GRASSHOPPERS (ACRIDIDAE)
OF COLORADO
IDENTIFICATION, BIOLOGY AND MANAGEMENT
J. L. Capinera and T. S. Sechrist

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GRASSHOPPERS (ACRIDIDAE) OF COLORADO: IDENTIFICATION, BIOLOGY AND MANAGEMENT

J. L. Capinera and T. S. Sechrist

1Associate professor and research associate, Department of Zoology and Entomology, Colorado State University, Fort Collins, Colo. 80523.

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J. L. Caudle and
T. E. Erskine

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Grasshopper populations present recurring problems to agriculture in the western United States, and large sums of money are spent annually to combat these pests. Those responsible for making decisions about grasshopper control often lack basic information concerning their target organism. This manual brings together some pertinent information about grasshoppers. It is intended for use by Department of Agriculture, Cooperative Extension and university personnel. Students and others also may find it useful. With this audience in mind, scientific terminology has been minimized, and a glossary has been provided.

Although intended for use in Colorado, this manual may be useful for grasshopper workers in nearby states. Wyoming, in particular, and also western Nebraska and Kansas and northern New Mexico have similar grasshopper fauna.
ACKNOWLEDGEMENTS

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GRASSHOPPER IDENTIFICATION

A wealth of knowledge concerning grasshopper biology and ecology, damage potential and control practices is available to anyone with the interest and the ability to search through entomological literature. The searcher will quickly note, however, that grasshoppers differ significantly in their biological attributes, damage potential and susceptibility to management. Hence, field workers must be able to identify grasshoppers, or the abundance of specific information on grasshoppers is practically useless.

Believing that grasshopper identification is the key to knowledge concerning grasshoppers, we provide a dichotomous key to the adult grasshoppers known or thought to occur in Colorado. The illustrated key presented here is adapted from Alexander (1941); it is revised extensively although the original format is retained.

Compared to some other groups of insects, grasshoppers are not difficult to differentiate. Nevertheless, the user will encounter some problems with grasshopper identification. In some groups, differentiation is based on only one sex. Thus, identification of Melanoplus spp. and some others requires male specimens. Similarly, nymphs are difficult to identify, and no attempt is made here to include them in this key. These problems do not represent oversights on our part; rather, they represent the state of the “art.” We have attempted to avoid use of color in this key because grasshopper color changes as specimens dry. Sometimes color use cannot be avoided, and where color characters are reliable, as in hind tibia color, we have used it extensively. We have not included subspecies designations in the key.

Anyone attempting to identify grasshoppers will find it much easier if several or many specimens of the same species are available. Individual specimens may be extremely difficult to identify because of the inherent variability within and among populations. Thus, when collecting specimens for identification, extensive collections should be made.

Grasshopper classification is constantly in a state of flux since universal agreement on subfamily, genus and species does not exist. We have attempted to provide current information but recognize that changes probably will occur in the near future. Also, some genera (Trimerotropis in particular) have not been examined critically since the early 1900s, and some species probably are only subspecies exhibiting significant geographic variation.

Additional useful information on identification of grasshopper species can be obtained in Otte (1981; Gomphocerinae and Acridinae of North America); Strohecker et al. (1968; California); Hewitt and Barr (1967; Oedopodinae of Idaho), Ball et al. (1942; Arizona); Beamer (1917; Oedopodinae of Kansas); Claassen (1915; Melanoplus of Kansas); Coppock (1962; Oklahoma); and Pfadt (1965; Wyoming).

Note that individual drawings of wings and tegmina are right wing and tegmen and are shown in spread position. The only exception is figure 1, which shows left wing and tegmen in spread position. An overview of grasshopper anatomy and the relationships of various segments are shown in figures 1-5.

Fig. 1-Top view of adult grasshopper.
Fig. 2-Side view of adult grasshopper.

Fig. 3-Front view of grasshopper head.

Fig. 4-Bottom view of grasshopper thorax.
Fig. 5A-Side view of male abdomen tip.

Fig. 5B-Subgenital plate of male pulled back to show aedeagus.

Fig. 5C-Top view of male abdomen tip.

Fig. 5D-Side view of female abdomen tip.
KEY TO STAGES OF GRASSHOPPER DEVELOPMENT

The nymphal instars of grasshoppers are difficult to differentiate; first and second instars are especially easy to confuse. Also, extra instars or reduced numbers of instars are sometimes encountered. In some species, males apparently have one fewer instar than females. Extra instars generally occur between the third and fourth instars. The following generalized key will help distinguish the instars in most cases. Both macropterous (long-winged, capable of flight) and brachypterous (short-winged, flightless) species can be differentiated, using principally wing pad development, although brachypterous species are more difficult. The most useful keys to identification of grasshopper nymphs are provided by Handford (1946), Brusven (1972) and Scoggan and Brusven (1972).

A Tegmina overlying the folded wings; tegmina and wings fully developed, often extending to the tip of the abdomen or beyond. 

ADULT

A’ Wings overlying tegmina, or wings and tegmina poorly developed and represented by pads.

B Tegmina and wing pads pointed down (ventrally).

C Tegmina and wing pads with indistinct venation.

D Wing pads broadly rounded, not prolonged at apex (fig. 6).

1st INSTAR NYMPH

D’ Wing pads rounded, but prolonged at apex (fig. 7).

2nd INSTAR NYMPH

C’ Tegmina and wing pads with distinct venation.

D Wing pads pointed ventrally but not posteriorly; or if slanted posteriorly then wing pads do not overlap (figs. 8, 9).

3rd INSTAR NYMPH

D’ Wing pads pointed ventrally but with a distinct posterior orientation; wing pads overlap (fig. 10).

EXTRA NYMPHAL INSTAR

B’ Tegmina and wing pads pointed up (dorsally).

C Wing pads short, not extending beyond first abdominal segment (fig. 11).

4th INSTAR NYMPH

C’ Wing pads more elongate, extending beyond the second abdominal segment (fig. 12).

5th INSTAR NYMPH
SEPARATION OF ADULT GRASSHOPPERS (ACRIDIDAE) FROM RELATED INSECT FAMILIES FOUND IN COLORADO

A Front legs greatly enlarged and modified for digging (fig. 13).
   GRYLLOTALPIDAE, mole crickets; and TRIDACTYLIDAE, pygmy mole crickets
   [These insects burrow through soil often feeding on roots. They are of no economic importance in Colorado.]

A' Front legs not greatly enlarged (figs. 14, 15, 16).

