

Introduction to the Orders of Aquatic Insects

DR. JUSTIN REEVES, UNIVERSITY HONORS PROGRAM, COLORADO STATE UNIVERSITY

Introduction to the Orders of Aquatic Insects © 2023 by Dr. Justin Reeves is licensed under CC BY-NC-SA 4.0. To view a copy of this license, visit <http://creativecommons.org/licenses/by-nc-sa/4.0/>

Phylogenetic relationships between aquatic insect orders:

- ▶ Becoming aquatic for at least some life stages has evolved independently multiple times across otherwise terrestrial insect orders broadly.
- ▶ Each of these orders (and more) will be covered in this series of lecture slides with a focus on local (CO) families within them when practical.

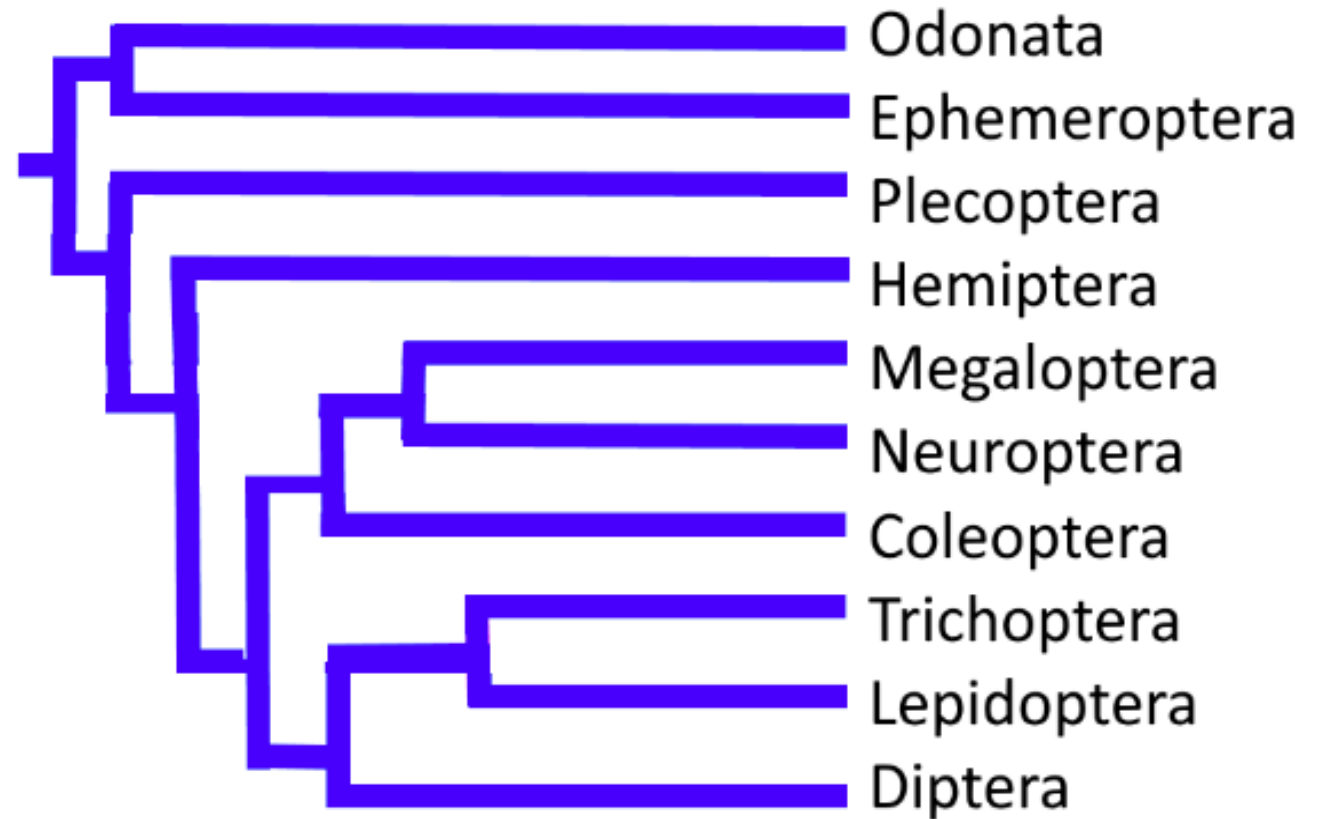


Image credit: Dr. Crystal Cooke, Colorado State University; based on Misof et al. 2014: <https://doi.org/10.1126/science.1257570>

Phylogenetic relationships between aquatic insect orders:

Note:

- ▶ This large file is broken into sections/lectures that represent two aquatic insect orders at a time. Unless otherwise noted, the pairings were arbitrary from a relatedness standpoint and were selected largely to be able to cover two orders in the same class period. Feel free to rearrange.
- ▶ The final section of this file includes insect orders that are only rarely aquatic or semi-aquatic. They are therefore not represented in the phylogenetic tree on the previous slide.



Paleoptera: Ephemeroptera and Odonata

ECOLOGY AND BEHAVIOR



Paleoptera (infraclass) = "old wing"

- ▶ Defining characteristic: cannot fold wings over abdomen (as with ancient insects)

Includes:

- ▶ Ephemeroptera – mayflies
- ▶ Odonata – dragonflies (suborder **Anisoptera**) and damselflies (suborder **Zygoptera**)



[https://commons.wikimedia.org/wiki/File:Mayfly_\(44320492872\).jpg](https://commons.wikimedia.org/wiki/File:Mayfly_(44320492872).jpg)



[https://commons.wikimedia.org/wiki/File:Sympetrum_flaveolum_-_side_\(aka\).jpg](https://commons.wikimedia.org/wiki/File:Sympetrum_flaveolum_-_side_(aka).jpg)



https://commons.wikimedia.org/wiki/File:Vestalis_gracilis_06845.jpg



https://commons.wikimedia.org/wiki/File:Imago_Ephemeroidea_Hexagenia.jpg

Ephemeroptera

MAYFLIES



[https://commons.wikimedia.org/wiki/File:Mayfly_nymph_dorsal_view_wing_buds_paired_gills_\(rotated\).JPG](https://commons.wikimedia.org/wiki/File:Mayfly_nymph_dorsal_view_wing_buds_paired_gills_(rotated).JPG)

Ephemeroptera

- ▶ Adults (**imagos**) live just a few hours to days (from Greek *ephemeros* - "lasting for a day")
 - ▶ Sometimes less than an hour!
- ▶ Adults have two winged stages (**unique!**) – first is **subimago** and emerges from final larval stage and is not sexually mature
 - ▶ This stage lasts hours to days (depends on species)
- ▶ Synonyms: subimago = *dun*; imago = *spinner*

Ephemeroptera

- ▶ Can be **univoltine** or **multivoltine** (multi- more common in warmer areas) - varies by species and geographic location
- ▶ **Hemimetabolous** (incomplete metamorphosis)
 - ▶ Note for upcoming lectures: juvenile/immature stage(s) called **nymph(s)** for hemimetabolous insects; called **larva(e)** for holometabolous (complete metamorphosis including pupal stage)
- ▶ Overwinter usually as nymphs, sometimes eggs. Can eat and grow all winter.

Ephemeroptera Adults - Characteristics

- ▶ Relatively long, slender bodies
- ▶ Two or three long "tails" (caudal filaments)
- ▶ Veiny wings held upright at rest
- ▶ Huge variety in size and color across species



https://commons.wikimedia.org/wiki/File:Ephemeroptera_2.jpg



<https://commons.wikimedia.org/wiki/File:Haff.jpg>



https://commons.wikimedia.org/wiki/File:Baetidae._Adult_male_mayfly_EOD_009s.JPG

Ephemeroptera Adults

- ▶ Adults have vestigial mouthparts – don't feed.
- ▶ Commonly form mating swarms to reproduce in one large event and overwhelm potential predators.
- ▶ Lay eggs on surface of the water then die shortly after.

Ephemeroptera Adults - Reproduction



<https://youtu.be/dzbLuLzMWE4>

Ephemeroptera Adults – SWARMS!



<https://youtu.be/5iyocigBFvA>

Note:

- ▶ Although mayflies can be infamous for mating swarms as in the videos above, they also commonly emerge ("hatch") year-round in much smaller numbers.

Ephemeroptera Nymphs - Characteristics

- ▶ Gills along sides or top of back half of abdomen (sometimes hidden)
- ▶ Three caudal/tail filaments coming off back of abdomen (sometimes two)
- ▶ Flattened to avoid current or fusiform/streamlined body for swimming
- ▶ Stay under rocks or in boundary layer



[https://commons.wikimedia.org/wiki/File:Spiny_crawler_mayfly,_Drunella_coloradensis_\(9638196107\).jpg](https://commons.wikimedia.org/wiki/File:Spiny_crawler_mayfly,_Drunella_coloradensis_(9638196107).jpg)



<https://commons.wikimedia.org/wiki/File:Ephemeropteraninfa2.jpg>

Ephemeroptera Nymphs

- ▶ Can be found in a variety of aquatic habitats (lentic and lotic)
 - ▶ Especially common in rocky streams (second and third order), but can be found even in Great Lakes (as seen in news clip on previous slide)
- ▶ Variety of diets:
 - ▶ Most are collector-gatherers or scrapers/grazers - diets can widen as they grow larger.
 - ▶ Some are carnivores!
- ▶ Go through many instars – typically 15-25 (sometimes up to 45!)

Ephemeroptera Nymphs

- ▶ Although life history can vary a lot by species, one thing mayflies generally have in common is that they **need high quality water** with plenty of oxygen.
- ▶ Although adults live very short time, nymphs can live up to two or three years (depends on the species – many are weeks to months).

Ephemeroptera Nymphs – Behavioral Groups

- Crawlers
- Clingers
- Burrowers
- Swimmers



https://youtu.be/0fApJ_8k2eo

Numbers and Key Families of Ephemeroptera

- ▶ 42 families – over 3000 species worldwide

Key Local (CO) families:

- ▶ **Baetidae** (especially genus *Baetis*) – hatch year round in CO; various sizes/colors depending on species, but small
- ▶ **Ephemeridae** ("drakes," especially Western Green Drake) - hatch in summer months - swarms - larger

Total Local Families (13)

- ▶ Ameletidae
- ▶ Ametropodidae
- ▶ Baetidae
- ▶ Caenidae
- ▶ Ephemerellidae
- ▶ Ephemeridae
- ▶ Heptageniidae
- ▶ Isonychiidae
- ▶ Leptohyphidae
- ▶ Leptophlebiidae,
- ▶ Oligoneuriidae
- ▶ Polymitarcyidae
- ▶ Siphonuridae

Be able to recognize these families as belonging to Ephemeroptera on the exam. It will be a matching exercise, not a spelling exercise...

Fly fishing – notes for next few lectures:



- ▶ For each order in this series of lectures, we will briefly look at common imitations or "patterns."
 - ▶ Note that there are many more than the one or two we will show – endless variety.
- ▶ Fly anglers often try to "match the hatch," meaning selecting a pattern that matches the insects that are out in the highest abundance.
 - ▶ Match either floating adults ("dry flies") or nymphs (drift; "wet flies")
 - ▶ Fish tend to focus on most common insect at any given time (anglers disagree on this to some extent)

Ephemeroptera fly fishing imitations:

Adults – Dry Flies:

- ▶ Mayflies very diverse in size and color – so are fly patterns.
- ▶ Most are this sort of basic profile with a wide variety of colors, sizes, etc.



https://commons.wikimedia.org/wiki/File:Pale_Morning_Dun.jpg

Nymphs – Wet Flies

- ▶ Fly patterns often general and can imitate either mayflies or stoneflies (Plecoptera – next lecture) at the same time:



https://commons.wikimedia.org/wiki/File:Bead_Head_Prince_Nymph.jpg



https://commons.wikimedia.org/wiki/File:Gold_ribbed_hairs_ear_trout_fly.JPG



https://commons.wikimedia.org/wiki/File:Dragonfly_nymph_-_Flickr_-_GregTheBusker.jpg

Odonata

DRAGONFLIES AND DAMSELFLIES



https://commons.m.wikimedia.org/wiki/File:Assorted_Odonata_from_the_University_of_Texas_Insect_Collection_cropped.jpg

Odonata

- ▶ *Odon* is Greek for tooth - both adults and nymphs are exclusively predators
 - ▶ Adults can capture flying insects on the wing – great vision! (more in upcoming slide)
 - ▶ Nymphs are ambush predators and strike very fast with serrated mouthparts to engulf prey

Odonata

- ▶ Can be **univoltine** or **multivoltine** (multi-more common in warmer areas) - varies by species and geographic location
- ▶ Hemimetabolous (incomplete metamorphosis)
- ▶ Some species overwinter as nymphs, some as eggs, some adults even migrate south to lay eggs

Odonata Adults - Characteristics

Dragonflies (**Anisoptera**): wings to side at rest and stouter bodies



Tends to hunt on the wing.

Damselflies (**Zygoptera**): wings up at rest (most families) and more slender body



Tends to hunt stationary prey.

Adult males of both **suborders** can defend territories (where eggs will be laid) to attract females.

Odonata Adults – Hunting/Feeding



<https://youtu.be/XWROwMxepoM>

Odonata Adults – Vision!



https://youtu.be/m5XUdvBO_TE

Odonata Adults - Reproduction



<https://youtu.be/Xm5nM93VScw>



<https://youtu.be/StkTknVqAp0>

Damselfly Video



<https://youtu.be/ebZRqQGABQ4>

Odonata Nymphs

- ▶ Often one year for life cycle to complete, but can take up to four.
- ▶ Nymphs go through 10-15 instars; first instar molts almost immediately upon hatching; this is unique – called the *pronymph*
- ▶ Hide to hunt by crawling up on plants, sprawling in sediment, or sometimes burrowing into sediment.
 - ▶ Largely ambush hunters
- ▶ Most live in permanent lentic or lotic habitats, but some are adapted for pooled water in bromeliads (tropics), can withstand dry conditions, etc.

Odonata Nymphs - Characteristics

Anisoptera:

- ▶ Relatively rounder abdomen with wedge-like extensions



In Common:

- ▶ Large eyes that resemble adults
- ▶ Scoop-shaped, serrated mouthparts that cover bottom of head)

Zygoptera:

- ▶ Relatively narrower body
- ▶ Three paddle shaped "tails" (gills)



Odonata Nymphs – Feeding and Ecdysis



<https://youtu.be/cyt4HtcMPgg>

Numbers and Key Families of Odonata

- ▶ Key local families:
 - ▶ Checklist of Colorado dragonflies and damselflies with beautiful images:
 - ▶ https://mountainscholar.org/bitstream/handle/10217/88633/BSPMGILL_InsectsofWesternNorthAmerica9.pdf
 - ▶ Not expected to know all families in above document for exam, but please do read through it.

Common Families of Odonates

Dragonflies (Anisoptera):

[Aeshnidae](#) - Darners

[Gomphidae](#) - Club-tailed dragonflies

[Libellulidae](#) - Skimmers

Damselflies (Zygoptera):

[Calopterygidae](#) - Broad-winged damselflies

[Coenagrionidae](#) - Narrow-winged damselflies

[Lestidae](#) - Spread-winged damselflies

- The links to the left go to family-level descriptions provided by NC State Agriculture and Life Sciences.

Odonata imitations for fly fishing:

Adults:

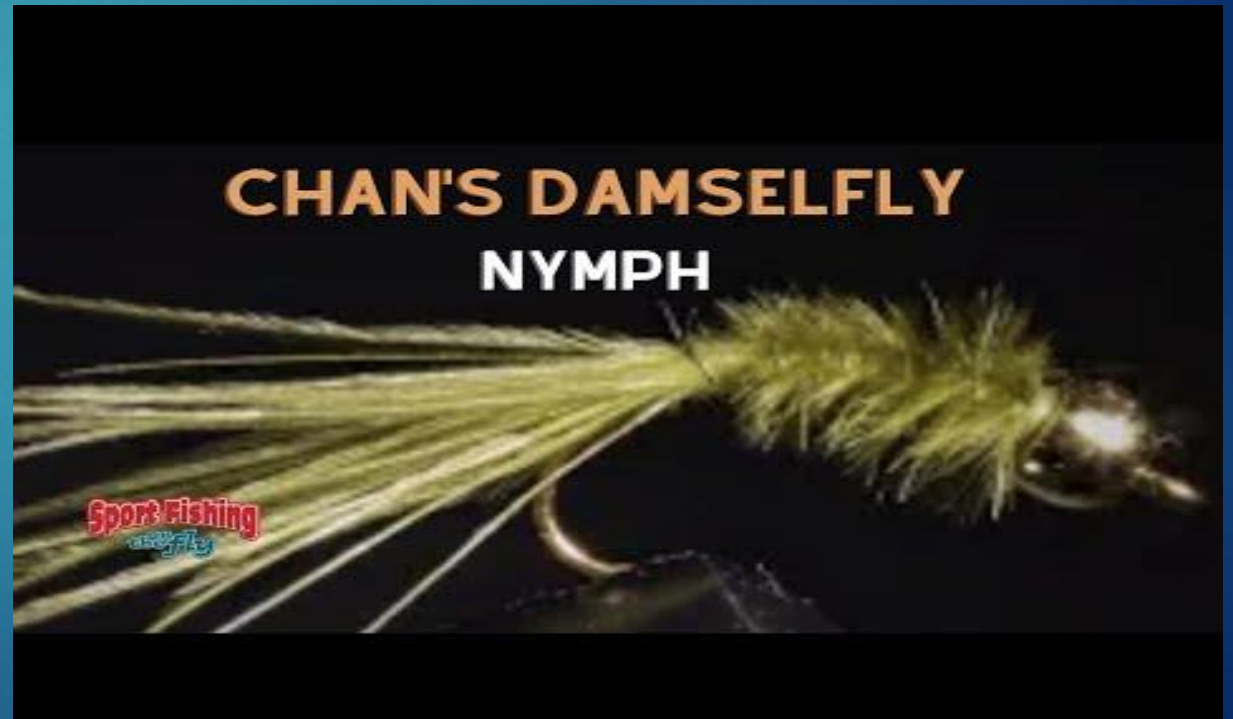
- ▶ Various designs, not always the most commonly fished insect pattern.



Photo Credit: Justin Reeves

Nymphs:

- ▶ Various designs... a little more commonly used. Video here is to get a sense of creating flies – called "fly tying."



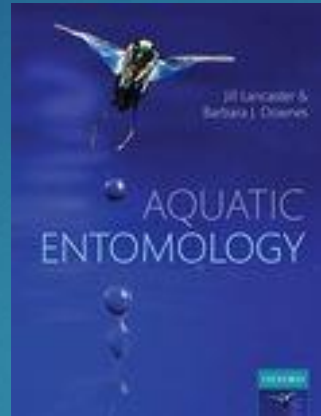
<https://youtu.be/ywyZgg5phSQ>

References and Additional Reading:

Aquatic Entomology

Jill Lancaster and Barbara Downes
Oxford University Press, 2013
ISBN: 9780199573219

Textbook covering basics of aquatic ecology and entomology (no ID).

