some adults with darker-brown markings similar to *C. l. sidara*, so some individuals are difficult to distinguish. I thought this was just a form when I discovered it, and studied it for decades and finally named it (Scott & Wright 1998 details the species and its immatures etc.). My several rearings in my lab (basement) produced only white-uns adults, so evidently its white uns is genetically different from *C. lucia sidara*. There are two ecotypes, the **hop ecotype** nearly everywhere, and the **lupine ecotype** in one small area of the foothills.

Habitat sunlit foothills and adjacent plains gulch/valley bottoms, where the host vines grow onto the lower part of coarse talus and onto various bushes. It occurs in almost all the lower foothills canyons in the Front Range, and on the plains along Clear Creek in Wheatridge and at Cherry Creek Res. in Denver, along Monument Creek in the Air Force Academy in El Paso Co., in foothills just W Colorado Springs, and Boy Scout Camp in Elbert Co. In the mountains it occurs as far upstream as Nighthawk along the South Platte R., and Pine Valley Ranch on the N Fork of South Platte R., and Central City in Gilpin Co. along N Fork Clear Creek. Several have been found in Rock Creek in the foothills of El Paso. Co. June 12-24 which are evidently *humulus*. *C. humulus* ranges north to the Laramie Mts. Wyo. and the eastern mtn. ranges in C Montana and the canyons on the SE Alberta plains. Hostplant in Colorado vine Cannabaceae: *Humulus lupulus* var. *neomexicanus* male flower buds for the **hop-ecotype**, and herb Fabaceae: *Lupinus argenteus* (var. ~*ingratus* with white flowers, non-folded leaves) and rarely *Trifolium repens* for the **Lupine-ecotype** in two N-S valleys in the lower mts. near Denver. The lupine ecotype once oviposited on *Verbascum thapsus*, a mistake as larvae evidently did not like it. Uncommon, but common where the hostplant is abundant.

Eggs pale bluish-green, becoming greenish-white. Eggs laid singly on male flower buds of *Humulus*, rarely on female flower buds (*Humulus* is dioecious: some plants are entirely male with grapelike tiny flower buds, all other plants entirely female with conelike hops). Larvae eat mainly male flower buds, rarely female flower buds-young fruits. Mature 4th-stage larvae are tended by ants (*Formica podzolica, Pogonomyrmex occidentalis, Myrmica rugosa*, *Camponotus herculeanus*, and rarely *Tapinoma sessile*) which use soldier ants to defend the larva against most predators, and the larvae provide the ants with honeydew (Kubik & Schorr 2018). Older larvae are very variable, most often yellowish-green with whitish marks (variations are red-brown & cream; brown & yellow or cream; olive green, yellow, red-brown; green, cream, brown; light-green & brown; light-yellow, maroon-brown; green & white or pale-green; blue-green; green & greenish-yellow; blue-green & yellow), the ground color varies from light-brown to brownish-green to usually green (sometimes olive-green or blue-green), the middorsal band varies from dark-green to maroon or reddish-brown, the subdorsal and oblique marks vary from cream and dark-red-brown to yellow & brown to mostly cream and green or light-yellow and blue-green or similar variants, the lateral band varies from tan to yellow or brownish-green or greenish-yellow to mostly yellowish or creamy, the edge of laterals is mostly green sometimes greenish-brown. The Lupine-ecotype older larva is mostly green or yellow-green or creamy-green, middorsal band gray to reddish or brownish-red, the subdorsal and obliques mostly yellow-cream & olive-green or greenish-cream & green, the lateral band paler-green or yellow-cream, the edge of laterals green or yellow-green. Pupa mottled slightly-reddish brown (top of abdomen a bit paler) (more reddish than *C. lucia sidara*), middorsal dark-brown band, a row of different-shaped subdorsal black spots. Pupae are more uniformly-mottled brown than *C. lucia sidara* (thorax and abdomen are more similar in color) and wings are slightly more translucent brown, and the variable blackish subdorsal spots on rear of abdomen average larger in size than *sidara* and sometimes touch on adjacent segments. Pupae hibernate.

One flight June-E July (sometimes L May and M July) for hop-ecotype, June (mostly M-L June) for lupine-ecotype. The later flight period than *C. l. sidara* is implemented physiologically by the pupa requiring a longer time period in spring before it will emerge.

Adults of both ecotypes seldom visit flowers, but prefer white or yellow ones, sometimes pink; the hop-ecotype visits *Apocynum cannabinum, Barbarea orthoceras, Ceanothus fendleri, Jamesia americana*, and feeds on honeydew from Cicadellidae, and imbibes mud; the lupine ecotype visits *Barbarea orthoceras*, *Euphorbia esula, Geranium caespitosum* etc., and feeds on dung and imbibes mud. Adults bask dorsally. Adults seem to be rather local, and do not fly far, though some fly hundreds of meters in a valley when they stray beyond a colony and attempt to find the host again.

Males of the hop-ecotype fleek all day over the canopy of valley bottom vegetation esp. the hostplant (or the talus supporting the hostplant) to seek females, as males fly 30cm-250cm above ground about vegetation including the *Humulus lupulus* vines that grow on talus at the lower part of S-facing slopes or grow on various bushes in sunlit gulch bottoms. Males of the lupine-ecotype fleek all day over the canopy of the *Lupinus argenteus* hostplant (a special local ecotype growing on deep soil in partial shade with white flowers and plane [non-folded] leaflets, evidently similar to var. *ingratus*) as they fly ~1/2m up often in dappled shade near *Pinus ponderosa* and aspen (this lupine ecotype occurs just in two valley systems in S Jefferson Co.). In courtship, both sexes may hover before landing, she lands and he may hover over her, or both may land and the male may flutter his wings widely (~70-120^{o} spread) to waft pheromone, while unreceptive females may flutter her wings widely (20-25^{o} to fully 150-175^{o} spread) to repel the male. The female may try to escape using zigzagging flight maneuvers. No completed courtships were seen. If a mating pair is disturbed, the female usually flies, the male dangling.

Scott, J., & D. Wright. 1998. A new *Celastrina* from the eastern slope of Colorado. Papilio (New Series) #9:1-15.

Kubik, T., & R. Schorr, 2018. Facultative myrmecophily (Hymenoptera: Formicidae) in the Hops Blue Butterfly, *Celastrina humulus* (Lepid., Lycaenidae). Entom. News 127:490-498.

***Euphilotes battoides ellisii* & *anasazi* Square-Spotted Blue**

Euphilotes butterflies are similar to *Plebejus alupini*, but lack the shimmering blue unh marginal spots. This W Colorado butterfly is very similar to *E. rita coloradensis*, which occurs only in E Colorado. The unh orange band is wide. It has the *E. battoides*-type male valva. Ssp. *ellisii* is very different from the W Colorado *E. rita emmeli* by having much larger uns spots and much wider male upf borders, and occurs in a different habitat on a much different hostplant. It flies much later and at lower altitude than *E. ancilla ancilla*. Ssp. *ellisii* has been treated as a distinct species, but it may just belong to the allopatric *E. battoides* which contains some very different critters such as ssp. *battoides* and others which evidently intergrade (DNA studies unfortunately fail to be of value in many blues, such as *Euphilotes* and *Celastrina*). Ssp. ***ellisii*** occurs in most of the Colo. range, while ssp. ***anasazi*** (wing pattern the same except the orange hw band is half as wide) occurs in extreme SW Colo. and NW New Mex. (on *E. corymbosum* var. *velutinum* in NM).

Habitat the lower mountains and canyons in pine/juniper woodland. Hostplants in Colorado herb Polygonaceae: *Eriogonum corymbosum* var. *orbiculatum* for ssp. *ellisii*, and var. *velutinum* in NM. Common.

Eggs pale bluish-white, turning white, laid singly on host flowers. Larvae eat flowers and young fruits, without nests. Larvae are tended by ants. Older larva (Emery Co. Utah) all red, with the darker middorsal band and paler lateral line very weakly noticeable; or cream-tan, with middorsal reddish-brown triangles, small oblique subdorsal reddish-brown dashes edged by cream, and a lateral cream band edged above by a little reddish-brown, underside reddish-brown; or larva pinkish-cream with middorsal reddish-brown triangles and reddish-brown lateral band. Or older larva cream or slightly pinkish, a red middorsal band, with a triangular red subdorsal patch on each segment (the band and patches sometimes weak), and a cream lateral band slightly edged above by weak reddish. Some larvae reported as yellowish with tan markings. The segments just above lateral band in the *Euphilotes* taxa with *battoides*/*glaucon*/*ellisii* valva protrude little (they form protruding vertical ridges in the *Euphilotes* taxa with *enoptes* valva). Pupa pale brown or orange-brown. Pupae hibernate, mostly in litter.

One flight M Aug.-E Sept.

Adults frequently feed on the flowers of the hostplant *Eriogonum corymbosum*, and probably visit mud. Adult flight is not very strong but they are hard to see. Adults bask laterally, and they roost head down with wings closed on the host or nearby small plants.

Males fleek all day over the canopy of the *Eriogonum corymbosum* hostplants. If a mating pair is startled, the males often fly, and the females probably fly also, the partner dangling.

Euphilotes glaucon centralis **Glaucon Blue**

Identified by very wide ups black borders on males, the fairly small uns spots, and the smoky suffusion on the unf. The orange band on uph is quite orange in color, and on unh it is fairly narrow. Males have the *E. battoides*-type valva. Ssp. ***centralis*** was considered a ssp. of *glaucon* beginning 101 years ago, and after a nomenclatural sojourn of several decades it has returned to that status as a ssp. of *E. glaucon*, which is widespread in W N.A. including the Sierra Nevada of Calif. where it is sympatric with *E. battoides*.

Habitat mostly pinyon/juniper hills. Hostplants in Colorado herb Polygonaceae: *Eriogonum jamesii* var. *jamesii*. Common.

Eggs bluish-white, turning white, laid singly on host flowers. Larvae eat flower buds/flowers/young fruits, and are tended by ants; no nests. Older larva (ssp. *glaucon* from Chelan Co. Wash. on *E. umbellatum*, James & Nunnallee 2011) olive-green, a cream heart-band with red dashes, subdorsal white oblique dashes edged esp. anteriorly and below by red with weak whitish obliques below that red (across anterior top of A7 the red is narrowly connected to the twin on other side), reddish blotches above lateral row of cream dashes, edged below by red. These larvae and those below on *E. heracleoides* average less red than other *E. battoides*-valva butterflies in Wash. Older larva of E Wash. *glaucon* on *E. sphaerocephalum* is very similar. Older larva (Wash. *glaucon* on *E. heracleoides*, claimed by some to be a different species but larvae and adults are very similar to the above) variable, greenish-gray with reddish-brown middorsal dashes edged by white, several subdorsal cream oblique dashes with brown sandwiched between them, a lateral band of white dashes; or the red markings much brighter with reddish heart-band dashes and the sandwich contents reddish brown (the contents connected over top of larva on rear of A7 to twin on other side). Ssp. *oregonensis* larva in SE Ore. mostly red (photo Guppy & Shepard 2001). In Wash., *heracleoides* pupa orangish-brown with abdomen ochre-brown and wings a little greener, a weak narrow middorsal brown heart-band; pupa of Wash. *glaucon E. umbellatum*-feeding variety rather uniform orangish-brown (cinnamon color) with the usual dark spiracles; pupa of *E. sphaerocephalum*-feeding variety rather uniform yellowish-tan (probably darkens). Pupae hibernate.

One flight L June-M Aug. (mostly M July-E Aug.). At two sites on the plains (just W of Pueblo, and Baca Co.) they fly at least Aug. 11-13.

Adults often visit the flowers of the hostplant *Eriogonum jamesii*, sometimes visit manure, and often visit mud. Adult flight is fast, jerky, and low only ~15 cm above ground. Adults bask laterally, and they roost head down with wings closed on the host or nearby small plants.

Males fleek all day over the canopy of the *Eriogonum* hostplants to find females.

Euphilotes ancilla Ancilla Blue

Males of these butterflies have the *E. enoptes*-type valva. The range, altitude, and wing pattern help identify them. Ssp. ***barnesi*** occurs in the Front Range foothills, and has the uns a little darker slightly-tan white, with considerable blackish on rear of unf. Ssp. ***ancilla*** occurs in the Canadian Zone in the higher mts. on both sides of the continental divide, and has a whiter uns with little smoky unf suffusion. It is mostly allopatric to *E. glaucon centralis*, but occurs in the Sawatch Range just SW of Buena Vista, not far north of *centralis*. Ssp. *ancilla* flies earlier than *centralis* on the S Uncompahgre Plateau, and has a narrower upf border on males, and a narrower orange band (aurora) on male uph.

Habitat chaparral hills and open woodland for *barnesi*, open areas often sagebrush for ssp. *ancilla*, from the foothills to Canadian Zone. Hostplants in Colorado herb *Eriogonum umbellatum* (vars. *umbellatum*, *aureum*) for *barnesi* and *ancilla* in most places. Ssp. *ancilla* may occur near but evidently does <u>not</u> eat *E. subalpinum* because that flowered a little too late at one site in Grand Co., where *E. umbellatum* was in the proper flower bud stage for oviposition and is the hostplant; in the Canadian Zone in Gilpin Co. etc. in C Colo. it associates with *E. umbellatum* and <u>not</u> the sympatric *E. subalpinum* (in contrast, *Plebejus alupini lutzi* likes *E. subalpinum* in Summit & Clear Creek Cos.). Common.

Eggs pale bluish-white, turning white, with comparatively smooth surfaces, laid singly inside flowers or sometimes on flower buds. Larvae eat flowers and young fruits; no nests, but 3rd-4th stages of some populations make shelters by tying blossoms together with silk. Larvae are tended by ants. Older larva (*ancilla*, all Utah) cream-tan, with reddish-brown middorsal line edged by cream dashes, a subdorsal oblique brown dash with a cream dash on top of each, one or two weak creamy dashes below that, lateral band cream; or larva slightly-greenish white with the dark and pale markings of the previous larva replaced by greenish and white; or (*E. ancilla columbiae* on *E. compositum*, James & Nunnallee 2011) cream with red middorsal band, red oblique subdorsal dashes, and red bands above and below lateral cream band; the *Euphilotes* taxa with *enoptes*-type valvae all have a strong vertical fold on each segment above the lateral band. Pupa light-brown, with a row of lateral blackish dots on abdomen. Pupae hibernate.

One flight L May-M (sometimes L) July, mostly June-E July but L May-June at lowest altitude on Green Mtn., L June-July at highest altitude.

Adults visit yellowish or whitish flowers mostly of the hostplants, the favorites including *Chrysothamnus* (*Ericameria*) *nauseosus, Eriogonum subalpinum, E. flavum, E. umbellatum, Heterotheca villosa*, and a few others, and adults frequent mud. Adults fly fairly fast. Adults bask laterally, and they roost head down with wings closed on the host or nearby small plants.

Males fleek all day over the canopy of the *Eriogonum* hostplants regardless of topography, ~15cm up. Adults may spend most of their time resting esp. on the hostplant. In courtship, the male and female may flutter and he may nudge. If a mating pair was startled, the male flew seven times, the female eight, the partner dangling.

Euphilotes ancilla stanfordorum Stanford's Ancilla Blue

This butterfly looks like Front Range *E. a. barnesi* and has the same *E. enoptes*-type male valva, but has the orange band (aurora) of females most-often wider, and it only occurs at low altitude on the western slope. It was named as a species, but I combine it with *E. ancilla* because it is so similar to *barnesi* except for that orange aurora which is variable. It flies earlier than ssp. *ancilla*, and in a lower drier habitat, so there is no possibility of interbreeding, thus there is no test of reproductive isolation in nature.

Habitat low–altitude open grassland/juniper hills. Hostplant in Colorado herb Polygonaceae: *Eriogonum ovalifolium* var. *ovalifolium*. Common where the host is abundant. It was thought that feeding on *E. ovalifolium* makes *stanfordorum* a distinct species from *E. ancilla* feeding on *E. umbellatum*, but in Nevada *E. glaucon oregonensis* and *E. glaucon glaucon* and *glaucon*= *fusimaculata* all feed on both *E. ovalifolium* and *E. umbellatum* (Austin & Leary 2008), so the switch from one plant to another is evidently no problem.

Eggs pale bluish-green, turning white, laid singly on host flower buds/flowers. Larvae eat flowers and young fruits, without nests; they are probably tended by ants. Older larva purple, a purple middorsal band edged by purplish-white dashes, an oblique cream dash or cream triangle is on top of a subdorsal purple dash on each segment, below that several small weak creamy spots one above the other, with a band of purple above and below a lateral band of cream dashes, intersegmental bands whitish; or white with a middorsal band of purple dashes, purple oblique subdorsal dashes, the body purplish below lateral area; or entirely cream with very weak purplish middorsal line on rear; larvae have a strong vertical ridge on the side of each segment. Pupa brown. Pupae hibernate.

One flight L April-E June.

Adults visit pinkish/white flowers of the hostplant *Eriogonum ovalifolium*, and probably visit mud. Adults bask laterally, and they roost head down with wings closed on the host or nearby small plants.

Males fleek all day over the canopy of the *Eriogonum ovalifolium* hostplants. Adult flight is fairly fast ~10 cm up, and very erratic with zigzags so the adults--especially males--suddenly disappear from view when they fleek from one hostplant flower to find another; females fly slower than males.

Euphilotes spaldingi **Spalding's Blue**

Identified by the orange band on unf (and on upf of females) as well as unh, like *Plebejus melissa*, but *melissa* has metallic blue marginal unh spots. Ssp. ***pinjuna*** from hills bordering the W side of San Luis Valley has wider orange unh band and the unf is a little smokier than ssp. ***spaldingi*** from SW Colorado (including Gunnison Co., the Uncompahgre Plateau) and S Utah which has narrower orange unh band and paler unf. The male valva of *E. spaldingi* is similar to that of *E. rita* but the terminal spines are pointed downward like *E. enoptes*; the female lamella is wider than that of *rita*.

Habitat open pinyon-juniper woodland hills usually with some Ponderosa Pine and sometimes *Quercus* and sagebrush. Hostplant in Colorado herb Polygonaceae: *Eriogonum racemosum*. Rare, seldom abundant.

Eggs pale green, becoming whitish, laid on host flower buds/flowers. Larvae eat flowers and young fruits, without nests. They are tended by ants. Older larva light-red, with dark-red heart band, an oblique red subdorsal dash and a weaker one just below on each segment, a redder lateral band that may be topped by a creamier line; or pinkish-cream with the same red markings and a red staple-shaped mark across top of A7; or white with purple heart-band and purple oblique subdorsal dashes. Pupa brown. Pupae hibernate.

One flight mostly July: L June-M July for *pinjuna*, July (less often E Aug.) for *spaldingi* on Uncompahgre Plateau/SW Colo.

Adults esp. males visit the cream flowers of *E. jamesii* (sometimes *E. racemosum*), and frequent mud. Adults fly very swiftly, faster than E. *glaucon centralis* and a little higher up ~20-30 cm. Adults bask laterally, and they roost head down with wings closed on the host or nearby small plants.

Males fleek all day over the canopy of the *Eriogonum racemosum* hostplants.

Euphilotes rita Rita Blue

The fw fringe seems to be less-checkered than other *Euphilotes*. They usually fly in Aug. There are two ssp. which are recognized by locality and wing pattern and flight period. They have the male valva similar to the *E. enoptes* type, but more boot-shaped and the terminal spines are aimed more posteriorly. Ssp. ***coloradensis*** occurs on the E plains and Arkansas Canyon, and has larger uns (esp. unh) black spots and narrower male upf border and whiter unf than *E. glaucon centralis* (which occupies the SE Colo. plains), and has larger uns spots than *E. ancilla*. Ssp. ***emmeli*** occurs on sandy lowland places mostly in E Utah and barely gets into Montezuma & Moffat Cos. Colo., and does not fly with other *Euphilotes*; it has small uns spots and very narrow upf male border and narrower orange hw band.

Habitat the plains and pinyon-juniper woodland and Arkansas Canyon grassland/open woodland for ssp. *coloradensis*, sandy areas at lowest altitude for ssp. *emmeli*. Hostplants in Colorado herb Polygonaceae: *Eriogonum effusum* for ssp. *coloradensis* E of the continental divide (an oviposition on *E. cernuum* in Arapahoe Co., where it mostly eats *effusum*) (assoc. usually *E. effusum* and supposedly assoc. *E. flavum* at one site in Wyo., assoc. with *E. brevicaule* and maybe *leptocladon* in Moffat Co., assoc. *E. microthecum* var. *simpsonii* in SE San Luis Valley Colo.); host *E. leptocladon* var. *ramosissimum* for ssp. *emmeli*. Often common.

Eggs greenish-white, turning white, laid singly inside host flowers. Larvae eat flowers and young fruits, without nests. Larvae are tended by ants, and in Calif. the eversible tubercles are everted frequently as the larva crawls (Ballmer & Pratt 1988). Older larvae have a tall ridge near top of T3-A6 unlike other *Euphilotes*. Older larva (ssp. *coloradensis*, few seen) mostly reddish. Older larva (Calif. ssp. *elvirae*) white (sometimes with slight greenish tinge) or pink, usually with pinkish-brown or red markings including middorsal dashes (that on A7 is a large middorsal red blotch) and oblique subdorsal triangular reddish dashes (that on A1 connected across top of larva to twin on other side), body slightly pinkish above lateral cream band, reddish below that band. Pupa becomes orange-yellow, in litter at base of hostplant. Pupae hibernate.

One flight M July-Aug. (mostly L July-M Aug.) for ssp. *coloradensis*, L Aug.-E Sept. for ssp. *emmeli*.

Adults visit whitish/yellow flowers of the hostplants *Eriogonum effusum* & *E. leptocladon*, and often visit mud. Adults bask laterally, and they roost head down with wings closed on *Eriogonum* and nearby Asteraceae shrubs, etc.

Males fleek all day over the canopy of the *Eriogonum* hostplants. In courtship, the male may hover over her while an unreceptive female flutters rapidly at wide amplitude to repel the male; unreceptive females may also drop into a bush. If a mating pair is startled, the male usually flies, the partner dangling.

Glaucopsyche piasus daunia Arrowhead Blue

Identified on unh by the white arrowhead-shaped submarginal spots and the white postbasal dash. The fringes are strongly checkered.