B Antennae short, usually less than one-half the length of the body and with 30 segments or less.

C Pronotum greatly enlarged, extending backward over the abdomen (fig. 14).
   TETRIGIDAE, pygmy grasshoppers
   [These small grasshoppers are of no economic importance in Colorado.]

C' Pronotum not extended over abdomen (figs. 15, 16).
   ACRIDIDAE, grasshoppers
   [Common and sometimes damaging in Colorado. See key to subfamilies of Acrididae.]

B' Antennae as long as or longer than body; antennae usually with more than 30 segments.

C Tarsi with three segments (fig. 17); ovipositor usually slender and cylindrical (fig. 18).
   GRYLLIDAE, crickets (fig. 19)
   [Crickets are common, usually nocturnal and rarely damaging in Colorado. The common black house crickets or field crickets rarely damage plants (occasionally seedlings or fruit) and often are entertaining; see Gryllus spp. Tree crickets occasionally injure shrubs by depositing eggs within stems but usually are associated with weeds; see Oecanthus spp.]

C' Middle tarsi (and usually front and hind tarsi) with four segments (fig. 20); ovipositor flat and sword-shaped (figs. 21, 23).

D Usually wingless with a strongly arched back (fig. 21); front tibia without auditory organ.
   GRYLLACRIDIDAE, camel crickets and cave crickets
   [These are obscure, nocturnal insects usually found in moist habitats. They may feed on plants but rarely become sufficiently abundant to inflict damage; see Ceuthophilus and related spp. - but see also Anabrus simplex, which is easily confused with camel crickets.]

D' Usually with wings; front tibiae with auditory organs (fig. 24).
   TETTIGONIIDAE, katydids and longhorned grasshoppers; and PROPHALANGOPSIDAE, primitive katydids (figs. 22, 23).
   [These usually are large, flattened, green insects. They are of little economic significance except for the wingless Mormon cricket; see Anabrus simplex (fig. 23).]
Fig. 16-ACRIDIDAE, grasshopper.

Fig. 17-Tarsus of GRYLLIDAE.

Fig. 18-Ovipositor of GRYLLIDAE.

Fig. 19-GRYLLIDAE, cricket.

Fig. 20-Middle tarsus of Anabrus simplex.

Fig. 21-GRYLACRIDIDAE, camel cricket.

Fig. 22-TETTIGONIIDAE, katydid.

Fig. 23-Anabrus simplex.

Fig. 24-Front tibia of TETTIGONIIDAE.
KEY TO THE SUBFAMILIES OF ACRIDIDAE

A Distinct conical or cylindrical spine inserted between front legs (figs. 25, 26); face usually quite vertical (fig. 27).

B Lobes of mesosternum longer than wide (fig. 28), their inner margins usually relatively straight, subgenital plate of male deeply notched at tip (fig. 29); large size - tegmina length usually over 30 mm.

Subfamily CYRTACANTHACRIDINAE

B’ Lobes of mesosternum not longer than wide (figs. 30, 31), their inner margins usually rounded; subgenital plate of male not notched (figs. 32, 33) or weakly notched at tip (figs. 34, 35); small to large size - but tegmina length usually less than 30 mm.

Subfamily CATANTOPINAE

A’ Without distinct spine between front legs (figs. 36, 37, 38); orientation of face variable.

B Vertex and front meeting at an angle, face slanted back (figs. 39, 40, 41) [this character is difficult to discern in a few genera (figs. 42, 43, 44, 45, 46)]; median carina of pronotum low (fig. 39); wings usually colorless; antennae usually slightly flattened, sometimes strongly flattened.

Subfamily GOMPHOCERINAE

B’ Vertex and front forming a rounded surface; face nearly vertical, not strongly slanted back (figs. 47, 48, 49); median carina of pronotum usually distinctly raised to form a sharp ridge (fig. 50); wings often brightly colored; antennae usually thread-like, not flattened.

C Hind tibiae with outer row of spines extending to tip, resulting in a spine immediately adjacent to spurs (fig. 51); very large and thick-bodied; tegmina reduced.

Subfamily ROMALEINAE

C’ Hind tibiae with outer row of spines not extending to tip, spine not immediately adjacent to spurs (fig. 52); size variable; tegmina normal.

Subfamily OEDIPODINAE

SUBFAMILY CYRTACANTHACRIDINAE

Only a single species in the subfamily Cyrtacanthacridinae occurs in Colorado. This species is large, green or yellow-brown, with a pale yellow band from the head to the tips of the tegmina. It is found throughout Colorado but usually is not abundant. Schistocerca alutacea Scudder
Fig. 25-Spine between front legs of CATANTOPINAE.

Fig. 26-Spine between front legs of CATANTOPINAE.

Fig. 27-Head and pronotum of Melanoplus spp.

Fig. 28-Bottom view of Schistocerca alutacea thorax.

Fig. 29-Subgenital plate of male Schistocerca alutacea.

Fig. 30-Bottom view of Hesperotettix viridis thorax.

Fig. 31-Bottom view of Dactylotum pictum thorax.

Fig. 32-Subgenital plate of male Melanoplus gladstoni.

Fig. 33-Subgenital plate of male Campylacantha olivaceae.
Fig. 34-Subgenital plate of male *Melanoplus sanguinipes*.

Fig. 35-Subgenital plate of male *Melanoplus borealis*.

Fig. 36-GOMPHOCERINAE with only a small spine between front legs.

Fig. 37-GOMPHOCERINAE with only a small spine between front legs.

Fig. 38-GOMPHOCERINAE without spine between front legs.

Fig. 39-Head and pronotum of *Paropomala wyomingensis*.

Fig. 40-Head and pronotum of *Acrolophitus hirtipes*.

Fig. 41-Head of *Chorthippus curtipennis*.

Fig. 42-Head of *Amphitornus coloradus*.

Fig. 43-Head of *Aeropedellus clavatus*. 
Fig. 44-Head of *Ageneotettix deorum*.

Fig. 45-Head of *Stenobothrus brunneus*.

Fig. 46-Head of *Phlibostroma quadrimaculatum*.

Fig. 47-Head of *Trimerotropis pallidipennis*.

Fig. 48-Head of *Arphia pseudonietana*.

Fig. 49-Head of *Metator pardalinus*.

Fig. 50-Pronotum of *Spharagemon collare*.

Fig. 51-Hind tibia of ROMALEINAE.