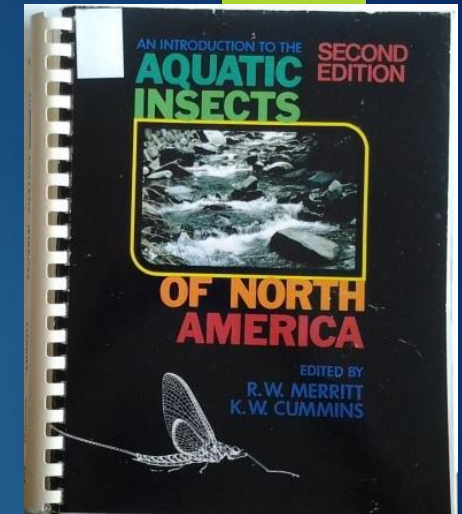


Introduction to the Aquatic Insects of North America (2nd ed)

(multiple newer versions)

R.W. Merritt and K.W. Cummins
Kendall Hunt Pub Co, 1984
ISBN: 0840331800

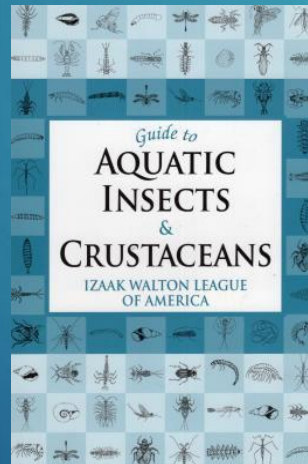
Advanced, comprehensive info and ID below order.



Guide to Aquatic Insects & Crustaceans

Izaak Walton League of America
Stockpole Books, 2006
ISBN: 0811732452

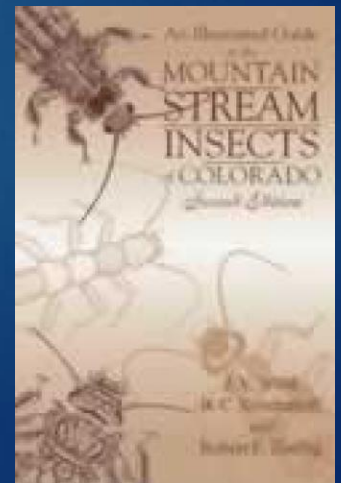
Simple (and **cheap!**) field guide to ID insects and more to order; water quality estimates.



An Illustrated Guide to the Mountain Stream Insects of Colorado (2nd ed)

J.V. Ward, B.C. Kondratieff, R.E. Zuellig
University Press of Colorado, 2002
ISBN: 9780870816536

Basic ecology and ID of local (CO) stream insects.





Plecoptera and Trichoptera

ECOLOGY AND BEHAVIOR

Note:

- ▶ Unlike the Paleoptera lecture, the orders of insects included together here (and in future lectures) are essentially arbitrary and not based on degree of relatedness.
 - ▶ Paired to be able to cover two orders per class.

Plecoptera

STONEFLIES



[https://commons.wikimedia.org/wiki/File:Common_stonefly,_Acroneuria_carolinensis_\(30586078101\).jpg](https://commons.wikimedia.org/wiki/File:Common_stonefly,_Acroneuria_carolinensis_(30586078101).jpg)



https://commons.wikimedia.org/wiki/File:Stonefly_-_geograph.org.uk_-_467522.jpg

Plecoptera Video



<https://youtu.be/ziDffsX6vI8>

Plecoptera

- ▶ Greek *plektos* (braided) wings and *pteron* (wings)
- ▶ Like mayflies, very important food source in trout streams
- ▶ Interesting: some adults remain aquatic; some nymphs are terrestrial in other parts of the world
 - ▶ Most species are aquatic as nymphs and terrestrial as adults, however

Plecoptera

- ▶ Like mayflies, stoneflies need good quality water that is highly oxygenated. This typically means they are associated with colder, high-altitude streams
- ▶ Some species are lake-adapted too
- ▶ Tropical species do exist

Plecoptera

- ▶ Univoltine or commonly semivoltine (takes more than one year to complete life cycle)
- ▶ Hemimetabolous (incomplete metamorphosis)
- ▶ Commonly overwinter as nymphs (sometimes eggs) – some stay active and grow all year.
 - ▶ Some adults even emerge in winter!
 - ▶ <https://blogs.scientificamerican.com/guest-blog/winter-stoneflies-sure-are-supercool/>

Winter Stoneflies



<https://youtu.be/bZQlIVl2jmw>

Plecoptera Adults - Characteristics

- ▶ Relatively long, dorso-ventrally flattened body; long antennae
- ▶ Veiny wings folded *held against abdomen* at rest
- ▶ Variety in size and color across species, but can be quite large as both adults and nymphs relative to other orders
- ▶ Adults often look similar to nymphs (just have wings)



https://commons.wikimedia.org/wiki/File:Stonefly_-_geograph.org.uk_-_467522.jpg



[https://commons.wikimedia.org/wiki/File:Stonefly_\(Plecoptera\)__\(14482324946\).jpg](https://commons.wikimedia.org/wiki/File:Stonefly_(Plecoptera)__(14482324946).jpg)

"Salmon Flies"



<https://youtu.be/-NOhEfGcg7g>

Plecoptera Adults

- ▶ Some adults have short wings (brachypterous) and some have none (apterous)
- ▶ Gills from nymphal stage may persist but shrivel and cause scars
- ▶ Commonly poor flyers as adults – some just skim along water with weak wing beats or even just use wings as sails
- ▶ Similar to mayflies, adults of many species do not feed; those that do eat algae and plants

Plecoptera Adults - Reproduction

- ▶ In some species, males drum subgenital plate to attract mates
- ▶ Adults typically die soon after reproducing
- ▶ Emerge/"hatch" in large numbers, but not necessarily incredible swarms like some mayflies

Abdominal Drumming...



<https://youtu.be/EYh2Z0bcunE>

Plecoptera Nymphs - Characteristics

- ▶ Flattened bodies
- ▶ Gills on thorax where legs join body (none on abdomen/back half of body – different than mayflies; *usually*)
- ▶ Long antennae (several times longer than head)
- ▶ Typically two long "tails" (caudal filaments)



[https://commons.wikimedia.org/wiki/File:Common_stonefly,_Calineuria_californica_\(7882576516\).jpg](https://commons.wikimedia.org/wiki/File:Common_stonefly,_Calineuria_californica_(7882576516).jpg)



[https://commons.wikimedia.org/wiki/File:Large_winter_stonefly,_Strophopteryx_fasciata_\(12820761335\).jpg](https://commons.wikimedia.org/wiki/File:Large_winter_stonefly,_Strophopteryx_fasciata_(12820761335).jpg)

Plecoptera Nymphs

- ▶ Diet: Predators or shredders (sometimes scrapers/grazers)
 - ▶ Some species switch diets to being predators in later instars
- ▶ Development can be slow – often more than a year – **sometimes multiple years**
- ▶ 10 – 30+ instars

Numbers and Local (CO) Families of Plecoptera

- ▶ 16 families – over 3500 species worldwide (over 600 in North America)

Local families (8 total):

- ▶ Capniidae
- ▶ Perlodidae
- ▶ Perlidae
- ▶ Chloroperlidae
- ▶ Leuctridae
- ▶ Nemouridae
- ▶ Pteronarchidae
- ▶ Taeniopterygidae

Plecoptera fly fishing imitations:

Adults – Dry Flies:

Click Link:

<https://news.orvis.com/fly-fishing/pro-tips-top-5-salmonfly-dries-madison-river>

Nymphs – Wet Flies

- ▶ Fly patterns sometimes specific, but often general and can imitate either mayflies or stoneflies at the same time:



https://commons.wikimedia.org/wiki/File:Box_Canyon_Stone.jpg



[https://commons.wikimedia.org/wiki/File:Trichoptera_indet._-K%C3%B6cherfliege-_Caddisfly_\(9673046466\).jpg](https://commons.wikimedia.org/wiki/File:Trichoptera_indet._-K%C3%B6cherfliege-_Caddisfly_(9673046466).jpg)



[https://commons.wikimedia.org/wiki/File:Common_netspinner,_Diplectrona_modesta_\(6890873148\).jpg](https://commons.wikimedia.org/wiki/File:Common_netspinner,_Diplectrona_modesta_(6890873148).jpg)

Trichoptera

CADDISFLIES



https://commons.wikimedia.org/wiki/File:Caddis_pupae.JPG

Trichoptera – Play at 1.5 speed



<https://youtu.be/NDKzzBAuXNs>

Trichoptera

- ▶ From Greek *trico* (hair/bristle) and *pteron* (wing)
- ▶ Also very important in trout streams
- ▶ Many species need high quality water, but some net spinners (more later) are more tolerant to lower quality water

Trichoptera

- ▶ Most species univoltine (some species two years to complete life cycle - **semivoltine**)
- ▶ Holometabolous (complete metamorphosis – have pupal stage)
- ▶ Most species overwinter as larvae; some as eggs

Trichoptera Adults - Characteristics

- ▶ Adults resemble Lepidoptera (moths/butterflies; they are related)
 - ▶ Have 'hairy' wings
 - ▶ Moths and butterflies have scales
- ▶ Wings held as peaked tents over abdomen
- ▶ Long antennae



Trichoptera Adults

- ▶ Often don't feed, but some species do. Those that do eat suck nectar.
- ▶ Adults of some species can live for several weeks – lots of variability, however

Trichoptera Adults - Reproduction

- ▶ As video earlier pointed out, can swarm for reproduction; "hatch" in large numbers
- ▶ Unique: communicate via sex pheromones to attract mates

Trichoptera Reproduction – stop at 1:55



<https://youtu.be/5Bwiwv4YdUI>

Trichoptera Larvae Characteristics

- ▶ Relatively short thorax and distinct, sclerotized head; caterpillar-like otherwise with segmented (8-10), soft abdomen
- ▶ Gills along abdomen may be single or branched
- ▶ Two extensions at base of abdomen that end in hooks
- ▶ Produce silk – some use it for food nets, some for building/attaching cases to substrate (salivary glands that extend into body cavity)



https://commons.wikimedia.org/wiki/File:L3_Dragovi%C5%A1tica_1_Hydropsyche.jpeg



[https://commons.wikimedia.org/wiki/File:Northern_case-maker_caddis,_Pycnopsyche_gentilis_\(8405367597\).jpg](https://commons.wikimedia.org/wiki/File:Northern_case-maker_caddis,_Pycnopsyche_gentilis_(8405367597).jpg)

Trichoptera Larvae

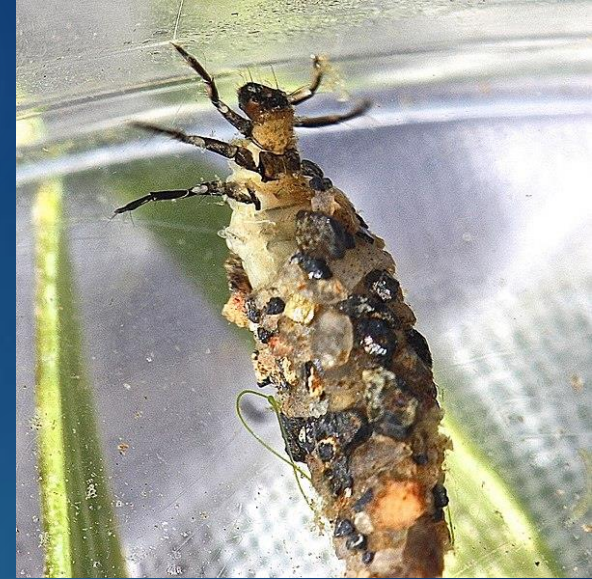
- ▶ ~5 instars (less than other orders we've discussed so far)
- ▶ Wide variety in diets by species
 - ▶ Shredders, collectors (nets), some are scrapers/grazers, some are predators
- ▶ Unique: Family Hydropsychidae can produce noise underwater! (rub legs on undersides of head)
 - ▶ Not case builders – defense over refuges

Trichoptera Larvae

Three major groups:

- ▶ Free-living (no net or case) - roam substrate
- ▶ Case Building (huge variety in shapes, materials, etc.) - can even help determine family
 - ▶ Lots of sub-categories here...
- ▶ Net Spinning – used to capture food

Trichoptera Larval Cases



[https://commons.wikimedia.org/wiki/File:Uenoid_case-maker_caddisfly,_Neophylax_consimplis_\(8238705594\).jpg](https://commons.wikimedia.org/wiki/File:Uenoid_case-maker_caddisfly,_Neophylax_consimplis_(8238705594).jpg)

<https://youtu.be/py6vf5P6kYk>

Net Spinning Caddis Example



https://youtu.be/_Zey0R53IOk

Caddisfly Art! - can buy online



https://youtu.be/jlD1_GwxiE0

Trichoptera Pupae

[Click here: link to photo of Trichoptera Pupa](#)

Numbers and Key Families of Trichoptera

- ▶ 46 families; over 12,600 species worldwide
- ▶ Reminder: the material used to build cases can help determine family (not as reliable as physical characteristics)
 - ▶ Don't have to memorize specific examples, but know this happens.
- ▶ Local families on next slide...

Local (CO) Families of Trichoptera

Local Families (14 total):

- ▶ Apataniidae
- ▶ Brachycentridae
- ▶ Glossosomatidae
- ▶ Helicopsychidae
- ▶ Hydropsychidae (*net-spinning*)
- ▶ Hydroptilidae
- ▶ Lepidostomatidae
- ▶ Leptoceridae
- ▶ Limnephilidae
- ▶ Philopotamidae (*net-spinning*)
- ▶ Polycentropodidae (*silk case*)
- ▶ Psychomyiidae (*silk case*)
- ▶ Rhyacophilidae (*free-living*)
- ▶ Ueonidae

Trichoptera imitations for fly fishing:

Adults:

- ▶ Most famous pattern probably elk hair caddis (Justin's favorite dry fly)



https://commons.wikimedia.org/wiki/File:Elk_Hair_Caddis_dry_flies.jpg

Larvae:



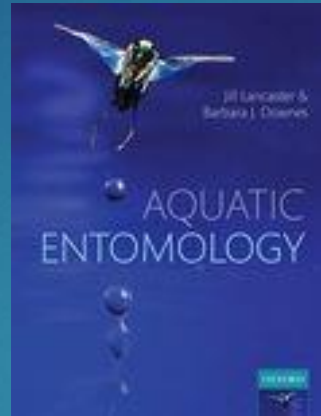
<https://youtu.be/OccYKGEYDmQ>

References and Additional Reading:

Aquatic Entomology

Jill Lancaster and Barbara Downes
Oxford University Press, 2013
ISBN: 9780199573219

Textbook covering basics of aquatic ecology and entomology (no ID).

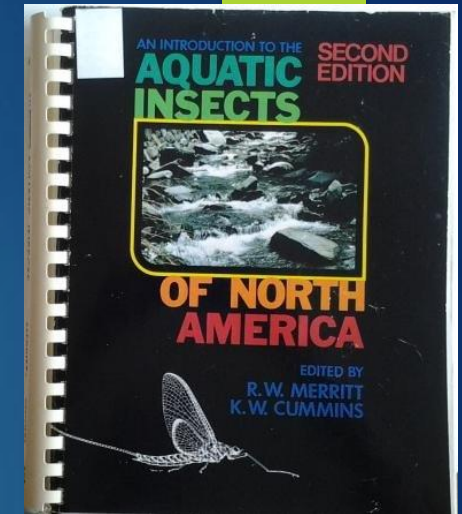


Introduction to the Aquatic Insects of North America (2nd ed)

(multiple newer versions)

R.W. Merritt and K.W. Cummins
Kendall Hunt Pub Co, 1984
ISBN: 0840331800

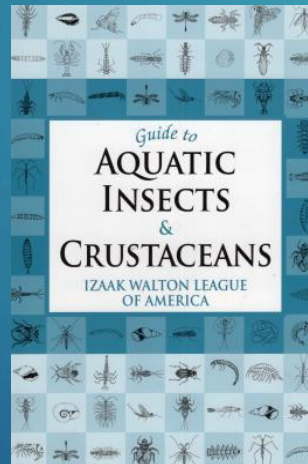
Advanced, comprehensive info and ID below order.



Guide to Aquatic Insects & Crustaceans

Izaak Walton League of America
Stockpole Books, 2006
ISBN: 0811732452

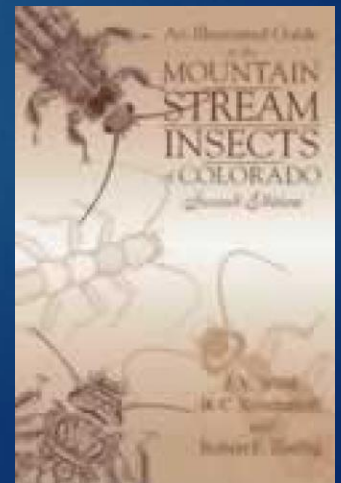
Simple (and cheap!) field guide to ID insects and more to order; water quality estimates.



An Illustrated Guide to the Mountain Stream Insects of Colorado (2nd ed)

J.V. Ward, B.C. Kondratieff, R.E. Zuellig
University Press of Colorado, 2002
ISBN: 9780870816536

Basic ecology and ID of local (CO) stream insects.