Habitat open areas in the mountains from foothills to lower Canadian Zone. Hostplant in Colorado herb Fabaceae: *Lupinus argenteus*. (*L. polyphyllus* is eaten in Nev. [Austin & Leary 2008], so its var. *prunophilus* may be eaten in W Colo.) Usually uncommon.

Eggs pale green with white ridges, becoming white, laid singly on host flower buds, sometimes on leaves or stems. Larvae eat flowers and fruits, sometimes leaves, without nests. Larvae variable (but much less so than *G. lygdamus*), described by Scott (1986a) as pinkish-cream, yellow-brown, brownish-cream, bluish-green, or greenish-white or greenish-gray (but most photos show the larva just gray sometimes with bluish tint), with brown or sometimes red heart-band edged by a row of creamy dashes, ~2 ½ rows of oblique cream or red dashes contrasting with darker ground color (the uppermost oblique sinuous dash generally connected anteriorly to the creamy dash beside the heart-band), lateral ridge creamy. Pupa mottled yellowish-tan or reddish-tan, middorsal line yellowish edged by brownish, wing cases green or bluish-green to greenish-yellow. Pupae hibernate.

One flight mostly M May-E July in foothills, June-M July at higher altitudes.

Adults visit white and yellow flowers, sometimes pink or purple, including *Astragalus flexuosus, Barbarea orthoceras, Chrysothamnus* (*Ericameria*) *nauseosus, Eriogonum umbellatum, Phacelia heterophylla*, and often visit mud; once seen sucking moisture from the broken ends of rotting reeds.

Males fleek all day ½m up near the hostplant *Lupinus*, throughout the habitat. In courtship, the female may hover with the male hovering behind her, they may land and the male flutters behind the female to waft pheromone, while an unreceptive female flutters her wings to repel the male. During mating, the male's valvae grasp the underside of her abdomen tip, like other Polyommatini. If a mating pair is startled, the female flies at least often (the male sometimes?), the male dangling.

Glaucopsyche lygdamus **mostly** ***oro*** **Silvery Blue**

Identified by the round black postmedian spots on the grayish-tan uns, which has no submarginal/marginal uns marks. Colo. has ssp. ***oro***, with large uns spots on a gray background. One adult from Yuma Co. near Kansas has small spots on a tan unh and may represent ssp. ***jacki*** (which occurs in SE Kansas and has large spots but is intermediate in uns color between *oro* and the browner ssp. *lygdamus* from SE U.S.). R. Mattoni suggested that *G. lygdamus* may be a ssp. of Eurasian *G. alexis*.

Habitat open areas in the foothills up through Canadian Zone, and the plains near Kansas. Hostplants in Colorado herb Fabaceae: *Astragalus flexuosus, miser* var. *oblongifolius, shortianus, drummondii, crassicarpus, laxmannii* (=*adsurgens*) var. *robustior, agrestis, bisulcatus*, *Lupinus argenteus,* (& var. *parviflorus=floribundus*), *ammophilus, caudatus, sericeus* (="*bakeri* ssp. *amplus*"), *Vicia americana, Thermopsis rhombifolia* vars. *divaricarpa, montana, Medicago sativa, Oxytropis lambertii*. *Lupinus* species with more alkaloids to discourage larvae bloom when *G. lygdamus* larvae feed the most, so females try to oviposit on the earlier *Lupinus* with fewer alkaloids (P. Dolinger, P. Ehrlich, W. Fitch, D. Breedlove 1973 Oecologia 13:191). {A synthetic diet for a Calif. ssp. using ground lentils or lima beans was developed by R. Mattoni et al. (1998 J. Res. Lepid. 37:67).} *G. lygdamus* has spread into the Central Valley of Calif. on alien *Vicia;* and *G. l. couperi* has spread westward in Ont. and south through New England and N.Y. on alien *Vicia cracca*; but no such expansion has occurred in Colo. Common.

Eggs pale bluish-green with white ridges, turning white, laid singly on host flower buds, sometimes on young leaves. Larvae eat flowers and green fruits, tended by ants. Older larva variable, pale-green, green (some with very weak cream markings), or gray-green with purple on the front, pale brown, pink and yellow, or purplish, often with a darker green or red or reddish-brown middorsal band (edged by whitish or yellowish), often with ~3 rows of creamy or yellow oblique subdorsal dashes (the upper ones may form yellowish or creamy triangles with darker centers and edged below by dark), and often with a whitish or yellowish lateral line (often edged by red). Larvae (evidently from Florissant CO) green with reddish-pink heart-band bordered by small yellow triangles (T. Emmel et al. 1992). Larvae may be greener if eating leaves, pale or purplish etc. if eating flowers. An ant is attracted by chemicals produced by an older larva's lenticles (that brood pheromone makes ants think larvae are ant larvae), and strokes the rear of the larva, which exudes a droplet of sugars and amino acids from the honey gland on top of A7 that the ant feeds on. Mature larvae on several *Lupinus* may even be taken into the ant nest to pupate (Douglas & Douglas 2005). Ants *Formica altipetens* and *F. fusca* effectively protect larvae from small parasitoid Ichneumonids and Tachinids in Colo. (N. Pierce & S.Easteal 1986 J. Anim. Ecol. 55:451-462). In S Calif. larvae may eat the inside of *Astragalus trichopodus lonchus* pods, where ants may go to tend them (R. Mattoni 1995 J. Res. Lepid 31:180-194). Pupa brown (thorax and wing cases often paler, the wing cases often greenish-brown, with a dark middorsal band and various light-brown patches and black dots; or pupa yellow-tan with same markings; or pupa blackish with no marks. Pupae hibernate.

One flight M April-June in foothills (most often May), L May-M July (most often June) at higher altitudes. This butterfly is a welcome sight in early spring.

Adults visit flowers of most colors except perhaps red, including *Allium cepa, Astragalus flexuosus, Astragalus* spp., *Barbarea orthoceras, Erigeron pumilus, Lesquerella montana, Medicago sativa, Oxytropis lamberti, Thermopsis rhombifolia* var. *divaricarpa* (they insert the proboscis between corolla and sepals), *Thlaspi arvense*, sometimes visit dung of dog and bird, and often visit mud. Adults body bask or dorsal bask, by spreading the wings somewhat. Adults roost on top of sagebrush etc.

Males fleek all day to find females, throughout the habitat but especially in swales and valley bottoms, as they fly ~1/3m up with a slow even fluttery flight. In courtship, the male overtakes the female, and both may hover, the male very often hovers 3cm over the female after she lands, after landing an unreceptive female flutters her wings at wide or small amplitude (she sometimes vibrates her nearly-closed wings very fast) to repel the male, the male lands several cm behind her and flutters his wings full stroke or sometimes flicks them to waft pheromone. No completed courtships were seen (a receptive female would presumably remain quiescent while the male joins without much fluttering); the usual encounter involves a male hovering over a fluttering unreceptive female. The resting female was sometimes observed to "flick" her wings ~6-7X in response to the male (each flick takes ~1/2 sec as the wings are opened 0-30^{o} spread ~5X per "flick" and there is ~one flick every 3-5 sec). A male continued to flutter around the spot where a female departed, perhaps because her pheromone remained there. If a mating pair is disturbed, the male usually flies (4x—the female flies sometimes?), the female dangling.

Hemiargus isola **Reakirt's Blue**

Easily identified on unf by the postmedian row of squashed-question-mark-shaped black-with-white-rim spots. And the fw tornus is uniquely perpendicular. The name *alce* from Larkspur, Douglas Co. Colo. is a synonym. Evidently migrates into Colo.

Habitat open areas on plains and middle altitudes, less common in the Canadian Zone to Alpine Zone where it is evidently mostly a stray migrant. Usually occurs in moist areas, but occurs everywhere in boom years such as 1991. Hostplants in Colorado herb Fabaceae: *Trifolium repens, fragiferum, pratense, Dalea purpurea, candida var. oligophylla, jamesii, Glycyrrhiza lepidota, Melilotus albus, officinalis, Medicago sativa, lupulina, Astragalus drummondii, agrestis, bisulcatus, laxmannii* (=*adsurgens*) var. *robustior, parryi, flexuosus, missouriensis, sparsiflorus* var. *majusculus, Oxytropis lambertii, Securigera* (*Coronilla*) *varia*; southward it eats some shrub-low tree Fabaceae, but not in Colo. Uncommon, but abundant in a few years.

Eggs bluish-green or greenish-white, laid singly on host flower buds. Larvae eat flowers, fruits, sometimes young leaves, without nests. They are tended by ants. Older larva variable, in Colo. usually whitish-green, T1 has a long transverse dorsal reddish stripe, a middorsal row of reddish spots (widest on T3-A6), a short red-brown dash on front of each segment below middorsal row, then two long oblique red-brown dashes on each segment (the lower narrower), a lateral row of short curved red dashes above a lateral row of white dashes, and below that a row of long red dashes; head very small, brown. Some Colo. larvae are yellow-green or pale-green with red marks, and on these the middorsal spots are green on rear and are connected by green constrictions, and below that the short red dashes are missing, and the oblique dashes are green. A light-brownish Ariz. larva is yellowish-tan with red markings only on middorsal spots and just below the obliques, plus a reddish staple-shaped mark across top of A1 (Allen et al. 2005 photo). Calif. larvae may have ground color of green, yellow, brownish, or red, with absent markings or often the reddish middorsal spots and dorsolateral chevrons, and red or yellow lateral lines (Ballmer & Platt 1988), and their photo shows a mostly-red larva with red heart-band edged by white then reddish above the two sinuous obliques which are cream above blackish, then a wide red area above the thick lateral row of white dashes. All these variants may occur in Colo., because *H. isola* is semi-migratory. Pupa in Colo. yellowish-green with a middorsal dark-green band, abdomen pale yellow with oblique reddish-brown or tan subdorsal streaks and light reddish-brown lateral bands, but some pupae green with weak pattern (some Colo. and esp. Ariz. and Calif. pupae may be redder); attached by silk girdle and cremaster. Perhaps there is no diapause stage.

There may be two or three generations with extremes L April-Oct., the first usually ~May-E June for early-adults, then several merged generations L June-Oct. However, there are not many L April-M June records, while after presumed northward migration there are many records from L June and very many in L July (evidently offspring of the June butterflies, or new migrants in July) and frequent records into Sept. or Oct. Some years they are uncommon, but some years they are abundant such as 1991 when I got most of my hostplant records by searching for the tiny eggs. It is generally assumed that they migrate north from the wintering home in S Ariz.-S New Mex.-C Texas etc., but they are seldom seen migrating north in spring in Colo., although July 1-9 in 2018 I saw some erratically flying mostly northward ~2/3-2m up. Do they fly high and are carried north by winds like migrating *Danaus* and *Vanessa*, or do they just weakly migrate, or probably they are so small that we don't see them very often? (they are much bigger than *Brephidium exilis*).

Adults have a tiny proboscis, and visit small yellow and white and purplish-violet and sometimes pink and reddish flowers, including *Melilotus* spp., *Aster ericoides, Astragalus* ssp., *Chrysothamnus* (*Ericameria*) *nauseosus, Limonium latifolium, Medicago sativa, Sedum lanceolatum, Thlaspi arvense, Trifolium fragiferum, T. repens* (they frequent small *Trifolium*), and often visit mud. Adults are body baskers/dorsal baskers; they bask with wings spread. When they are warm, they rest with head downward, which according to M. Douglas is a common lycaenid position. In the rain adults may rest upside down or sideways on grass stalks etc. Adults do "hindwing rubbing" and the unh does have a small black eyespot.

Males fleek all day throughout the habitat but often on flat land to seek females, as they fly erratically (slow but jerky) ~10-30cm up. In courtship, the male may hover/flutter near the female and then land and flutter widely beside her to transfer pheromone and bend his abdomen to attempt to join. Unreceptive females flutter her wings (either from an upraised or widely-spread average position) to repel him, or fly away. A male may try to join with another male, but he flies when his abdomen touches the other male. If the mated pair is startled, either sex may fly, the partner dangling.

***Hemiargus hanno* (*ceraunus*) Hanno Ceraunus Blue**

Similar to *Hemiargus isola*, but the unf postmedian black spots are replaced by white-edged brown dashes. A rare stray to Colo., recorded from Dolores, Las Animas, and Prowers Cos. The Ariz.-NM ssp. ***gyas*** has whitish uns and one black unh dot (in cell CuA_1); the Texas ssp. ***zachaeina*** has whitish-tan uns and two black unh dots (in cells M_3 and CuA_1). Most Colo. records are probably *gyas* including the Dolores Co. record, and most SE Colo. records may be ssp. *zachaeina*.

Habitat open woodland and desert in S Ariz.-S Texas. Hostplants southward many herb and shrub Fabaceae including *Astragalus*, *Medicago sativa*, *Melilotus*, and *Phaseolus*. Immatures are described by Scott (1986a). Eggs laid on flowers & buds, larvae eat flowers pods & leaves. Larvae are tended by ants. Older larva variable (green, red, brownish, or yellow, photos in Allen et al. 2005 & Minno et al. 2005), often green with dark-green heart-band edged by curved cream dashes, weak oblique paler dorsolateral dashes, a lateral cream line, covered with short white hair; some larvae have reddish heart-band with the adjacent marks rabbit-shaped and white, or the dorsolateral line and upper pale dashes may be edged by reddish, the lateral cream-red band may be edged by reddish. Pupa unreported.

Adults visit many flowers (whitish and pink ones at least) and mud.

Males fleek all day to find females.

Plebejus atrapraetextus sublivens **Hybrid Blue**

Ssp. ***sublivens*** has small orange spots and flies at high-altitude in SW Colo. (Gunnison Co. to San Juan Mts. & San Miguel Mts.). It is distinguished from *P. melissa pseudosamuelis* by having slightly smaller black spots and smaller orange spots on uns, the uns averages a bit paler, the ups blue of males is very slightly paler-blue, and most females have some or much grayish-blue on ups. The male gnathos of *P. atrapraetextus* ssp. (*sublivens, longinus* from Wyo., *atrapraetextus*, etc.) averages shorter than that of *P. melissa* but is intermediate between *melissa* and *P. anna*/*P. scudderii*.

I analyzed the American *Plebejus idas* stenchospecies (superspecies) (Scott 2006) and separated them into the bookkeeping species (semispecies) *P. melissa*, *P. atrapraetextus, P. anna*, and *P. scudderi*. These species are sympatric or nearly-sympatric without interbreeding at some places (the ranges overlap considerably, though there are few localities where adults can actually come near enough to possibly mate). *P. anna* has a very short gnathos, and is a legume feeder ranging from Calif. to BC (a colony occurs 2 miles away from *P. atrapraetextus benwarner* in the Warner Mts. Calif.). *P. scudderi* (an Ericaceae feeder from C and E Canada) also has a short gnathos. *P. atrapraetextus* evidently includes the ssp. *alaskensis, atrapraetextus, benwarner*, *fridayi*, *annetta*, <u>*sublivens*</u>, and *longinus*, all of which have gnathos length intermediate between *P. melissa* and *anna/scudderi*, although the gnathos of *longinus* from the Bighorn Mts. Wyo. averages a little closer to *melissa*, and the *annetta* gnathos is long like *melissa* (but the wing pattern is like the other ssp.) (ssp. *alaskensis* needs more study, it resembles *scudderii* but eats legumes). Recent DNA workers have misnamed the Calif-Nev. taxa: the "Warner Mts." taxon of C. Nice & A. Shapiro [1999, J. Evol. Biol. 12:936-950] with intermediate gnathos is *benwarner*, not *P. anna* as claimed in misguided checklist. And Nice et al. (2002) also misidentified taxa, as their "*idas*" from Trap Crk. & Yuba Gap. [hosts *Lotus oblongifolius* var. *nevadensis*] & Leek Springs [host *Lupinus polyphyllus*] with short gnathos on their fig. 2 are *anna*, their Mt. Rose & Carson Pass [host *Astragalus whitneyi*] with intermediate gnathos are *fridayi*, and their Verdi with very long gnathos are *melissa*. And C. Nice, N. Anthony, G. Gelembiuk, D. Raterman, & R. Ffrench-Constant (2005 Molecular Ecol. 14:1741-1754) continued to misname some N. Amer. taxa, as their Fig. 4 short gnathos=falx cluster of populations on lower left is *anna*, the #57-58(TL)-59 cluster with longer gnathos is Warner Mts. *benwarner*, the nearby cluster #36-37 is *P. scudderi nabokovi*, their cluster #26-30 is Sierra Nevada *fridayi*, and the large cluster in upper right with long gnathos is *melissa* and *annetta* and *samuelis* [their "*pseudosamuelis*" from Pitkin Co. Colo. may be misidentified just *melissa*]. Most *P. atrapraetextus* ssp. including *benwarner* and *fridayi* etc. have distinctive large shimmering-blue spots on unh margin. *P. atrapraetextus* overlaps the ranges of *melissa*, *anna* and *scudderi* (Scott 2006) (V. Nabokov [1953 Lepid. News 7:51] found *longinus* and *melissa* near Afton Wyo.), so is just as good a "species" as the others, with the understanding that all of these bugs belong to the stenchospecies *P. idas*, and evidently all of them occasionally interbreed or did so recently; their older larvae all look rather similar.

Habitat of *sublivens* valley bottoms and dry meadows and open slopes and clearings in forest in Subalpine and lower Alpine Zones (up to 12,800') of the San Juan Mts. (& San Miguel Mts.) northward on the W side of the Sawatch Range to the Elk Range at Emerald Lake vicinity in N Gunnison Co. Hostplants in Colorado Fabaceae: *Lupinus argenteus* var. *parviflorus* (near Telluride, V. Nabokov) (the same plant also reported as *L. argenteus* var. ~*parviflorus* "*tenellus*"), *Astragalus alpinus* (the obvious host N of Weminuche Pass). *P. atrapraetextus* in its entire range uses Fabaceae hostplants of *Lupinus, Astragalus, Hedysarum*, and *Oxytropis* (Scott 2006), (commonly *A. miser* in the central Rockies, Z. Gompert et. al. 2012 Evolution 67:2500); the species evidently prefers hairier hostplants. Common to uncommon.

Eggs greenish-white, turning white, laid singly on stems and probably mostly on litter below the host. Larvae eat mostly leaves, sometimes flower buds. Larvae associated with ants; similar related butterfly "species" in Scandinavia associate with ants (*Lasius niger* & 8 sp. of *Formica* including *F. cinerea* etc.) and diapausing larvae are reported to be carried into ant nests, and larvae often pupate in ant nests. Older larva (Wash. ssp. *atrapraetextus*, James & Nunnallee 2011) green, the heart-band dark-green edged by white dashes, ~3 oblique faint whitish oblique dashes arrayed along below, then a white lateral band of white dashes. (European *P. idas* larvae fit this same description [photos in H. Malicky 1961 Zeitschr. der Arbeitsgemeinschaft Osterr. Entomologen 13: 33-49], or are green with dark-red and brown middorsal markings and red-brown lateral dashes, with oblique white subdorsal dashes, or the larva is tan.) Yukon *alaskensis* (C. Guppy photo) olive-green with white lateral band edged above and below by wide crimson band, middorsal heart-band is greenish-white, crimson bent-staple-shaped marks beside heart-band (aimed forward) compress into more spots on thorax. Pupa green, the head and middle of wings and end of abdomen more tan. Eggs hibernate. Probably biennial at the usual high altitude, hibernating as older larvae the 2nd winter.

One flight L June-M Aug.

Adults visit various flowers, sometimes imbibe mud; *P. atrapraetextus* visits urine elsewhere. They evidently body bask & bask dorsally.

Males rait all day in little gully bottoms/swales/roadside ditches to await females, and also fleek ~60cm above ground on hillsides and flats near the hostplants to seek females. In courtship, a male of ssp. *fridayi* was observed to flutter to transmit pheromone to the female. Adults seem to use the presence or absence of orange uns spots and the size of unh black spots to help choose the species they wish to mate with: *P. anna* males preferred to court adults/models with small orange and small black spots, while males of the larger-spotted *fridayi* preferred those with larger orange and black spots, and lowland *melissa* males did not discriminate (J. Fordyce, C. Nice, M. Forister, A. Shapiro 2002 J. Evol. Biol. 15:871-879). O. Pellmyr studied mating of closely-related *Plebejus idas* in Sweden (1983, J. Res. Lepid. 21:147-157.). Males are attracted to blue adults, but in most cases males search for females that rest in the normal position of head-down with wings closed (showing the orange-margined white uns) on plants (head-up posture does not attract male fluttering), the male approaches the female, flutters around her, then if the test subject (dead dried females or freshly-killed females—males did not buffet the dead ones) has the proper female pheromone (only the fresh females) the male buffets her with his wings while fluttering, then he lands and vibrates his wings rapidly next to her (the fluttering and vibrating transmits pheromone) and bends his abdomen to mate. Unreceptive females raise the abdomen, vibrate her wings rapidly to repel the male, or try to escape. (Males may recognize other males using the blue ups, while females may require a blue adult for mating.) If a mating pair of European *idas* and American butterflies of similar taxa is disturbed, the male reportedly flies often, the female dangling, and if a mating pair of *P. atrapraetextus* ssp. is startled, the male or female may fly, the partner dangling.

Scott, J. 2006. *Plebejus* (*Lycaeides*) classification in North America. Papilio (New Series) #12:52-68, pl. IV.