Fig. 52-Hind tibia of OEDIPODINAE.
SUBFAMILY CATANTOPINAE

A  Face markedly slanting back (fig. 53); antennae sword-shaped (fig. 54); body very slender; weak spine inserted between front legs.
   Refer to subfamily GOMPHOCERINAE

A'  Face nearly vertical or slanting back only slightly (fig. 55); antennae not sword-shaped; body not extremely slender; spine between front legs distinct.

B  Lateral margins of subgenital plate of male, as seen from the side, straight or only slightly convex (fig. 56) - never suddenly inflated at base; tegmina almost always short.

C  Furculae of male cylindrical appendages, projecting distinctly (fig. 56); pale green-tan color, including hind tibiae; found on Artemisia; plains or foothills of eastern Colorado.
   Hypochlora alba Dodge

C'  Furculae of male small, not projecting distinctly (fig. 57).

D  General body color bright and contrasting - black, orange and yellow; hind tibiae blue-black; widespread in eastern Colorado.
   Dactylotum bicolor (Thomas)

D'  General body color uniform - green to brown, including hind tibiae; uncommon in southeast Colorado.
   Campylacantha olivacea (Scudder)

B'  Lateral margins of subgenital plate of male, as seen from the side, strongly convex or inflated at base (figs. 58, 59); tegmina variable.

C  Subgenital plate with distinct subapical tubercle (figs. 58, 59, 60); cerci of male slender, never broad and flattened (figs. 58, 59).

D  General body color green, bright green when alive turning yellow-green in dried specimens; furculae consisting of small but distinctly projecting lobes (figs. 61, 62); outer face of hind femora without transverse bands.

E  Pronotum mostly smooth, may be punctate on metazona; tegmina usually fully developed or at least twice length of pronotum, overlapping above (fig. 63), but occasionally short and separated by space dorsally (fig. 64); median carina marked by white or pink stripe and bordered by black stripes; hind tibiae pale blue-green; widespread in eastern Colorado.
   Hesperotettix viridis (Scudder)

E'  Pronotum rough on both prozona and metazona; median carina marked by red stripe; hind tibiae pale green; widespread in eastern Colorado.
   Hesperotettix speciosus (Scudder)
Fig. 53-Head and pronotum of *Mermiria bivittata*.

Fig. 54-Sword-shaped antenna.

Fig. 55-Head and pronotum of *Melanoplus* spp.

Fig. 56-Side view of abdomen tip of male *Hesperotettix speciosus*.

Fig. 57-Top view of abdomen tip of male *Campylacantha olivaceae*.

Fig. 58-Side view of abdomen tip of male *Hesperotettix speciosus*.

Fig. 59-Side view of abdomen tip of male *Aeoloplides turnbulli*.

Fig. 60-Side view of abdomen tip of male *Hesperotettix viridis*.

Fig. 61-Top view of abdomen tip of male *Hesperotettix speciosus*.

Fig. 62-Top view of abdomen tip of male *Hesperotettix viridis*.
D' General color brown-green or brown; furculae scarcely or not apparent (fig. 65); outer face of hind femora with two or three dark transverse bands.

E Tegmina about twice as long as pronotum, or longer, meeting dorsally.

F Hind femora with wedge-shaped structure ventrally at base (fig. 66); hind tibiae red to blue; western Colorado. **Aeoloplides tenuipennis** (Scudder)

[We consider the short-winged A. minor Brunner to be synonymous with A. tenuipennis]

F' Hind femora without wedge-shaped structure ventrally at base; hind tibiae pale blue-grey; widespread and common in eastern Colorado. **Aeoloplides turnbulli** (Caudell)

E' Tegmina shorter than pronotum, not meeting dorsally; hind tibiae blue-green; western Colorado. **Aeoloplides chenopodii** (Brunner)

[If a wedge-shaped structure is present ventrally at the base of the hind femur the specimen is a short-winged form of A. tenuipennis]

C' Subgenital plate of male without distinct subapical tubercle (figs. 67, 68).

D Head large and prominent in comparison with pronotum (fig. 69); tegmina usually short; cerci of male pointed (fig. 70); hind tibiae blue or green; dark band extends back from eye across much of the lateral lobes of the pronotum; widespread in eastern Colorado. **Phoetaliotes nebrascensis** (Thomas)

D' Head not large or prominent in comparison with pronotum (fig. 71).

E Cerci of male variable but not as described below for **Oedaloenotus**; prozona not swollen (fig. 55); many common species.

**Melanoplus** spp.

[See key to this large genus, which follows this section]

E' Cerci of male broad in basal two-thirds and distinctly pointed in apical one-third (fig. 72); prozona when viewed from side appearing swollen (fig. 73); tegmina variable but usually short; hind femora with three dark bands on upper face, sometimes extending to outer face; hind tibiae blue-grey; not recorded in Colorado but may occur in the northwest. **Oedaloenotus enigma** (Scudder)
Fig. 63-Top view of head, pronotum and tegmina of Hesperotettix viridis.

Fig. 64-Top view of head, pronotum and tegmina of Hesperotettix viridis.

Fig. 65-Top view of abdomen tip of male Aeoloplides turnbulli.

Fig. 66-Hind femur of Aeoloplides tenuipennis.

Fig. 68-Side view of abdomen tip of male Melanoplus sanguinipes.

Fig. 69-Head and pronotum of Phoetaliotes nebrascensis.

Fig. 70-Cercus of Phoetaliotes nebrascensis.

Fig. 67-Side view of abdomen tip of male Melanoplus gladstoni.

Fig. 71-Head and pronotum of Melanoplus spp.

Fig. 72-Cercus of Oedaleonotus enigma.
Key to the *Melanoplus* Species

A Tegmina short, never as long as abdomen (occasional specimens have long tegmina).

B Cerci of males broad, expanding from the base, or if the basal half tapers slightly the cerci are much less than twice as long as the width at the middle.

C Cerci swollen from base, with finger-like projection directed upward and inward; ridge extends along posterior portion of cerci but not on projection (fig. 74); hind tibiae blue; plains of eastern Colorado.

*Melanoplus lakinus* (Scudder)

C' Cerci not as described in “C.”

D Cerci swollen (fig. 75); hind tibiae red; color predominantly brownish yellow; southeastern Colorado.

*Melanoplus discolor* (Scudder)

D' Cerci flat (fig. 76); hind tibiae blue; color predominantly reddish brown or grey; widespread in Colorado.

*Melanoplus occidentalis* (Thomas)

B' Cerci of males not significantly expanding from base (figs. 77, 78, 79).