Megaloptera and Hemiptera

ECOLOGY AND BEHAVIOR



https://commons.wikimedia.org/wiki/File:Flickr_-_ggallice_-_Dobsonfly.jpg

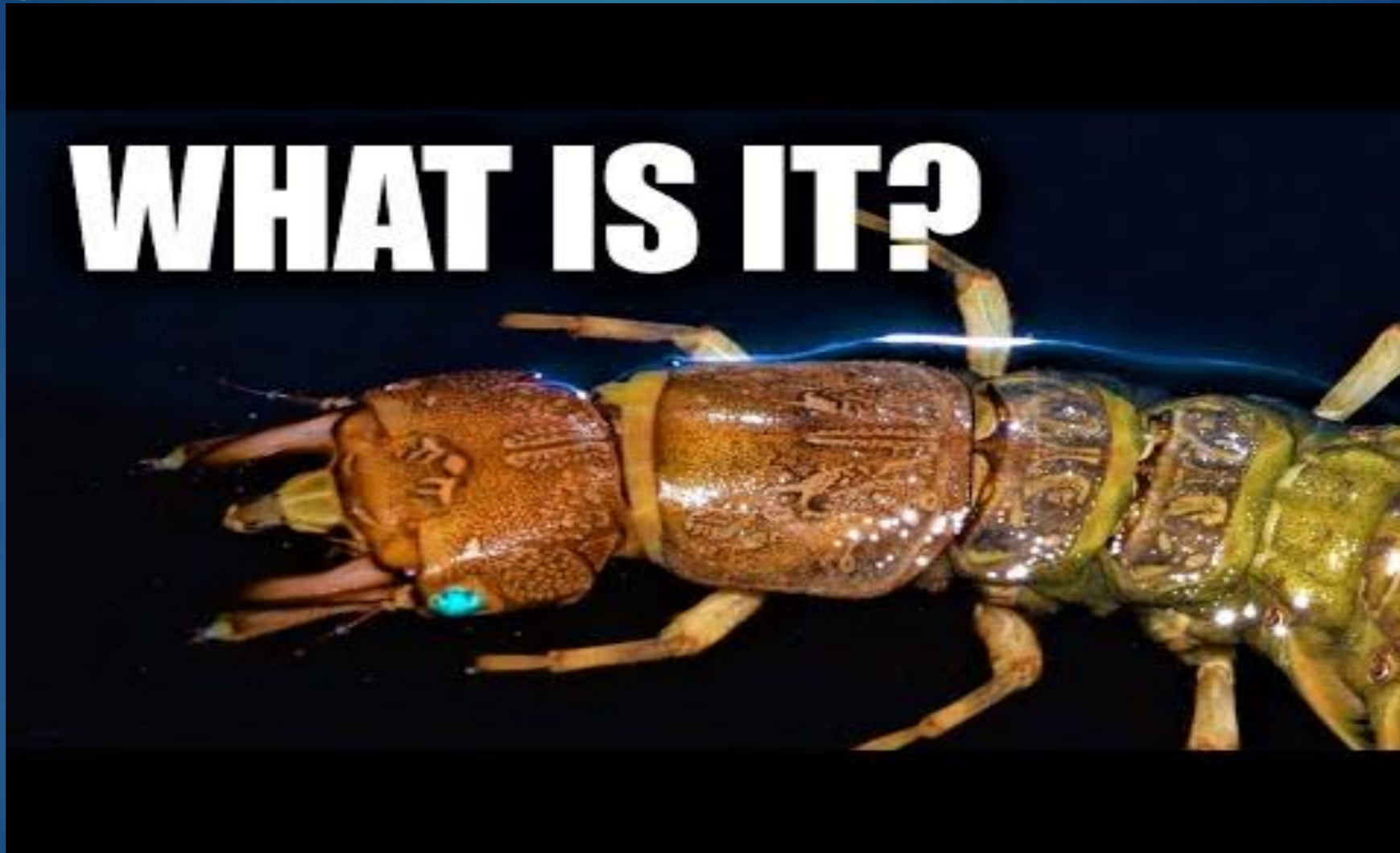
Megaloptera

DOBSONFLIES/HELLGRAMMITES, FISHFLIES, ALDERFLIES



[https://commons.wikimedia.org/wiki/File:Hellgrammite,_Nigronia_fasciata_\(7222779876\).jpg](https://commons.wikimedia.org/wiki/File:Hellgrammite,_Nigronia_fasciata_(7222779876).jpg)

Megaloptera Video



<https://youtu.be/Aak-Kd8B-H8>

Megaloptera

- ▶ Greek *megas* (big) and *pteron* (wing); adults are large-winged and usually quite large overall
 - ▶ Larvae often quite large too
- ▶ All are predators (larvae); adults may not eat
- ▶ Some of the largest and most spectacular of all macroinvertebrates!

Megaloptera

- ▶ Dobsonfly larvae (family Corydalidae) need high quality to moderately high quality water.
- ▶ Alderflies (family Sialidae) can exist in broader range of quality.
 - ▶ More later on these families.
- ▶ Species exist in both lotic and lentic, temperate and tropical habitats.

Megaloptera

- ▶ Univoltine or commonly semivoltine (2-5 years for larval development)
- ▶ Holometabolous (complete metamorphosis with pupal stage)
- ▶ Larvae are aquatic – unlike other orders discussed so far, all other stages (eggs, pupae, adults) are terrestrial

Megaloptera Adults - Characteristics

- ▶ Large-bodied with large, veiny wings.
- ▶ Males (upper right) usually have very large mandibles; females' not as large but still pronounced.
- ▶ Adults are nocturnal and often poor fliers despite impressive wings.



https://commons.wikimedia.org/wiki/File:Eastern_Dobsonfly_-_Corydalus_cornutus,_Allegany_County,_Maryland.jpg



https://commons.wikimedia.org/wiki/File:Dobsonfly_Corydalus_cornutus.JPG

Megaloptera Adults - Reproduction



<https://youtu.be/fqHL6W3IPa0>

Megaloptera Larvae - Characteristics

- ▶ Long-bodied
- ▶ Have 6 true legs like all insects, but also filaments coming off rear body segments that look like legs.
- ▶ Large mouthparts! Can bite humans.
- ▶ Variety in gills by taxa, but larvae distinctive either way.



Megaloptera Larvae

- ▶ Diet: all predators
- ▶ Development can be slow – larger species up to 5 years; smaller species can finish development in one year
- ▶ 10 – 12 instars
- ▶ Dobsonfly larvae called "hellgrammites"

Megaloptera Pupae

- ▶ Pupate on land – burrow into soil, under rocks

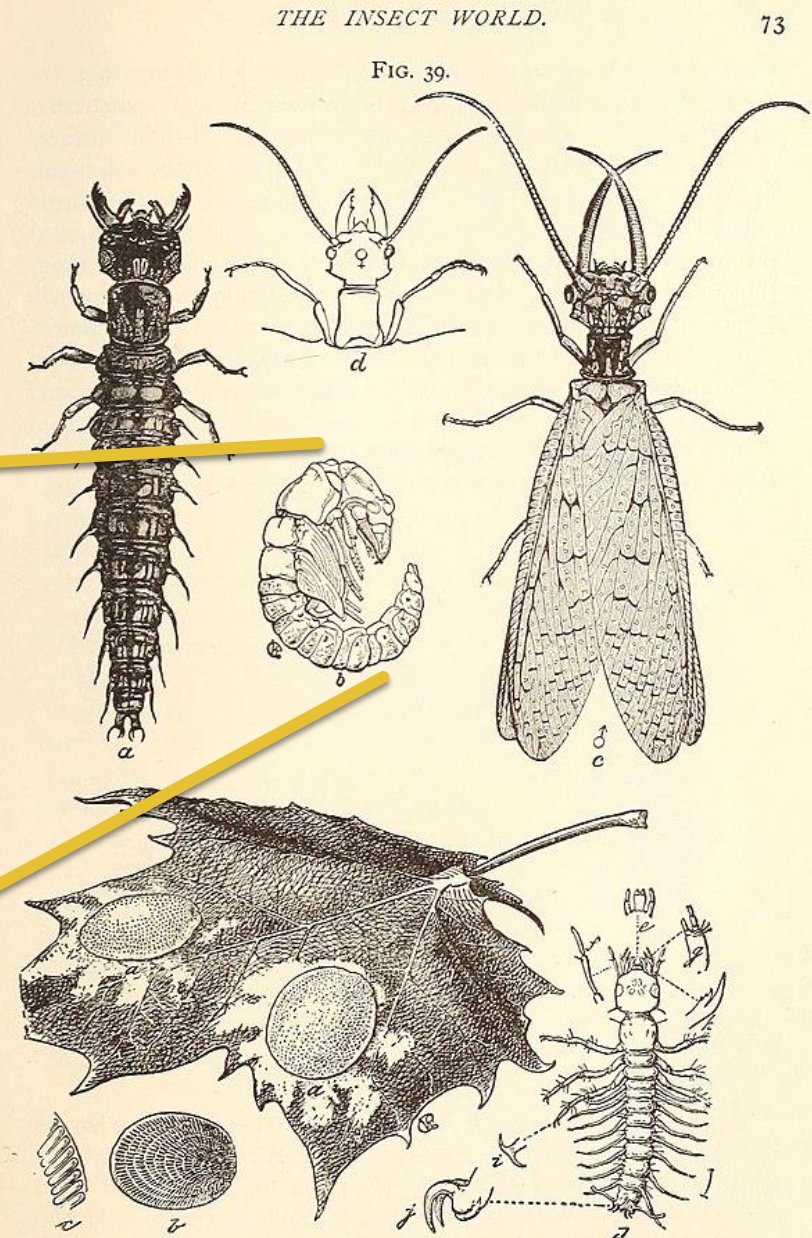


FIG. 39.

The "hellgrammite" or "dobson" in all its stages.—Upper series: *a*, the larva; *b*, the pupa; *c*, the male adult; *d*, the head of the female: in the lower series the leaf bears egg masses at *aa*, enlarged at *bc*; *d*, the larva just hatched, with details from *e* to *j*.

Numbers and Key Families of Megaloptera

- ▶ Only 2 families and ~328 species

Families:

- ▶ **Corydalidae** – dobsonflies or fishflies (hellgrammites as larvae) - photos/videos in lecture from this family
- ▶ **Sialidae** – alderflies – similar in appearance and life history (next slide)

[Click here](#) for info on local dobsonfly.

Sialidae (alderflies) - Photos



https://commons.wikimedia.org/wiki/File:Sialidae_-_Sialis_lutaria-001.JPG



[https://commons.wikimedia.org/wiki/File:Sialis_lutaria_larva_\(aka\).jpg](https://commons.wikimedia.org/wiki/File:Sialis_lutaria_larva_(aka).jpg)

Similar to Corydalidae, but usually not as large and features not as dramatic/striking. Same general characteristics and life history, however.

Megaloptera fly fishing imitations:

Adults – Dry Flies:

Not commonly used – they are terrestrial and lay eggs on land.

Larvae – Wet Flies

- ▶ Also not the most common compared to other orders we have covered so far (but fish do eat them).
- ▶ [Click This Link For Example](#)



[https://commons.wikimedia.org/wiki/File:Water_bug_single_\(16009934868\).jpg](https://commons.wikimedia.org/wiki/File:Water_bug_single_(16009934868).jpg)

HEMIPTERA

TRUE BUGS

[https://commons.wikimedia.org/wiki/File:Giant_Water_Bug_2_\(5928165970\).png](https://commons.wikimedia.org/wiki/File:Giant_Water_Bug_2_(5928165970).png)



Semantics Note:

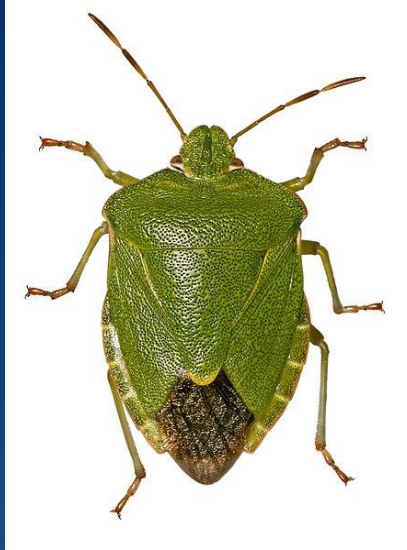
- ▶ All bugs are insects but not all insects are bugs.
- ▶ "Bugs" are only in the order Hemiptera even though people often use "bugs" to mean insects in general.

Lots of Variety and Key Families!

- ▶ Unlike other orders we have covered recently, we will split Hemiptera into specific families and briefly cover their basic biology.
- ▶ Focus will be on adults for this order.
- ▶ Families quite distinctive by morphology and/or behavior (pay attention in videos), so will not have specific 'characteristics' slides as typical.

Hemiptera – Common Traits

- ▶ Hemiptera from Greek *hemi* (half) and *pteron* (wing) - part of forewing is sclerotized (photo on right not aquatic bug)



https://commons.wikimedia.org/wiki/File:Palomena_prasina_MHNT_L%C3%A9guevin_Blanc.jpg

Order-level characteristics/traits:

- ▶ Elongated, straw-like sucking mouthparts (called beak or rostrum) for largely liquid diet
- ▶ Most aquatic Hemiptera are predators (pierce prey, inject venom/digestive enzymes, and suck out juices)
 - ▶ Some consume plants and detritus

Hemiptera – Common Traits

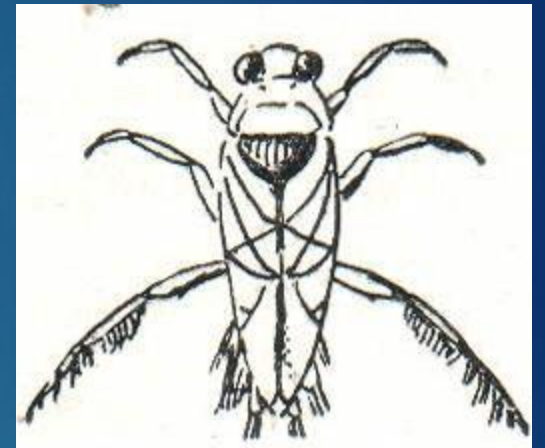


https://commons.wikimedia.org/wiki/File:Ranatra_linearis_Desnianskyi_Biosphere_Reserve_2018.jpg

- ▶ All are hemimetabolous
- ▶ Variety of sizes and shapes as we will see. Some can be up to 11 cm (giant water bugs – family Belostomatidae).
- ▶ 19 different families (4300+ species, 301 genera) of aquatic or semi-aquatic bugs – we will cover only some common ones here.

Hemiptera – Common Traits

- ▶ Exists in both lentic and lotic systems, but do not like fast flowing water.
 - ▶ In lotic systems, found in slowest areas.
- ▶ Voltinism can vary by family, but typically univoltine.
- ▶ Most commonly overwinter as adult – lay eggs in spring and develop to adults by winter and start over each year.



https://commons.wikimedia.org/wiki/File:LA2-Blitz-0417_wanzen.JPG

Heteroptera

- ▶ Suborder of Hemiptera – aquatic bugs are largely in this suborder.
- ▶ Defined largely by wings (Heteroptera has sclerotized portion), but also by where mouthparts attach to head (at the front).

Gerromorpha (infraorder)

- ▶ Water striders, water measurers, water skaters (lots of species and common names)
- ▶ Some morphological variability, but all stay on surface of water and similar basic life history
- ▶ Common locally (and most places): family **Gerridae** – "water striders"
- ▶ **Neuston** – water surface-living organisms

Gerridae



<https://youtu.be/4CU8gYYkwSw>

Gerridae



<https://youtu.be/E2unnSK7WTE>

Gerridae – Additional Info

- ▶ Use atmospheric oxygen since they are above surface
 - ▶ Not as sensitive to water quality because they spend their time above the surface
- ▶ Commonly bivoltine (unlike most other aquatic Hemipteran families that are univoltine)
- ▶ Interesting: Signal to each other using different frequencies of ripples on water (repel competitors or attract mates); males stay attached to female for whole mating season
- ▶ Some are marine

Nepomorpha (Infraorder)

Key families:

- ▶ Water boatmen: family Corixidae
- ▶ Backswimmers: family Notonectidae
- ▶ Giant water bugs: Belostomatidae
- ▶ Water scorpions: Nepidae

Some of the upcoming videos for these families will cover basic life history facts – take notes.

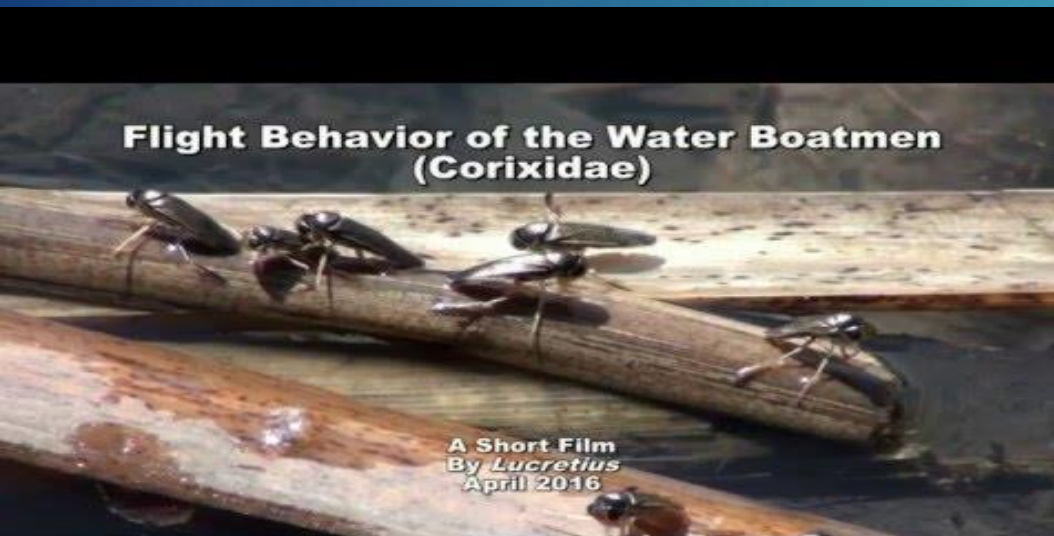
Corixidae – "Water Boatmen"

- Name Comes from oar-like legs
- Largely feed on plants, algae, detritus – unusual among the aquatic Hemiptera



Corixidae – Additional Info

- ▶ Males attract mates with sound – can be considered loudest animal on earth relative to body size!
- ▶ Strong fliers

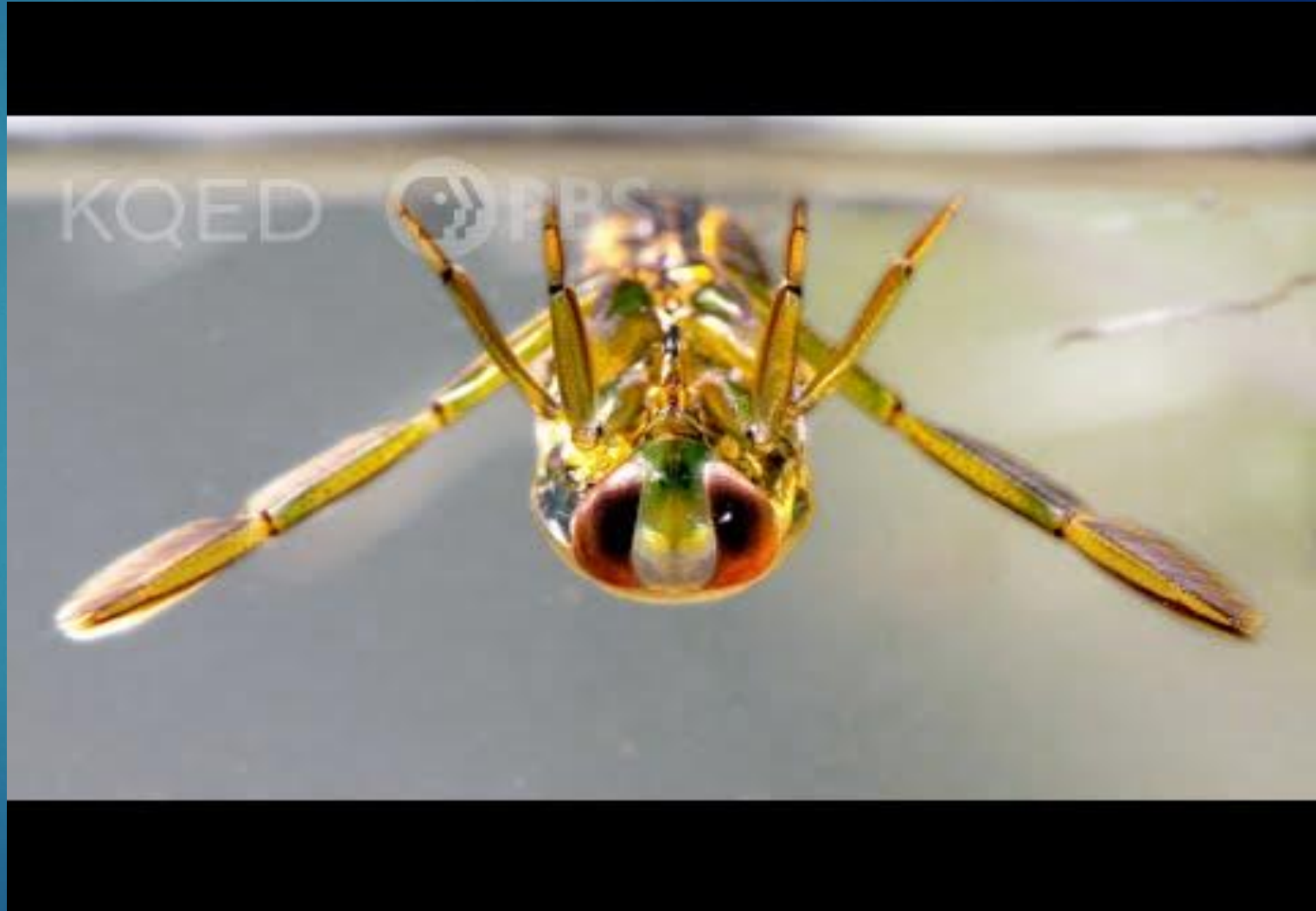


https://youtu.be/XP_hrEbCiel

<https://youtu.be/ayl88vs5G68>

Notonectidae - "Backswimmers"

- ▶ Superficially similar to Corixids, but as name implies, they swim on their backs.
- ▶ Also differ from Corixids by being predatory.