Plebejus melissa pseudosamuelis Melissa Blue

P. m. pseudosamuelis is another high-altitude butterfly with small orange spots. It has a long gnathos like *P. melissa*, unlike the variable but mostly shorter gnathos of *P. atrapraetextus sublivens*. The uns black spots are larger than *sublivens*, the orange uns spots are small (smaller than *melissa*, a little larger than *sublivens*), the uns averages a little browner whitish than *sublivens*, and the female ups is generally brown not bluish like *sublivens*. It is found in rather constant populations in the Subalpine Zone in clearings in valley bottoms or hillsides. The TL is in Lake County (not Pitkin Co.) at 10,000' at the Red Mountain Inn where it still flies; and Nabokov also found it at Snowmass Lake 11,000'(~13 air mi. SW Aspen) in Pitkin Co. July 3; I found it common at Slumgullion Pass 11300' Hinsdale Co. July 30; and M. Fisher found it just S Spring Creek Pass 10000' in Hinsdale Co. So *pseudosamuelis* occupies the periphery of the range of *sublivens*, and basically it seems to represent populations of *P. melissa* at the periphery that have introgressed with *sublivens* to create a *melissa*-genitalia butterfly with wing pattern closer to *sublivens* with small orange spots. {Another butterfly has smaller orange uns spots but long gnathos: the name *samuelis* refers to an inbred *Lupinus perennis* butterfly in NE U.S. from Minn. to N.H. and SE Ont., which could be treated as a species also but its westward populations have mtDNA of *melissa* (eastern *samuelis* have haplotype C, western *samuelis* have A like *melissa*; Gompert, Z., et al. 2006 Molecular Ecol. 15:1759-1768); it has the long *melissa* gnathos, so I treat it as *P. melissa samuelis*.}

This *pseudosamuelis* butterfly has been incompetently treated in publications for most of its history, ever since Nabokov listed the wrong TL county when he named it, and F. M. Brown thoroughly made a mess writing about it, as he was evidently annoyed at Nabokov's horning in on Brown's turf involving the study of Colorado butterflies (and Brown wrote in J. Lepid. Soc. that Nabokov's measurements were not significantly different statistically), so Brown wrote how the high-altitude *P. melissa* were much different from the low-altitude butterflies, and then he tried to synonymize Nabokov's name *pseudosamuelis* by incorrectly claiming that the name *melissa* applied to high-altitude butterflies even though Brown surely had read the original description of *melissa* and must have realized that it described only low-altitude butterflies (including *melissa* from Arizona), and then Brown went further and picked out a high-altitude lectotype of *melissa* from Twin Lakes caught by T. Mead in 1871 even though Mead had collected *melissa* from six other places including the plains, and then Brown went even further and wrongly claimed that his lectotype must have been collected on La Plata Peak, which is exactly abutting Nabokov's Red Mountain Inn TL (a large red house still exists now at that spot), all of this despite the fact that W. H. Edwards' original description of *melissa* clearly applied only to the low altitude butterflies with large orange spots also found in Arizona, and despite F. Brown's #1 syntype of *melissa* being a perfect *melissa* syntype specimen with good label data from Denver in the Carnegie Museum that matches Edwards' description of *melissa* (T. Mead caught that syntype on his first day collecting in Colorado on June 1, 1871). Brown's multiple irrational efforts to pinpoint his *melissa* lectotype on top of Nabokov's TL in order to invalidate it fortunately failed: Brown's lectotype is not valid because it is not a syntype of *melissa* because it is not the low-altitude large-orange-spotted taxon that Edwards definitely named (J. Scott, N. Kondla, & M. Fisher 2016. News of Lepid. Soc. 58:145-147; and J. Scott & M. Fisher 2017 News of Lepid. Soc. 59:124-125), so Brown's lectotype has to be ignored. F. M. Brown unfortunately spent much of his life (more than 30 years) working on old butterfly names, including trying to correct the hundreds of mistakes made mostly by Edwards, who horribly discarded most of the data on specimens he kept for his collection. Brown evidently liked history more than butterflies. I like to name the troubles of scientific names caused by old bad types the Old Name Sewer; most of those old names are based on specimens with bad or erroneous or missing data, and the original descriptions are bad, or crucial parts of the types are missing, or the types are missing or consumed by dermestids, etc., causing people to waste huge amounts of time and money on all those problems. Strangely, even today there are people who are addictively drawn into this world of old rotten scientific names and spend much of their time working on those problems. And unfortunately the ICZN (International Commission on Zoological Nomenclature) currently does not wish to make it easier for scientists to get rid of old bad names, so that waste of time will evidently continue for another few decades until taxonomists become even more scarce and geneticists take over.

Habitat openings in valley bottoms or hillsides in forest in the upper Canadian and Subalpine Zones. Hostplant in Colorado herb Fabaceae: *Astragalus alpinus* in Lake Co. and evidently also in Hinsdale Co. (*Lupinus argenteus* var. *parviflorus* is the host of *P. a. sublivens*, not *pseudosamuelis*). Common, but populations have a small area, and small populations in general should not be collected.

Early stages unknown.

One flight E July-start of Aug.

Adults visit purplish and yellow flowers of *Astragalus alpinus, Erigeron ursinus*, and *Potentilla fruticosa*, and probably visit mud. Adults were observed roosting in clusters of 3 and 5 adults on the inflorescences of grass clumps, basking laterally and dorsally.

Males seem to flait preferably in low spots of meadows evidently all day to await females, and fleek sometimes about the hostplants on hillsides.

***Plebejus melissa melissa* (*P. argyrognomon melissa*) Melissa Blue**

Ssp. **melissa** is identified by the large marginal orange uns spots on unf and unh which are generally fused (not separate orange spots), the unh black line on the margin is thicker esp. at the veins (very thin in *sublivens* and ***P. melissa pseudosamuelis*** discussed above), the presence of unh metallic (shiny blue or greenish) marginal spots (lacking in *Euphilotes*), the lower to middle altitudes, the several generations at least at lower altitudes (any population with more than one generation has to be *P. melissa*), and the long male gnathos. Higher-altitude populations of this butterfly (such as those on the floor of South Park) average smaller orange spots than the low-altitude plains populations, and some have the spots quite small. However the spot size varies considerably in *P. melissa* (unlike *P. melissa pseudosamuelis* which is rather constant), so I would not name those as a distinct subspecies, although F. M. Brown was convinced they differed enough. The name of this butterfly may actually be *P. argyrognomon melissa*, because in Eurasia the *argyrognomon* gnathos is longer and similar to North American *melissa*, and in Eurasia *argyrognomon* has larger orange uns spots and is bivoltine like our *melissa*. Thus anyone who uses the name *idas* in North America surely also can use the name *argyrognomon* (which also occurs in Asia) for *melissa*, because there seems to be as much justification for using the name *argyrognomon* for *melissa* in N.A. as for using the name *idas* in N.A. Perhaps those names belong to a single stenchospecies in Eurasia, like the situation in North America. Perhaps all of these butterflies are just one stenchospecies.

Habitat the plains and open areas including openings in forest in the mountains up to the middle or upper Canadian Zone (rarely higher). Hostplants in Colorado herb Fabaceae: *Astragalus flexuosus, laxmannii* (=*adsurgens*) *var. robustior, miser, drummondii, bisulcatus, agrestis, racemosus, crassicarpus, parryi, halli, Sphaerophysa salsula, Medicago sativa, Trifolium fragiferum, Lupinus argenteus, polyphyllus* var. *prunophilus, Melilotus officinalis, Oxytropis deflexa* var. *sericea, lambertii*. *A. bisulcatus* and *M. sativa* are also hosts in C. Wyo. People writing about Calif. *melissa* (Nice et al. 2002, & A. Shapiro, etc.) have mistakenly published that *melissa* has recently adapted to feed only on *Medicago sativa*; the truth is that *melissa* is polyphagous on legumes everywhere, and quickly populates alfalfa fields (*M. sativa*) without any genetic adaptation (all over W U.S. and in Minn. & Kans. & Man.), simply because the fields offer high-quality legumes in huge quantity. Similarly, *Astragalus laxmannii* invaded scraped-off land in South Park Colo., and it and *P. melissa* multiplied hugely there. In Nevada (Austin & Leary 2008), hostplants are equally diverse, with *Astragalus* 10 sp., *Lotus* 3 sp., *Lupinus*, *M. sativa*, and *Melilotus* all hostplants). Common, sometimes abundant in those lush-legume fields.

Eggs pale-green, quickly turning white. The female lands on the plant and crawls down a stem, laying eggs singly on stems or trash near the plant base, sometimes on leaves or pods etc. Females can lay up to 200 eggs in lab. Larvae eat leaves and flowers. Older larva green, heart-band dark-green edged by a greenish-cream line, several faint oblique dashes (angled downward posteriorly) may be edged below by darker-green, a lateral strong yellowish-white band edged above by dark-green; some Calif. larvae plain green. {Larvae of *P. argyrognomon* in Japan crawl into ant nests to pupate [M. Watanabe & Y. Hagiwara 2009 J. Res. Lepid. 41:70-75], so N.A. *melissa* may be similarly associated with ants, but its ease of colonizing alfalfa fields could suggest it can prosper without ants.} Pupa green, abdomen yellowish-green, outer half of wing tan, head and abdomen near cremaster tan-green. Eggs hibernate.

About three flights on the plains and lower foothills with mostly continuous records from E May to M Oct. that may represent flights mostly M May-E July and M July-Aug., plus a third generation Sept.-E Oct. that occurs if freezes did not kill the adults, while at higher altitudes there seem to be two flights end of May-E July and L July-Aug. (sometimes E Sept.).

Adults visit whitish, yellow, and blue/purple flower colors but seldom pink or reddish, including *Aster ericoides* (& var. *falcatus*), *Astragalus flexuosus, Centaurea diffusa, Chrysothamnus* (*Ericameria*) *nauseosus, Erigeron pumilus, Heterotheca villosa, Medicago sativa, Psoralidium tenuiflorum*, and often visit mud. Adults body bask (with wings spread partially), but sometimes bask laterally. They do "hindwing rubbing" even though there is no obvious eyespot for predators to peck. Several adults roosted on Ponderosa Pine boughs up to 5m up.

Males mate-locate all day, usually by raiting in little swales such as small gulch bottoms and roadside ditches or hillside swales or trails and sometimes in low spots of meadows, as they rait an average of 21cm up (10-50, N=7). Males sometimes flait or fleek, but seem to do this less than 10% of the time to seek females, and they usually do it locally in swales where flying males evidently should be called flaiting, although in *Medicago sativa* fields they often fleek by traveling much farther. Raiting males pursue only fluttering passerbys, not slow gliding ones. (Scott 1976a underreported the frequency of raiting in some Polyommatini, actually *P. melissa* and relatives and *P. glandon* and *Cupido amyntula* actually rait very often or usually.) Luckily I saw several good completed courtships. In courtship, the male overtakes the female and they both fly erratically in a zigzag flight (the male fluttering fast just below her) for up to ~8m then they land on grass etc., and she remains motionless with wings closed while he flutters fast with wide amplitude just behind her, then she often flies again (just ~1m, or longer if they repeat the erratic dual flight), and they land again and she remains motionless while he flutters again for ~5-10 sec. then bends his abdomen to join. The male's fluttering is rapid (~10-20x/sec.) which transmits pheromone to her, and varies in amplitude after he lands: it is wide-amplitude 45-110^{o}-wings-spread at first, but the second bout of fluttering may involve small amplitude (0-35^{o}-spread) for a couple sec. then wider. One female seemed somewhat reluctant as she crawled away after joining and crawled around a grass inflorescence 8x as he was forced to back up behind her and fly to a new spot but she still rotated around with him behind and later crawled around a *M. sativa* tip 10x. The zigzag pursuit as the male flies beneath and the strong male fluttering to transfer pheromone to the landed female occurred in another courtship in which she flew eight times and was clearly unreceptive, suggesting that the zigzag flight may be the female's way of testing the male's fitness, and may serve an unreceptive female as a chance to escape as well (very receptive females may avoid the zigzags and just land and accept the male). Both sexes may hover before landing. After landing, when the male flutters to waft his pheromone, unreceptive females flutter strongly to reject him. Mating lasts 31.5 min. on average. During mating, the abdomen tips move up and down a little every 4-5 seconds but the valvae do not move, unlike *Erynnis*. If a mating pair is startled, the male usually flies (5x), the female sometimes (2x), while the partner dangles.

{Wing pheromones are used in courtship, studied in *Plebejus argyrognomon* from Europe by L. Lundgren & G. Bergstrom (1975, Wing scents and scent-released phases in the courtship behavior of *Lycaeides argyrognomon*, J. Chemical Ecology 1:399-412).}

Plebejus saepiolus Greenish Blue

Resembles *P. icarioides*, but the uns spots are rather uniformly small and black, whereas *icarioides* has large unf postmedian spots and very small unh submarginal-marginal spots. Also, *saepiolus* males are shiny light blue on ups (usually greenish-tinged) and there is a black dash on upf. Several ssp. occur in Colorado. NW Colorado has ssp. ***saepiolus***, with little blue on female ups, while central and southern Colorado (Gunnison County, the San Juan Mts., most of the Sawatch Mts., Sangre de Cristo Mts., Wet Mts., etc.) has ssp. ***gertschi*** with females mostly blue on ups. The E slope of the Front Range and the continental divide at Tennessee Pass northward along the top of the Front Range have intermediate-average slightly-blue females (named "*whitmeri*", which I treat as a synonym because it is just intermediate *saepiolus*X*gertschi*). {Scott 2006 Papilio (New Series) #12:51-52 revised the western ssp. of *P. saepiolus*, then Scott 2008 Papilio (New Series) #19:60 showed that ssp. *saepiolus* has just a little female blue like NW Colo. butterflies, and *maculosus* is a syn. of *saepiolus* as topotype series from Snake Range Mts. Nev. in Univ. Colo. Museum have small unh spots like *saepiolus*.}

Habitat mostly moist meadows/moist valley bottoms, usually a little higher than the lowest foothills then up into the lower Alpine Zone; rare colonies are at the plains edge {notably three colonies: 1) on a hill swale on Green Mtn. in Jefferson Co.; 2) on a moist saddle on a ridge beside Crawford Gulch in Jeff. Co.; 3) a valley at Marshall on the plains in Boulder Co.}. Hostplants in Colorado herb Fabaceae: *Astragalus alpinus, agrestis, Trifolium repens, longipes=rusbyi, hybridum, parryi, dasyphyllum*, less often *pratense*. In the rest of North Amer. *Trifolium* is the only host (except *Lotus* in a few Calif. sites, Shapiro 2007), but in Colo. the two *Astragalus* have ball-like inflorescence mimicking *Trifolium,* and they are major hosts in moist places on the E slope: *A. alpinus* is a main host at high altitude (on both sides of the continental divide) and *A. agrestis* the main host in the Front Range foothills down to the edge of the mts. even on moist saddles in grassland or open *Pinus ponderosa* woodland. Common.

Eggs greenish-white, laid singly among host flowers. Larvae eat flowers and fruits, without nests. Older larva (Wash. & Calif.) green, with very faint paler dashes, a strong white lateral line. T. Emmel et al. (1992) note red and green color forms of Calif. larvae. Ontario larva is greenish-cream with purplish heart-band, several rows of oblique cream dashes on most of body, a lateral cream band (edged with reddish in 3rd-stage but not 4th). Pupa (Wash.) reddish-brown, the thorax and wings more translucent brown; elsewhere sometimes gray mottled with black. 2nd (sometimes 3rd) –stage (of 4 stages) larvae hibernate (all Polyommatini blues generally have just 4 larval stages [Ballmer & Platt 1988 and James & Nunnallee 2011 report diapause stages well]). Maybe the lower Alpine Zone populations are biennial, maybe hibernating as older larvae the 2nd winter?

One flight, mostly L May-M July in the foothills, mostly M June-M Aug. at middle altitudes, and July-Aug. above timberline.

Adults visit yellow, whitish, and blue/purple flowers (seldom reddish), esp. those of the hostplants, including *Astragalus agrestis, Trifolium hybridum, T. repens, Erigeron pumilus, Senecio crassulus,* and often visit mud. Adults body bask/dorsal bask, by spreading the wings somewhat, or they bask laterally. A female strayed from Green Mtn. or the foothills nearly 4 or more miles away to Lakewood. And I found an adult in Wheatridge, straying several km from the mountains.

Males fleek all day to seek females, mostly in moist meadows, moist swales, and riparian areas where the hosts grow (but they fleek over the hostplant *Astragalus agrestis* on moist hillsides in the Front Range foothills at Guy Hill and Green Mountain and on a moist saddle NE Crawford Gulch), as adults fly ~20-30 cm above ground. In courtship, the male overtakes the female, the male may hover over a landed female, they land, and the male flutters strongly (at wide amplitude, or flutters his widely-spread wings with less amplitude) to transfer his pheromone, while an unreceptive female flutters usually at wide amplitude (sometimes small amplitude) to reject him. (Receptive females would presumably be quiescent and accept the male as usual in butterflies.) A male hovered under a *Plebejus icarioides* female and rose up near her repeatedly to try to induce her to land. If a mating pair is startled, the male usually flies (6x), the female sometimes (2x), the partner dangling.

Plebejus icarioides **Lupine Blue (Boisduval's Blue)**

Similar to *P. saepiolus,* but on males there is usually no black dash at the end of the upf discal cell (females may have a narrow black dash on upf, and that spot is large on unf), the ups of males is a darker shade of blue, the unf postmedian spots are large and more prominent than the submarginal ones, the unh marginal spots are absent or inconspicuous (definite marginal black spots occur in *P. saepiolus* esp. in unh cell CuA_1), and the black unh postmedian spots are usually ringed with white and smaller. *Satyrium fuliginosum* is also similar, but it has the spots at the end of the unf and unh discal cells weak (they are solid black on unf and whitish on unh in *icarioides*). There are ~five subspecies/varieties of *P. icarioides* in Colorado. Ssp. ***lycea*** occurs in most of the mountains in SW

Colo. and the E slope, and has small black dots in the unh postmedian white spots, and just one generation. On the high plains from east of Colorado Springs and around the Black Forest north into SE Wyoming and NW Neb. there are two generations, in L May-June and Aug.-E Sept., but adults of this **two-generation variety of *lycea*** look similar to *lycea*. In extreme NW Colorado in Moffat Co., ssp. ***pembina*** has the black dots in the unh postmedian white spots reduced to a gray point (to compare, the small black dots are present in the white spots in ssp. *lycea*, absent in solid white patches in ssp. *fulla* from W Nev.) and females are brown or a little bluish on ups. But all over the W slope in NW Colo. the unh postmedian white spots frequently lack a small dot, so they could also be called *pembina*, however females mostly have bluish ups in this area so could be considered a new **bluish-female variety of *pembina* or ssp.** (this bluish variety is all over Grand, Summit, Routt, Jackson, Garfield, Pitkin, Gunnison, and Eagle Cos. CO and Albany Co. Wyo.). At high altitude in upper Canadian Zone/lower edge of Subalpine Zone on the E slope in N-C Colo. (Lamartine in Clear Creek Co., and Pine Creek in Chaffee Co.) unh dots are bigger like *lycea*, but females are also usually quite blue on upperside, so that is another variation of that **blue-female variety of *lycea* or ssp.** that has intergraded with *lycea* (females are mostly brown in *lycea*, and brown females are at least common in ssp. *pembina* from NW U.S.). The blue-female varieties or ssp. in Colo. have a single generation.

Habitat the upper plains around the Black Forest, and open areas in the mountains including the foothills to lower Subalpine Zone. Hostplants in Colorado herb Fabaceae: *Lupinus argenteus* (and var. *rubricaulis*, and lower Front Range white-flowered var. ~*ingratus* with plane leaves), *argenteus* X *caudatus* (=”*alpestris*”), *caudatus, polyphyllus* var. *prunophilus, sericeus* (incl. “*bakeri* ssp. *amplus*”), *plattensis*, and assoc. *L. argenteus* var. *parviflorus*=*floribundus*. J. Downey found that they prefer the hairier *Lupinus*, esp. *L. caudatus* and *sericeus*. Common.

Eggs greenish-white, laid singly on leaves (usually on uns), stems, flowers (most often on flower buds in Nev.), and pods, esp. on new growth. Young larvae eat leaves in Colo., then in spring transfer to young shoots flowers and fruits. No nests. Larvae are tended by ants, and sometimes rest by day in holes dug by ants below the plant. 2nd-stage larvae become darker with light purplish dorsal stripe or are all darker reddish-brown, and diapause as brownish stage 2 then after diapause often remain somewhat darker until early stage 4. Older larva (SE Denver) light-green, with dark-green heart-band edged by cream, ~3 rows of long oblique cream dashes, and a lateral cream band. Other older larvae (Wash. etc.) green, heart-band red-purple or purplish or dark-green edged by a row of creamy dashes, several rows of oblique creamier dashes on each segment, a purplish-edged cream lateral line with purplish above it (larvae become greener during stage 4). Larva (Ore.? Neill 2007) just green with white lateral line. Pupa greenish, the abdomen slightly-reddish yellowish-brown or brown or green, the head green or brownish-green. 2nd-stage (of 4 stages) larvae hibernate (and aestivate through the summer in some areas such as C Wash.) in soil below the host.

One flight L May-July in the foothills (mostly June [sometimes May 13 Green Mtn.]-M July) (my Colo. *pembina* are M June-E July), mostly L June-E Aug. at higher altitude (L June-M Aug. for the blue-female *lycea* ssp.), except two flights on the plains near the Black Forest L May-June and Aug.-E Sept.

Adults visit whitish, yellow, sometimes bluish/purplish, rarely reddish, flowers, including *Astragalus flexuosus, Ceanothus fendleri, Eriogonum subalpinum* (favorite), *E. umbellatum, Sedum lanceolatum, Senecio* (*Packera*) *fendleri*. They sometimes suck human sweat, imbibe leafhopper honeydew from *Monarda fistulosa* and *Heterotheca villosa* plants, and often visit mud. In a mark-recapture study in Calif., adults lived an average of 8 days. Adults bask dorsally with wings spread considerably. Several adults strayed nearly 4 miles from Green Mtn. to near my house on W side of Denver.

Males fleek all day near the *Lupinus* hostplants, as they fly ~40 cm up; rarely a male raits to chase others. In courtship, the male overtakes the female and may hover under her for up to ~1 minute, and if she lands and flutters he may hover over her a little, or they land and the male flutters his wings at more- or less-wide amplitude in bursts of maybe 5 flicks/sec. near her, while unreceptive females refuse to evert her abdomen properly and they fly or crawl away or drop to the ground or flutter her wings strongly to reject him. If a mating pair is startled, the male flies (3x), the female sometimes (1x), the partner dangling.

Plebejus shasta **Cushion-Plant Blue (Shasta Blue)**

P. shasta is identified by the numerous brown (not black) unh postmedian spots, the narrow orangish lunules clasping the metallic dark submarginal unh spots, and the black bar at the end of the upf and uph discal cells. Adults are quite small. Three ssp. occur in Colorado on “cushion plants”. Ssp. ***pitkinensis*** is common on dry windy sometimes Subalpine Zone and mostly Alpine Zone tundra, and is darker gray on uns, and females are perhaps grayer-blue than males on ups. Ssp. ***platazul*** is the same but has the ups silver-blue (violety blue in the other ssp.), and occurs in the same alpine habitat in the central Sangre de Cristo Mts. (it intergrades with *pitkinensis* from Hayden Pass northward to the N end of the range). Ssp. ***minnehaha*** occurs on plains shortgrass prairie on small mesas on the Colo.-Wyoming border and on mesa tops in sagebrush areas of Canadian Zone NW Colo., and is paler on uns. Lab-raised *pitkinensis* remain distinctly darker than *minnehaha*, so they seem to be genetically different.