C Cerci beyond middle expanding, sometimes appearing equal; cerci about two to three times as long as width at constriction, or at middle of cerci if no constriction (figs. 77, 78, 79, 82, 84). (*M. fasciatus* cerci sometimes appear four times as long as width but can be distinguished from other species with similar length cerci in that width of cerci at expansion is about same as width at base.)

D Cerci about three times as long as width at middle (figs. 77, 78).

E Cerci at base twice as wide as at expansion beyond middle (fig. 77); tegmina approximately length of pronotum; abdomen bright yellow beneath; top of abdomen with transverse light stripes; hind tibiae red; foothills and front range.

*Melanoplus dawsonii* (Scudder)

E' Cerci at base about as wide as expansion beyond middle (fig. 78); tegmina approximately twice length of pronotum; abdomen not distinctly striped; hind tibiae red; foothills to timberline.

*Melanoplus fasciatus* (F. Walker)

D' Cerci about twice as long as width at middle (fig. 79).

E Tegmina not meeting dorsally, separated by distinct space (fig. 80); tegmina approximately length of pronotum; hind tibiae blue-brown; mountains at fairly high elevations.

*Melanoplus oregonensis* Thomas
Fig. 73-Side view of pronotum of *Oedaleonotus enigma*.

Fig. 74-Cercus of *Melanoplus lakinus*.

Fig. 75-Cercus of *Melanoplus discolor*.

Fig. 76-Cercus of *Melanoplus occidentalis*.

Fig. 77-Cercus of *Melanoplus dawsoni*.

Fig. 78-Cercus of *Melanoplus fasciatus*.

Fig. 79-Cercus of *Melanoplus oregonensis*.

Fig. 80-Top view of head, pronotum and tegmina of *Melanoplus oregonensis*.

Fig. 81-Top view of head, pronotum and tegmina of *Melanoplus borealis* and *M. kenneclotti*. 
E' Tegmina meeting dorsally, not separated by space (fig. 81).

F Cerci appearing swollen (fig. 82); subgenital plate tapering to a blunt point when viewed from rear (fig. 83); hind tibiae blue-brown; mountains of central Colorado.

*Melanoplus kennicotti* Scudder

F' Cerci flat, not appearing swollen (fig. 84); subgenital plate truncate with small notch when viewed from rear (fig. 85); hind tibiae red to yellow-brown; mountains of southern Colorado.

*Melanoplus borealis* (Fieber)

C' Cerci slender, tapering beyond middle or appearing approximately equal; cerci about four or more times as long as width at constriction (figs. 86, 87).

D Furculae diverging (fig. 88); subgenital plate without apical tubercle (fig. 89); hind tibiae tan; southwestern Colorado.

*Melanoplus tristis* Bruner

D' Furculae parallel (fig. 90); subgenital plate with apical tubercle (fig. 91); hind tibiae red; light bands on tegmina form faint "V" when folded; widespread in foothills and mountains.

*Melanoplus dodgei* (Thomas)

[If the hind tibiae are not red the specimen may be *Phoetalotis nebrascencis*. *P. nebrascencis* lacks the light band on tegmina, and the base of the cerci are expanded slightly dorsally and ventrally.]
Fig. 82-Cercus of Melanoplus kennicotti.

Fig. 83-Back view of subgenital plate of Melanoplus kennicotti.

Fig. 84-Cercus of Melanoplus borealis.

Fig. 85-Subgenital plate of Melanoplus borealis.

Fig. 86-Cercus of Melanoplus tristis.

Fig. 87-Cercus of Melanoplus dodgei.

Fig. 88-Furculae of Melanoplus tristis.

Fig. 89-Top view of subgenital plate of Melanoplus tristis.

Fig. 90-Furculae of Melanoplus dodgei.

Fig. 91-Top view of subgenital plate of Melanoplus dodgei.
A' Tegmina about as long as abdomen, or longer.

B Cerci of males equal or tapering beyond middle; never expanding markedly, not forked, nor boot-shaped (figs. 92, 93, 94).

C Cerci of males markedly expanding from base (fig. 92); chiefly on plains but found even above timberline; hind tibiae blue.  
*Melanoplus occidentalis* (Thomas)

C' Cerci of males only slightly expanding or tapering in basal half, sometimes tapering throughout.

D Furculae relatively prominent, at least one-third as long as supra-anal plate (figs. 95, 96, 97).

E Cerci of males elongate, tapering distally to a sharp or blunt point (figs. 93, 98).

F Cerci cylindrical, slender, appearing finger-like with tip rounded (fig. 93).

G Lateral lobes of prozona with dark band on the upper part; center of tegmina often with dark and light flecks along midline; hind tibiae blue; as viewed from side, aedeagus without cup-shaped depression at tip but folded (fig. 99); widespread.  
*Melanoplus bowditchi* Scudder

G' Lateral lobes of prozona without a distinct band; tegmina without midline flecks; hind tibiae blue; as viewed from side, aedeagus with cup-shaped depression at tip (fig. 100); widespread in eastern Colorado.  
*Melanoplus flavidus* Scudder

F' Cerci somewhat elongate, flat, not cylindrical or finger-like (figs. 98, 101).

G Tip of cerci pointed (fig. 98); hind tibiae blue; widespread in eastern Colorado.  
*Melanoplus regalis* (Dodge)

G' Tip of cerci blunt (fig. 101); hind tibiae usually red, sometimes yellow; widespread and common, often abundant in urban and disturbed areas.  
*Melanoplus femurrubrum* (DeGeer)
Fig. 92-Cercus of *Melanoplus occidentalis*.

Fig. 93-Cercus of *Melanoplus bowditchi* or *M. flavidus*.

Fig. 94-Side view of abdomen tip of male *Melanoplus sanguinipes*.

Fig. 95-Furculae of *Melanoplus bowditchi*.

Fig. 96-Furculae of *Melanoplus regalis*.

Fig. 97-Furculae of *Melanoplus bruneri*.

Fig. 98-Cercus of *Melanoplus regalis*.

Fig. 99-Aedeagus of *Melanoplus bowditchi*.

Fig. 100-Aedeagus of *Melanoplus flavidus*.

Fig. 101-Side view of abdomen tip of male *Melanoplus femurrubrum*. 
E'  Cerci of male broad, tapering slightly, usually rather blunt (figs. 84, 94).

F  Subgenital plate of males long, prolonged at apex (figs. 94, 103).