Notonectidae – Additional Info

- ▶ Good fliers – can disperse easily and relatively far
 - ▶ Show up on lots of places/habitats, including swimming pools (as video mentioned)
- ▶ Can painfully bite humans (stab with mouthparts)

Belostomatidae – Giant Water Bugs



<https://youtu.be/IDfcEj4GhVQ>

Belostomatidae – Additional Info

- ▶ For scale (**giant** water bug)...
- ▶ Largest of all Hemipterans (terrestrial or aquatic)
- ▶ Eat fish and amphibians too, not just other inverts
- ▶ Raptorial forelegs



[https://commons.wikimedia.org/wiki/File:Giant_water_bug_\(Belostomatidae\),_Vohimana_reserve,_Madagascar_\(13569458513\).jpg](https://commons.wikimedia.org/wiki/File:Giant_water_bug_(Belostomatidae),_Vohimana_reserve,_Madagascar_(13569458513).jpg)

Nepidae – "Water Scorpions"

Get name from looking superficially like a scorpion, but are not actually related to scorpions.



https://youtu.be/EiviWI_Rmfo

Nepidae – Additional Information

- ▶ Not great swimmers and rarely fly - usually stick in vegetation
- ▶ Can also bite (stab) humans
- ▶ Some species are long and narrow like stick insects
- ▶ Raptorial forelegs



[https://commons.wikimedia.org/wiki/File:Water_scorpion,_Nepidae,_Atlantic_forest,_northeastern_Bahia,_Brazil_\(6299414518\).jpg](https://commons.wikimedia.org/wiki/File:Water_scorpion,_Nepidae,_Atlantic_forest,_northeastern_Bahia,_Brazil_(6299414518).jpg)

Hemiptera imitations for fly fishing:

Not most common fly for people to use, but some do exist:

Click Link:

Backswimmer/Water boatmen:

▶ <https://fridaynightflies.com/friday-night-flies-water-boatman-backswimmer/>

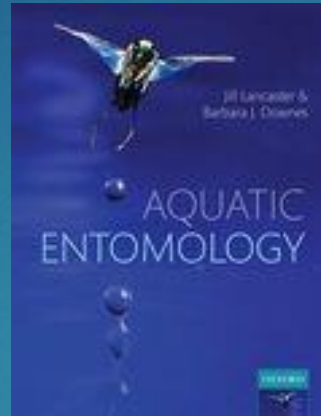
▶ Note: Link not meant to be product endorsement, just a reference to photos.

References and Additional Reading:

Aquatic Entomology

Jill Lancaster and Barbara Downes
Oxford University Press, 2013
ISBN: 9780199573219

Textbook covering basics of aquatic ecology and entomology (no ID).

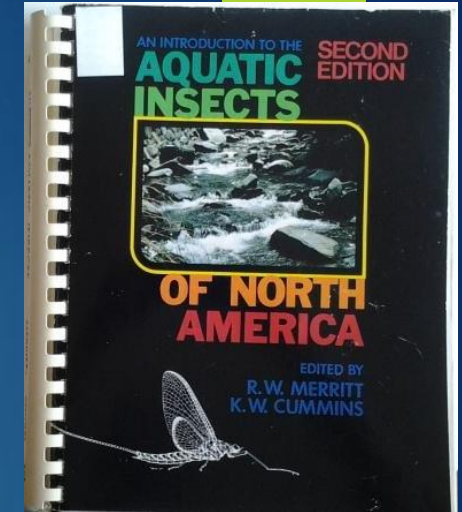


Introduction to the Aquatic Insects of North America (2nd ed)

(multiple newer versions)

R.W. Merritt and K.W. Cummins
Kendall Hunt Pub Co, 1984
ISBN: 0840331800

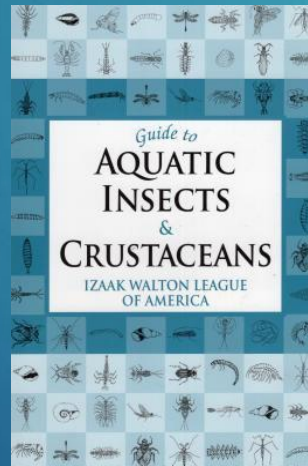
Advanced, comprehensive info and ID below order.



Guide to Aquatic Insects & Crustaceans

Izaak Walton League of America
Stockpole Books, 2006
ISBN: 0811732452

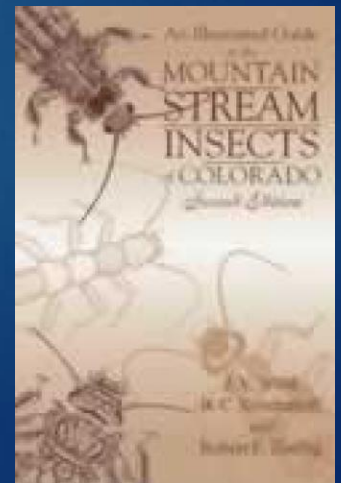
Simple (and cheap!) field guide to ID insects and more to order; water quality estimates.



An Illustrated Guide to the Mountain Stream Insects of Colorado (2nd ed)

J.V. Ward, B.C. Kondratieff, R.E. Zuellig
University Press of Colorado, 2002
ISBN: 9780870816536

Basic ecology and ID of local (CO) stream insects.





Lepidoptera and Diptera

ECOLOGY AND BEHAVIOR



https://commons.wikimedia.org/wiki/File:Acentria_ephemera_0002003.jpg



https://commons.wikimedia.org/wiki/File:Pyralidae_individuals.jpg

Lepidoptera

MOTHS AND BUTTERFLIES

Lepidoptera

- ▶ Greek *lepidos* (scale) and *pteron* (wing); adults have scales (powdery, flat) on wings
- ▶ Very diverse group of insects overall: ~180,000 species (including terrestrial), but relatively few aquatic species (~730+)

Lepidoptera

- ▶ Not as well studied as other orders of aquatic insects (not as many videos/photos for this order)
- ▶ Some historic notions that they are not as important as other orders, ***but probably not a good assumption***
- ▶ Not all are fully aquatic (submerged for most of life) – some are semi-aquatic and live above water line on emergent aquatic plants
- ▶ Overwinter as larvae commonly, but sometimes as eggs
- ▶ Reminder: Closely related to Trichoptera

Lepidoptera

- ▶ Univoltine or multivoltine
- ▶ Holometabolous (complete metamorphosis with pupal stage)
- ▶ Eggs, larvae, and pupae are aquatic; adults are terrestrial (usually – *Acentria ephemerella* has wingless females that stick around water)
 - ▶ some variability for semi-aquatic species, however

Lepidoptera Adults - Characteristics

- ▶ Lepidoptera (butterfly/moth) body form is easily recognizable...
- ▶ Large, scaly wings; "fluttery" flight
- ▶ Variety in size, coloration, etc....
- ▶ Long proboscis for feeding



<https://youtu.be/ikvfn7nTxE4>

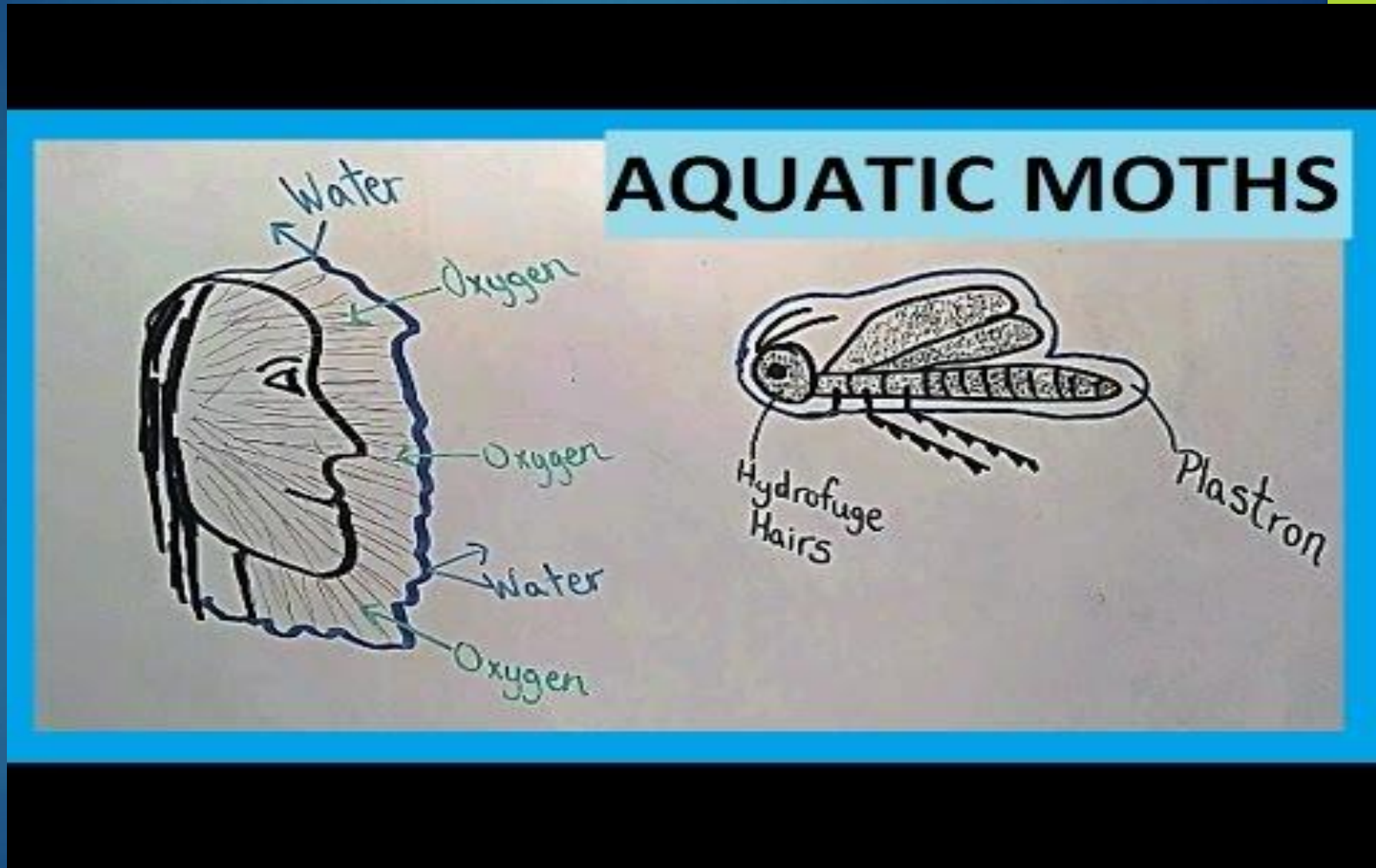
Lepidoptera Adults

- ▶ Can feed on nectar like other moths/butterflies, but don't usually live too long
- ▶ Many species nocturnal as with terrestrial moths
- ▶ Interesting: *Acentria ephemerella* (photo)
 - ▶ Wingless females...



https://commons.wikimedia.org/wiki/File:Acentria_ephemerella_f.jpg

Lepidoptera Life Cycle and Interesting Facts



Lepidoptera Larvae - Characteristics

- ▶ Long-bodied (caterpillars) - range usually 10-25mm
- ▶ Distinct head with ring of ocelli (simple eyes)
- ▶ Have 6 true legs like all insects, but also prolegs on rear body segments
- ▶ Fully aquatic species commonly have filamentous gills along body, especially those in flowing water

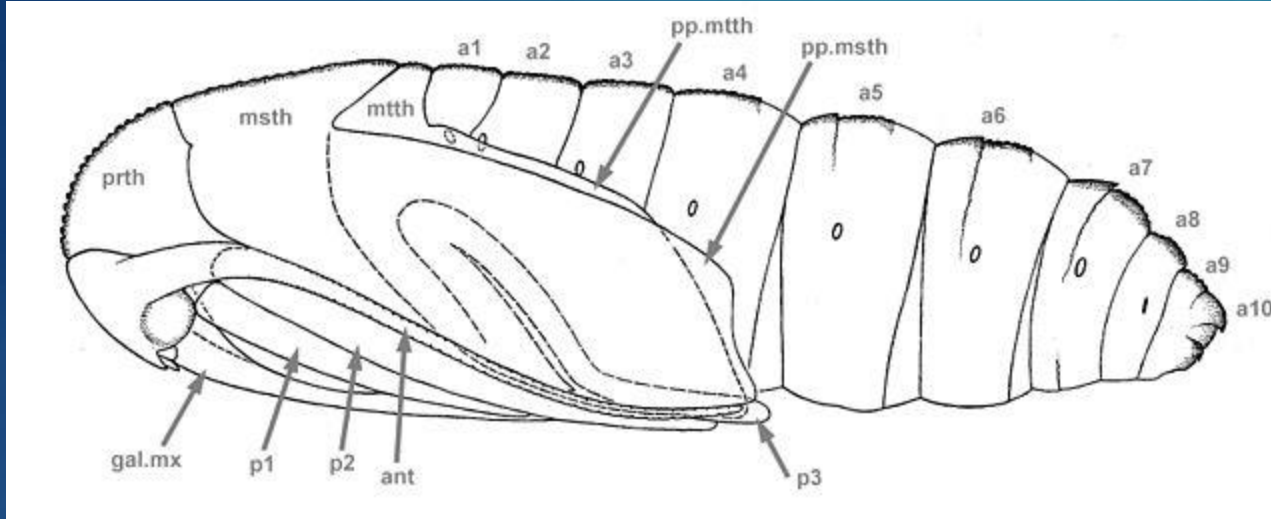


<https://youtu.be/WPerlGCpiOo>

Lepidoptera Larvae

- ▶ Diet: herbivores (shredders) – usually associated with vascular plants, but sometimes graze algae
- ▶ Typically 4-5 larval instars
- ▶ Because of damage they cause to vascular plants, have been successfully used for invasive plant control efforts (*Acentria ephemerella*)
- ▶ Poor swimmers – usually stay on their host plant for entire life.
- ▶ Some make protective retreats from plant matter (similar to caddis) as video mentioned

Lepidoptera Pupae



<https://commons.wikimedia.org/wiki/File:Galleria-pupa-abbr.jpg>



https://commons.wikimedia.org/wiki/File:Saucrobotys_futilalis_pupa.jpg

Note: These are images of terrestrial Crambidae pupae (aquatic photos could not be found).

Numbers and Key Families of Lepidoptera

- ▶ Majority from family Pyralidae and Crambidae (many moved recently to Crambidae, but some disagreement)
 - ▶ both families in superfamily Pyraloidea
- ▶ Semi-aquatic species can be found in 10+ other families, but you just need to know the above.
- ▶ 730+ aquatic species worldwide

Lepidoptera fly fishing imitations:

Adults – Dry Flies:

Patterns look similar to caddis flies...

Nocturnal = missed by many anglers



https://commons.wikimedia.org/wiki/File:Elk_Hair_Caddis_dry_flies.jpg

Larvae – Wet Flies

- ▶ Also not the most common compared to other orders we have covered so far (but fish do eat them)
- ▶ Lots of things can mimic – sometimes people use mimics of terrestrial caterpillars...



https://commons.wikimedia.org/wiki/File:Tipulidae_April_2008-2.jpg



https://commons.wikimedia.org/wiki/File:Black_Fly_Larva.png

Diptera

TRUE FLIES, MIDGES, MOSQUITOS

[https://commons.wikimedia.org/wiki/File:Midge_\(20422956509\).jpg](https://commons.wikimedia.org/wiki/File:Midge_(20422956509).jpg)



Similar to Hemiptera, lots of variety and key families of Diptera...

- ▶ We will split Diptera into specific key families and briefly cover their basic biology separately.
- ▶ Flies are extraordinarily diverse and can commonly make up 90% of sampled macroinvertebrate biomass (this is subjective)
 - ▶ So longer lecture section here...

Diptera – Common Traits

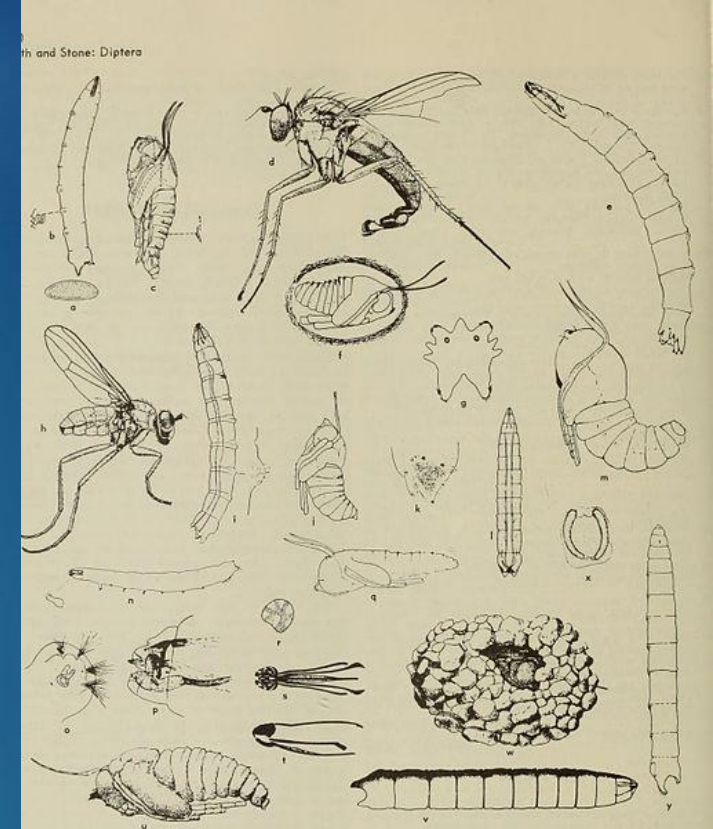
- ▶ Diptera from Greek *di* (two) and *pteron* (wing) - flies only have one pair of true wings! Only order with this trait.
- ▶ All are holometabolous.
- ▶ Lots of morphological variability across order otherwise as we will see.
- ▶ Exists in both lentic and lotic systems.
- ▶ Voltinism, overwintering, etc. will be covered for each selected family....