Habitat treeless cushion-plant community on open windy places: those places usually on S-facing slopes above timberline, and on prairie mesa tops on the plains and on treeless bushless Canadian Zone ridge/mesa tops in NW Colo. This butterfly is called the Cushion-Plant Blue because it mostly lives on windswept ridgetops or on small plateaus with low vegetation on shortgrass prairie, always where the plants are mostly cushion plants, which are prostrate dicotyledon plants that look like little cushions because strong winds in those locations blast and trim any protruding parts of the plants with windblown sand and ice crystals. The process is like people using air hoses in sealed sandblast chambers to blow ground walnut shells or sand to sandblast wood and glass etc. to carve it or make it look frosted in appearance. So the plants that thrive there are both physically shaped and genetically programmed to grow in cushions to minimize damage and hug the warmer ground. Hostplants in Colorado herb Fabaceae: *Astragalus spatulatus, chamaeleuce* for ssp. *minnehaha* (Nevada hosts [Austin & Leary 2008] are *Astragalus* 2 sp., *Oxytropis* 2 sp., *Trifolium*, [several ovipositions were seen on 2 sp. of *Eriogonum*, which possibly are hostplants]); *Trifolium dasyphyllum, nanum* for ssp. *pitkinensis*; *T. dasyphyllum* (& surely *nanum*) for ssp. *platazul*. Common near/above timberline; *minnehaha* is uncommon.

Eggs greenish-white, glued singly mainly on host leaves, sometimes on stems or seed pods. Larvae eat leaves and flowers, without nests. Older larva (Colo., too-small sample size) solid grass-green, with black subdorsal spots on abdomen. Older larva (Calif. ssp. *shasta*, photo Ballmer & Pratt 1988) multicolored, with dark-brown-to-maroon middorsal band (often narrowed almost to a line), next a row of large cream triangular to crescentic bumps/patches edged below by blackish diagonal dashes (except whole top of A7 and A9 is blackish and whole top of A8 is brown except a black middorsal stripe), then a mottled tawny area, and a lateral wide cream band (edged by brown that is topped by a brown spot on each segment) from front to rear; or larva brown (with a blackish middorsal band edged with tan, blackish oblique subdorsal bars, and a blackish lateral band); or white (with a brown middorsal band, brown oblique subdorsal bars, and a faint brown side band); or green. Pupa (Colo.) green, the head and end of abdomen tan, outer part of wings sometimes tan; or yellowish-tan with middorsal browner line, thorax and wings light greenish-brown. Pupa (Calif.) light tan to pale greenish-tan with green wing cases. Pupa usually attached to underside of a rock by a silk girdle and cremaster. Biennial at least at high altitude, hibernating as eggs the first winter, nearly mature larvae the 2nd (J. Emmel & O. Shields 1980. The biology of *Plebejus* (*Icaricia*) *shasta* in the western U.S. [Lycaenidae]. J. Res. Lepid. 17:129-140). At low altitude in Colo. (and in Calif.) they hibernate as eggs, and probably are not biennial at least on the plains.

One flight July-Aug., but mostly M July-M Aug. above timberline, M-L June (worn E July) for plains *minnehaha* (L June-July for NW Colo. *minnehaha*).

Adults visit usually yellow flowers, sometimes cream/white or blue/violet, including *Erigeron* spp., *Eriogonum flavum*, *Haplopappus* (*Tonestus*) *pygmaeus*, *Heterotheca villosa*, *Sedum lanceolatum*, *Solidago simplex* var. *nana*, and probably visit mud.

Males fleek all day near the "cushion plant" hostplants, as they fly an average of only 7cm above ground (2-15cm, N=10). Flight is fairly slow and steady but if they are disturbed they quickly vanish with the wind. In courtship, the male encounters the female and they may hover, then after landing the male flutters strongly to transmit pheromone, while unreceptive females flutter strongly to repel the male. If the mating pair is startled, either sex may fly, the partner dangling.

***Plebejus alupini* "*lupini*" Large Silver-Studded Blue**

P. alupini has orange only along the uph and unh margin, like *Euphilotes*, but differs from *Euphilotes* by having shimmering silver-blue spots around the unh submarginal black dots, the unh orange band of crescents touches those shimmering spots, and the wing fringes are not checkered. Males are blue on ups, females mostly brown, like most blues. Three ssp. occur in Colo. (Scott, 2008). Ssp. ***lutzi*** occurs mostly in the upper foothills and Canadian Zone over most of Colorado; it is large in size and the male upf border is only an average of 1mm (0-1.5) wide. (Near-*lutzi* in the upper Wet Mts., and the San Juan Mts. on the W side of the San Luis Valley, is large in size but the male upf border is wide like *texanus*.). Ssp. near ***texanus*** occurs on the plains, and the lowlands in Arkansas River Valley and lower altitudes in W Colorado, and is small with a wide ~1.5 (0-2, mostly 1-2) mm male upf black border (it is not quite as wide and distinctive as ssp. *texanus* from Ariz.-W Texas), and has a slightly more grayish uns than *lutzi*. Finally, ssp. ***cotundra*** is on Alpine Zone tundra from Rocky Mtn. Nat. Park south along the continental divide to the central Sawatch Mts. then along the Sangre de Cristo Mts. Ssp. *cotundra* resembles *P. alupini lutzi*, but the orange band on hw is very narrow (the orange spots very small), the upf border of males is just a narrow black line, the ups of males is a little more silvery-blue, most females have some to much silvery-bluish on ups, the uns black spots often tend to be proportionately larger than other ssp., and the uns is a little darker creamy-gray. Ssp. *cotundra* is surely adapted to the alpine zone at least physiologically, and may differ genetically in the more-silvery blue ups (all "altitudinal forms" of butterflies have been proven to be genetically different—note that cool-season forms [such as *Pontia callidice occidentalis* form calyce] may predominate at high altitude merely due to its colder temperature, and their genes just cause the wings to be greener at low temperature), but the two most conspicuous characters by which *cotundra* is distinguished (reduced orange band, darker uns) also occur in the L winter-E spring form of California *P. acmon* form cottlei, suggesting that they may be influenced by cold temperatures, so I treat it as a ssp. {*P. a. spangelatus* from Olympic Mts. Wash. to S Alberta tundra is similar to *cotundra* but the grayer uns has smaller black spots.} {The name *alupini* is correctly spelled *lupini* according to the ICZN Code, which does not allow improper/misleading scientific names to ever be corrected (the butterfly never visits *Lupinus*, as an adult or egg or larva, so the name *lupini* is ridiculous), which of course is completely improper for any rational human being or any scientist (science is the search for truth, not the perpetuation of lies), so here I act rationally and scientifically and use the *lapsus contrarius* method of correcting improper scientific names by adding the prefix a- or anti- or the suffix –anti or –no or –un. See Scott, J. A. 2014. Problems with the ICZN Code of Zoological Nomenclature, and some solutions. Papilio (New Series) #22:69-73.}

Habitat open areas from the plains up into the Canadian Zone and sometimes the Subalpine Zone. Habitat of *cotundra* dry alpine tundra, on gentle or steep sunny slopes (most often E- or SE-facing probably because of more morning sun and less wind); *cotundra* colonies are rather local because the hostplant is very local and rather uncommon in the Front Range, though in the Sangre de Cristo Mts. it may be more common on alpine tundra slopes. So far *cotundra* has not been found in the San Juan

Mts., maybe because those mts. are wetter, though perhaps local colonies will be found. Hostplants in Colorado herb Polygonaceae: ssp. *lutzi* hosts are various *Eriogonum* including *E. umbellatum* var. *umbellatum*, *subalpinum* (esp. in the Subalpine Zone), *flavum* (=*jamesii* var. *flavescens*), and *racemosum* (occasionally) (and assoc. *E. heracleoides* & *E. brevicaule* in NW corner of state in Moffat Co.), while near-*lutzi* from S Colo. eats *E. jamesii*, and ssp. near-*texanus* eats *E. effusum*, *lonchophyllum*, *brevicaule*, *corymbosum* var. *velutinum*, and occasionally *umbellatum* (some populations eat different *Eriogonum* in spring and late summer), and assoc. *E. cernuum* var. *cernuum*. Ssp. *cotundra* eats *Eriogonum arcuatum* var. *xanthum*=*E. flavum* var. *xanthum*=*E. flavum* var. *chloranthum* (Weber & Wittman 2012 note that this may be just a variety of *E. flavum*, and *E. jamesii* may be just a ssp. of *E. flavum*). Other *Eriogonum* are eaten in the rest of western N.A.; and ssp. *texanus* eats legumes (Fabaceae) in Mexico, and in S Ariz. evidently feeds on legumes in spring and *Eriogonum wrightii* in late summer (Paul A. Opler research); and in Nevada (Austin & Leary 2008) *texanus* hosts are legumes (*Astragalus* 3 sp., *Lotus*, *Lupinus argenteus*, *Oxytropis*) and *Eriogonum* (assoc. 11 sp.); so maybe spring larvae on the Colorado plains might eat legumes sometimes? (I found a female resting on the legume cushion plant *Astragalus sericoleucus* on Pants Butte N of Mitchell in the Pine Ridge of Sioux Co. Neb. May 16, 1994, which may mean nothing). Calif. *P. alupini* was reared on the legume *Lotus scoparius* in the lab (Ballmer & Platt 1992). Common.

Eggs greenish-white, laid singly on host flower buds or leaves. Larvae eat flower buds and leaves: most ssp. eat primarily flower buds/growing seeds, but ssp. *texanus* often eats different parts during the two or three generations: leaves for the first generations, then flower buds later. Larvae sometimes tended by ants. 3rd-stage larvae may be reddish if they fed on flowers. 4th-stage mature larva (James & Nunnallee 2011) dark-green covered with white setae, with weak darker heart-band, ~3 faint oblique creamy dashes on each segment, a lateral row of white or yellowish dashes. A Wyo. larva light-green with double pink and white lateral stripes. Some larvae reddish. Pupa green, the abdomen yellowish-green, the front and rear tan-green. 2nd stage larvae hibernate in S Calif.; sometimes 3rd. In Wash. L2 and L3 often diapaused, and a 4th-stage (mature) larva aestivated/hibernated in lab [James & Nunnallee 2011]. Perhaps *cotundra* hibernates in 2nd & 4th stages in several winters. {True *P. acmon* from Calif. older larvae may be green, cream, or maroon in ground color, some with middorsal reddish band and paler subdorsal oblique dashes and many have white or yellow lateral line which may be bordered with red. *P. acmon* mostly diapauses as 2nd-stage.}

Three flights for plains *texanus*, L April-E June, L June-M July (or L July), and end of July (or M Aug.)-M Oct. Two flights for *texanus* in Arkansas Can./Wet Mts./Wet Mtn. Valley/San Luis Valley ~M June-E July then ~L July-Aug. Ssp. *lutzi* has one flight mostly M June-July (rarely E June and M Aug.). Near-*lutzi* from upper Wet Mts. and the mts. on W side of San Luis Valley flies L June-M July. One flight for *cotundra* July-E Aug.

Adults visit yellow and whitish flowers, sometimes blue-purple, including *Ceanothus fendleri*, *Chrysothamnus* (*Ericameria*) *nauseosus*, *Erigeron* spp., *Eriogonum* spp., *Heterotheca canescens* and *H. villosa*, *Senecio* (*Packera*) *fendleri*, sometimes feed on manure, and often visit mud. Adults bask dorsally (by spreading the wings), sometimes laterally. Adult *cotundra* roost upside down under the hostplant flowers and probably on other low plants. A male *texanus* at Barr Lake evidently strayed ~1km from its prairie hostplant, and another was found at my house after straying 1km+.

Males fleek all day about the hostplant *Eriogonum*, as they fly ~20-40 cm up. Males of *cotundra* fleek all day near the hostplant, as they fly fairly fast only 5-10cm above ground/hostplants. In courtship (of ssp. *texanus*), the male overtakes the female and both may hover/flutter, they land and the male flutters to transmit pheromone, and the unreceptive female flutters to reject him. If a mating pair is startled, the female may fly (the male may fly sometimes also?), the partner dangling.

Scott, J. A. 2008. *Plebejus alupini lutzi* and *Plebejus alupini texanus* distribution in Colorado and adjacent states. Papilio (New Series) #18:57-63.

***Plebejus* (*Agriades*) *glandon rustica* Arctic Blue**

Identified by the unique unh with large unh white spots (often containing black dots), large often-weaker pointed submarginal spots, and the grayish-blue male ups. Ssp. ***rustica*** has small black dots in most of the white unh spots, and the unh is paler creamy-tan or creamy-browner compared to other ssp., although some adults esp. at high altitude are browner on unh similar to the northern Rockies ssp. *megalo*.

Habitat open places in the foothills woods to Alpine Zone, mostly in valley bottoms or hillside swales. F. M. Brown once found a stray on the plains S of Colorado Springs, and M. Fisher found one in SE Denver. I found a male at Red Rocks in the lower foothills, and a regular tiny colony exists at Tinytown just above the mountain front. Hostplants in Colorado tiny herb Primulaceae: *Androsace septentrionalis* everywhere (vars. *puberulenta*, *subumbellata*, *subulifera*), and above timberline also *A. chamaejasme carinata*. Hostplants elsewhere are an odd assortment: European ssp. *glandon* also eats Primulaceae (*Androsace, Soldanella*, *Gregoria*), but *aquilo* is also recorded on Fabaceae (*Astragalus* in Europe, and Fabaceae in arctic N.A.); arctic N.A. ssp. with large unh black spots and ssp. *megalo* are recorded on *Saxifraga* (Saxifragaceae); and the Calif. ssp. *cassiope* and intergrading Montana *cassiope*X*megalo* population eat *Cassiope* (Ericaceae). Common except in foothills.

Eggs greenish-white, laid singly under host leaves, sometimes on sepals or bracts. Larvae eat leaves or flowers {Calif. *P. podarce* mines its *Dodecatheon* leaves until the last stage}, mostly at night. Older larva of Wash. ssp. *megalo* (photo James & Nunnallee 2011) dark-green on much of side, a blackish middorsal stripe edged by a cream or yellowish crescent on each segment bump (with red spots invading the cream in the middle and sometimes also on the front, and sometimes the red runs across top to its cream-bump twin on the other side), below each segment bump is an oblique black dash in a dark-green (slate colored wide area in Neill 2007 photo) area (this black dash is missing in *P. podarce*), then a wide (narrower in Neill photo) reddish band above a cream lateral line. Olympic Mts. Wash. ssp. *megalo* (photo J. Emmel & T. Emmel 1998, Systematics W N.A. Butt. chapter 20) similar, with near-middorsal bumps mostly red (whiter at rear of each bump) and lateral stripe mostly red. {The *aquilo* Fabaceae feeders elsewhere are green.} {Photos in Allen et al. 2005 of "*glandon*" and in Ballmer & Pratt 1988 of "*franklinii*" are actually *P. podarce* from Calif., and the former and Emmel & Emmel also illustrate *P. glandon cassiope* larvae from Calif. The blackish heart-band is more sinuous in *megalo* and *cassiope*, straight in *P. podarce*.} Calif. *P. podarce* are the only Polyommatini larvae that lack both the honey gland and eversible tubercles (Ballmer & Platt 1988), so Colo. *rustica* probably also lack them. Pupa mostly red or dark-olive-brown, wings greenish, abdomen has a middorsal red or blackish band edged by white and a lateral cream line. Larvae hibernate in 1st 2nd & 3rd stages (of 4 stages) (James & Nunnallee 2011), so maybe lower-altitude pops. overwinter mostly as L2, alpine biennial pops. as L1 and L3?; they thought *P. glandon* is biennial in alpine N Wash., and alpine zone populations may be biennial in Colo. also (every butterfly species native to the alpine zone is biennial or multiannual as far as known).

One flight E June-M July in foothills, M June-E Aug. at middle altitudes, and M July-E (sometimes M) Sept. above timberline.

Adults visit yellow and whitish (sometimes bluish/purplish and rarely reddish) flowers, including *Achillea millefolium* "*lanulosa*", *Antennaria parvifolia, Arnica* spp.*, Aster foliaceus* var. *apricatus, Erigeron elatior, E. ursinus, Erigeron spp., Eriogonum subalpinum, E. umbellatum, Heterotheca pumila, Potentilla spp., Sedum lanceolatum, Senecio* spp. incl. *atratus*, *Solidago multiradiata, S. simplex* var. *nana*=*decumbens*, and often visit mud. Adults bask by facing away from the sun and spreading the wings partly or halfway (dorsal basking), or sometimes by orienting their closed wings perpendicular to the sun (lateral basking) which they often do in cloudy weather; they prefer to bask in tiny hollows that are warmer. Adults roost on small plants including *Erigeron* and *Vaccinium* etc.

Males usually rait all day in swales or gulch bottoms to await females, where they rait on the ground or low plants an average of <10cm above ground, but males sometimes fleek especially in Subalpine and Alpine Zone localities on slopes that have little topographic variety. In the alpine zone where they are abundant, males often rait at the base of swales next to a shrub willow carr, but on uniform slopes in the high mountains they fleek. In the foothills where they are uncommon, they usually rait in swales on N-facing slopes near the hostplant, or in gulch bottoms. Scott (1976a) wrongly reported that *P. glandon* just "patrols"; actually most Polyommatini just fleek, but certain species usually rait. 14 mating pairs were found, from 08:32-15:30. In courtship, the male overtook the passing female and she hovered and he hovered close below her, she landed and spread her wings 120^o while he landed behind her and flicked his wings 0-50^o-spread for ~1sec. to waft pheromone, then he crawled under her left wing and bent his abdomen to try to join while his wings were flicking only 0-25^o apart in bursts (~5-10 flaps/burst and ~2 bursts/sec), for 10 sec., then she flew for 30 cm over short willows with male flying just below and behind ~2 cm and they landed, and the male flicked his wings (0-30^o spread) like before while the female had wings spread 115^o in basking position, and the male bent his abdomen and after 10 sec. he joined. Courting males flutter next to the female to waft pheromone (by fluttering/flicking/sometimes vibrating his wings from a closed or nearly closed position averaging 8^o to an average of ~83^o-spread position on each stroke {extremes 30^o to 180^o}), but if the female is unreceptive she flutters strongly ~5x/sec. to reject him (on each stroke her wings open usually from a closed or nearly-closed position to a 70-110^o-spread position, or often from a basking position of 70-80^o-spread to a nearly-or-fully-spread 130-180^o position on each stroke); the amount that males and females open their wings during each fluttering stroke is similar, roughly 75^o for males and 83^o for females on average (note that these numbers for the butterflies I have observed are just my guesstimates, made without benefit of video analysis). Unreceptive females also may rotate away or fly away. If the mating pair is disturbed, the male generally flies (18x), the female rarely (1x), while the partner dangles.

Stories

One of the first butterfly books that I got was The Butterfly Book, by W. J. Holland, 1931 edition. There was very little actual scientific information in that book about the butterflies and their biology, yet it sold well from 1898 (the first edition) to ~1960 evidently because of the color plates; what I liked most about it was the stories, which were interesting and well-written. So here I add some stories or little essays, about my butterfly studies, some adventures in nature, my attempts to forage on wild foods and make bread and pie etc. out of those foods and my garden crops, and other topics, which I hope readers will find useful or interesting.

Colorado Fruit and Nuts

Colorado is a bad place to grow fruit and nuts. Among the usual tree fruits, apples produce the most fruit, but they are usually infested with ~Codling Moth caterpillars that mine out the center and growing seeds. Commercial growers spray insecticide etc. three+ times/year on apples and other orchard fruits, so I located about 20 wild trees in the Front Range near Denver, but most of them produce small mediocre apples of several ancient late 1800s varieties (maybe the variety most often widely spread by Johnny Appleseed) with small wild size and green to red color and mediocre taste, heavily infested with those caterpillars (one wonders how the "organic" apples in the grocery stores can possibly be produced because every apple tree in the Denver suburbs and foothills wilds is heavily infested with caterpillars—maybe with the help of grillions of pheromone traps to confuse the male moths of those caterpillars?). (Most apple trees in Lakewood suburbs taste mediocre also, except occasional Golden Delicious apples that taste great and last until April in a garage rack, and a few large trees producing purplish apples with delicious flavor in Sept. but fall down and rot by the end of Oct.). Pears and apricots can produce good crops in some years in Denver (maybe one out of four years), and offer the most hope. Peaches grow well only near warmer Grand Junction and Canon City, because they bloom weeks too early and are usually frozen by Colorado spring weather, and horticulturalists have failed to produce peach grafts that bloom later than the usual frost (the roots of all peach trees--if allowed to produce limbs as I once mistakenly did—produce small tough weak-tasting peaches whose skins cannot be blanched off and whose pits cannot be removed, so cannot be eaten or canned and are only useful for compost after stomping them to remove the pits). Sour Montmorency Cherries flower later, and produce well for a few years, but then get hordes of Robins and Common Grackles which nest nearby for years and eat the pinkish cherries even before they ripen, then the maggots arrive en masse, then the trees die of fire blight. All of those and other Rosaceae trees (plums etc.) are infested by fire blight.

Native small fruits are scarce in Colorado also. *Amelanchier* is scarce on the E slope lower mts., and the tiny bluish apple-shaped fruits are tasty but very sparse—the bushes are uncommon, and each bush has few of the good fruits. *Amelanchier* is more common on the W slope (go to the Kaibab Plateau in Ariz., where I saw thousands full of fruit). *Prunus virginiana* Chokecherry is common but the berries don't taste very good, hence the common name. *Prunus americana* is locally abundant in valley bottoms, but the plum production is usually sparse, and they get ripe only at the exact time they fall to the ground below the bush, so to gather them you must crawl around under the bushes and watch out for rattlesnakes. Freezing them in plastic bags works well, where they become a tasty frozen snack. I once canned some *P. americana* fruits, and discovered that the flavors of the pits (due to cyanide present in plum and peach pits or due to the Plum Curculio Beetle larvae boring into the pits) ruined the taste and I had to discard them. *Crataegus* Hawthorn fruits are small and flavorful (tastier than apples), however each small fruit is stuffed with ~20 big seeds. *Fragaria* is often common in Colo., but the strawberries are very small ~7mm and usually sparse. *Vaccinium myrtillus* and *V. cespitosum* produce nice blue berries, and *V. scoparium* nice red berries, and the first and third plant species grow by the thousands in the Subalpine Zone, but the berries are tiny and sparse.