G  Dorsal edge of cerci not contracted near middle (fig. 94); furculae approximately one-third length of supra-anal plate, or less (fig. 102); subgenital plate moderately long (fig. 94); hind tibiae red, sometimes blue; widespread and common, often common in disturbed and urban areas.

*Melanoplus sanguinipes* (Fabricius)

G' Dorsal edge of cerci contracted near middle (fig. 103); furculae approximately one-half length of supra-anal plate; subgenital plate extremely long (fig. 103); hind tibiae red to greenish-yellow; mountains at moderate elevations.

*Melanoplus bruneri* Scudder

F' Subgenital plate of males not prolonged at apex but ending apically in a prominent horseshoe-shaped ridge (figs. 101, 104).

G  Subgenital plate black or distinctly margined with black; cerci less narrowed at tip (fig. 84); wings approximately length of abdomen; hind tibiae red to yellow-brown; found at high altitudes.

*Melanoplus borealis* (Fieber)

G' Subgenital plate not black or distinctly margined; cerci more tapered at tip (fig. 101); wings usually extend well beyond tip of abdomen; hind tibiae usually red, sometimes yellow; widespread and common, often abundant in disturbed and urban areas.

*Melanoplus femurrubrum* (DeGeer)

D' Furculae very short, one-fourth as long as supra-anal plate, or less (fig. 105).

E  Subgenital plate of male deeply grooved vertically at apex (fig. 106); hind tibiae red or blue; widespread and abundant, often a serious pest.

*Melanoplus sanguinipes* (Fabricius)

E' Subgenital plate of male rounded posteriorly (fig. 107).

F  Cerci of males not markedly wide; about four times as long as wide (fig. 108); hind tibiae usually red; widespread and sometimes common.

*Melanoplus gladstoni* Scudder

F' Cerci of males obviously wide, about twice as long as wide (fig. 109); hind tibiae green-blue; southeastern Colorado.

*Melanoplus glaucipes* (Scudder)

[Occasional long winged specimens of *Melanoplus kennicotti* will key to this point but can be differentiated by their red-orange tibiae.]
Fig. 102-Furculae of *Melanoplus sanguinipes*.

Fig. 107-Back view of subgenital plate of *Melanoplus gladstoni*.

Fig. 103-Side view of abdomen tip of *Melanoplus bruneri*.

Fig. 108-Side view of subgenital plate and cercus of *Melanoplus gladstoni*.

Fig. 104-Top view of subgenital plate of *Melanoplus femurrubrum*.

Fig. 109-Cercus of *Melanoplus glaucipes*.

Fig. 110-Cercus of *Melanoplus differentialis*.

Fig. 105-Furculae of *Melanoplus gladstoni*.

Fig. 111-Cercus of *Melanoplus yarrowii*.

Fig. 106-Back view of subgenital plate of *Melanoplus sanguinipes*.  

Fig. 107-Back view of subgenital plate of *Melanoplus gladstoni*.  

Fig. 108-Side view of subgenital plate and cercus of *Melanoplus gladstoni*.  

Fig. 109-Cercus of *Melanoplus glaucipes*.  

Fig. 110-Cercus of *Melanoplus differentialis*.  

Fig. 111-Cercus of *Melanoplus yarrowii*.  

Fig. 106-Back view of subgenital plate of *Melanoplus sanguinipes*.  

Fig. 107-Back view of subgenital plate of *Melanoplus gladstoni*.  

Fig. 108-Side view of subgenital plate and cercus of *Melanoplus gladstoni*.  

Fig. 109-Cercus of *Melanoplus glaucipes*.  

Fig. 110-Cercus of *Melanoplus differentialis*.  

Fig. 111-Cercus of *Melanoplus yarrowii*.  

23
B' Cerci of male expanding beyond the middle, boot-shaped, or forked (figs. 110, 111, 112).

C Cerci boot-shaped, or distinctly forked (figs. 110, 112).

D Cerci boot-shaped, the "heel" varying in prominence (figs. 110, 113, 114).

E Larger species; males over 27 mm, females over 35 mm long.

F General color as viewed from above uniform olive to brown, occasionally yellow or black.

G Black bands form herringbone pattern along entire length of hind femora (fig. 115); hind tibiae yellow; a black morph and a yellow morph occur as a small percentage of the population; widespread and common in agricultural and urban environments.

Melanoplus differentialis (Thomas)

[The black morph of M. differentialis may lack the banding pattern along the entire length of the hind femur (fig. 116), resembling M. ponderosus; the distinct black color, however, clearly indicates M. differentialis.]

G' Black on outside face of hind femora forming two or three diffuse bands (fig. 117); hind tibiae orange to red; uncommon.

Melanoplus ponderosus (Scudder)

F' General color above green to brown with a yellow-buff stripe on each side extending from behind the eye, along margins of pronotum and converging on tegmina; hind femora with longitudinal stripe on outer surface (fig. 118); hind tibiae variable; widely distributed; our common large grasshopper and a serious urban and agricultural pest.

Melanoplus bivittatus (Say)

E' Smaller species, male up to 25 mm, female up to 29 mm long.

F Cerci expanding slightly greater dorsally, but dorsal expansion not grooved (fig. 111); hind tibiae red; western Colorado.

Melanoplus yarrowii (Thomas)

F' Cerci boot-shaped; "heel" sometimes reduced; "toe" grooved apically (fig. 119); hind tibiae red; eastern Colorado; widespread; an early season species.

Melanoplus confusus Scudder

D' Cerci distinctly forked (figs. 112, 120, 122).

E Smaller branch of cerci on dorsal side (figs. 112, 120).

F Smaller, male 15.5 mm, female 20 mm long; apex of subgenital plate not square as viewed from rear (fig. 121); ventral arm of cerci often comparatively straight, tip often rounded (fig. 112); hind tibiae blue; foothills of eastern Colorado, occasionally on eastern plains.

Melanoplus infantilis Scudder

F' Larger, male 22 mm, female 24 mm long; apex of subgenital plate rectangular as viewed from rear (fig. 123); ventral arm of cerci strongly curved downward, tip narrowing to a point (fig. 120); hind tibiae red, blue or brown; mountains at moderate elevations; uncommon.

Melanoplus a/pinus Scudder

E' Smaller branch of cerci on ventral side (fig. 122); hind tibiae red; plains and lower foothills, eastern Colorado.

Melanoplus keeleri (Thomas)
Fig. 112-Cercus of *Melanoplus infantilis*.

Fig. 113-Cercus of *Melanoplus ponderosus*.

Fig. 114-Cercus of *Melanoplus bivittatus*.