Diptera Key Families

Focus for today:

- ▶ Chironomidae: midges
- ▶ Simuliidae: black flies
- ▶ Tipulidae: crane flies
- ▶ Culicidae: mosquitoes
- ▶ Chaoboridae: phantom midges

- ▶ Others with aquatic larvae (**don't memorize**): Athericidae (watersnipe flies); Empididae (dance flies); Tabanidae (horse/deer flies); Stratiomyidae (soldier flies); Blephariceridae (net-winged midges); Muscidae (house flies), Sciomyzidae (snail-killing or marsh flies)... even more!



[https://commons.wikimedia.org/wiki/File:Aquatic_insects_of_California,_with_keys_to_North_American_genera_and_California_species_\(1956\)_-\(19562651459\).jpg](https://commons.wikimedia.org/wiki/File:Aquatic_insects_of_California,_with_keys_to_North_American_genera_and_California_species_(1956)_-(19562651459).jpg)

Diptera Key Families



Note: Family selection for this lecture is not necessarily meant to indicate relative importance - that varies a lot by habitat/location.

The following are just especially common and often observed, local, or of medical relevance....

Chironomidae - "Midges"



<https://youtu.be/NGQEPZqNZU8>

Chironomidae - "Midges"

- ▶ Large and very common family (2,000+ species)
- ▶ Many species tolerant of poorer water quality than lots of other orders/families we have discussed
- ▶ Exist in lentic and lotic habitats of all kinds
- ▶ Often have very high biomass and are key targets of predators (both insects and fish)
- ▶ Overwinter commonly as larvae or pupae in sediment – depends on species/location
- ▶ Can be either univoltine or multivoltine – varies by species

Chironomidae Characteristics

Larvae:

- ▶ Distinct, often darkened head
- ▶ One set of prolegs below head
- ▶ Can vary in color – red common (called "bloodworms"); also commonly white to olive otherwise
- ▶ 2 - 30mm



[https://commons.wikimedia.org/wiki/File:Chironomidae_indet._\(Chironomidae\)_-_\(_larva\),_Elst_\(Gld\),_the_Netherlands.jpg](https://commons.wikimedia.org/wiki/File:Chironomidae_indet._(Chironomidae)_-_(_larva),_Elst_(Gld),_the_Netherlands.jpg)



<https://commons.wikimedia.org/wiki/File:Mikrofoto.de-Zuckmueckenlarve3.jpg>



https://commons.wikimedia.org/wiki/File:Chironomus_plumosus01.jpg

Adults:

- ▶ Plumose (fuzzy) antennae (males)
- ▶ Long, slender abdomen and legs
- ▶ Superficially resemble mosquitoes, but have no proboscis
- ▶ 1.5 - 20 mm

Chironomidae Adults

- ▶ Mate in aerial swarms, on water's surface, or on substrate – females broadcast eggs or lay mass on water or plants
- ▶ Often don't feed – when they do it is honeydew or nectar
- ▶ Like many other orders, adults live short life (a week or less) and die after reproducing

Chironomidae Larvae

- ▶ Red species ("bloodworms") have hemoglobin – rare in insects (usually just have hemolymph) - particularly hardy to poor water quality
- ▶ Big variety in functional feeding groups – can be:
 - ▶ Shredders
 - ▶ Scrapers/Grazers
 - ▶ Collector Gatherers
 - ▶ Sometimes will predate upon other midge larvae
- ▶ Commonly 4 instars

Chironomidae Pupae



https://commons.wikimedia.org/wiki/File:Chironomus_zealandicus.jpg

Simuliidae - "Black flies"



and basically organic materials are made available

<https://youtu.be/k9epmJGUhso>

Simuliidae - "Black flies"

- ▶ Medically important – eat blood to reproduce – can be a disease vector
- ▶ Usually found in lotic systems (but can be in any size stream/river)
- ▶ Can be either univoltine or multivoltine based on species
- ▶ Overwinter as either eggs or mature larvae

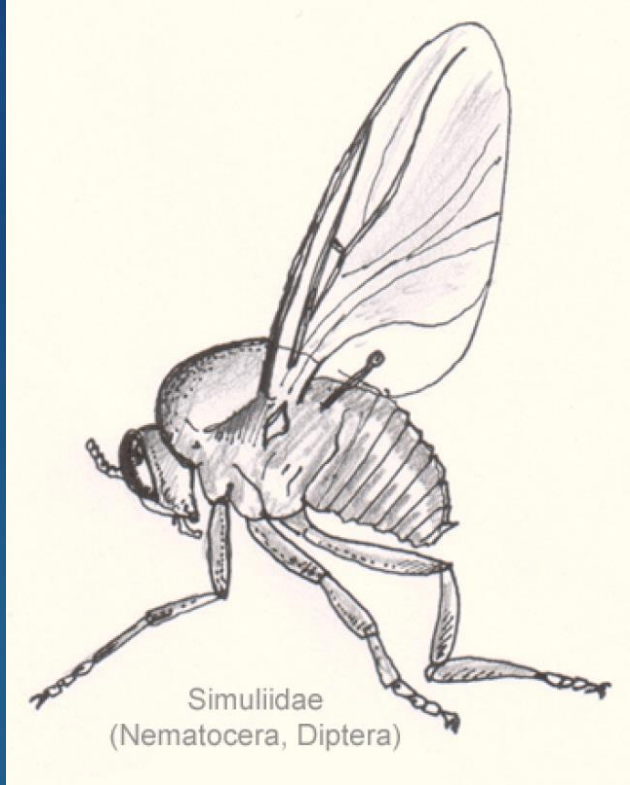
Simuliidae Characteristics

Larvae:

- ▶ Bulbous posterior with attachment disc at bottom (some say bowling pin shaped)
- ▶ Well developed/sclerotized head
- ▶ Single proleg under head and no other appendages
- ▶ Labral fans for getting food from water (not all species)

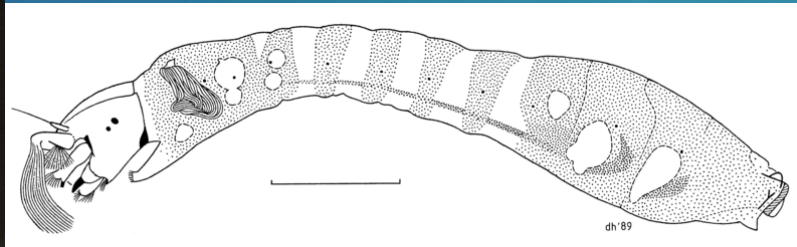
Adults:

- ▶ Small, stout bodies (1.2 - 5.5 mm)
- ▶ Black or dark brown, but can be other colors too
- ▶ Broad wings that have strong anterior veins; weak posterior
- ▶ Short proboscis, strong mouthparts (females especially).



<https://commons.wikimedia.org/wiki/File:Dip-nem-simuliidae-sp.gif>

https://commons.wikimedia.org/wiki/File:Black_Fly.png



https://commons.wikimedia.org/wiki/File:DIPT_Simuliidae_Austrosimulium_australense_larva.png



<https://commons.wikimedia.org/wiki/File:Simuliidae.jpg>

Simuliidae Adults

- ▶ Some species are a nuisance and bite humans (animals too)
 - ▶ females need blood to reproduce; males eat nectar
- ▶ Feed in middle of day unlike mosquitoes that often feed most in crepuscular hours
- ▶ Egg laying behavior depends on species - can be freely on water or on plants in water, or some even go under water

Simuliidae Larvae

- ▶ Attach to substrate in streams with silk and filter out food particles with labral fans (collectors/filter feeders)
- ▶ Species without labral fans gather detritus from around them at attachment site
- ▶ Drift downstream on silk threads from abdomen to get to new location/food
- ▶ 4-9 instars (often 7)
- ▶ Last instar before pupa spins a cocoon

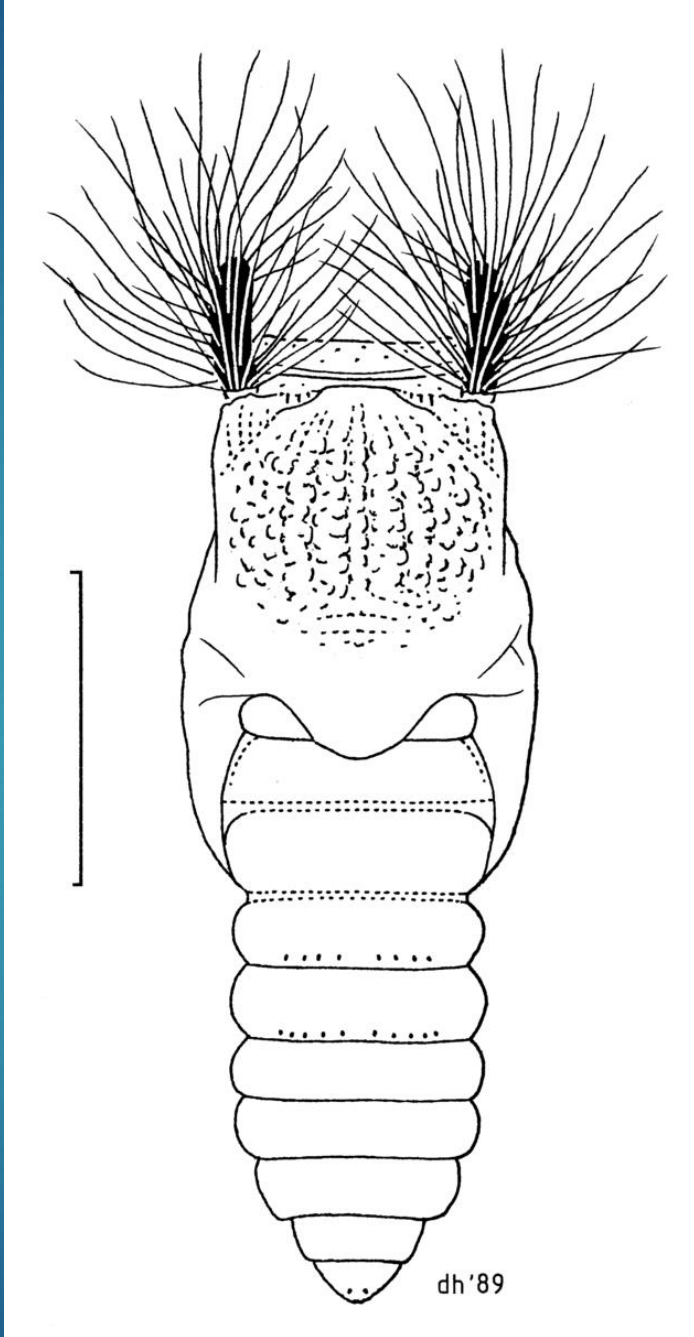
Simuliidae Larval Feeding



<https://youtu.be/42v75SbNquM>

Simuliidae Pupae

- ▶ Pupal stage lasts 4-7 days



Tipulidae - "Crane Flies"

**I AM NOT A
MOSQUITO**



<https://youtu.be/2RF6iyrwAeU>

Tipulidae – "Crane Flies"

- ▶ Over 15,000 species (some consider the largest Diptera family) - not all are aquatic, but most are associated with wet environments
- ▶ Often large, but some are mosquito-sized
- ▶ Can be found in both lentic and lotic habitats
- ▶ Overwinter as larvae or pupae in moist soil, vegetation, or underwater
- ▶ Some (more terrestrial) species can be agricultural pests (root eaters), but harmless to humans otherwise
- ▶ Most are univoltine

Tipulidae Characteristics

Larvae:

- ▶ Relatively large and plump – caterpillar-like
- ▶ Head usually retracted – rounded appearance to front of body
- ▶ Extensions/lobes(finger-like) on posterior



[https://commons.wikimedia.org/wiki/File:Tipulidae_sp._\(26445350520\).jpg](https://commons.wikimedia.org/wiki/File:Tipulidae_sp._(26445350520).jpg)



<https://commons.wikimedia.org/wiki/File:CraaneFly.jpg>

Adults:

- ▶ Long, slender body and legs
- ▶ As video indicated, often mistaken for large mosquitoes.
- ▶ No long proboscis like mosquitoes and commonly much larger than a mosquito

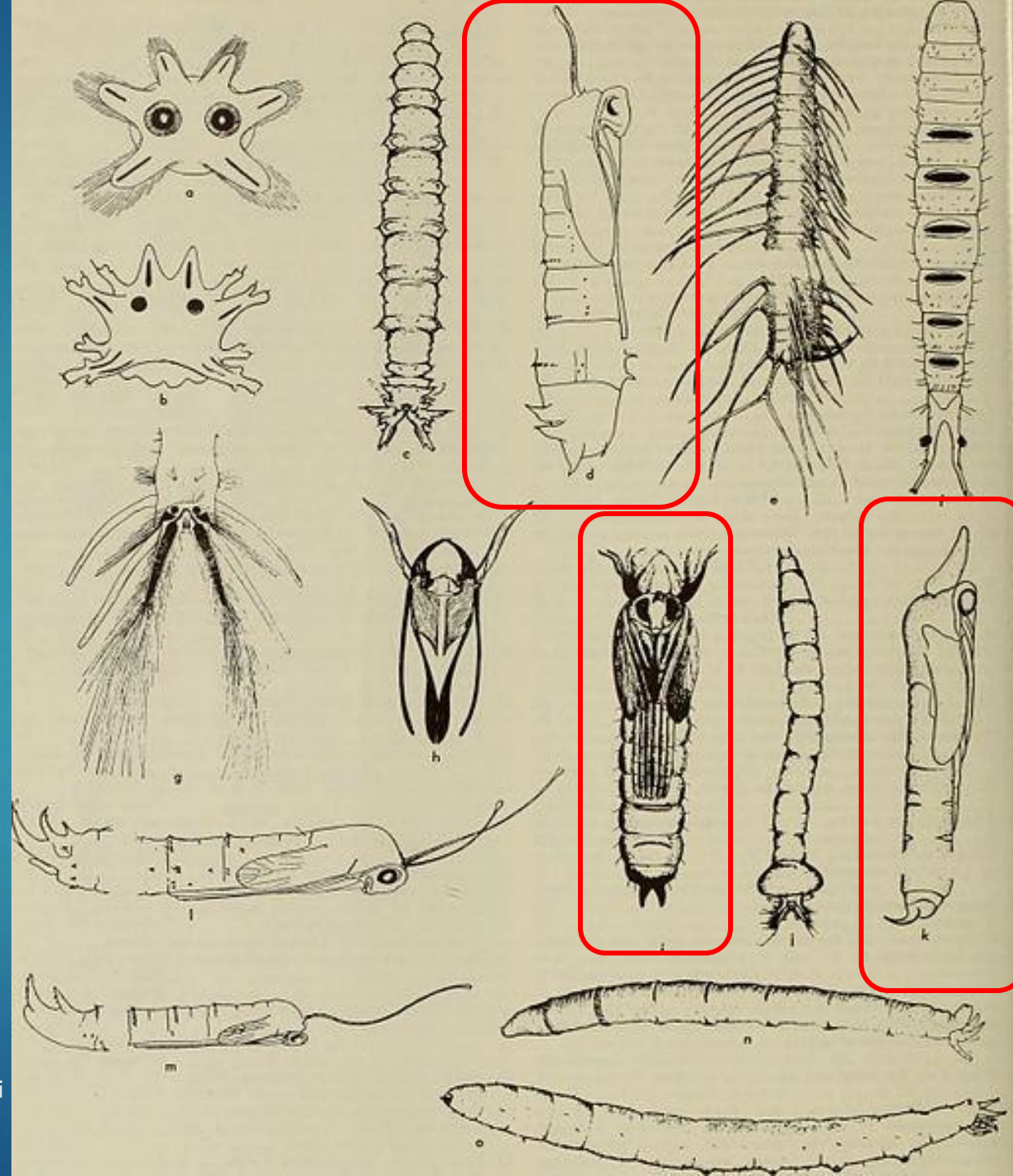
Tipulidae Adults

- ▶ Often colloquially called "mosquito hawks" or "skeeter eaters"
 - ▶ They do not eat mosquitoes!
- ▶ Often don't eat anything at all and die shortly after mating like so many other (10-15 day lifespan)
- ▶ Mate right away after emerging from pupal stage
- ▶ Females lay eggs in algae mats, soil, or can even just drop them into water in flight

Tipulidae Larvae

- ▶ Many species depend on atmospheric oxygen and cannot venture far from water's surface
- ▶ Detritivores – commonly shredders and collectors found in leaf packs; some are predators; some are collectors of detritus
- ▶ Commonly 4 instars, but varies a bit by species
- ▶ Can get to 5 cm long
- ▶ Tough skin has garnered nickname "letherjackets"

Tipulidae Pupae



Culicidae – Mosquitoes

Click video link:

<https://youtu.be/wFfO7f8Vr9c>

Culicidae – Mosquitoes



<https://youtu.be/rD8SmacBUcU>

Culicidae - Mosquitoes

- ▶ Overwintering depends on species – can be in any stage
- ▶ Multivoltine – have quick life cycle
- ▶ Interesting fact: some humans are more attractive to mosquitoes than others (based on genetics and skin compounds)
- ▶ Most mosquito species are non-discriminate in terms of hosts, but some do specialize (including on humans) - the human specialists spread the most disease

Culicidae Characteristics

Larvae:

- ▶ Long bodied with distinct head
- ▶ Distinguished by breathing apparatus (which, like head morphology, is used in identification below family)



https://commons.wikimedia.org/wiki/File:Larva_mosquito.jpg



[https://commons.wikimedia.org/wiki/File:Culicidae_-_Flickr_-_gailhampshire_\(1\).jpg](https://commons.wikimedia.org/wiki/File:Culicidae_-_Flickr_-_gailhampshire_(1).jpg)

Adults:

- ▶ Readily recognizable by slender body, long legs, and proboscis (especially in females)
- ▶ Males have proboscis too, but it is smaller and weaker

Culicidae Adults

- ▶ Females drink blood, males do not (males eat nectar or sap)
- ▶ Responsible for more deaths than any other animal - most dangerous animal in the world!
- ▶ After mating (lots of behavioral variability by species from swarms to underground animal burrows), females will lay eggs in just about any kind of standing water
- ▶ Can live for a few months if conditions are right (but commonly just a couple weeks) - females tend to live longer (unfortunately!)