Raspberries are difficult to get in Colo. also; the wild plants usually fail to produce much fruit, although sometimes you get lucky. We transplanted the native Red Raspberry *Rubus idaeu*s into the yard, but got very few berries because the young canes would not survive the winter to produce fruit the next year, and other native species failed also. After 40 years I finally discovered the secret: one must find some friendly person in town with a big patch of the cultivated Heritage Variety with great late berries, dig the extra plants and transport them in water to your garden, and mow them off every fall; using that procedure they grow new canes the next spring and produce berries from July to frost, and every day you can wander among them and munch with delight. {Move to Ore.-Wash. for abundant raspberries.}

Wild gooseberries sometimes produce tasty berries (*Ribes inerme* berries are tasty but usually sparse, while *R. cereum* produces berries that are too waxy so you can't eat more than a handful). My cultivated gooseberries produce well, but they have too many little pedicels (and some varieties have fierce thorns requiring leather gloves) and to freeze them one must add too much unhealthy sugar to make them taste good. Cultivated currants are too small and sour (store "currants" are actually raisins).

Elderberries (*Sambucus canadensis*) are found along watercourses on the plains and I used to gather those with difficulty and make elderberry pie, until I discovered a few long hedges in Lakewood which produce abundantly. Below is a great recipe for elderberry pie.

Mulberries are occasional Denver suburban trees, and there is one tree growing wild just E of Lookout Mtn. (SW of Golden), but unfortunately those are *Morus alba* which produces bland berries.

Pie Crust: 2 ¼ cups flour (white wheat flour, or gluten-free flours such as oat, barley, millet, garbanzo, tapioca [don't add much of this], sorghum, buckwheat, teff, rice, etc.), salt ¼ tsp., water ½ cup (use ¼ cup for all-wheat flour), canola oil ¼ cup (use ½ cup for all-wheat flour—gluten-free flours require much more water and less oil, so for them you have to reverse the amounts of water and oil). Mix by hand with wire pie dough mixer until it all sticks together in one lump (if it is crumbly add a bit more water and keep mixing), divide lump into two 2/3 and 1/3 lumps, place larger lump between two plastic rectangles (cut from cereal box bag) and squash it flat with your hand, then using rolling pin roll it into a circle and place it into 10" glass pie baking dish and press it onto bottom and sides. Roll the smaller lump into a smaller circle for the top of pie, and make a few ventilation holes in that top crust using a spoon tip or whatever.

Elderberry (or mulberry) pie filling: 3 ½ cups ripe blackish elderberries (*Sambucus canadensis*) are needed for each pie. To pick elderberries, break the stalk of each umbel and stuff the umbels into a plastic bag. Back home, sit down and pick the berries off the umbels by pulling them gently off between thumb and fingers. Then place the loose berries into a large deep pan of water in the sink, and using a glass skim off everything that floats and discard that refuse (compost, which includes stems and bad hollow berries that float), then drain and save only the good dense elderberries that sank to the bottom. Then freeze extra berries in 3.5 cup bags or large plastic cottage cheese/yogurt containers. Now place 3 ½ cups of fresh or thawed berries in bowl and add 1 tbsp. lemon juice and mix; in another bowl mix 7/8 cup white sugar and ¼ tsp. salt and 1/3 cup flour, then mix that into the berries. Fit and press bottom pie crust into pie dish bottom and sides, and pour berry mixture into pie bowl. Attach top crust (make a few slots in the middle of it for juice to bubble out a bit) and beautify the rim if you wish (my mother used to form the rim into zigzags with her fingers—mine are uglier.). Bake 350°F 50 minutes or until the juice bubbles up through slots. {Slight variations of this recipe are good for most fruit pies. Butter and refrigeration are not needed for pie crusts, and do not waste pie crust; most TV bakers make those mistakes.}

Apple pie filling: Cut apples into 1" chunks (I do not peel them, I just quarter them with large knife on chopping block then remove stems/seeds/sepals with one move of paring knife), enough to fill an empty pie dish to rim, rinse and drain chunks. Mix ¾ cup brown sugar, ¼ cup flour, 1 tsp. cinnamon, ¼ tsp. ground nutmeg, together in large bowl by hand using wire dough-blender, then using large spoon mix with apples in large bowl, spoon them into bottom crust in pie dish. Attach top crust, with a few slots poked in middle. Bake 350°F 60-80 min. until bubbles come though slots in crust and apples are soft when pierced.

My favorite **cookbook** is The Settlement Cook Book, which sold well in at least 33 editions from at least 1901-1976.

Nuts (edible ones) are also scarce in Colo. *Quercus gambelii* is extremely common, but the native americans did not gather the small nuts as much as they gathered oak nuts in California, as most years the crop is sparse, and one must boil and leach out the bitter tannins. *Corylus cornuta* (Filbert) bushes are sparse on the shady S edges of ravines in the Front Range etc., and those produce very few flowers and tiny nuts. Black Walnuts (*Juglans nigra*) were grown in Denver yards and are my favorite nut, and I found about 20 trees near my house to gather the great nuts (one must use a 20' apple picker to gather them, then dump them in the street gutter and repeatedly run over them with your truck tire to squash off the thick husk, then sit on the sidewalk and pick out the 3 cm nuts [passing people will think you are pawing through horse manure—that's what it looks like] and put the nuts on a ½"-mesh screen and blast them with the water hose to clean off the husk, then store them dry. To extract the edibles place the dehusked nuts in a clear plastic bag on concrete and smash each nut with a small sledgehammer until all parts are less than 1/3 size, then use special nippers with points grinded narrow and miniature screwdrivers to crack and dig out the flesh—a lot of work because the nuts are built super-strong with thick internal struts, but they are delicious—English Walnuts have a bad bitter taste to me). But in 2012 Thousand Cankers Disease (a fungus *Geosmithia morbida* [transmitted by the

Walnut Twig Beetle *Pityophthorus juglandis* bark beetle] that clogs the water and sap transport systems of the trees) killed all the Black Walnut trees in Denver (that disease has now spread over most of the U.S. from Calif. to Wash. and Ohio North Carolina Virginia, so may eventually kill most of the Black Walnuts in North America).

(Colorado is also a bad place to have a garden as noted below, as the growing season is short, soils are frequently horrible clay, and hail is frequent and ruins gardens roofs and cars.)

Cactus fruits. The ripe fruits (called "tuna" in Mexico) of *Opuntia macrorhiza* (the "nopal" pads smooth and ~12mm thick, flowers yellow, fruits purple ~15mm X 40mm and tapered at base) make great snacks (*Opuntia polyacantha* fruits and those other *Opuntia* with purple flowers are bad), if you take the trouble to remove the tiny spines (those ~2mm long spines called glochids; and of course stay away from the 2cm spines) before you collect them: one must squat down, pull out your pocket knife, and carefully scrape off the glochids [=tiny spines from the ~dozen bumps on the outside of each fruit and around the end] <u>before</u> you touch the fruit, then grab the spineless area with finger and thumb and cut the narrow base off the pad, then lift it up and carefully cut/saw the wide end off and discard that without touching the glochids there, and then eat the fruit. They are delicious, though you have to spit out ~20 seeds. Save a few dozen in a ziploc bag for later consumption (they aren't as good frozen). The fruits are generally uncommon in nature, but my secret source is a public xeriscape garden with several patches of cactus bearing hundreds of big succulent fruits in Sept. The Mexican grocery tunas are insipid by comparison to ripe wild ones of the right species.

Whole Wheat Bread. I have made this recipe about 100 times, and it works great: In giant mixing bowl, mix 5 ½ cups lukewarm water (110-115°F—hotter water will kill yeast), ½ cup canola oil, 1 ¼ cups brown sugar, 2 tbs. salt, two packages rapid-rise active dry yeast. Gradually add 7+ cups whole wheat flour and 7+ cups regular wheat flour alternately while mixing with giant very-sturdy spoon. Mix until stiff, then place lump on lightly-floured table and knead ten minutes or until stiff, adding flour if sticky. Place lump into mixing bowl, butter the top, cover with dish towel, let rise until lump rises above top of bowl (~2 hours in warm site). Crimp waxed paper onto scale, and cut lump into five lumps weighing about 1.5, 2, 2, 2, 2 pounds. Knead each lump until compressed and stiff, and place each into a buttered baking pan (one medium, four large rectangular bread pans). Butter the tops. Cover all five pans with that dish towel, and let rise in warm place (~2 hours) until they rise just above top of pans. Bake in preheated 375°F oven, 15 minutes without foil on top, 25 min. with one large sheet of aluminum foil placed uncrimped over top of all 5 pans (the foil produces moist bread with browned not burned tops). Totally delicious slightly-sweet bread. Eat one now and freeze the others in plastic bags for later.

Brief Biography of my Butterfly Activities

My father was a geologist, so when I was a kid we went out in nature a lot, to study rocks and find fossil ammonites, and dig for mineral specimens (topaz and smoky quartz and amazonite etc.), and he also liked to fish in beaver dams, so we went fishing a lot. But I liked bugs and butterflies more than the rocks for some reason—bugs and plants are intrinsically more interesting to me, plus maybe I had a little contrary thinking including passive-aggressive resistance to authority. And we hardly ever caught any big fish because beaver dams generally have just little 5" fish that are hard to catch, so fishing was boring. On one boring fishing trip I noticed a lot of green spotted frogs, and decided to see if I could catch them with the earthworm dangling from the fishhook and fishing pole. It worked, I just had to move the worm near the frog and wiggle it up and down, so I recruited my sister and we caught about a dozen frogs, and that night my mother fried their legs for supper and we camped there for the night. We met the lepidopterist Don Eff on that trip, when he spotted our nets as he drove by, and we became friends. Anyway, my first butterflies: Long before that trip I wanted to catch some of the butterflies I saw in the back yard, so I asked my mother to make me a net to catch them. She sewed a reddish cloth bag onto a wire clothes hanger and I tried out that net. I managed to catch a few of them, but found that trying to see them inside the reddish cloth was difficult so I caught very few good specimens. So my mother got some whitish mesh cloth and made a better net. The next step was a better handle, as it was hard to hang onto a tiny wire handle which worked poorly. My father had some wooden golf clubs, and he seldom golfed and wasn't very good at it, so he contributed a few clubs and we sawed off the metal striker and got some thicker wire and made a regular net handle with grooves and holes to fit the bent wire into the wood inside a short copper pipe that kept the wire positioned inside the pipe. That worked pretty well; the design came from a butterfly book (How to Know the Butterflies, by Paul & Anne Ehrlich, 1961, Wm. C. Brown Co., a nice book I totally studied). So the net problem was solved, and I managed to catch some butterflies, but where to put them? At first I got a little cardboard box, and got some common pins and skewered them and pinned them to the bottom of the box. Later we bought some insect pins from the Jonas Bros. taxidermy shop. I learned to make folded paper envelopes to store my earliest butterflies. That summer we went to my grandparent's houses in Ohio, where my relatives and I went to visit a man with cows for some reason, and I spotted a Giant Swallowtail (*Papilio cresphontes*) on manure in a cow pen, and managed to catch it, but didn't know where to put such a large specimen, so I put some dry straw into a jar and put it in there until I could make a large paper envelope for it. (My collection still has the specimen, which isn't too badly beat up). Later I got some "celotex" which was used on the ceiling of the basement in our house, and cut it to fit into the bottom of cardboard boxes. Celotex was hard stuff, and it hurt your fingers to ram the pin into it, but I had to endure that stuff for decades, because after a few years I made 125 new drawers and cabinets for my collection, using celotex for the drawer bottoms, and the tops were a pane of glass slid into the front and sliding into grooves on the sides and back (my stupid design—of course that wasn't very tight because the rear glass groove had to be lower to account for glass sag, so I had to use napthalene and paradichlorobenzene mothballs/crystals to keep the dermestids under control, so I and my folks and sisters had to endure the bad stench of those mothballs, and eventually the collection was moved to the garage. Much later, I practiced learning how to make good butterfly drawers, and finally settled on a genuinely "foolproof" design and made hundreds of them, that are so tight the pests can't get inside (Tom Emmel visited my collection, and pronounced that my drawers were "as good as the german ones"--I made the crack so small the dermestids can't get in). I detailed how to make those truly "foolproof" drawers and nice portable cabinets in Papilio [New Series] #15-16).

When I first collected, there was a tiny creek flowing near the house, with crayfish, and some good butterflies were there, notably many *Lycaena helloides*, and some *Lycaena hyllus* and *L. dione*, and some skippers such as *Polites mystic* (at first I didn't collect skippers much, because of the popular ridiculous opinion of some people that skippers aren't really butterflies, so when my father offered to buy me a copy of F. Martin Brown's Colorado Butterflies I got just the section on Papilionidae and Pieridae, but shortly thereafter I reneged and we bought the whole book with the skippers too). Anyway it was nice to collect butterflies so close to the yard. More than 40 years later, one of those *L. helloides* males was designated a neotype of the name *castro*, when the International Commission on Zoological Nomenclature approved a petition I wrote to them to fix the nomenclatural problem that noone knew what species the name *castro* applied to because the *castro* type specimens contained two species. After awhile some houses were built on that little creekside habitat, and the creek was rerouted into a concrete ditch, exterminating the butterflies. And later about a dozen or more of the butterfly species found near my house disappeared, including *Asterocampa celtis* butterflies that were in the back yard where a *Celtis occidentalis* tree still grows (maybe there are too few of those trees in the neighborhood).

Anyway, I soon became an avid collector, and collected butterflies on the family's trips for butterflies or minerals or fish or fossils and on the family vacations to nice wild places. I consulted the membership list of the Lepidopterists' Society to find other collectors who traded butterflies, and every

winter I traded butterflies with several dozen people, and finally ended up with a collection in which some specimens were collected by 385 different people (many collectors traded me specimens that had been collected and traded by a third collector). I even traded butterflies with Robert M. Pyle, when he was an avid collector and lived near the Highline Canal in east Denver, before he became a reknowned conservationist and butterfly watcher. That was a different era, when it was easy to assemble a collection; nowadays there are lots of protectionist laws and many people are binoculars watchers and do not collect, and most people just fixate on their cell phones and don't even go out into nature anymore, making me think that I was among the last of the butterfly naturalists. Traditional taxonomists are becoming extirpated and people are hired to sequence bits of DNA and then they vehemently claim that the true phylogeny must be what those tiny little DNA bits show (even if morphology/behavior/natural history clearly demonstrate a different phylogenetic tree). Today's young butterflyers face a fauna increasingly extirpated by global warming and development caused by the massive human population explosion and their wastage of oil and coal and natural gas etc.
Anyway I became a scientist, and took entomology courses in college (the first two years I thought I would major in physics, but in my junior year I changed to biology after learning the electron was just a probability cloud), and thanks to a recommendation from the ant expert and CU professor Dr. Robert E. Gregg I got an NSF Graduate Fellowship to pay for several years at the Univ. of California Berkeley where I got my Ph.D. in entomology. My thesis was on butterfly behavior and movements, and I hadn't taught much because my voice is weak and I was shy in my youth (until I forced myself in my later 20s to become relatively unshy), so basically noone wanted to hire anyone with that experience, so I worked on houseflies and mosquitoes and computerized grassland ecosystem research for a while (fly scientists evidently have a harder time recruiting workers, so I was chosen), and coauthored a paper on electrophoresis of Yellow Fever Mosquito ecotypes in the journal Nature, and published a couple mathematical papers on butterfly populations and seasonal ecotypes of insects including that mosquito (in the journals Theoretical Population Biology, and Journal of Animal Ecology). It was a shock to me that instead of working in nature and working on beautiful butterflies and fascinating plants I ended up stuck indoors working on flies. So I got shook up after realizing that job prospects were so bad that I had made a mistake pursuing butterflies as a career, and I started chasing girls and started living for the moment instead of for the future. Some unproductive years ensued. I continued to research butterfly behavior and expand my collection, and spent thousands of days out in nature studying them, mostly near Denver. I realized that there was no butterfly book reporting the biology of North American butterflies, so I decided to write that butterfly book and make some money from it. Not much money as it turned out, as books only made good money if they got placed in the chain bookstores. Actually there are thousands of people around the country who have degrees in biology/entomology etc. who lack relevant jobs, and if I had any common sense I probably should have quit school at age 15 and built houses--I would be very rich now if I had, if I hadn't quit that profession due to boredom. I published a lot of papers on my butterfly research, and noticed that they didn't help earn money; in fact I soon realized that scientific publishing is a "vanity press", in which the author has to pay to get his research published (page charges etc.), and the more you pay the better journal you can get published in (quite expensive in the better journals), which led to the lifelong opinion that one should not have to pay any money to have good research published. Anyway, after publishing my butterfly book with Stanford University Press I knew that few hostplants were known for Colorado butterflies, so I spent decades concentrating on researching hostplants (documenting much more than 3000 hostplant records etc.) and natural history, and always recording observations of mate-locating behavior (~100,000 of them), and publishing the systematics of numerous butterflies that needed study and fixing. And I helped Ray Stanford with his decades-long program to obtain tens of thousands of county records of butterflies. I curated part of the butterfly collection at the University of Colorado. In the winters of 2015-2017 I spent ~700 hours curating the ~30,000 specimens of North American butterflies in the C. P. Gillette Museum of Arthropod Diversity at Colorado State University,

identifying and sorting them completely. I spent a couple years summarizing my 40,615 observations of adult butterflies visiting flowers etc. (Scott 2014a), and researching the pollinators of Colorado flowers, which is surely the best paper of its type ever published worldwide (there aren't any others that complete), and since then "finished" this current book on butterflies of the Southern Rocky Mountains area, which summarizes my lifelong research, plus all the good results that I could find on Colorado area butterflies that were published and unpublished by other people. I took thousands of color Kodachrome slides of butterflies and their eggs larvae and pupae, although the early photos were mostly bad because of poor equipment; the cameras of today are vastly better than those available decades ago. Many of the best photos are used for this book {download the four Papilio (New Series) issues after this text issue.}

Following are some stories from my butterfly adventures:

Prairie Fire

It was a memorable spring trip in northeastern New Mexico, finding butterflies here and there, including the great little hairstreak *Callophrys mcfarlandi*. I was driving happily along in my just-purchased used little Datsun pickup, holding my elbow out the window, with the kind of satisfaction that comes from traveling onward in nature without any of the stresses of the big city. Then I sniffed a bit of something burning, and thought "wow, it must be a prairie fire", and looked out the front and side windows to spot the fire but I saw nothing, so I thought the fire must be miles away and drove onward down the highway. But after a mile or so the smell became a little stronger, and I looked around again and still could not see any fire, but then I looked back out the rear window, and was horrified to see my sleeping bag on fire in the back of my pickup. So I screeched to a halt on the side of the highway, got out and ran back and pulled the tailgate handle to open the tailgate, and I managed to grab the sleeping bag and pull it out of the pickup bed onto the side of the road which seemed to lack stuff that would catch on fire—I seem to remember the road was asphalt but maybe it was concrete--I didn't care much about the road surface at the time, except it was a nice wide highway that didn't burn—and the sleeping bag kept burning, so I got my water jug from the back and poured water over it, but the water would not put out the fire, it just kept burning. So I got some more water and poured that on, but that was futile too, it seemed like nothing could put out that fire on my sleeping bag. So I gave up and just stood there watching, as my entire sleeping bag burned into ashes on the side of the road in just a few minutes. A couple people in cars drove by fast and peered out at the strange sight, but did not stop. Kind of a strange experience, just watching your sleeping bag burn up and turn into some kind of crispy critter. I eventually understood that my sleeping bag was made about 10 years before they passed the law requiring sleepwear to be fire-resistant, and mine was made of some kind of cotton or something that once ignited could not be stopped. So I watched it burn into a little pile of ashes beside the road, carefully watching to make sure it would not catch the roadside weeds on fire and cause a real prairie fire. Then I realized what had happened. My clear gallon water jug had been positioned beside the sleeping bag, and because I didn't have time to buy a camper for the pickup bed the sun beamed brightly through the water jug and was focused into a hot little point on the sleeping bag, setting it on fire. Once before that same thing happened to me, when my gallon water jug was in a plastic tub on the front seat of my earlier pickup—a Dodge D200 pickup that reliably broke down about every month especially the voltage regulator and alternator and the clutch throw-out bearing--and the sunlight pored in through the windshield and was focused onto the plastic wall of the tub, and melted the side down, but luckily there was no fire that time in my parked truck, just melted plastic. Anyway I was now missing my sleeping bag, and lacked a camper, and being a lepidopterist I didn't have much money (I went to college to get a B.A. and Ph.D. in entomology and become Dr. Jekyll the learned scholar, and instead I discovered that most of the jobs were for Mr. Hyde the exterminator [of mosquitoes, roaches, bark beetles, cotton bollworms, bedbugs, gypsy moths, codling moths, ad infinitum]), so I slept in the back of my pickup 3 or 4 nights for the rest of that trip, one night parked in the parking lot of a Holiday Inn motel. That was a cold trip. After that I always put my gallon jugs of water and other water bottles into a high cardboard box with foam at the bottom and around each container to prevent breakage, and to keep the sun off those insidious magnifying glasses. (Of course glass bottles should be discarded and opaque water containers used; another difficulty with glass water bottles is that water freezes in the winter and expands and cracks them, then the ice melts and leaks all over the place.)