Fig. 115-Hind femur of *Melanoplus differentialis*.

Fig. 116-Hind femur of black morph *Melanoplus differentialis*.

Fig. 117-Hind femur of *Melanoplus ponderosus*.

Fig. 118-Hind femur of *Melanoplus bivittatus*.

Fig. 119-Cercus of *Melanoplus confusus*.

Fig. 120-Cercus of *Melanoplus alpinus*.

Fig. 121-Back view of subgenital plate of *Melanoplus infantilis*. 
C' Cerci not boot-shaped, nor distinctly forked (figs. 126, 127, 130, 134, 136).

D' Furculae one-half length of supra-anal plate or greater (figs. 133, 135).

E' Furculae about one-half length of supra-anal plate, expanding from base and then tapering to a point (fig. 135); hind tibiae green; not reported from Colorado but may occur in the southeastern portion of the state.
Melanoplus bispinosus Scudder

D Furculae less than half as long as supra-anal plate (figs. 124, 125).

E Subgenital plate of males notched posteriorly as viewed from above (fig. 124).

F Cerci symmetrical with shallow spoon-like depression (fig. 126); hind tibiae variable in color but usually red; widespread and common in eastern Colorado.
Melanoplus angustipennis (Dodge)

F' Cerci not symmetrical; cerci grooved or depressed at tip (fig. 127); hind tibiae brown; associated with juniper and pinon; nocturnal and rare; southeastern Colorado.
Melanoplus splendidus Hebard

E Furculae less than half as long as the supra-anal plate (figs. 124, 125).

F Cerci symmetrical with shallow spoon-like depression (fig. 126); hind tibiae variable in color but usually red; widespread and common in eastern Colorado.

E F Subgenital plate of males notched posteriorly as viewed from above (fig. 124).

F Cerci symmetrical with shallow spoon-like depression (fig. 126); hind tibiae variable in color but usually red; widespread and common in eastern Colorado.
Melanoplus angustipennis (Dodge)

F' Cerci not symmetrical; cerci grooved or depressed at tip (fig. 127); hind tibiae brown; associated with juniper and pinon; nocturnal and rare; southeastern Colorado.
Melanoplus splendidus Hebard

E' Subgenital plate of males notched (fig. 125).

F Cerci not symmetrical; cerci grooved, curved inward moderately to strongly (figs. 108, 119, 126).
[Long-winged M. dawsonii will key to this point but cerci not grooved nor curved inward]

G Cerci with small thumb-like projections as seen from rear (fig. 129); furculae nearly one-half length of supra-anal plate; plains of eastern Colorado.
Melanoplus arizonae Scudder

G' Cerci without thumb-like projections; furculae less than one-fourth length of supra-anal plate.

H Cerci expanded dorsally and ventrally, at least somewhat boot-shaped although "heel" may be reduced (fig. 119); tip of cerci strongly twisted dorsally; an early season species; widespread in Colorado.
Melanoplus confusus Scudder

H' Cerci not boot-shaped, tip bent inward and slightly expanded dorsally but not ventrally (fig. 108); a late season species; widespread in Colorado.
Melanoplus gladstoni Scudder

F' Cerci symmetrical, with shallow spoon-like depression, usually moderately curved inward (fig. 130); hind tibiae usually red; widespread and common in eastern Colorado.

G Darker; dorsal pronotum with longitudinal dark band in center and another behind eye on lateral lobe; as viewed from the side, aedeagus with anterior lobe enlarged (fig. 131); plains of eastern Colorado; an agricultural pest.
Melanoplus packardi Scudder

G' Coloration lighter, dark bands indicated in M. packardi absent; as viewed from the side, aedeagus with lobes projecting about equally (fig. 132); widespread in eastern Colorado.
Melanoplus foedus Scudder

D' Furculae one-half length of supra-anal plate or greater (figs. 133, 135).

E' Furculae well over half as long as the supra-anal plate, broad at base and tapering rather abruptly (fig. 133); hind tibiae blue; should occur in northwestern Colorado in sagebrush.
Melanoplus complanatipes Scudder
Fig. 122-Cercus of *Melanoplus keeleri*.

Fig. 123-Back view of subgenital plate of *Melanoplus alpinus*.

Fig. 124-Top view of abdomen tip of male *Melanoplus angustipennis*.

Fig. 125-Top view of abdomen tip of male *Melanoplus arizonae*.

Fig. 126-Cercus of *Melanoplus angustipennis*.

Fig. 127-Cercus of *Melanoplus splendidus*.

Fig. 128-Cercus of *Melanoplus arizonae*.

Fig. 129-Back view of cerci of *Melanoplus arizonae*.

Fig. 130-Cercus of *Melanoplus packardii* or *M. foedus*.
SUBFAMILY GOMPHOCERINAE

A Lateral foveolae of vertex not visible from directly above (fig. 137).

B Antennae triangular in cross-section (figs. 138, 139); wings colorless.

C Tegmina with several parallel longitudinal veins in marginal field (fig. 140); median carina distinct on vertex (fig. 141); hind tibiae brown; tegmina usually short; uncommon in northeast Colorado.
   *Pseudopomala brachyptera* (Scudder)

C' Tegmina with only two or three parallel longitudinal veins in marginal field (fig. 142); median carina absent to very weak on vertex (fig. 143).

D Lateral carinae present on pronotum (fig. 144).

E Lateral carinae weak; tips of tegmina usually extending beyond tips of hind femora; tegmina with dark and pale stripes; uncommon in southeast Colorado.
   *Mermiria texana* Bruner

E' Lateral carinae distinct; tips of tegmina usually not extending to tips of hind femora; tegmina without pale stripes; eastern Colorado.
   *Mermiria picta* (Walker)

D' Lateral carinae of pronotum absent (fig. 145).

E Tips of tegmina extending approximately to tip of abdomen; dark stripe extending posteriorly from eye across pronotum (fig. 53); light stripe beneath eye absent; 27 to 55 mm in length; widespread in eastern Colorado, occasionally abundant.
   *Mermiria bivittata* (Serville)
   [If a distinct dark band is present on dorsum of head and pronotum the specimen is probably *M. texana* with very weak lateral carinae.]

E' Tegmina usually much shorter than abdomen; dark stripe behind eye absent; light stripe present below eye, extending posteriorly (fig. 39); color uniform pale green, pink, tan or grey; 20 to 29 mm in length; widespread in eastern Colorado.
   *Paropomala wyomingensis* (Thomas)
Fig. 131-Aedeagus of *Melanoplus packardii*.