Culicidae Larvae

- ▶ Many species can complete development in just 7-10 days
 - ▶ 4 instars
- ▶ Breathe through spiracles at surface
- ▶ Eat small particles of detritus (collectors) via mouth brush action (seen in videos)

Culicidae Pupae



https://commons.wikimedia.org/wiki/File:Underwater_view_of_mosquito_pupae_in_standing_water.jpg

Culicidae Life Cycle Video (Including Pupae)



<https://youtu.be/d1CpWPDjVvU>

Chaoboridae – "Phantom Midges" or "Glass Worms"

- ▶ Cosmopolitan distribution
- ▶ Very important and often extraordinarily abundant in lentic systems
- ▶ Important food source for fish
- ▶ Can be either univoltine or multivoltine based on species, habitat, conditions.
- ▶ Overwinters as mature larvae commonly, but sometimes as eggs

Chaoboridae Characteristics

Larvae:

- ▶ Antennae modified as predatory graspers! (video)
- ▶ Body often clear/translucent - hence common name
- ▶ Anal fans (setae)



<https://commons.wikimedia.org/wiki/File:ChaoborusSpec.JPG>



<https://commons.wikimedia.org/wiki/File:Chaoborus.crystallinus.male.jpg>

Adults:

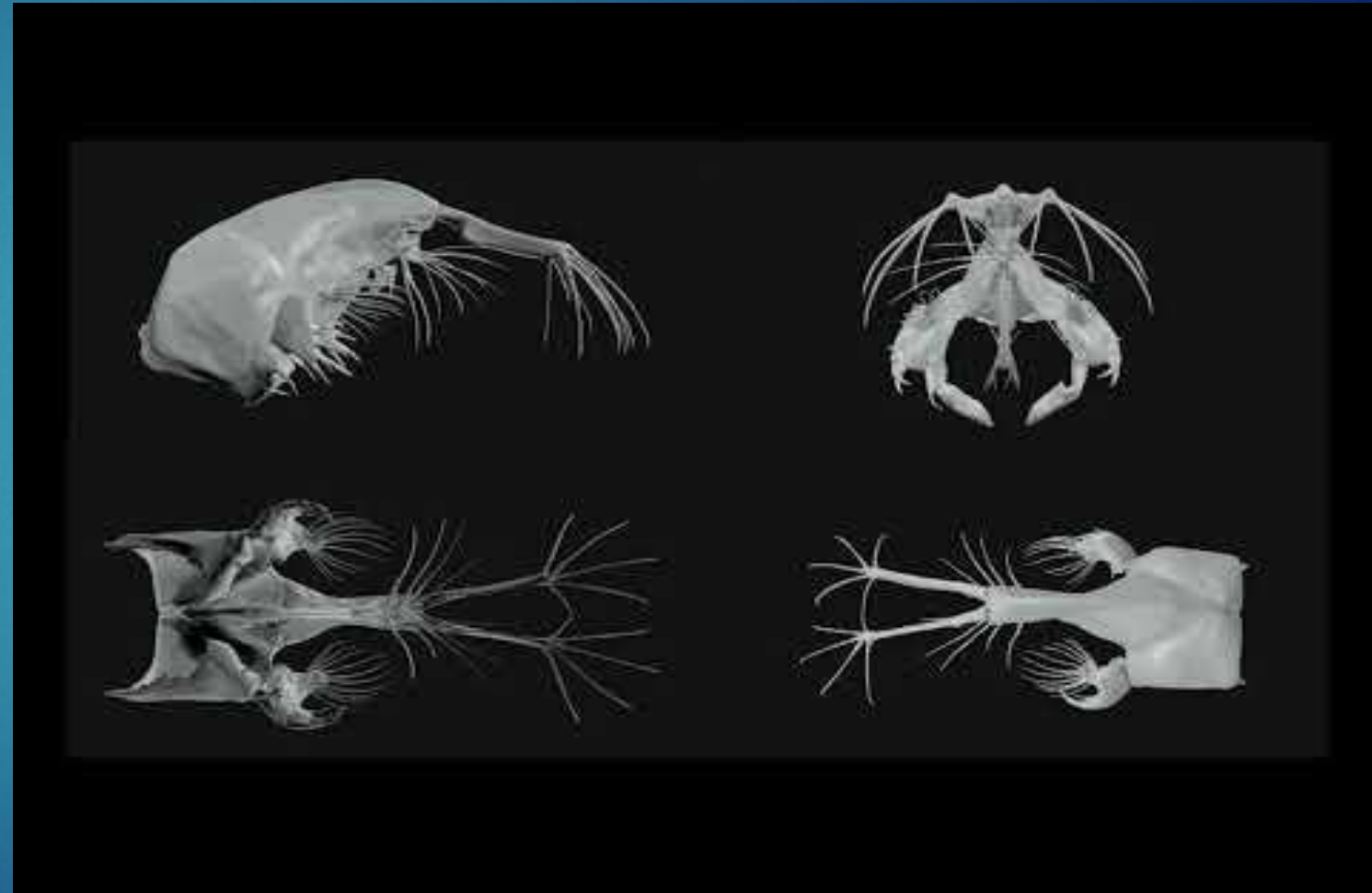
- ▶ Look similar to Chironomidae with plumose antennae and overall body form
 - ▶ You will not be asked to differentiate the two
- ▶ 2-10mm long
- ▶ Color variability by species, but sometimes translucent too

Chaoboridae Adults

- ▶ Often don't feed, but eat nectar when they do
- ▶ Lay eggs in rafts on the surface of the water

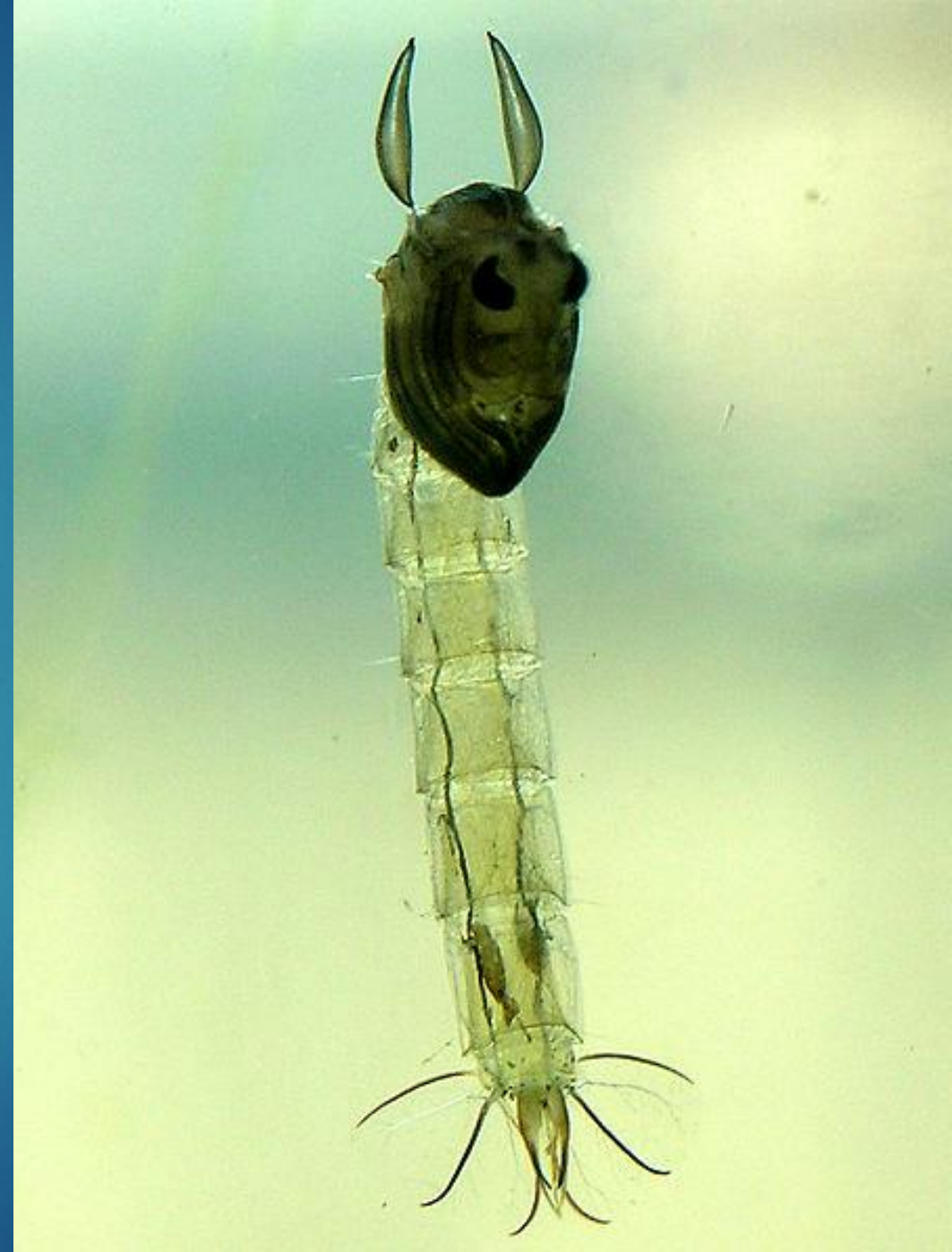
Chaoboridae Larvae

- ▶ Live in water column – neutrally buoyant (plankton)
- ▶ Predators (often on mosquitoes and daphnia)
- ▶ Commonly 4 instars
- ▶ Larvae migrate from bottom during night hours to feed and avoid being eaten



<https://youtu.be/y5r1DHb9nOY>

Chaoboridae Pupae



https://commons.wikimedia.org/wiki/File:Chaoborus_sp._pupa,_Netherlands.jpg

Diptera Imitations for Fly Fishing – (sometimes very small – midges!)

Adults



https://commons.wikimedia.org/wiki/File:Biot_Para-Midge.jpg



https://commons.wikimedia.org/wiki/File:Pale_Morning_Dun.jpg

Larvae



<https://commons.wikimedia.org/wiki/File:Bloodworm-trout-flies.jpg>



https://commons.wikimedia.org/wiki/File:Biot_Midges.jpg

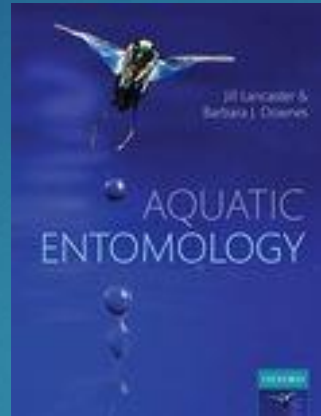
Lots of variety in both size and color based on family, but flies often have classic dry fly (minus 'tail' sometimes) and nymph forms.

References and Additional Reading:

Aquatic Entomology

Jill Lancaster and Barbara Downes
Oxford University Press, 2013
ISBN: 9780199573219

Textbook covering basics of aquatic ecology and entomology (no ID).

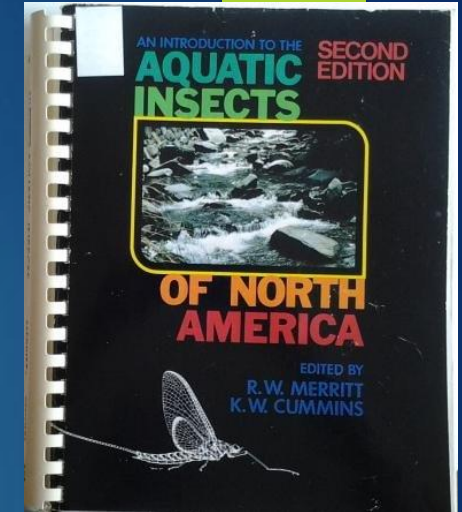


Introduction to the Aquatic Insects of North America (2nd ed)

(multiple newer versions)

R.W. Merritt and K.W. Cummins
Kendall Hunt Pub Co, 1984
ISBN: 0840331800

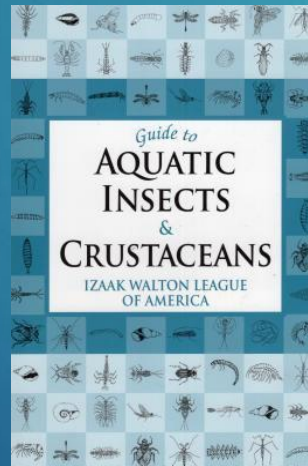
Advanced, comprehensive info and ID below order.



Guide to Aquatic Insects & Crustaceans

Izaak Walton League of America
Stockpole Books, 2006
ISBN: 0811732452

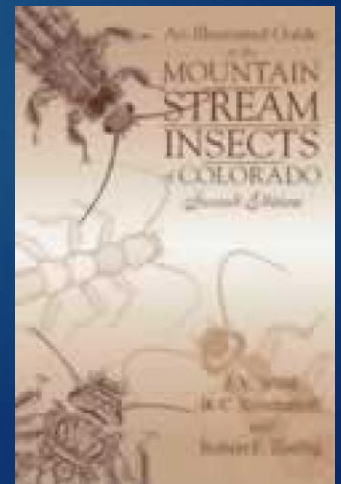
Simple (and cheap!) field guide to ID insects and more to order; water quality estimates.



An Illustrated Guide to the Mountain Stream Insects of Colorado (2nd ed)

J.V. Ward, B.C. Kondratieff, R.E. Zuellig
University Press of Colorado, 2002
ISBN: 9780870816536

Basic ecology and ID of local (CO) stream insects.





Neuroptera and Coleoptera

ECOLOGY AND BEHAVIOR

Neuroptera

LACEWINGS AND SPONGILLA FLIES



[https://commons.wikimedia.org/wiki/File:Neuroptera_Osmylidae_\(2489420416\).jpg](https://commons.wikimedia.org/wiki/File:Neuroptera_Osmylidae_(2489420416).jpg)

Neuroptera

- ▶ Greek *neuron* (sinew or tendon or nerve) and *pteron* (wing); adults have very pronounced veins on wings
- ▶ Aquatic or semiaquatic larvae – all other stages are terrestrial
- ▶ Often described with Megaloptera in books/keys (related and look somewhat similar), but separate here as small order to pair with another big order (Coleoptera - beetles)
- ▶ Terrestrial forms include lacewings, mantidflies, antlions – neat order!

Neuroptera

- ▶ Holometabolous and aquatic species often univoltine
- ▶ Typically overwinter as pupae or larvae
- ▶ 17 families in order with only two having fully aquatic (Sisyridae) or semiaquatic (Osmylidae) larvae
- ▶ Sisyridae (spongilla flies) will be focus for this lecture (has been collected in the eastern plains of CO)
- ▶ Osmylidae (lacewing) is semi-aquatic – lives near edge of water and enters water to find prey
- ▶ 73 aquatic species described; Only 6 aquatic species in North America

Neuroptera (Sisyridae) Adults - Characteristics

- ▶ Large, veiny wings
- ▶ Long antennae
- ▶ Adults smaller (5-6 mm wing length) and lacking big mouthparts compared to Megaloptera
- ▶ Variability in color (can even be green)



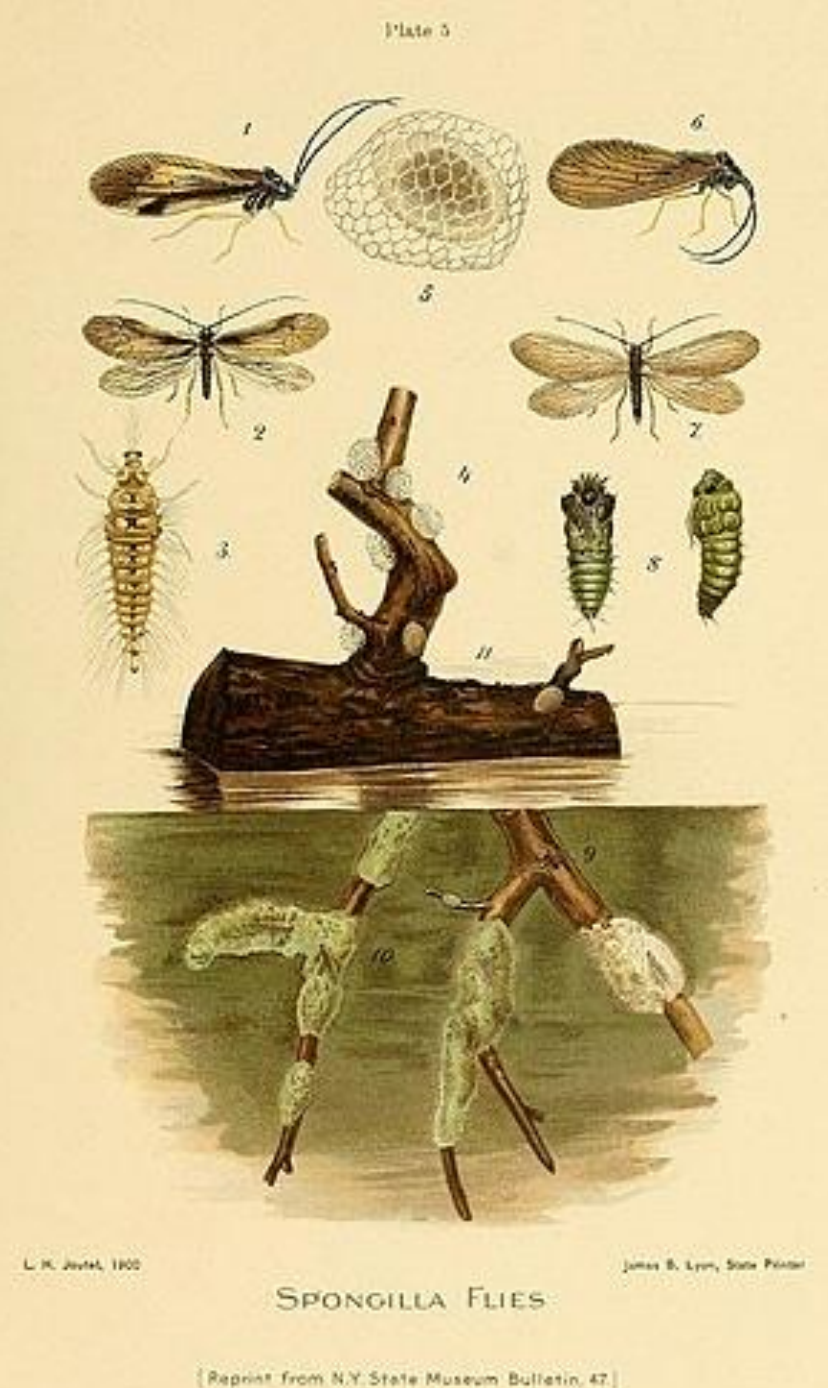
https://commons.wikimedia.org/wiki/File:Sisyra_terminalis.jpg



[https://commons.wikimedia.org/wiki/File:Sisyra_nigra_\(Sisyridae\)_-_\(_imago\)_,_Elst_\(Gld\),_the_Netherlands.jpg](https://commons.wikimedia.org/wiki/File:Sisyra_nigra_(Sisyridae)_-_(_imago)_,_Elst_(Gld),_the_Netherlands.jpg)

Sisyridae Adults - Reproduction

- Eggs are laid over water and larvae hatch and fall in



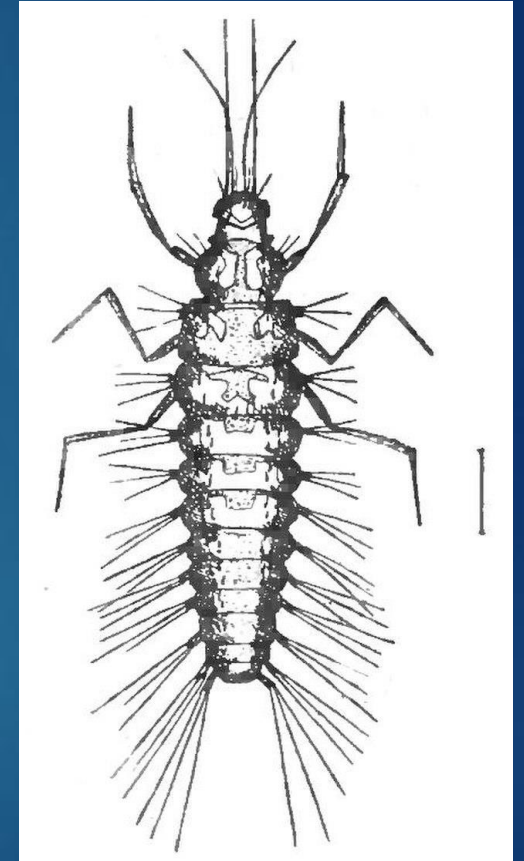
[https://commons.wikimedia.org/wiki/File:Annual_report_of_the_Forest,_Fish_and_Game_Commission_of_the_State_of_New_York_\(1899\)__\(14755454805\).jpg](https://commons.wikimedia.org/wiki/File:Annual_report_of_the_Forest,_Fish_and_Game_Commission_of_the_State_of_New_York_(1899)__(14755454805).jpg)

Sisyridae Larvae - Characteristics

- ▶ Long-bodied
- ▶ Long antennae
- ▶ Setae along body (look hairy)



[https://commons.wikimedia.org/wiki/File:Annual_report_of_the_Forest,_Fish_and_Game_Commission_of_the_State_of_New_York_\(1899\)__\(14755454805\).jpg](https://commons.wikimedia.org/wiki/File:Annual_report_of_the_Forest,_Fish_and_Game_Commission_of_the_State_of_New_York_(1899)__(14755454805).jpg)



<https://commons.wikimedia.org/wiki/File:SisyridaeLarva.jpg>

Neuroptera Larvae

- ▶ Diet: predators (Osmylidae) or parasites on freshwater sponges (Sisyridae) - sort of a different functional feeding group!
- ▶ Suctorial mouthparts (suck juices from sponges or prey)
- ▶ Only 3 instars – perhaps the lowest of all aquatic insects
- ▶ Leave water to form really neat cocoons to pupate...