Broken Habitat, Broken Me, & Great Discoveries

New discoveries can still be made in Colorado butterflies. George Austin published a paper detailing minor geographic variation of *Neominois ridingsii*, and named several mostly-weak subspecies. But then I discovered that in Wyoming and NW Colorado resides a related creature that looks a little different, which some people could even think is a different species because it flies two months later than sympatric ssp. *ridingsii* and they overlap in ranges by 500 miles, so I named it *wyomingo*. Later I reared it and studied it more and concluded it was evidently evolved from some progenitor that somehow evolved diapause in the 1st larval stage rather than the 4th, and it has the wing markings of *stretchi* and the coloration of *ridingsii*, so maybe it evolved somewhere that those taxa meet such as in Wyo. Much later, a very black ssp. was discovered in the Gunnison Basin, that we named *curicata*, which is evidently camouflaged on the often-blackish volcanic rock there. And a third oddity was found in Colo., a very whitish bug that seemed to be very local and evolved camouflage on whitish rock—white due to the mineral albite--spilling down from the Parachute Creek Member of the Green River Formation (geology words used to describe the rock layers) on the Roan Plateau, which extends from W Colorado into central Utah. That bug was named *coloalbiterra*. Those three very distinctive taxa were very surprising in what had been seen as a rather ordinary butterfly. Still later another ssp.? was found in mts. of NE Mexico, *pseudochazaroides*=*carmen*, which has oranger wings. I went to the habitat of *coloalbiterra* with Mike Fisher to study *coloalbiterra*, and we were horrified to discover that a mining company, in order to mine out some oil shale from the Parachute Creek Member (as part of the world's rapaceous search for oil and coal that is transformed into CO_2 etc.—global warming gases--that are starting to roast the planet), had tunneled into that layer high up on the mesa, and made numerous openings on the side of the mesa from which they just dumped waste rock out the openings, where it spilled far down the steep slope onto the whitish side of the mesa and buried all the habitat for a long way along that slope. We were horrified that hundreds of vertical feet of hillside along about a mile of federal land could be totally trashed merely to get a thin layer of oil shale. We managed to find a little habitat left for the butterfly. Then I visited that spot again to get ovipositions and get a couple females to lay eggs, so I could rear the immatures and get photos. I was successful and saw oviposition and got a female to lay eggs. I was also able to observe males rait (mate-locate) in little gullies in the morning, behavior that proved typical of several western ssp. of *N. ridingsii*, contrasting with ssp. *ridingsii* which raits on little ridgetops, also in morning. I pursued one butterfly up a gully to try to keep it in sight, and at a steep place I was met by an *Artemisia* bush so I grabbed onto it for support, but instead of support the branch just crumbled in my hand, and I fell downward over a rocky spot and pitched forward and landed face up on my back sliding down loose dirt in the gulch for a meter or two. My arm hurt some but I mostly seemed ok, so I got up and continued watching, and soon managed to observe an oviposition, and wrote the details down, but to record the time I looked for my watch and found it missing. So I had to go back and paw through the dirt where I landed, and luckily found my watch which had been ripped off my arm when I tumbled over the rocky spot. Swinging my net to catch butterflies hurt my arm, and I was getting tired of pursuing butterflies on steep slopes from morning to mid afternoon so I just drove home several hundred miles with my bum arm. It still hurt after a week when I used it, so I got it X-rayed and found that my arm had a non-displaced fracture, so I had to baby it without a cast for five more weeks. Anyway the female laid some eggs in a net over some potted grass and I managed to rear the butterfly through to pupae after three months, and did the same for *curicata*, and got nice photos. So what seemed like an ordinary butterfly *N. ridingsii* turned out to have amazing large surprises: a black ssp., a white ssp., an orange ssp., and a two-month-later ssp. that is sympatric with other ssp. for 500 miles, all discovered after George Austin wrote a large paper reporting that the species had only minor geographic variation. (I should have learned from that trip not to dangerously chase after butterflies, because a couple years later I stupidly chased after a common *Erynnis* and tripped over a tiny rock and landed on my knee and permanently wrecked it. Those are some of the triumphs and defeats encountered in lepidopterology.)

Interesting Butterfly Trips

When I was still a kid long ago, we decided to go to Mexico, so the whole family went, my folks and sisters and my grandmother. That was a nice trip, and we stopped for butterflies now and then, and I caught many of them and stored them in triangular paper envelopes in a wicker basket that I bought on the trip. Unfortunately it was in May, in the dry season in Mexico, and many of the butterflies were rather worn because they were in diapause awaiting the summer rains. In southern Mexico we found the butterfly *Baronia brevicornis* which is the only member of its subfamily. In NE Mexico we found some of the nice tropical rain forest butterflies, and in Sinaloa we found the giant white *Morpho polyphemus*. Even northern Mexico was interesting, where we found tiny Pygmy Blues etc. on arid sand dunes, and found the Mexican ssp. of *Limenitis archippus* on some Globe Willow trees at a motel. We had some misadventures too. On one butterfly stop my grandmother spotted some cactus fruits (called “tuna”) on the ubiquitous prickly pear cactus pads (“nopal”), and she grabbed one and started to eat it, and discovered all the little spines covering the cactus fruit. In Mexico City we didn’t pay to have a kid watch our car at a theatre, and were deceived by crooks and had to get another fuel pump installed to replace ours evidently clogged with sugar by those crooks, after hours of dealing with the crooks and the helpful tourist police. Then while sleeping in a motel one night, we heard a loud SPROING, which turned out to be a broken torsion bar on our Dodge sedan with big fins in back, and we had to get another torsion bar installed. The others went out in a boat and caught a big fish for supper, while I stayed behind with Montezuma’s Revenge. In Oaxaca we were surprised to get an incredible delicious five-course meal at an ordinary motel, while in Torreon we got a horrible meal with awful ‘mole’. A sister caught ordinary hepatitis.

Another interesting trip was to Montana and Alberta in 1966. Charles Remington was interested in documenting the meeting of prairie and Rocky Mts. Lepidoptera in one of his “suture zones”, so he had Douglas Ferguson organize a trip out west. So Douglas and I and another young collector collected moths at night (with black lights and white bed-sheets) and butterflies by day in the Crazy Mts. Montana for a month or so, then drove just E of Banff National Park in Alberta Canada and collected moths and butterflies in that area. In Montana we found very interesting butterflies, such as *Argynnis egleis albrighti* that has the underside bright green. And we had a gallon of fermented peaches sugar etc. that Dr. Ferguson had made, that we brushed onto some tree trunks, which lured hundreds of moths and about 200 *Polygonia* of four different species including *P. oreas*. In Alberta, Don Eff had supplied me with directions to good butterfly spots, which he got from the British butterfly collector Colin Wyatt, so we caught nearly all the butterflies in that area of Alberta. After long hikes we found many of the fabulous *Boloria alberta* butterfly, whose life history is still unknown. To go to Nigel Pass, we could have followed Colin Wyatt’s advice and hiked around the headwaters of the area through the forest, but a park ranger suggested we just ford a creek, so we did that. It turned out that we had to ford two creeks at their junction, each one knee-deep and about 20’ wide, which was scary because if we had fallen we might have been washed away and drowned. But we caught lots of butterflies that day, and had to ford both creeks again when we came back. Numerous moths and butterflies were found on that trip, now preserved in the Peabody Museum at Yale University. The others knew the identity of many moths, so they mostly collected the rare ones on the collecting sheet, while I often collected common ones too (maybe some of those were "sibling species" which they would have ignored). We had some interesting experiences. The other young fellow was driving his car through Montana when we drove fast over a little hill on the highway, and as we started down the other side suddenly a herd of sheep appeared and charged across the road. He screeched to a halt, but we heard a thump thump thump as one of the sheep rolled under the car. He was horrified, and buried his head and arms on the steering wheel in shock, expecting the worst. I got out to survey the damage, and looked under and around the car, and found—nothing. The sheep had run off, and that single sheep had evidently gone under the car and rolled three times, accounting for the three "thump" sounds, and then got up and ran off. The car was not damaged, but the poor sheep—wow he must have been awfully sore the next day; hopefully he survived. I don't give the driver's name here because he might not appreciate this story. In Alberta, one evening we drove around to find a good spot for the white sheet to hang to collect moths, by using the black [ultraviolet] lights and spare car battery to power them, and we found a good spot so we set up the apparatus and started collecting moths. {The car battery proved to be a bit leaky, and ate large holes in my parka.} But after a while, about four or five indians drove up, after spotting our white sheet in the dark night. They wondered what we were doing, because it turned out we were trespassing on their Kananaskis? indian reservation, so the end result was that we had to pay them $10 to collect there [today we have to call them Native Americans, in their First Nation land]. The moths in Alberta were uncommon, as it was too cold there at night, but they were very common in Montana.

Another interesting trip I made to Colombia many decades ago. That was a good and bad trip. The first day I was there a black guy in sneakers stole the camera off my back and ran off with it, and his small hispanic friends stole my bag, which some bystanders recovered. I found interesting butterflies on that trip, but the problem was that I had to take buses, which basically don't get into the best natural spots. One time I was at Popayan, and looked around and saw 6 fires burning at once; much of the habitat in the higher Andes is gone. I took the bus from the Andes to Mocoa, a six-hour trip along very steep Andean gorges, which was quite scary, and midway along the bus suddenly stopped and everyone started to nap. Evidently breakdowns must be a common occurrence, and the usual response is just to accept it and take a nap! I asked my seat-mate what had happened and he determined that a truck in front had trouble with its drive shaft and just parked hogging the road to await another shaft to be delivered. I looked at the truck, and in my poor spanish I managed to speak and draw how we could jack up the front of the truck and push it off the jacks to gradually move the truck to the side of the road so we could pass. So after the seat-mate was convinced, he recruited others who rounded up two tall jacks and after three or so pushes of the truck off the jacks it was securely positioned enough to the side of the road so we could pass, so everyone got in their dozen vehicles and went on our journeys up and down the scary road. In Colombia (and latin america) people don't seem to get upset much at breakdowns, they just nap while waiting for the problem to go away. Some people had been robbed on that road a week before. Mocoa had great Amazon Basin rain forest butterflies. I definitely didn't want to repeat taking that awful road back to the Andes, so I flew out of Puerto Asis instead. Some latin american countries can be dangerous for tourists; my parents were robbed at gunpoint near Puerto Vallarta Mexico while seeking butterflies and she lost her wedding ring. And Mexico now charges something like a thousand dollars to get a butterfly-collecting permit, so studying Latin American butterflies can be difficult.

One trip to the southern Sierra Nevada in California was memorable. We camped, and got up very early in the morning and hiked for about six hours to an alpine peak, and finally on the jagged rocky ridgetop we found the endemic *Hesperia* males raiting on the ridgetop boulders, but they flew as fast as I have ever seen a butterfly fly, so only with carefully creeping up to them and making herculean boulder-ricocheting swings could one be caught, but after hours I managed to catch plenty. Maybe it was my ambidextrous swings and my childhood expertise at the tetherball court that enabled me to catch them; my companion on the trip only managed to catch one. I managed to catch one female, but it failed to lay eggs; the early stages of that butterfly are still undiscovered.

One of my best trips was a six-day backpacking trip to the Alpine Zone in Wyoming. We hiked in for ~six hours, and found interesting butterflies on a talus slope, then found a newly-named *Boloria* colony, and over five days we found eleven colonies of that butterfly on just one ridge. Each day had good weather and we explored a different area, and managed to find two species of *Lycaena*, three species of tundra *Oeneis*, several species of *Erebia*, several species of *Boloria*, some *Argynnis*, 3-4 species of *Colias*, etc. That mountain range in Wyoming has the largest number of Alpine Zone species found in the lower U.S. At night we stared up at the stars from our sleeping bags, and were treated by the whitish trails of hundreds of meteorites streaking overhead.

I made many more memorable trips over the decades. One was to Kenya and Tanzania with one of Tom Emmel's butterfly tours, and we got to see butterflies, as well as almost all the large animals, some of which are now extirpated (we saw a live pangolin, one of five species of pangolin worldwide which are being exterminated by stupid people mostly in China who buy the scales thinking they have medicinal value). I was surprised to find *Lycaena phlaeas*—a Colorado butterfly--on the plains near Mt. Kenya. Most of my butterfly work has been in Colorado and vicinity, as my goal was to study as many species as I could, while spending a minimum amount of money. That strategy does work for people who study biology, because to search for eggs or caterpillars for instance, requires focusing on plants rather than chasing some desirable butterflies, so only when one gets tired of chasing exciting adults can one focus on the slower task of searching for eggs and caterpillars.

Pot Growers and Scientists

About 25 years ago I was studying butterflies in a gulch near Tinytown, behind a chain placed between two poles, when I heard a small gas-powered dirt motorcycle come up the old-road trail. I was behind some bushes where the rider could not see me, and noticed that he stopped the motorcycle and walked across the gulch and seemed to water a little plant on the other side of the tiny stream. I thought that was very odd, so as he left and motored on up the trail I managed to get a view of the license plate on his motorcycle and wrote it down. I inspected where he watered and discovered a small marijuana seedling; obviously he had planted marijuana up and down the gulch and was watering them for later harvest to support some kind of stoner habit. So, I pulled up the plant and laid it beside the hole to dry out, and wrote his license number on another sheet and placed it under a pebble where the plant had been. It would have been nice to see his expression when he next tried to water the pot plant and discovered his own license plate number, and feared imminent arrest.

Recently Colorado passed laws making it legal to grow and smoke marijuana, which does seem to have certain medical benefits, and the non-addictive hemp plant has many good uses. But one wonders how many people are damaged by the addictive attraction of marijuana to some people. I once knew a butterfly collector who was very eager and happily studied and published papers on butterflies, but every time I visited him his room reeked of marijuana smoke. Much later he quit work on butterflies and my only attempted contact with him—his phone number given to me by his father—reached a nonproductive phone answering system found in places such as a prison or sanitarium, so I never learned the exact nature of his decline. But drugs like that are being legalized now. Perhaps the major reason to legalize those kinds of drugs is to allow the countries to recover which have been destroyed by the drug trade—Mexico, Colombia, Bolivia, Myanmar, etc.—many whole countries that transfer illegal drugs to U.S. addicts.

One Really Stupid Cow

Hilltops in the foothills of the Front Range are great for butterflies, because many species mate-locate there, as males usually rait or sometimes flait there to wait for females to arrive on the hilltop for mating; they use hilltops as genetic rendezvous sites for males and females to meet. I was studying butterflies on an especially-nice hilltop a mile from the road up a nice gulch, and wandered down the NW slope of the hilltop, through some woods where females of *Argynnis* seemed to be congregating, then down onto a flat that had a tiny gully eroded across it. I heard some strange noise and investigated, and after several minutes of trying to locate the source I was surprised to see a cow in the little gully, moving strangely, so I took a look. The cow seemed to be hoofing and pushing forward into the slotlike gully to try to get out of it. I studied the remarkable situation, and concluded that the cow had wandered into the little gully for some reason, and moved north through it to get back to the main herd, but the gully narrowed gradually for 5-10 meters or so, until the cow got stopped by the narrow end of the gully only a couple feet wide. It was one of those erosion-type gullies one finds on the prairie that start suddenly and get deep as rainfall cascades into them from the virgin prairie sod all around and washes away erodible earth beneath; this gully was nearly 2m deep. Anyway the cow was panicked and was pawing with hoofs etc. and charging forward to try to get out, but the mini gully was too deep and narrow to get out of by going forward. I tried to scare her to back up and get out of the gully, but my yelling and flailing etc. failed to get her to back up. Meanwhile I heard the bleating of a calf in the main herd to the north, evidently from the calf of this stuck cow. After a while I gave up, and when I got home I called the local government agency and described exactly where the cow was in relation to the hilltop, and the lady on the phone seemed to properly record my information, and I told her that several people and maybe some straps etc. would be required to get the cow out of the tiny gully. I heard nothing about the situation from anyone, as nobody phoned about the cow. But a couple years later, I went back to that same exact spot, and found a couple cattle rib bones there. Unfortunately, the cow must have died trying to get out of the gully by only using forward effort, and her calf must have died of starvation.

That story is my most memorable animal story while collecting butterflies. Less memorable: I found the skull of a mountain lion in a gulch south of Canon City, but I have never seen a living mountain lion. I found a giant bull cattle dead in the Pine Ridge of Nebraska laying there with its tongue eaten off probably by coyotes, and nearby was a perfect bathtub formed by erosion in the sandstone at the bottom of a narrow gulch. And on top of the Wind River Mts. in Wyoming in a 6-day backpacking trip with another lepidopterist I found a dead horse next to a trail, so bloated that rocks bounced off his exterior. And I have found 50+ rattlesnakes over the years including two dens. I fried and ate one of them, which did taste good like chicken as people say, though the thought of it being a rattlesnake ruins the experience.

Centaur and *Notamblyscirtes*

I had studied the little skipper butterfly "*Amblyscirtes*" *simius* as part of my Ph.D. thesis research, which included a mark-release-recapture study, so I knew about its habits including adult movements and mate-locating behavior and flower feeding etc. I had tried to rear it then, but the eggs hatched and the tiny larvae refused to feed and eventually died. So I finally decided to look for larvae in the field, and deduced that because the 1st-stage larvae diapaused and evidently overwintered and adults fly in late June, the older larvae should be found in May. So I drove to a large shortgrass prairie N of Pueblo Colo., which looked perfect for the butterfly, and parked and (illegally) hopped the barbed-wire fence and walked to a nice place with some topography and prime shortgrass prairie and searched for larvae. Eureka!, a few hours staring down at the ground/plants resulted in successful discovery of *Chlosyne leanira fulvia* larvae on *Castilleja integra* and four *simius* larvae in leaf-rolled tubes formed in the grass *Bouteloua gracilis* base and into the sod beneath. While kneeling down to inspect a grass clump

I suddenly heard someone say "what are you doing?", and I was greatly startled and rose up with my big net and was shocked to see a horse and rider only about five feet away. The horse was startled by my standing up and raising my big net and it reared up on its hind legs a foot or two, but the cowboy rider was expert and quickly calmed the horse. I explained to him that I was looking for butterflies, and showed him my net and camera and one of the larvae I had found. He asked me if the truck parked over at the highway was mine and I said yes. He explained he rides the range of the very large ranch to check on the cattle, and was nice and did not tell me to leave when he could have. He then swiftly rode off to continue his inspection tour of the ranch, so I continued looking for larvae. Evidently he rode a fresh horse each day around the ranch, or probably he took turns with another rider or two to ride the range, as a complete circuit around that ranch may be 10 or 20 miles. The amazing thing to me is that the horse and rider rode so silently from afar toward me, crossing a little wash, without making the slightest sound; the rider was a young fellow maybe 20-30 or so, and the horse was a magnificent beast, and they seemingly merged as one creature swiftly and silently moving across the landscape in amazing perfection, as if they were linked with one brain and one body--like a centaur, that mythical combination of horse and human. That perfection of rider and horse was far from my experience with horses, which was riding horses a time or two at a for-pay horse stable when I was a kid, when the horse walked slowly away from the feed barn, then moved scarily fast back to the barn, making me afraid of horses. Anyway, I managed to find four mature larvae of *simius*, in silked-leaf tubes at the base of the grasses, and on one of them an orange Ichneumonid wasp was trying to crawl into the nest, before my presence? made her back out and fly away before I could catch her and make her a specimen. I reared some *simius* to adults, and found that the *simius* larvae and other stages are grossly different from real *Amblyscirtes* (for one thing, real *Amblyscirtes* have spectacular "dracula fangs" at the bottom of the older larval head to whack predators/parasitoids that invade the nest), so eventually I named the new genus *Notamblyscirtes* to include *simius*, and later named a new ssp. of the butterfly from Mexico and S Ariz. I will never forget that horse and rider, swiftly and silently moving across the ranch as one magnificent animal, far better than our modern machines that are cumbersome and noisy and spew out gases from their giant rear A-holes that are overheating our planet.

Disappearing Butterflies?

Some butterflies do seem to be disappearing, due to development, forest overgrowth, tropical forest clearing, global warming, and chemicals. This book mentions some of the butterflies that seem to be disappearing (including *Lethe*, *Neominois*, *Boloria selene*, etc.). The most shocking thing I have observed, is the decrease of moths in the Denver suburbs. In 1955 when parents bought my house, at night we would go out and numerous moths and other insects would fly around the light near the back door. Then decades later there were still some insects, but we could hear some of those electric bug zappers running several houses away. Now, when I go out the back door at night, there are almost NO moths or insects at all near the light. The Cecropia Moth was present in the 1950s but disappeared quickly. And the yard insects have been mostly replaced by foreign pests: the European Paper Wasp instead of the bigger Yellowjacket, the European earwig, the Japanese Beetle, the common European Isopod, etc.

Gardening for Food

Colorado is not a good place for a food garden either. Denver gets only 15" rain per year, the growing season is only about 5 months May-Sept. between damaging frosts, and hail damage is the worst of any state. The soils are often horrible clay. But my parents and I gardened for more than 60 years, so we learned the crops that grow best. Swiss chard grows great and is frost hardy because it is biennial. When you plant it you must cover it with bird netting or the House Sparrows will eat most of the little sprouts. Cut off and harvest everything on the chard 1" above ground and you can get three or four crops of chard per year (heat it in large pans with a bit of water until it "melts", then freeze it). Harvest only first-year chard because 2nd–year chard has small leaves and goes to seed. Spinach doesn't grow very well and bolts quickly in spring, and doesn't grow much better in fall. Leaf mustard grows fairly well in fall, but it bolts too quickly in spring. Greencrop (bush) green beans grow very well and freeze well. Plant ~six rows of those green beans, then several hills of Butternut squash, then more rows of green beans, etc.; the squash vines will grow into the beans, and the beans will be harvested by early August when the squash will take over the whole area, so you can get two crops in the same area (this is similar to what the native americans did, as they grew small-corn and Anasazi beans [like Pinto beans] and squash together). {Banana squash grows well too [it is basically a giant elliptical Butternut Squash]--once I grew a 35 lb. squash 1m up on a lilac bush—but they are so big that few people know what they are, making them difficult to sell or donate.} Don't plant acorn squash, the seeds don't sprout well. Zucchini grows great in Colo. Carrots grow well, as does parsnips (parsnips taste fairly good and take only 10 minutes to cook in a little water). Small tomatoes such as Large Red Cherry tomatoes and Yellow Pear tomatoes are best to grow, because you will be guaranteed to get many ripe tomatoes—the large tomato varieties often produce only a bunch of large green tomatoes because the first frost kills the vines before you get many ripe ones (you must cover your tomatoes and squash and other frost-sensitive plants with blankets or they freeze sometime in Sept. or Oct. in the first hard freeze). Eggplant grows fairly well—small ones anyway—but freezes. Chilis such as jalapenos grow okay, we could grow small ones anyway. Cabbages didn't grow large for me, one would have to buy cabbage plants or start them indoors from seed to get good-sized cabbages. Spices don't grow very well, except for dill and oregano (oregano spreads and grows well, but I don't like it because it seems to annihilate the flavor of everything it is placed into). I like basil but it grows slowly and quickly freezes. Garlic grows well, just plant cloves from the grocery store, and they seem to multiply in your garden (though not as large) and are hard to kill even if you try. Radishes grow poorly, we got few and most had just linear roots with superhot flavor, so the store radishes are better and cheaper. Broccoli grew poorly and produced mostly aphids. Rhubarb grows well in Colo., and the plants can last for 50 years or more; the only problem is that one must dump a cup of sugar into every rhubarb sauce or pie, which is unhealthy now that sugar and white flour are atop the evil foods list. I grew corn a couple years, which grew okay (grow the large-eared kinds, not the small-eared), but one must have an electric fence to keep out the raccoons or they will eat most of your ears (my uncle in Ohio would take his shotgun out to the corn patch at night to deal with raccoons), and corn takes too much water if you sprinkle overhead. Concord Grapes and some other grapes grow well, on chain link fences etc. where people don't water them much, but raccoons raid them.