Fig. 132-Aedeagus of *Melanoplus foedus*.

Fig. 133-Furculae and supraanal plate of *Melanoplus complanatipes*.

Fig. 134-Cercus of *Melanoplus complanatipes*.

Fig. 135-Furculae and supraanal plate of *Melanoplus bispinosus*.

Fig. 136-Cercus of *Melanoplus bispinosus*.

Fig. 137-Head of *Amphitornus coloradus*.

Fig. 138-Antennal cross section of *Mermiria picta*.

Fig. 139-Antennal cross section of *Pseudopomala brachyptera*.

Fig. 140-Tegmen of *Pseudopomala brachyptera*. 
B' Antennae not triangular in cross-section although they may be somewhat flattened or clubbed (fig. 146); wings generally colorless.

C An arched crest present on metazona of pronotum only (fig. 147) (not as pronounced in A. nevadensis); head pointed; general color green; antennae red; wings pale yellow with dark band.

[Chortophaga viridifasciata may key to this point if the face is determined to be slanted back. It can be differentiated by the sharp ridge on both the prozona and metazona (fig. 210).]

D Hind tibiae with more than 12 spines in outer row; tegmina usually uniform green but sometimes mottled; eastern Colorado.

Acrolophitus hirtipes (Say)

D' Hind tibiae with fewer than 12 spines in outer row; may occur in western Colorado.

Acrolophitus nevadensis (Thomas)

C' Metazona of pronotum without high crest (fig. 148); wings usually colorless.

D Vertex with surface largely convex, and lacking a conspicuous groove or depression (a weak or shallow depression may be present) (fig. 137).

E Lateral carinae of pronotum prominent and almost parallel (fig. 149); antennae sword-shaped (fig. 150); outer row of spines on hind tibiae 9 to 12; hind femora without bands on outer face; widespread and locally common, primarily in eastern Colorado.

Opeia obscura (Thomas)

[Orphulella spp. will key to this point, if the fastigium of vertex is determined to be convex, and lateral carinae are determined to be almost parallel. The antennal segments near the base are wider than long in Opeia (fig. 151), but longer than wide in Orphulella (fig. 152).]

E' Lateral carinae of pronotum not parallel, usually well constricted near middle, or hardly visible (figs. 155, 156).

F Internal spurs of hind tibiae equal in length (fig. 153).

G External spines of hind tibiae 16 to 24; tegmina of females with scalloped markings (fig. 154).

H Lateral carinae only gently bowed inward (fig. 155); external spines of hind tibiae 20 to 23 in females; probably occurs in southern Colorado.

Syrbula admirabilis Uhler

H' Lateral carinae decidedly bowed inward (fig. 156); external spines of hind tibiae 16 to 18 in females; uncommon in southern Colorado.

Syrbula montezuma (Saussure)
Fig. 141-Head of *Pseudopomala brachyptera*.

Fig. 142-Tegmen of *Paropomala wyomingensis*.

Fig. 143-Head of *Mermiria* spp.

Fig. 144-Top view of pronotum of *Mermiria picta*.

Fig. 145-Top view of pronotum of *Mermiria bivittata*.

Fig. 146-Antennal cross section of *Acrolophitus hirtipes*.

Fig. 147-Head and pronotum of *Acrolophitus hirtipes*.

Fig. 148-Side view of pronotum of *Opeia obscura*.

Fig. 149-Top view of pronotum of *Opeia obscura*.

Fig. 150-Antenna of *Opeia obscura*.
G' External spines of hind tibiae 10 to 15.

H Antennae thread-like (fig. 157); hind femora with dark bands on outer face (fig. 158); hind tibiae blue to lavender; common and widespread, especially in eastern Colorado.

*Amphitornus coloradus* (Thomas)
[*Orphulella* spp. will sometimes key to this point. *Orphulella* lacks bands on the hind femora and has grey hind tibiae. Similarly, *Chloealtis conspersa* can be differentiated by its yellow-brown hind tibiae and lack of distinct parallel stripes on top of head and pronotum; see below.]

H' Antennae sword-shaped (fig. 150); hind femora without bands on outer face; uncommon in eastern Colorado.

*Paropomala virgata* (Scudder)

F' Internal spurs of hind tibiae decidedly unequal in length (fig. 159).

G Lateral carinae of pronotum moderately elevated, well marked by color (figs. 160, 165); size small.

H Face strongly to moderately vertical (fig. 161); tegmina with three or four large, distinct dark spots, often scalloped (figs. 162, 163); hind tibiae tan to red-orange; widespread and common throughout eastern Colorado.

*Phlibostroma quadrimaculatum* (Thomas)

H' Face slanted back (fig. 164); tegmina without large, distinct spots but with dark band running the length of the tegmina, broken by irregular white areas; white streak below the anterior portion of the dark band; hind tibiae tan, sometimes spotted with brown; antennae usually expanded at tip; widespread and common in eastern Colorado.

*Eritettix simplex* (Scudder)
[*Eritettix variabilis* Bruner is considered to be synonymous with *E. simplex*.]

G' Lateral carinae not elevated, well marked by color in females (fig. 166), not marked in males; size medium to large; females green, brown and grey with light markings, occasionally blackish; males black; hind tibiae pink to red; wing bluish; widespread in eastern Colorado but generally not common.

*Boopedon nubilum* Say
Fig. 151-Basal antennal segments of Opeia obscura.

Fig. 152-Basal antennal segments of Orphulella pelidna.

Fig. 153-Internal tibial spurs of Syrbeula admirabilis.

Fig. 154-Tegmen of Syrbeula montezuma.

Fig. 155-Top view of pronotum of Syrbeula admirabilis.

Fig. 156-Top view of pronotum of Syrbeula montezuma.

Fig. 157-Antenna of Amphitornus coloradus.

Fig. 158-Hind femur of Amphitornus coloradus.

Fig. 159-Internal tibial spurs of Phlibostroma quadrimaculatum.

Fig. 160-Top view of pronotum of Phlibostroma quadrimaculatum.

Fig. 161-Head of Phlibostroma quadrimaculatum.
D' Vertex with surface flattened or concave or with a conspicuous groove or depression (figs. 167, 181).

E Vertex with distinct medio-longitudinal carina (fig. 167); tegmina of males distinctly expanded at tip (figs. 168, 170, 174).

F Lateral carinae of pronotum approximately equidistant anteriorly and posteriorly (fig. 172).