Sisyridae Larvae



https://youtu.be/_TZTdLDRUB8

Sisyridae Pupae



[https://commons.wikimedia.org/wiki/File:Annual_report_of_the_Forest,_Fish_and_Game_Commission_of_the_State_of_New_York_\(1899\)_\(14755454805\).jpg](https://commons.wikimedia.org/wiki/File:Annual_report_of_the_Forest,_Fish_and_Game_Commission_of_the_State_of_New_York_(1899)_(14755454805).jpg)

Spongilla – freshwater sponge!



https://commons.wikimedia.org/wiki/File:Spongilla_lacustris.jpg

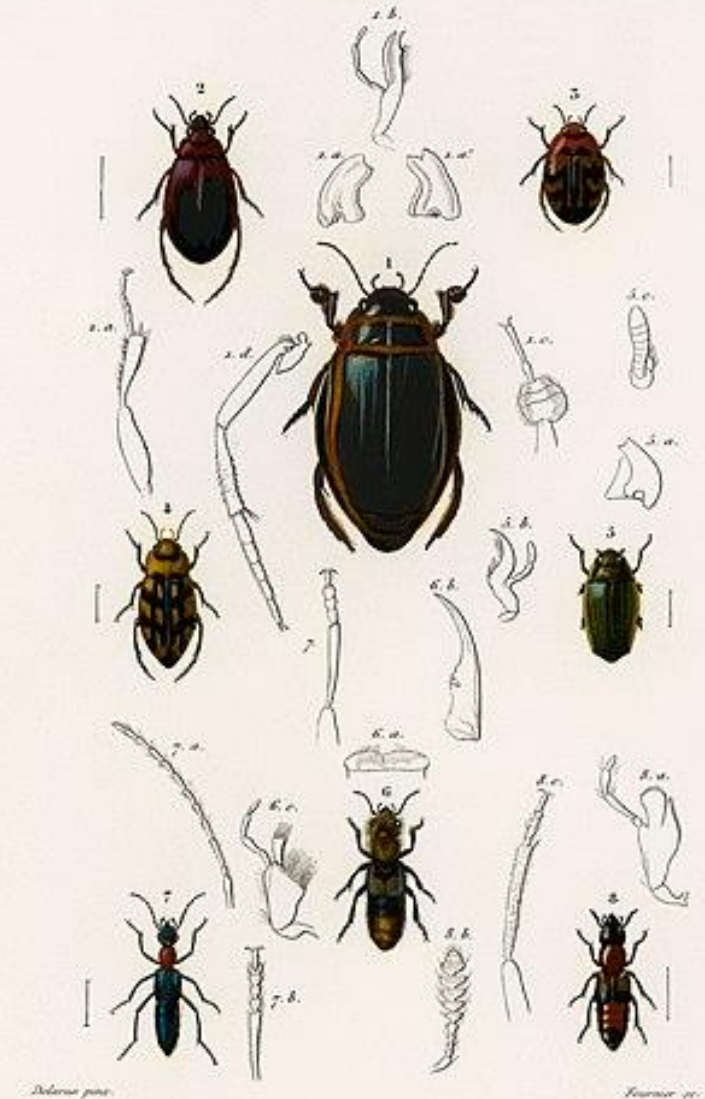
Neuroptera imitations for fly fishing:

- ▶ Some patterns do exist, but they typically resemble terrestrial adults: [Click Link](#)

Coleoptera

BETLES

[https://commons.wikimedia.org/wiki/File:1.dyticus_latissimus_\(predaceous_diving_beetles\);_2.hygrobia_hermani_\(aquatic_beetles\);_3.hyphidrus_variegatus_\(water_beetle\);_4.hydroporus_duodecimpustulatus_\(water_beetle\);_5.gyrinus_strigosus_\(aquatic_beetles\);_6.staphylinus_hirtus.jpg](https://commons.wikimedia.org/wiki/File:1.dyticus_latissimus_(predaceous_diving_beetles);_2.hygrobia_hermani_(aquatic_beetles);_3.hyphidrus_variegatus_(water_beetle);_4.hydroporus_duodecimpustulatus_(water_beetle);_5.gyrinus_strigosus_(aquatic_beetles);_6.staphylinus_hirtus.jpg)



1. *Dytique très large*. (Dyticus latissimus, Fab.) 2. *Hygrobie d'Herman*. (Hygrobia hermanni, Fab.)
3. *Hyphidre varié*. (Hyphidrus variegatus, Mq.) 4. *Hydropore à 12 pustules*. (Hydroporus duodecimpustulatus, Fab.)
5. *Gyrin strié*. (Gyrinus strigosus, Fab.) 6. *Staphyline hérissé*. (Staphylinus hirtus, L.)
7. *Bedon à cou rouge*. (Psephenus rubellus, Grav.) 8. *Cyffore roux*. (Cyphorus rufus, Fab.)

Longhair imp.

Beetle Respiration Video



<https://youtu.be/T-RtG5Z-9jQ>

Coleoptera – Common Traits

- ▶ Coleoptera from Greek *koleos* (sheath) and *pteron* (wing) - forewings are hardened for protection (called elytra)
- ▶ Elytra are a primary distinguishing characteristic of Coleoptera – lots of variability otherwise in larval and adult morphology and behavior...

Lots of Variety and Key Families!

- ▶ Similar to Hemiptera and Diptera, we will split Coleoptera into specific families and briefly cover their basic biology.
- ▶ There are ~30 families (out of ~170 total) that have aquatic representation, but we will focus on:
 - ▶ Elmidae (riffle beetles)
 - ▶ Psephenidae (water pennies)
 - ▶ Gyrinidae (whirligig beetles)
 - ▶ Dytiscidae (predaceous diving beetle)

Coleoptera – Common Traits

- ▶ All are holometabolous
- ▶ Larvae have well-developed, sclerotized head with often short (3-4 segment) antennae
- ▶ Larval prolegs normally absent; some species have filamentous gills
- ▶ Lots of variability in adults as we will see...

Elmidae - "Riffle Beetles"

- ▶ Commonly found in faster flowing streams (hence name)
- ▶ Commonly univoltine and overwinter as larvae.
- ▶ 6-8 larval instars – may take more than a year to develop (semivoltine)
- ▶ Both adults and larvae are fully aquatic – even mate underwater
- ▶ Diet: Scrapers/grazers (periphyton) or eat detritus and would be a collector or shredder based on food size



[https://commons.wikimedia.org/wiki/File:Elmis_aenea_\(Mueller,_1806\)__\(23410554701\).png](https://commons.wikimedia.org/wiki/File:Elmis_aenea_(Mueller,_1806)__(23410554701).png)

Elmidae - Characteristics

Adults:

- ▶ Small (1-8 mm)
- ▶ Covered in hydrophobic hairs
- ▶ Long legs and tarsal claws



[https://commons.wikimedia.org/wiki/File:Elmis_aenea_\(Mueller,_1806\)_\(23410554701\).png](https://commons.wikimedia.org/wiki/File:Elmis_aenea_(Mueller,_1806)_(23410554701).png)

Larvae:

- ▶ Elongate - less than 8 mm typically (but up to 16 mm)
- ▶ Filamentous gills at tip of abdomen



https://commons.wikimedia.org/wiki/File:Elmidae_Larvae.jpg



https://commons.wikimedia.org/wiki/File:Elmidae_Serbia_19.jpg

Elmidae - More Larvae and Adults



<https://commons.wikimedia.org/w/index.php?search=elmidae+&title=Special:MediaSearch&go=Go&type=image>



https://commons.wikimedia.org/wiki/File:Ancyronyx_adults_and_larvae_2.jpeg

Elmidae Pupae

[Click here – link to website with photo.](#)

Psephenidae - "Water Pennies"

- ▶ Univoltine or sometimes semivoltine and overwinter as larvae
- ▶ 5-6 Larval instars
- ▶ Live under rocks in rapid currents and suction to them
- ▶ Larval Diet: Scrapers/grazers (periphyton)
- ▶ Adults are short-lived and don't really feed
- ▶ Females lay eggs near or above water – larvae hatch and fall or crawl in



https://commons.wikimedia.org/wiki/File:Water_penny_larva.JPG

Psephenidae Video



<https://youtu.be/f-EQiKoHkoA>

Psephenidae - Characteristics

Adults:

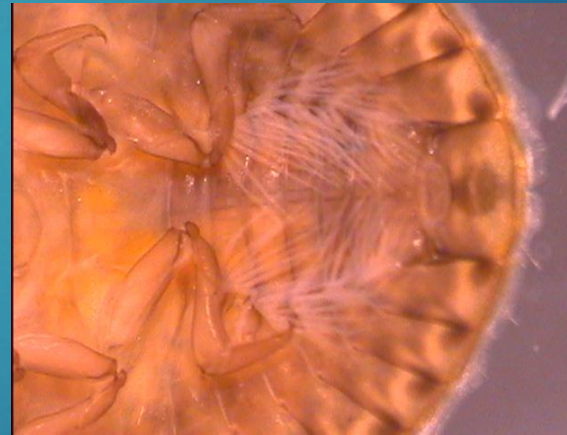
- ▶ Usually dark brown or black
- ▶ 4-6 mm long
- ▶ Oval shaped, commonly wider at back than front



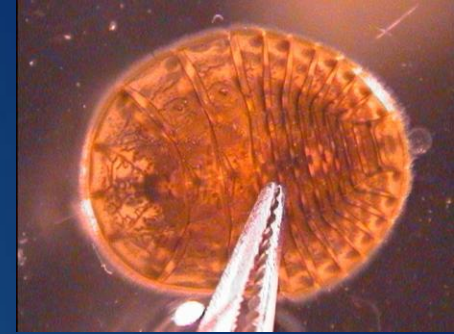
[https://commons.wikimedia.org/wiki/File:Eubria_palustris_\(Germar,_1818\)_23239996820.png](https://commons.wikimedia.org/wiki/File:Eubria_palustris_(Germar,_1818)_23239996820.png)

Larvae:

- ▶ Look like pennies (flat, round or oblong, brown hues)
- ▶ 3-10 mm
- ▶ Feathery gills on abdomen



https://commons.wikimedia.org/wiki/File:Psephenus_Gills.jpg



<https://commons.wikimedia.org/wiki/File:Psephenus.jpg>

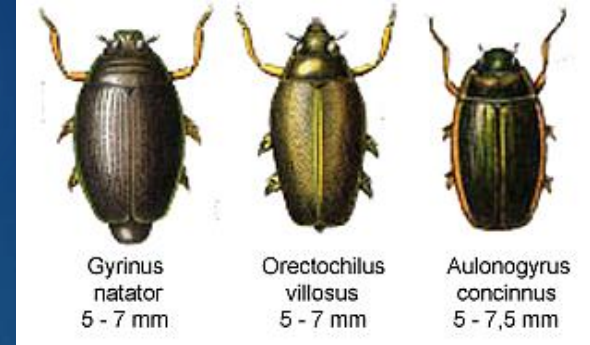
https://commons.wikimedia.org/wiki/File:Water_penny_larva.JPG



Psephenidae Pupae

- ▶ Pupae are terrestrial (as are adults)
- ▶ Photograph could not be found.

Gyrinidae - "Whirligig Beetles"



<https://commons.wikimedia.org/wiki/File:Gyrinidae.png>

- ▶ Most univoltine and overwinter as adults
- ▶ Usually found in lentic habitats (or at least slower lotic habitats)
- ▶ Amazing divided eyes!
- ▶ Diet: predators (or scavengers of dead insects) as larvae and adults
- ▶ Mate on surface of water – eggs are attached to vegetation or other things underwater

Gyrinidae Video

Click Link – video would not embed:

<https://youtu.be/RlbzOeNcaxE>

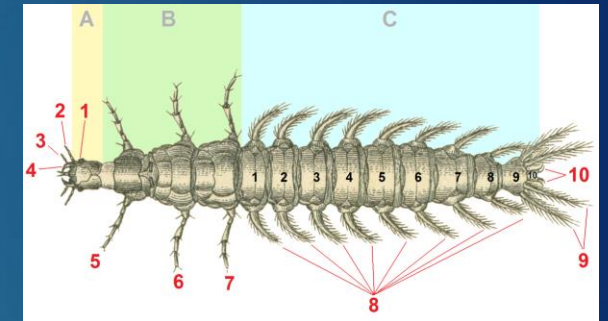
Gyrinidae - Characteristics

Adults:

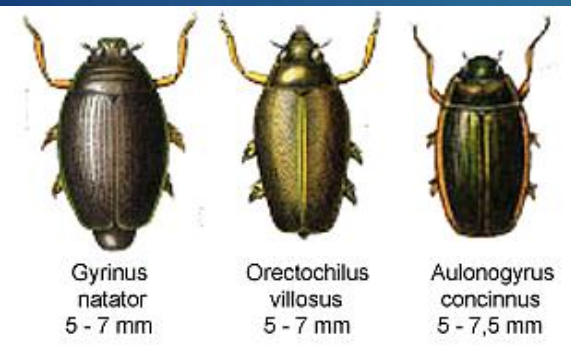
- ▶ Oval shaped – flattened
- ▶ Short antennae
- ▶ Long forelegs often held forward
- ▶ Can range from 2-40 mm

Larvae:

- ▶ Elongate, usually pale
- ▶ 8 pairs of gills protrude from abdomen



https://commons.wikimedia.org/wiki/File:Gyrinidae_larva_tagged.png



[https://commons.wikimedia.org/wiki/File:Metagyrynus_italisi_\(10.5852-ejt.2021.767.1481\)_Figure_7.png](https://commons.wikimedia.org/wiki/File:Metagyrynus_italisi_(10.5852-ejt.2021.767.1481)_Figure_7.png)



<https://commons.wikimedia.org/wiki/File:Gyrinidae.jpg>

<https://commons.wikimedia.org/wiki/File:Gyrinidae.png>

Gyrinidae Pupae

[Click here – link to website with photo.](#)

Dytiscidae - "Predaceous Diving Beetles"

- ▶ Most species univoltine and overwinter as adults
 - ▶ Adults of some species can live 2-3 years
- ▶ Typically found in lentic habitats (especially in places with few fish)
- ▶ Adults and larvae both voracious predators – will eat anything they encounter (including fish)
 - ▶ Larvae sometimes called "water tigers"



Dytiscidae Video



<https://youtu.be/Hwaja6FWUzA>

Dytiscidae- Characteristics

Adults:

- ▶ Streamlined, oval shaped body
- ▶ Usually dark brown or black (but not always)
- ▶ Hind legs fringed with flattened hairs for swimming



<https://commons.wikimedia.org/wiki/File:Geelgerande01.jpg>



https://commons.wikimedia.org/wiki/File:Dytiscidae_life_stages.jpg



https://upload.wikimedia.org/wikipedia/commons/f/f5/Reitter-1908_table40.jpg

Larvae:

- ▶ Elongated bodies with no gills
- ▶ Elongated spiracles for breathing at end of abdomen
- ▶ Short but sharp mandibles (inject digestive enzymes into prey)



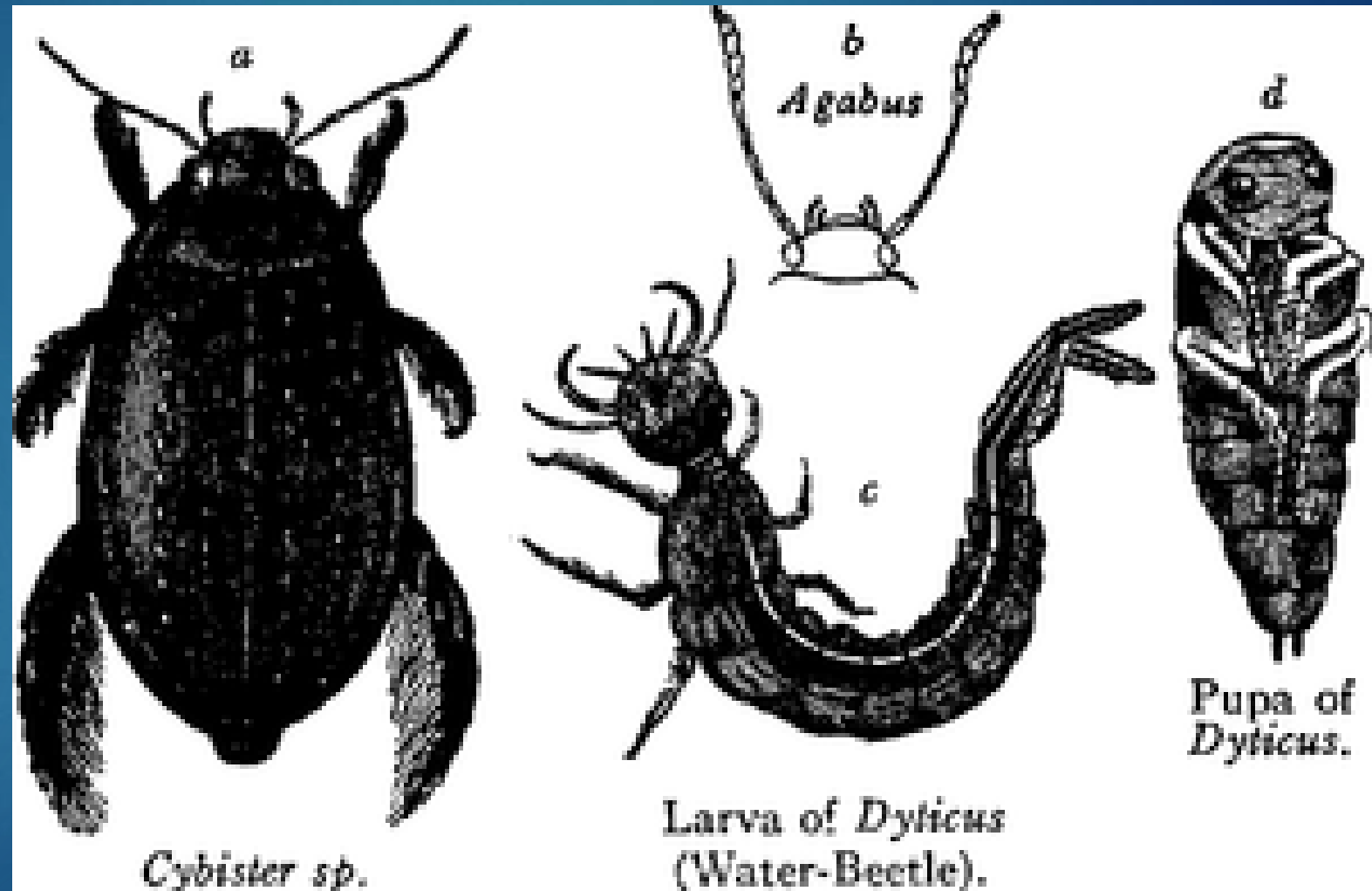
https://commons.wikimedia.org/wiki/File:Dytiscidae_larva.jpg



https://commons.wikimedia.org/wiki/File:20191129_Dytiscidae_larva_hunting_wiggler.jpg

Dytiscidae pupae

Typically pupate in soil.