The Old Name Sewer, and Solutions

People are often intimidated by scientific names, so they use common names instead. That works for birds, which have common names that are generally accepted. Butterfly common names aren't standardized as well, so scientists and the scientific amateurs use scientific names. All scientific names use the latin alphabet. The scientific name of a species of butterfly consists of a capitalized genus name, and an uncapitalized species name, and often an uncapitalized subspecies name, all of them italicized in print. Those names can be followed by the name of the person who named the last name (either the species or subspecies) (for instance *Oeneis calais altacordillera* Scott). Other scientific names are used for the superfamily, family, subfamily, and tribe (those names are capitalized and end in -oidea, -idae, -inae, -ini).

Scientific names are regulated by the latest 4th edition of the Code of Zoological Nomenclature, published by the International Commission of Zoological Nomenclature. Unfortunately, despite that Code there are still problems with scientific names (I detailed many in Scott, J. A. 2014. Problems with the ICZN Code of Zoological Nomenclature, and some solutions. Papilio (New Series) #22:69-73.).

People think that scientific names usefully describe the species or its habitat. Unfortunately, they usually don't. Many scientific names are the name of someone's colleague, or the name of the describer's wife or daughter or friend etc., usually named to "honor" someone very few people have heard of. A scientific name that is someone's name is called a patronym. I do not like patronyms, because I think a scientific name should describe some distinctive feature of the butterfly or its habitat etc. Patronyms are very common, even though we usually don't know or care who those people are. Sometimes someone will name a butterfly after the person who collected the specimens, as an incentive for the collector to send more specimens, or name it after the person who gave him money to collect or study the butterflies. That happens a lot. On the sleazier side, someone may collect a species and want to have it named after himself, so he gives some specimens and information to someone else in exchange for having it named after him. That actually happened.

Even worse are names that are gross errors, names that are inappropriate or misleading. Among the worst is *Plebejus lupini*, a blue butterfly that does not visit lupine flowers for nectar, and its caterpillars do not eat lupine plants. Unfortunately the ICZN Code requires that we must use that phony name forever, because the Code has no way to fix it. I personally am a scientist, and science is the pursuit of truth, not the perpetuation of lies, so I think we should use a principle called the **lapsus contrarius**, by attaching a prefix a- or anti- or a suffix –anti or –no or –non or –un, which negates its inappropriateness. For the name *lupini*, when I invented the lapsus contrarius I renamed it *alupini*, by adding the prefix a-, which works for me, although it is not acceptable by that ICZN Code. But ideally a lapsus contrarius should use a suffix rather than a prefix, so that the new corrected name would be indexed the same place as the old erroneous name, to minimize confusion. So the name could be *lupinanti*, or *lupinon*, or *lupino*, which would be indexed next to *lupini*.

Scientific names must use latin letters, because the Swedish man Karl Linne (Carolus Linnaeus in latin) used latin (he started the current naming system in 1758 in his Systema Naturae 10th edition), and the hundreds of kinds of letters used in many of the world's languages would be too confusing if any kind of letters were permitted to be used. But the Code got a little too particular about making names latinized, by specifying dozens of pages of rules regarding the the spelling and latinization of names. Those detailed rules are annoying, because most people do not know latin, and some people change the spelling by trying to latinize it. One very annoying rule in the Code requires that species and subspecies names must have the same gender as the genus name (the ending –us is usually considered to be masculine, and –a feminine, for instance), so some people change the endings of those names, resulting in different spellings. That rule causes problems, because English speakers do not consider their words to be masculine or feminine as other languages such as Spanish and German do, so that requirement is peculiar and onerous for english speakers, the most common language. And if a species is transferred from one genus to another, it is a nuisance to change the spelling of the species from masculine to feminine or vice-versa. Even worse, when people invent names to describe a species or genus, they usually do not say whether it is masculine or feminine (the names I invent were merely invented to sound good and be appropriate, and I do not assign a sex to any of them), so some people will change the species name to match the sex they think it is, when the author actually gave it no sex. So one of the latest checklists (the J. Pelham checklist) now ignores that rule and lists the original spelling of names, and not the latinized (sex-changed) spelling.

Sometimes there is trouble spelling people's names. For instance, James McDunnough spelled his name thus but some people argue that the ICZN rules require the butterfly to be named *macdunnoughi* by converting all the mc- prefixes to mac-, but I use another rule that states that the prevailing (most common in scientific papers) spelling should be used, so it should be spelled *mcdunnoughi* after all, because most people spelled it the way the famous Dr. McDunnough did. Another annoying feature of the latinized system of names is that some names are allowed to have –ii at the end, and some are –i, even though it's hard to remember which is which, and it's a bother to keep looking them up. All the –ii names should be changed to –i.

The worst feature of ICZN nomenclature is the Principle of Priority. That principle happened about the time people started giving single or double names to animals and plants, for convenience rather than having to describe the critter every time you wrote about it. Linnaeus gave each critter two names—genus and species—and people liked that, so eventually it was decided that one of his publications of names—the 10th edition of Systema Naturae in 1758--would be the start of official ICZN nomenclature. That all sounds good. Unfortunately, it turned out badly, because <u>the principle of priority is the springboard into the Old Name Sewer</u>. It places a huge burden on taxonomists and supporting systems including their publications and journals, libraries, and butterfly collections. The principle of priority means that the first-published name of a species or genus is the name that must be used, not the best name, and any younger names for that species or genus are called synonyms and must not be used. This started a rush to describe new species, as many people wanted to be the first to name a species, so often the species would be named from just a few crummy specimens with vague localities. Along the way, "type" specimens became popular to use. A "type" is a single specimen or specimens on which the species was based. Eventually many different kinds of types were developed (holotype, paratype, syntype, lectotype, paralectotype, neotype, and topotype are the kinds often used today). The holotype is a single specimen on which a species or subspecies is based at the time of first naming using ICZN rules. (The type representing a genus is merely called the type species.) Old names were often named in skimpy lousy papers written 200-100 or more years ago, meaning that taxonomists are required to spend time and money to look up those names in expensive distant libraries, and find old "type" specimens in expensive museums. The libraries must spend money to store old publications containing those old names. Museums must spend money to store the old type specimens and pay to keep pests such as dermestid beetles from destroying those types. Old publications are often difficult to obtain or are very expensive, and are usually of bad scientific quality. Old specimens are often damaged or mislabeled or lack useful localities or are unidentifiable or lost, causing problems and disagreements. In all other sciences, old bad work is simply forgotten. But the principle of priority forces taxonomists to dive into what I call the Old Name Sewer to study the oldest names, which generally involve the worst publications and the worst specimens. Ironically, the worst cases involve old type specimens that still exist in a collection but lack good localities or are the unidentifiable sex or are damaged by loss of critical parts (maybe those were eaten by dermestid beetles) etc. so are unidentifiable. If the original type is lost or destroyed, a taxonomist can pick out a new specimen, and designate it a "neotype" specimen to solve the problem of the identity of that species. An inadequate existing type specimen is the worst thing that can happen, because then the taxonomist nowadays could spend a large amount of money to sequence the DNA of that type and hundreds of others to perhaps determine where that type might have been collected (maybe it came from the middle of a cline, causing horrible problems), and the taxonomist must write up a "petition" to the ICZN to ask that the old bad type be ignored and a new specimen "neotype" be accepted as the proper representative of that species. That petition may take a lot of time and expense to write, even months and thousands of dollars. The *Hesperia* petition took me more than three months to write and rewrite, while burdening other authors who helped, and along the way I wrote two other associated papers (one detailing Theodore Mead's Colorado butterflies based on computerizing the papers and Mead's journal and other records from numerous sources; the second detailing Ernest Oslar's frequently mislabeled specimens), so the total time was maybe six months, as I waded through the Old Name Sewer, basically dealing with gross incompetence on everything everywhere all the time. All thanks to the principle of priority. The idealistic goal of improving the naming of animals and plants should be to repeal the principle of priority. Unfortunately, that will probably not happen, not soon anyway, because so many people in the ICZN wish to retain the power that they currently have over these names and the designation of neotypes.

Naming subspecies involved in clines is difficult because of the principle of priority. A cline should have at most two names, one for each end of the cline. Trouble arises if there are three names in the cline and the two oldest names are not at the two ends. I like to cite the case of three *Plebejus saepiolus* subspecies, *aehaja*, *hilda*, and *aureolus*, all three names used for a cline of brown to increasingly-blue females from the Sierra Nevada of Calif. to mts. near Los Angeles. *P. s. aehaja* has brown females, *P. s. hilda* partly-blue females, and *P. s. aureolus* the bluest females, yet the name *hilda* is older than *aureolus*, so to reduce three names to two and satisfy the principle of priority we must synonymize the newer name *aureolus* to *hilda*, a process I call "jumping subspecies', as the middle name *hilda* jumps the end name *aureolus* and gets crowned queen *hilda* in a game of nomenclatural checkers. Then the "pretend type locality" of *hilda* becomes the TL of the end name *aureolus*. Ideally, there should be a new article in the Code allowing taxonomists to designate a **<u>clinotype</u>**, a type specimen from the end of a cline which would retain the same name as the older name in the middle of the cline but would move the type locality to the end of the cline to enable the cline to be properly named with just two names.

There is a simple way to fix the ICZN Code to make it much easier to deal with old bad names. The solution is **<u>redefining the name-bearing type</u>**, by changing one rule in the ICZN Code: Article 72.1.2 should be amended to read as follows:

Article 72.1.2. name-bearing types: specimens with a name-bearing function, whether fixed originally (holotype [Art. 73.1] or syntypes [Art. 73.2]) or fixed subsequently (lectotype [Art. 74] or neotype [Art. 75]). After [year of publication by ICZN of this new article], the name-bearing type must possess traits and associated information that adequately define the taxon and distinguish it from other taxa, and any time that the existing name-bearing type is found to fail to adequately define the taxon, that type becomes invalid and must be replaced by a neotype physical <u>specimen</u> (or representation) with adequate traditional morphological/locality etc. information, or by a neotype DNA-sequence <u>specigen</u> (DNA type specimen) that adequately defines the taxon (and any time that an existing name-bearing type specigen is found to be too short to adequately define the taxon, a new neotype larger specigen must be designated to adequately define it).

This improved article 72 will make it easy for taxonomists to fix old bad names, and also brings the ICZN code into the modern age by allowing for DNA type specimens, as the specigen can replace the inadequate type if DNA better defines the taxon. I submitted a paper detailing this replaced article to Science magazine, where it is now published as a letter (attached to the article Hibbett, D. 2016. The invisible dimension of fungal diversity. *Science* 351: 1150-1151). I also submitted a similar paper to the ICZN, but a commissioner reviewing that paper expressed the view that the commissioners who decide taxonomic matters within the ICZN are now not willing to give up their exclusive ability to designate neotypes for inadequate existing types. So it will evidently take many more years to bring the ICZN Code into the modern age.

The time and money involved working in the Old Name Sewer can be so great that human lives are greatly changed. Some work in the Old Name Sewer is necessary for taxonomic work. But it can become an addiction, causing people to give up collecting and studying the biology of creatures in nature, and instead do library work and study types in museums. Perhaps we could call that kind of addiction **<u>onsa</u>** (for Old Name Sewer Addiction). Colorado has an example. F. Martin Brown collected butterflies a lot, and did taxonomic work and published a book on Colorado butterflies in 1957 that lepidopterists appreciate. But as an older man, he spent about 40 years mainly working on old names and the history involving those names. He got a U.S. Government grant to work on the type specimens of William Henry Edwards, a very sloppy person who threw away most of the data on his specimens and failed to label many specimens in a series and failed to place "type" labels on his type specimens and often mixed up the identities of species (in his worst mistake, Edwards received a specimen from the Philippines from his brother and labeled and named it a new species *Hesperia mingo* wrongly stated to be from West Virginia) and made numerous other mistakes, so eventually

Brown spent 24 years and considerable federal grant $ to produce a 10-cm stack of 14 publications published 1964-1987 to make some sense of the types of the hundreds of butterfly names established and poorly labeled and confused by Edwards. And Brown published approximately another 10cm stack of papers on other people's old names and on historical butterfly expeditions etc. Several older men today also seem to suffer from onsa. Of course the people who do this work do not consider it to be an addiction; and older people may be physically unable to hike around in nature because of bad knees etc. so they do the work they are still able to do; and it is necessary to work in the Old Name Sewer because of the principle of priority; but biologists suggest that all that time and expense would be better spent on scientific studies of the biology and diversity of our butterflies, and geneticists like to insult taxonomists as "typological" and they think genetics/DNA is the proper way to do systematics.

The shocking conclusion: all that time and money, and onsa, is caused by the principle of priority. We should not be forced to spend so much time and money just on scientific names.

If the principle of priority were eliminated, some chaos would ensue, as people would get rid of inappropriate names, and dubious names would be discarded and better names used, and new names would be proposed to replace names based on dubious types, but that chaos would settle down, and the result would be better names. The current system also has chaos, due to differing opinions on the interpretation of the Code (which is not well written in places), differing opinions on the identity of type specimens caused by bad descriptions or mislabeled or damaged or wrong-sex or lost type specimens, or names proposed in the middle of a cline, etc. One thing we learn about human nature is that there are numerous squabblers, all arguing about almost everything. There would be a lot of squabbling about some names, just like we have now, but eventually merit would resolve most disputes.

Appendix 1. Butterflies at or near my House in Lakewood, 5400', Jefferson Co. Colorado, 1959-2019.

This list details the butterflies found in the yard of my house or the nearby neighborhood. My house is in a typical American metropolitan suburb (of Denver), with ranch houses and yards with an abundance of mostly-cultivated perennials and annuals and lawns and weeds, and a few grassy parks. The house was built in 1955, and in the early years some butterflies were found especially along a tiny creek that later disappeared as its habitat was converted to houses, while in later years some butterflies were added as they moved into the state or their larvae fed on plants that became common in the suburb. These butterfly records offer good evidence about how far some of the butterfly species stray, because some species that normally occur only in the mountains were found as just one or a few adults that had to fly in from rather far away (about 7 miles from the foothills for some species, or nearly 4 miles away from Green Mountain which has many foothills species).

Epargyreus clarus clarus common resident.
Pholisora catullus catullus occasional resident, recorded 5+ times May 10-Oct. 17.
Erynnis funeralis rare migrant, found 22vii01, 2viii2019 very fresh, both alfalfa fields.
Burnsius (*Pyrgus*) *communis communis* abundant resident.
Piruna pirus uncommon resident mostly along nearby McIntyre Gulch.
Atalopedes campestris campestris common starting 3 records in 1963, to present; flies May 24-Oct. 20 esp. late summer.
Hesperia juba only two records, resident early 21viii62 1f, 15ix62 1f, before growing housing development, no longer present.
Polites themistocles themistocles common resident.
Polites peckius surllano common resident.

Polites mystic dacotah on little creek at BalsamXBayaud streets 1962-1966, later developed, in 1966 found along McIntyre Gulch, in 1984 in wet field at AlamedaXGarrison, no longer found.
Hylephila phyleus phyleus 1f migrant 9viii92.
Poanes taxiles common resident.
Ochlodes sylvanoides napa found 3+ times in 1986-1987 including in back yard, a stray from foothills 4+ miles.
Papilio cresphontes ssp. (*cresphontes* or *rumiko*) rare migrant, female back yard flew N ~1.5m up to *Clematis jackmanii* flower 26vi10, another flew S straight and fast through yard 6 feet up 19viii15.
Papilio eurymedon rare stray from foothills 7 miles, a back yard male 26vi10.
Papilio glaucus glaucus one rare large summer form male (unh marginal spots all red, valva prong forked), on *Echinacea purpurea* 24vii15 back yard.
Papilio glaucus rutulus common resident found dozens of times, but much less common than *P. multicaudata*.
Papilio multicaudata multicaudata common resident.
Papilio zelicaon 3 rare strays from Green Mtn. or foothills in 1963 18v, 7vi, 24vi.
Papilio polyxenes polyxenes not very common resident.
Colias eurytheme common resident.
Colias philodice eriphyle common resident.
Kricogonia lyside rare stray from near Mexico 7vii12.
Phoebis sennae sennae rare stray from near Mexico 1x05, 14x17.
Phoebis agarithe agarithe rare stray from near Mexico 13ix71.
Eurema nicippe stray from New Mexico 14+ times May 5-July 22.
Eurema mexicana mexicana rare stray from New Mexico 30v61, 21vi65.
Nathalis iole rare stray from southward, recorded June 21 to Oct. 25.
Pieris rapae common resident.
Pontia callidice occidentalis rare stray from Green Mtn. 4 miles away 19&28vii05.
Pontia protodice common resident (migrates in nearly every year).
Libythea carinenta larvata 1male rare migrant 3ix60, one rare migrant 31vii71 Michael Young.
Danaus plexippus plexippus uncommon resident (common 1960-1962, now several seen/year).
Danaus gilippus thersippus rare stray from southward 6+ times (including at house) from 1vii to 16x.
Cercyonis pegala nephele uncommon resident in moist areas, last one seen 1988.
Coenonympha tullia ochracea 1 male back yard 15vi2020
Neominois ridingsii ridingsii 1 on grass at E gate of Federal Center 1vii64, no longer present.
Limenitis archippus archippus rare resident 19v62, 22viii64, 6ix64, not seen later.
Limenitis weidemeyerii weidemeyerii common until late 1960s, seldom seen later but found 3-6viii14.
Dione vanillae incarnata rare stray from near Mexico seen over roof of house 8viii87.
Euptoieta claudia common resident (migrates in about every year).
Argynnis aphrodite whitehousei strays from foothills 4-7 mi. away, 11+ records 6vii-18ix, 2f found at house Aug. 17-26 in 2019 suggests maybe breeding on cultivated *Viola*?
Argynnis edwardsii uncommon resident with a dozen+ records, perhaps eats lawn *Viola ~odorata*, found 30v-11ix.
Argynnis hesperis hesperis rare stray from foothills 7 miles away, 3 records including back yard 21viii97 & 12-13viii17 & 3vii19.
Asterocampa celtis jeffermont common on *Celtis occidentalis* through 1964 incl. back yard, uncommon through 1981 (11viii1988 on Federal Center), absent later.
Vanessa cardui cardui common migrant many or most years.
Vanessa virginiensis rare stray, including June-Sept.-Oct. 6
Vanessa carye annabella rare stray found 8+ times, records 30v & 18vii-13x.
Vanessa atalanta rubria occasional stray, found mostly 13iv-24v seldom 13ix.

Nymphalis antiopa uncommon resident mostly found in spring incl. L March, M July, and Oct-M Dec.
Aglais milberti uncommon resident found mostly L March-M May, M June-M July, seldom L Oct.
Polygonia interrogationis rare stray from southward 14ix63, 22ix72, 22x90.
Polygonia gracilis zephyrus rare stray from 4+ miles away in foothills, 6+ records L March-April and E Aug.-M Oct.
Polygonia satyrus satyrus uncommon resident, 10+ records May-M June and L July.
Junonia coenia rare stray from New Mex., 6+ records 17viii19, 17-19ix19, 1ix87, 22-24ix13, 5xi16, 17ix19.
Chlosyne gorgone resident through 1962, found 31viii65, now rare stray.
Phyciodes (*Anthanassa*) *texana texana* rare stray from New Mex., back yard 4vii81.
Phyciodes pulchella camillus fairly common through ~ 1966, seldom found later ~6+ times including 2010, found May7-M June and L Aug.
Phyciodes tharos orantain uncommon resident found 4+ times from 1960-2010, May and L July.
Lycaena helloides helloides common from 1960-1962 (it flew May 10-13-16-19-30, June 4-6-7-8-10-11-12-13-14, July 10-11-12-13-14-17-23-28-30, Aug.9-17-30-31, Sept. 3-4-8-9-15, Oct.2,9,15) at a tiny creek before houses and Balsam Pond were built at Balsam X 1st Ave. before 1980, neotype *helloides* is from this site, habitat now under houses.
Lycaena hyllus at same tiny creek 1960-62 now under houses, in moist meadow 30vi84, probably now absent, 8+ records M-L June & July-E Aug.
Lycaena dione 14+ records at same tiny creek 1961-65 now under houses, and 1970-1971 &1984-1988 in moist meadow remnants, records June-E Aug. (mostly July), now evidently absent
Satyrium liparops aliparops uncommon/common assoc. *Prunus virginiana* var. *melanocarpa* in McIntyre Gulch at Creighton Junior High School 14+ records there from 1961 to 1977, L June-M July, now probably absent.
Satyrium calanus falacer one found 9vii77 in McIntyre Gulch at Creighton Jr. High (no *Quercus*, hostplant evidently *Prunus virginiana var. melanocarpa*).
Satyrium acadica common 14vii84 on *Salix exigua* on Federal Center and adjacent 6th Ave. fence (perhaps still there) and one found then Alameda X Garland St.
Callophrys gryneus siva females back yard 6vi60 & 14vi84, and once along Bayaud St. *Juniperus* (now gone) probably now absent.
Strymon melinus melinus uncommon resident, several dozen records.
Leptotes marina back yard 6x63, 6-9vii16, occasional strays from southward that reproduce locally.
Hemiargus isola somewhat migratory, usually uncommon but many records, host back yard *Trifolium repens.*
Celastrina neglecta? female flying over my garden beans 27-28vii14.
Cupido comyntas comyntas one 1ix60, a rare ?resident evidently no longer found.
Glaucopsyche lygdamus oro McIntyre Gulch April-May 1962 & 24v91 & 12v93, no longer present.
Plebejus melissa melissa evidently resident 22vii60 & 10vii61, but strays from as far as ?Green Mtn. 4 miles to back yard 5vii11 & 3viii17.
Plebejus icarioides lycea one stray evidently 4 miles from Green Mtn. 25vii60.
*Plebejus saepiolus saepiolus*X*gertschi* female in back yard a stray 4 miles from Green Mtn. 7vi60.
Plebejus alupini texanus near house 10v62 & 26vii60 & 28vii61, a stray 13x05 N of house 1 km from next record of one found at Addenbrooke Park on tiny prairie remnant on *Eriogonum effusum* ~2010.