Coleoptera imitations for fly fishing

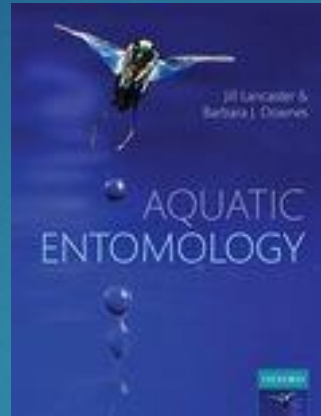
- ▶ Beetle patterns are often meant to imitate terrestrial beetles, but some do exist for aquatic beetles:
 - ▶ [Click here for examples of beetle patterns](#)
 - ▶ [Click here for a "bubble butt" beetle meant to imitate aquatic beetles](#)

References and Additional Reading:

Aquatic Entomology

Jill Lancaster and Barbara Downes
Oxford University Press, 2013
ISBN: 9780199573219

Textbook covering basics of aquatic ecology and entomology (no ID).

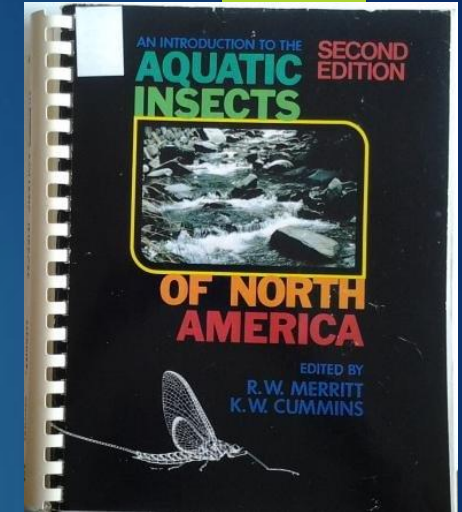


Introduction to the Aquatic Insects of North America (2nd ed)

(multiple newer versions)

R.W. Merritt and K.W. Cummins
Kendall Hunt Pub Co, 1984
ISBN: 0840331800

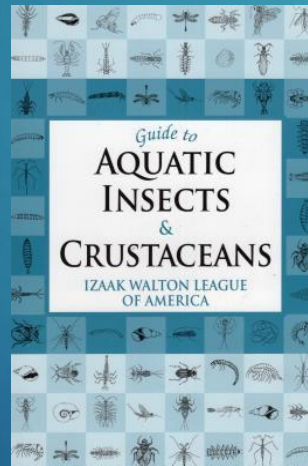
Advanced, comprehensive info and ID below order.



Guide to Aquatic Insects & Crustaceans

Izaak Walton League of America
Stockpole Books, 2006
ISBN: 0811732452

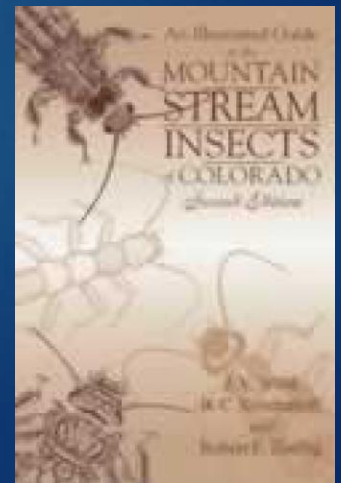
Simple (and cheap!) field guide to ID insects and more to order; water quality estimates.




An Illustrated Guide to the Mountain Stream Insects of Colorado (2nd ed)

J.V. Ward, B.C. Kondratieff, R.E. Zuellig
University Press of Colorado, 2002
ISBN: 9780870816536

Basic ecology and ID of local (CO) stream insects.





Other Rarely Aquatic & Semi-Aquatic Insect Orders

ORTHOPTERA, HYMENOPTERA, MECOPTERA

Notes:

- ▶ We will finish up aquatic insect orders today by covering the last three orders that are more rarely aquatic (Orthoptera, Hymenoptera, Mecoptera)
- ▶ These orders are not as well covered and studied as some of the others (at least for the aquatic members), so not as much info, photos, videos, etc. today as we've had with other orders...

Othoptera



<https://www.flickr.com/photos/andreas-kay/44384265690>

- ▶ Order includes grasshoppers, katydids, crickets, pygmy locusts, etc.
- ▶ From Greek *orthos* (straight or perpendicular) and *pteron* (wing)
- ▶ Some families observed swimming to submerged objects/plants; otherwise, good at swimming on top of or through water without many specialized adaptations
- ▶ Hemimetabolous and typically univoltine or semivoltine in temperate North America

Orthoptera

- ▶ Commonly overwinter as eggs, but all of this depends on family, location, etc.
- ▶ 188 species reliant on water on some level; around 80 species considered aquatic (worldwide)
- ▶ Diet: often herbivorous (shredders) like terrestrial counterparts (especially Acrididae – grasshoppers); some families eat detritus or periphyton (so can be collectors or scrapers/grazers)
- ▶ Eggs are often laid on or within aquatic plants, but some less aquatic species will lay in soil, on terrestrial plants, etc. near to water
- ▶ Breathe as terrestrial counterparts, but some have hair-like structures on body that may help bring air bubbles below surface (plastron)

Aquatic Orthoptera Characteristics

- ▶ Being hemimetabolous, nymphs and adults look similar
- ▶ Familiar grasshopper, cricket, katydid forms with enlarged hind legs for jumping, long-bodied, etc.
- ▶ Variability in family for body shape (next slide)
- ▶ Females typically have conspicuous ovipositor
- ▶ Weak fliers, some are even **apterous** (no wings)



Families of (semi-)aquatic Orthoptera

- ▶ **Acrididae** (grasshoppers): Three species in two genera are aquatic in North America
 - ▶ Main focus for today as we briefly talk about Orthoptera

Also:

- ▶ **Tettigoniidae** (katydids) – commonly detritivores (collectors), but some will eat just about anything (cannibals even!) – usually just live near water (marshy areas)
- ▶ **Gryllidae** (ground crickets): ~10% of North American cricket species occur near water – also detritivores – diet can vary, but can eat just about anything too
- ▶ **Tetrigidae** (pygmy locusts) - aquatic species eat algae and diatoms (scrapers) but also plants too

Families of (semi-)aquatic Orthoptera

Tettigoniidae (katydids or long-horned grasshoppers)



https://commons.wikimedia.org/wiki/File:Conocephalus_nigropleurum.jpg

Gryllidae (ground crickets)



[https://commons.wikimedia.org/wiki/File:CRICKET_\(8201332879\).jpg](https://commons.wikimedia.org/wiki/File:CRICKET_(8201332879).jpg)

Tetrigidae (pygmy locusts)



https://commons.wikimedia.org/wiki/File:Tetrigidae_P1160386a.jpg

Acrididae (short-horned grasshoppers): *Cornops aquaticum* & *Paulinia acuminata*



<https://www.flickr.com/photos/andreaskay/4384265690>

- ▶ These are the species I've heard the most about given my research on aquatic plant-insect interactions; they are both from the southern hemisphere and used to control invasive plants
- ▶ *C. aquaticum* (upper photo) Specializes on aquatic plants in the family Pontederiaceae (especially invasive water hyacinth [*Eichhornia crassipes*])
- ▶ *P. acuminata* (lower photo) specializes on giant salvinia (also invasive)
- ▶ Strong swimmers – readily swim even underwater

https://commons.wikimedia.org/wiki/File:Paulinia_acuminata.jpg

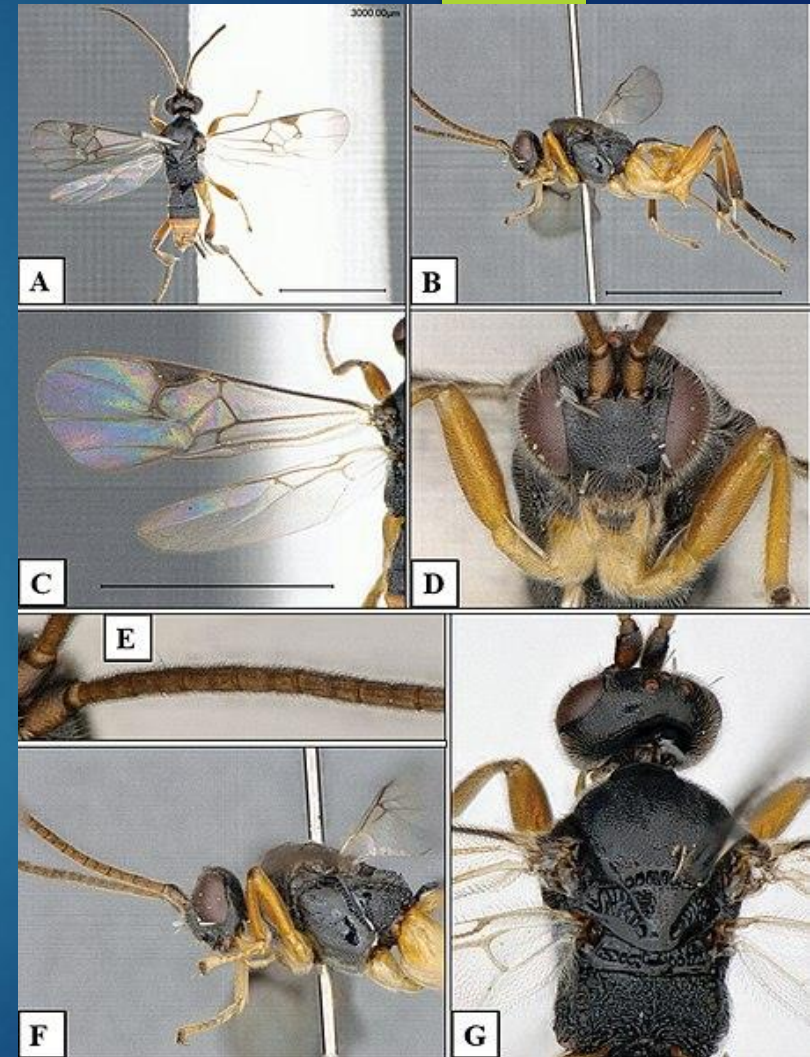


Hymenoptera

- ▶ Large and familiar order: wasps, bees, ants, sawflies
- ▶ From Greek hymenos (membrane) and pteron (wing) - have membranous wings
- ▶ 150 species from 11 families of suborder Apocrita (wasps, bees, ants) are aquatic (less than 0.1% of all species)
- ▶ All "aquatic" species are **parasitoids** (a different sort of functional feeding group) - more on upcoming slide
- ▶ Hydrophobic bodies (hairy) allow them to bring air underwater (plastron) - also have long tarsal claws help them stay underwater as they search for hosts that are often on macrophytes

Hymenoptera Characteristics

- ▶ Familiar order of insects with bees, wasps, ants...
- ▶ Larvae are generally maggot-like
- ▶ Females have well-developed, conspicuous ovipositors - "stingers" in species that can be a painful nuisance for humans
- ▶ [Click here: link to website with photos of life stages](#)



https://commons.wikimedia.org/wiki/File:Microgaster_godzilla_figs.jpg

Microgaster godzilla

Parasitoids...

- ▶ Lay their eggs on or inside of other organisms (insects) - larvae consume host from the inside – emerge to pupate (or as adults) after chewing way out!
- ▶ Cool and gruesome!
- ▶ There are even hyperparasitoids! (video on next slide)
 - ▶ Not sure if there are any aquatic hyperparasitoids...

Hyperparasitoid Video (terrestrial)



<https://youtu.be/yneQTGCjA5A>

Hymenoptera as parasitoids:

- ▶ Various families (not covering families for this order) attack different life stages of insects
- ▶ Can live inside (endoparasitoid) or outside (ectoparasitoid) of host
- ▶ Parasitoids often specialize on narrow taxonomic range of hosts (whether aquatic or terrestrial)

Hymeoptera Video



<https://youtu.be/L09SMdkM8SE>

Hymenoptera Video:



<https://youtu.be/-vQj2cDPBJY>

Interesting Article/Further Reading:

<https://entomologytoday.org/2021/02/12/the-lepidopteran-life-aquatic/>

(Article also has some basic aquatic Lepidoptera info too.)

Mecoptera - Scorpionflies



[https://commons.wikimedia.org/wiki/File:Nannochorista_philpotti_\(cropped\).jpg](https://commons.wikimedia.org/wiki/File:Nannochorista_philpotti_(cropped).jpg)

Mecoptera

- ▶ From Greek *mekos* (long) and *pteron* (wing) - relatively long wings
- ▶ They have tails that look like scorpions' (but of course not related)
- ▶ Small, but really neat, order - only 9 aquatic species, all in southern hemisphere
 - ▶ All in family Nannochoristidae
 - ▶ Some even place them on own order: Nannomecoptera
- ▶ Related to fleas (order Siphonaptera)

Mecoptera

- ▶ Holometabolous
- ▶ Adults are terrestrial, larvae are aquatic
- ▶ Larvae are predators
- ▶ Not a lot known about basic ecology otherwise

Mecoptera Characteristics

- ▶ Larvae are elongate (more details in link below)
- ▶ Adult males have swollen, turned up genitalia that gives the scorpion-like tail appearance
- ▶ Larvae have compound eyes – unique!
- ▶ [Click here: link to photo of larva](#)

Nannochorista philpotti



[https://commons.wikimedia.org/wiki/File:Nannochorista_philpotti_\(cropped\).jpg](https://commons.wikimedia.org/wiki/File:Nannochorista_philpotti_(cropped).jpg)

Imitations for Fly Fishing (Orthoptera and Hymenoptera)

- ▶ Many fly anglers use grasshoppers and bees (terrestrials) as fly patterns.
- ▶ Often meant to resemble terrestrial species that wind up in water, but fish surely eat aquatic species too

[Click here for bee/wasp patterns](#)

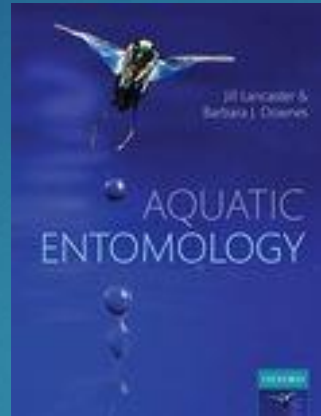


References and Additional Reading:

Aquatic Entomology

Jill Lancaster and Barbara Downes
Oxford University Press, 2013
ISBN: 9780199573219

Textbook covering basics of aquatic ecology and entomology (no ID).

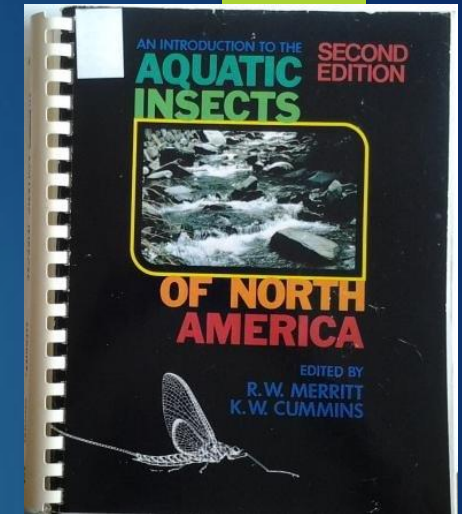


Introduction to the Aquatic Insects of North America (2nd ed)

(multiple newer versions)

R.W. Merritt and K.W. Cummins
Kendall Hunt Pub Co, 1984
ISBN: 0840331800

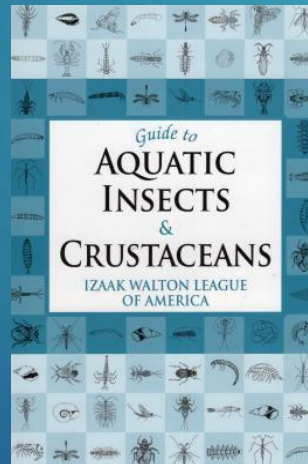
Advanced, comprehensive info and ID below order.



Guide to Aquatic Insects & Crustaceans

Izaak Walton League of America
Stockpole Books, 2006
ISBN: 0811732452

Simple (and cheap!) field guide to ID insects and more to order; water quality estimates.



An Illustrated Guide to the Mountain Stream Insects of Colorado (2nd ed)

J.V. Ward, B.C. Kondratieff, R.E. Zuellig
University Press of Colorado, 2002
ISBN: 9780870816536

Basic ecology and ID of local (CO) stream insects.