Appendix 2. Butterflies of Green Mountain, Jefferson Co. Colorado, 1959-2017

Green Mountain is a lone domelike plains mountain 6855' about 2.4X2.4 miles in size just east of the hogback that marks the eastern edge of the regular Front Range. It is now included in Hayden

Park, as one of the parks in Jefferson County Open Space. It is mostly prairie, but has several *Pinus ponderosa* on the west side and much *Cercocarpus montanus* chaparral. It has several very tiny springs in the gulches draining the mountain, but is mostly dry, though north-facing slopes near the top offer a few cooler/moister areas to support some foothills butterflies. Yet it has a rather full fauna of butterflies, including most of the species in the foothills and most of the plains butterflies, though many of them are scarce or just strays. Houses have destroyed most of the short-grass prairie that was just S, E, and N of the mtn.

Epargyreus clarus clarus fairly common resident.
Cecropterus "*Thorybes*" *mexicana mexicana* rare stray from foothills 7vi85.
Cecropterus "*Thorybes*" *pylades pylades* uncommon resident 8+ records 1980-1993 mostly SW part May-E June.
Pholisora catullus catullus fairly common at times, usually scarce, a dozen records L April-E June and M July-E Aug.
Erynnis brizo burgessi rare stray at least ½ km from foothills (no *Quercus* present) 26iv81 & 19vi85.
Erynnis martialis uncommon perhaps strays 7vi85, 10viii89, possibly no longer present.
Erynnis afranius uncommon resident but 14+ records L Apr.-M May & M July-E Aug.
Erynnis persius common resident.
Erynnis horatius rare stray at least ½ km from foothills (no *Quercus* present) 3viii85, 1ix87.
Burnsius (*Pyrgus*) *communis communis* common resident.
Pyrgus scriptura uncommon in SW valley bottoms 1972-1978 M July-E Aug., now absent due to houses covering most of the prairie.
Piruna pirus uncommon resident ~6 records, once June 7, others E-M July.
Oarisma garita common resident mostly M June-M July.
Amblyscirtes oslari common resident, mostly L May-E July.
Amblyscirtes vialis rare, surely stray at least several miles from foothills, one found at stream NE side 3vi86.
Amblyscirtes phylace uncommon resident in coolest area but 13+ records L May-June.
Atalopedes campestris campestris rare, 3 records of strays end Aug.-Sept., surely common now near houses & green lawns in L Summer.
Hesperia uncas uncas common resident, 14+ records. end May-June & M July-M Aug.
Hesperia juba uncommon resident 11+ records M May-M June and M Aug.-E Oct.
Hesperia comma ochracea common resident Aug.-Sept. rarely E Oct.
Hesperia pahaska pahaska uncommon resident but a dozen+ records June-E July.
Hesperia viridis uncommon resident but only in 1972 4 records June-E July, none found other years.
Hesperia leonardus pawnee common resident. M Aug.-Sept. rarely E Oct.
Polites peckius surllano common resident starting 1971.
Polites themistocles themistocles fairly-common resident.
Polites mystic dacotah uncommon resident in grassy swales, 7 records 1973-1985, M June-M July, perhaps no longer present.
Polites origenes rhena uncommon resident 11+ records M June-M July.
Atrytone arogos iowa uncommon resident 7+ records July.
Poanes taxiles common resident.
Ochlodes sylvanoides napa scarce evidently stray 1 km from foothills 6+ records mostly M-L Aug.
Anatrytone logan lagus present L June-M July one year 1972, one record 15vii73, absent later.
Euphyes vestris kiowah common resident June-E July.
Parnassius smintheus smintheus resident NW end of Mtn. 10+ records June-E July 1972-1997, perhaps still present.

Papilio machaon bairdii form *brucei* rare resident in larger region including foothills, only one record 21vi88.
Papilio zelicaon common resident (f. *nitra* ~5% of population) mostly on hilltops.
Papilio polyxenes polyxenes common resident, (f. pseudoamericus rare 1ix87); (*Papilio polyxenes* X *P. machaon bairdii* f. *bairdii* male 12vii90).
Papilio indra indra scarce stray 1 km from foothills, 4 records mostly on rockslide W of summit M May-June 1977-1980 (5 found one day so briefly breeding), none seen since.
Papilio multicaudata multicaudata common resident (one male flew across top of Mtn.).
Nathalis iole uncommon migrant.
Zerene cesonia cesonia. Rare migrant 27vi91.
Colias edwardsii altiplano uncommon resident 16+ records M May-L June and M Aug.-L Sept., from 1968-1993, perhaps still present.
Colias eurytheme common resident.
Colias philodice eriphyle common resident.
Phoebis agarithe agarithe rare stray from near Mexico 1ix71.
Euchloe ausonides coloradensis uncommon resident mostly May.
Euchloe olympia moderately common resident L Apr.-M June.
Pieris rapae resident in lower valleys.
Pontia callidice occidentalis uncommon resident 14+ records M May-M June, July 16, M Aug.-E Oct.
Pontia protodice common immigrant most years.
Pontia sisymbrii elivata evidently resident, 7 records L April-E June from 1980-1989, perhaps no longer present.
Danaus plexippus plexippus uncommon migrant.
Danaus gilippus thersippus two rare migrants 14ix71 & 14ix92.
Coenonympha tullia ochracea common resident mostly L May-E July.
Cercyonis pegala nephele common resident.
Neominois ridingsii ridingsii uncommon 10+ records L May-June 1972-1989, absent by 2014.
Oeneis uhleri uhleri one rare stray male from the foothills 1 km away Apr 28, 1962.
Limenitis weidemeyerii weidemeyerii somewhat common resident, male flying over mountaintop 15vi85 and was fairly common that year, 15vi to 5ix.
Euptoieta claudia common migrant about every year.
Argynnis aphrodite whitehousei common resident, 8+ records 1vi to 17ix.
Argynnis callippe meadii uncommon occasional resident from 1980 to 1988 only (9+ records June 3-21 in those years).
Argynnis coronis halcyone rare stray from foothills, common 4vi60, one 26ix85.
Argynnis edwardsii common resident, a dozen+ records June-M Sept.
Asterocampa celtis jeffermont rare stray from foothills 7-11-12vii72, 10viii78, 13ix83.
Vanessa virginiensis occasionally found, evidently mostly immigrants, 8+ records, most often later in season.
Vanessa cardui cardui common migrant most years.
Vanessa carye annabella rare stray, 6+ records, one 13v86, the rest Sept.-E Oct.
Vanessa atalanta rubria occasional migrant or stray, M May-Sept.
Aglais milberti uncommon resident in spring, L Apr.-M June, probably overwinters.
Nymphalis californica timidar rare stray from foothills 26iv81 (2 seen) & 27iv88.
Nymphalis antiopa common resident in gullies.
Polygonia satyrus satyrus rare resident 1v88, 31v94, 12vii60.
Polygonia gracilis zephyrus frequent resident.
Euphydryas anicia capella occasional resident, 5 records M-L June.
Poladryas minuta arachne common resident, incl. M June, M Aug.-E Sept.

Chlosyne leanira fulvia rare one larva found 12viii77.
Chlosyne gorgone common resident.
Phyciodes pallida pallida rare stray from foothills 24vi72.
Phyciodes tharos orantain occasional esp. flats to SW now under houses, incl. 26ix88.
Phyciodes cocyta selenis one rare stray 1 km from foothills 8vi85.
Phyciodes pulchella camillus common resident May-Sept.
Lycaena helloides helloides one record 7vi85 (a stray ~1 km because there is too little moist valley bottom habitat).
Lycaena heteronea gravenotata strays 1 km from foothills 19vi94, 26vi93, 17vii73, but probably sometimes breeding.
Lycaena dione uncommon resident 6+ records 1972-1984, end June-M July, perhaps no longer present.
Satyrium behrii crossi common resident mostly L June-M July.
Satyrium liparops aliparops common 6-7-11-12vii72 in a SW gulch near the *Prunus virginiana* var. *melanocarpa* host, 17vii73, 16vii84, now either rare or absent.
Satyrium calanus falacer one probable stray from foothills? found in gulch 16vii84 (usual host *Quercus* is absent, but Colo. *falacer* evidently also eat *Prunus*).
*Satyrium titus immaculosus*X*watsoni* common resident L June-E Sept.
Callophrys dumetorum homoperplexa uncommon resident mostly M May-E July.
Callophrys sheridanii sheridanii uncommon resident, near *Eriogonum umbellatum*, L March-M May.
Callophrys gryneus siva stray from the foothills 1 km away, found once 8vi85
Callophrys spinetorum one rare stray of many km from higher mts. 22vi89
Callophrys mossii schryveri sometimes common resident, found 16v73 common, 26iv81 common, 27iv88, 2v89, perhaps now absent.
Strymon melinus melinus common resident L April-Sept.
Leptotes marina rare stray from southward, found 11vii72, 17ix86 at least.
Cupido comyntas comyntas rare, male 20ix77, male northern gulch 20ix88.
Cupido amyntula valeriae common resident in gulches, 13+ records mostly end April-E June. Perhaps the second partial generation is missing here because Green Mtn. often dries out in summer.
Hemiargus isola common stray from southward.
Euphilotes ancilla barnesi common resident L May-June.
Glaucopsyche piasus daunia uncommon resident, 9+ records mostly June (sometimes E July).
Glaucopsyche lygdamus oro common resident.
Plebejus melissa melissa common resident.
*Plebejus saepiolus saepiolus*X*gertschi =whitmeri* fairly common resident in highest gulch and just N highest point 3vi80, 7vii84, 7vi85, 22vi89, 31v94, perhaps no longer present.
Plebejus icarioides lycea common resident, M May-M July.
Plebejus alupini texanus common resident L April-E Oct.
Possible other species that may stray in: *Erynnis funeralis*, *pacuvius pacuvius*, *telemachus*, *Papilio glaucus rutulus*, *Eurema nicippe*, *Eurema mexicana mexicana*, *Libythea carinenta larvata*, *Cercyonis oetus charon* a possible stray, *Argynnis hesperis hesperis* probably an occasional stray as it strays farther east in Lakewood, *Lycaena hyllus*, *Satyrium saepium saepium*, *Satyrium californica* near *helena*, *Satyrium acadica*.

Glossary

Drawings for morphological terms are in Scott (1986a).

abdomen. The large legless rear part of adult behind the legs/wings, and larval segments A1-10 (segments A1-2 & 7-9 have no prolegs, but segments A3-6, 10 have prolegs--larvae have 3 pairs of true legs on segments T1-3).

adfrontal cleavage line. Just lateral to the adfrontal sulcus on head of larva. It splits apart during molting.
adfrontal sulcus. A groove edging the frontoclypeus (conical area) on lower front of head of larva.
aedeagus=penis, the male's mating organ that transfers sperm and spermatophore into the female.
aestivate. Passing part of the summer in a dormant (diapausing) state.
allochronic. Does not fly at the same time as the other taxon.
allopatric. The range does not overlap the range of the other taxon.
androconia. Scales that disseminate pheromone, usually on adult wings.
annual. Having just a one-year or less life cycle.
apex or apical. The anterior outer tip of the wing.
basal. Near the base, such as that part of the wing near the body.
Batesian mimicry. An edible species that mimics a poisonous species to reduce predation.
biennial. Having a two-year life cycle.
body basking. The same as dorsal basking, but spreading the wings just a little apart and orienting the body to get sunlight on top of the body.
bursa copulatrix. A sac in the female holding the male's mating substances (sperm and accessory fluids and a harder plug).
carr. A spring-fed meadowy wet area with low bushes, generally willows or dwarf birch.
chaparral. A habitat with mostly shrubs/small trees, usually rather dry.
cline. Gradual continuous intergradation from one taxon to another.
cocoon. A silk web structure enclosing the pupa.
collar. A hard transverse plate across top of T1 behind head of larva.
cornutus. Tiny separate spine on posterior end of male aedeagus.
coronal cleavage line. Runs along the coronal sulcus above the adfontal cleavage line. It splits apart at molting.
coronal sulcus. A vertical middorsal linear groove from top of larval head to front of head (ending on top point of frontoclypeus).
costal fold. A flap on front edge of fw that pops open to waft pheromone/androconial scales.
coxa. The first (short and attached to the thorax) segment of the adult leg.
cremaster. A point on the rear of a pupa with crochets that hook into a silk pad.
crochets. Hooks on proleg & cremaster that hook into silk that the larva lays with its spinneret.
diapause. A dormant state, usually in winter (hibernal diapause), in some butterflies also in summer (aestival diapause). Diapause can occur in eggs, larvae (in any of the usually-five stages), pupae, or adults in various species.
discal cell. A space from the wing base to the middle of wing that is enclosed with veins.
distal. The outer part of a structure.
dominant. A gene that prevails over another gene even when both occur in an individual.
dorsal basking. Spreading the wings and orienting the body to receive sunlight on top of wings/body to get warm.
dorsal. The top of something, such as the ups of the wing.
ecotype. A similar variety that has a different hostplant or habitat than the other variety.
exoskeleton. The hard (chitin) shell surrounding the body and appendages of arthropods.
fen. A grassy marshy area.
flaiting. A mate-locating method in which the male flies slowly about a genetic mating-rendezvous site to await females.
fleeking. A mate-locating method in which the male flies about the habitat to find females (the other main strategy is raiting, and flaiting also prevails in some species).
form. Any distinctively-different variant set of individuals within a species/subspecies, of adults or immatures, either genetic or environmental.

frontoclypeus. The triangular area on lower front of larval head. It (and a dorsal spike called the apotome) splits away from the rest of head during molting.
fw. forewing.
gnathos. Several mostly hooklike structures below the uncus of the male genitalia, which help attach the sexes during mating.
hair pencil. A cluster of long hairlike scent scales that is everted during courtship to waft pheromone.
herb. A comparatively-small non-grasslike plant that is not a shrub or tree or succulent (cactus or *Sedum* etc.).
hibernaculum. A rolled-silked leaf in which the larva hibernates (esp. used for *Limenitis*/*Adelpha*).
hw. hindwing.
inflorescence. The flowering portion of a plant.
instar. One of the growth stages of a caterpillar. I use the word stage in this book.
intergrade. Intermediate individuals resulting from hybridization between two taxa.
introgression. Occasional hybridization that results in genes introduced into the population of one of the hybridizing species.
juxta. A Y-shaped structure below the aedeagus, which helps position it.
labial palp. Each of two three-segmented long lobes on font of the adult head, between the antennae, containing a scent organ.
labrum. A hard flap overhanging the front of the caterpillar's mandibles., to keep the food in place.
lamella. A hard plate around or next to the female's mating orifice.
lateral basking. Orienting the closed wings to receive sunlight from the side to get warm.
lateral. On the middle of the side of the body or structure.
lenticle. Tiny ringlike structure on body of Lycaenidae larvae that wafts pheromones.
life zones. The Alpine life-zone includes the alpine tundra (above ~11500' in central Colo.); the Subdorsal zone (roughly 10,000-11,500') is mostly *Picea engelmannii* and *Pinus contorta* forest/grassland; the Montane zone is above the lower foothills and below the subalpine (roughly 7,500-8,000' to 10,000') and consists of much coniferous and some deciduous woods and some open areas; the Transition zone includes the lower foothills (roughly 5,500-6,000 to roughly 8,000') and has *Pinus ponderosa* and *P. edulis* and shrubs; the plains and lowest altitude in W Colo. is the Upper Sonoran zone. These life zones are not used much nowadays, but they still retain some value in describing the altitudinal ranges of the butterflies. One must understand that N-facing slopes are colder than S-facing slopes, and local differences in moisture and slope and soil and vegetation and hostplants etc. may greatly influence the presence or absence of a butterfly.
mandible. Two toothlike jaws beside the larval mouth that close together and bite off chunks of food.
marginal. At the outer edge of the structure, such as the outer edge of the wing.
meconium. The fluid voided by newly-emerged butterflies, often blood-red esp. in Nymphalini.
median. A band running up and down the middle of a wing.
mesothorax. The second thorax segment, containing the middle pair of legs, and the forewings of adults.
metathorax. The third thorax segment, containing the hind legs, and the hindwings of adults.
micropyle. A depression on top of egg with tiny pores through which the sperm enter and fertilize the egg.
middorsal. The midline of the top of the body or structure.
midventral. The midline of the bottom of the body or structure.
molting. Growing of the caterpillar by shedding the old exoskeleton and expanding and hardening a new exoskeleton.
monocotyledon. A plant group (grasses, sedges, lilies, etc.) with just one leaf sprouting from the seed, and usually linear veins on the leaves.
Müllerian mimicry. Both species are quite poisonous and mimic each other.

multiannual. Having a variable life cycle of 1, 2, or 3 years or more. This occurs in many above-timberline species and many desert species and some checkerspots such as *Euphydryas*.
nudum. A scaleless area on the antenna club (on *Phyciodes*, some *Erebia*, Pyrginae skippers, etc.).
ocellus. (plural, ocelli). An eyespot on wings or larva.
ommatidium. A single eye on the compound eye of an adult, or one of the 6 larval eyes.
osmeterium. A V- or Y-shaped stinky middorsal organ popping out behind the head of some Papilionidae larvae, often orange or yellow.
oviposit. Lay one or more eggs.
palpi (labial). Two long scent organs on front of the adult head, on both sides of the proboscis.
partial flight. A few adults emerging, while most of their generation remain in diapause.
pheromone. A chemical used to attract, seduce, or repel mates, or (in general: a chemical that influences the behavior of another individual of the same or different species).
photoperiod. The number of hours between dawn and dusk on a given day.
polymorphism. The presence of several genetic forms in one population.
postbasal. Just beyond the base of the wing.
postmedian. A band running up and down just beyond the middle of a wing.
primary setae. The comparatively-few setae present on most moths and the 1st-stage larvae of most butterflies (numerous secondary setae appear on 2nd-stage and older butterfly larvae). See figures in Scott 1986a.
proboscis. A coiled strawlike tube on lower front of head that adults use to suck liquids to drink.
proleg. Fleshy broad "legs" with crochets (hooks) on segments A3-6 & A10 of larva.
prothorax. The 1st of three segments of the thorax, containing the forelegs, just behind the head and in in front of the wings of adults.
pupa. The mummylike quiescent stage between the caterpillar and the adult (it can move only between segments A4-5, A5-6, and A7-8).
quantitative inheritance. Due to many different genes rather than just one.
raiting. A mate-locating method in which the male rests and watches—generally at a genetic mating-rendezvous site--to await females.
recessive. A gene that determines the appearance of an individual only if two duplicates of that gene occur in the individual (one on each homologous chromosome).
saccus. Forward projection from bottom of male genitalia (a muscle attachment).
sclerite. A hardened plate made of chitin on the arthropod exoskeleton.
scolus (plural scoli). A larval spine with numerous branches of spikes or setae. Frequent in Nymphalidae. Named for positioning next to primary setae, thus BD1 is middorsal or near, BD2 just below, BSD is above lateral, BL1 is below spiracles, BSV is sublateral.
secondary seta. Any of numerous extra setae on a larva usually developing after the 1st stage, and very numerous on older butterfly larvae. (Primary setae are the few setae present in most butterfly and moth larvae that were present on the primordial Lepidoptera larva.)
seta. "Hairs" on larvae or adult (mostly appendages).
sex-linked. A trait that is produced by a gene(s) that are on the X or Z (Y) sex chromosomes (males are XX, females XZ). (Today, the Y chromosome is called the Z chromosome.)
signum. Chitinous small plate on wall of bursa copulatrix of female.
spermatophore. A whitish thick soft sac containing his sperm, which the male pumps into the female's bursa copulatrix, then the sperm migrate to her spermatheca for storage, then they move to the eggs.
sphragis. A hard hoodlike structure the male *Parnassius* uses to plug the female's mating tube.
spinneret. Small hoselike structure on bottom rear of caterpillar head that lays silk threads.
spiracle. Oval tiny air openings along side of body for breathing.
stage. The growth stages (instars) of caterpillars, usually five stages (four in Lycaenidae).
stigma. A conspicuous patch of scent scales (androconia) generally on the wing.

stink club. A tiny projection among the female genitalia that wafts pheromone (that came from the male during mating) that mated females use to repel other males.
subdorsal. Just below the very top of a larva or structure.
sublateral. Just below the very side of a larva or structure.
submarginal. Just inside the marginal area of a wing.
sulcus. A sunken line representing an internal strengthening ridge on the exoskeleton.
supralateral. Just above the very side of a larva or structure.
sympatric. Overlaps in range with another taxon.
synchronic. The flight period overlaps the flight period of the other taxon.
taiga. Coniferous forest south of the arctic tundra, or sometimes used for below the alpine tundra.
tarsus. Tip of adult leg, usually having five short segments, terminated by a pair of claws.
tegula. A long near-middorsal scaled crescentic structure behind head between top of thorax and forewing.
tegumen. The top of abdominal A9 segment of the male genitalia that supports the uncus and gnathos.
tibia. The long segment of leg that is before the tarsus.
tornus. Far lower corner of the wing.
transverse. Running from side to side or up and down around a larva, rather than front and back.
tubercle. Long fleshy projection on a larva or pupa.
type locality (TL). The geographic location of the name-bearing type specimen (usually holotype).
ultraviolet. Light invisible to humans, but visible to butterflies, with wavelength shorter than violet.
uncus. Middorsal pointed-rearward structure on top of male genitalia, which during mating hooks into a membrane on the female just below her ovipositor.
unf. underside of forewing.
unh. underside of hindwing.
uns. Underside.
upf. upperside of forewing.
uph. upperside of hindwing.
ups. Upperside.
valva. One of two “claspers” on bottom of male genitalia, that help grip the female’s lower abdomen tip during mating.
ventral neck gland. A larval gland that pops out of the underside just behind the head, and disseminates nasty chemicals to repel ants etc.
ventral. The bottom of something, such as the uns of the wing.
verruca. A chitin plate with numerous setae, common in Riodininae.
zone. See life zones.

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