G Tegmina of males with three distinct longitudinal veins in marginal field (fig. 168); lateral lobes of pronotum in males entirely dark (fig. 169); tegmina of females as long or longer than head and pronotum; generally uncommon; foothills of northern Colorado.

**Chloealtis conspersa** (Harris)

G' Tegmina of males with one distinct longitudinal vein (and one weak vein) in marginal field (fig. 170); lateral lobes of pronotum in males dark dorsally only (fig. 171); tegmina of females shorter than head and pronotum; generally uncommon; foothills and mountains at moderate elevations and along the eastern slope of Colorado.

**Chloealtis abdominalis** (Thomas)

F' Lateral carinae of pronotum more compressed anteriorly as compared to posteriorly (fig. 173); tegmina of females one and one-half length of head and pronotum; tegmina of males extending beyond tips of hind femora; color green to brown; males with stridulatory pegs on intercalary vein of tegmina (fig. 174); mountains of central Colorado.

**Stethophyma gracile** (Scudder)

E' Vertex lacking a distinct medio-longitudinal carina (figs. 180, 181); carina may be indicated by color but not by structure; tegmina not expanded at tip (figs. 175, 177, 179).

F Tegmina with only one longitudinal vein in basal part of marginal field (figs. 175, 177); lateral carinae of pronotum indicated by color but not by structure; size small.

G Tegmina with a row of rather distinct dark spots along the middle (fig. 175); median carina of pronotum with incision well behind the middle (fig. 176); widespread in eastern Colorado.

**Cordillacris occipitalis** (Thomas)

G' Tegmina with row of spots usually connected dorsally, forming a scalloped band (fig. 177); median carina with incision only a little behind the middle (fig. 178); widespread in eastern Colorado.

**Cordillacris crenulata** (Bruner)
Fig. 162-Tegmen of *Phlibostroma quadrimaculatum*.

Fig. 163-Tegmen of *Phlibostroma quadrimaculatum*.

Fig. 164-Head of *Eritettix simplex*.

Fig. 165-Top view of pronotum of *Eritettix simplex*.

Fig. 166-Top view of pronotum of female *Boopedon nubilum*.

Fig. 167-Head of *Chloealtis abdominalis*.

Fig. 168-Tegmen of *Chloealtis conspersa*.

Fig. 169-Side view of pronotum of *Chloealtis conspersa*.

Fig. 170-Tegmen of *Chloealtis abdominalis*.

Fig. 171-Side view of pronotum of *Chloealtis abdominalis*. 
F' Tegmina with more than one longitudinal vein in basal part of marginal field (fig. 179); lateral carinae of pronotum well indicated by structure (figs. 180, 181).

[Chloealtis occasionally lacks a distinct medio-longitudinal carina on the vertex and will key to this point. Chloealtis males can be distinguished from Orphulella by the expanded tips of the tegmina; in Orphulella the tegmina are not expanded apically. Females of Chloealtis are medium sized (20 mm to 30 mm in length) and usually have abbreviated tegmina; females in Orphulella have tegmina approximately the length of the abdomen and they are smaller (less than 20 mm in length).]

G Lateral carinae of pronotum cut by one sulcus (fig. 180); vertex generally bluntly rounded anteriorly, posterior edge of depression strongly curved (fig. 180); tegmina usually not extending to tips of hind femora; dark stripe behind eye distinct; widespread in Colorado.

Orphulella speciosa (Scudder)

G' Lateral carinae of pronotum cut by two or three sulci (fig. 181); vertex somewhat pointed anteriorly, posterior edge of depression curved moderately (fig. 181); tegmina usually extending to tips of hind femora or beyond; stripe behind eye less distinct; widespread in Colorado.

Orphulella pelidna (Burmeister)
Fig. 172-Top view of pronotum of Chloealtis conspersa.

Fig. 173-Top view of pronotum of Stethophyma gracile.

Fig. 174-Tegmen of Stethophyma gracile.

Fig. 175-Tegmen of Cordillacris occipitalis.

Fig. 176-Top view of pronotum of Cordillacris occipitalis.

Fig. 177-Tegmen of Cordillacris crenulata.

Fig. 178-Top view of pronotum of Cordillacris crenulata.

Fig. 179-Tegmen of Orphulella speciosa.

Fig. 180-Head and pronotum of Orphulella speciosa.

Fig. 181-Head and pronotum of Orphulella pelidna.
A' Lateral foveolae of vertex visible from above (fig. 182) [they may be obsolete in Boopedon (fig. 183) and Stethophyma].

B Antennae clubbed (fig. 184); widespread but usually found in foothills or mountains.

Aeropedellus clavatus (Thomas)

B' Antennae not clubbed.

C Lateral foveolae of vertex obsolete to weak (fig. 183).

D Tegmina of females approximately the length of head and pronotum; tegmina of males not reaching tips of hind femora, and lacking stridulatory pegs on intercalary vein; males black, females sometimes blackish; hind tibiae pink to red; widespread in eastern Colorado, but generally not common.

Boopedon nubilum (Say)

D' Tegmina of females approximately 1 ½ times the length of head and pronotum; tegmina of males reaching or extending beyond tips of hind femora and with stridulatory pegs on intercalary vein (fig. 174); males greenish or brown; mountains of central Colorado.

Stethophyma gracile (Scudder)

[If the specimen has tegmina extending beyond the tips of the hind femora, broad bands on the tegmina, and blue hind tibiae, it may be an Oedipodine, Encoptolophus.]

C' Lateral foveolae of vertex distinct (fig. 182).

D Hind tibiae blue, lavender or green.

E Head often appearing disproportionately large; median carina of pronotum distinct, lateral carinae not distinct structurally, but often well marked by color.

F Tip of female abdomen, when viewed from below, with two deep clefts (fig. 185); tegmina often not reaching tips of hind femora; bands on upper and outer faces of hind femora, and blotches on sides of prozona, dark and distinct; widespread, primarily in eastern Colorado.

Aulocara femoratum (Scudder)

F' Tip of female abdomen, when viewed from below, without deep clefts (fig. 186); tegmina usually reaching or exceeding tips of hind femora; bands on femora and blotches on sides of prozona weak; widespread and common, primarily in eastern Colorado.

Aulocara elliotti (Thomas)

E' Head appearing disproportionately small; median and lateral carinae of pronotum weak or absent; uncommon.

Cibolacris parviceps (Bruner)

D' Hind tibiae brown, red, orange, tan or white.

E Hind femora without dark bands or spots, except tip of femora dark; tegmina usually uniform, sometimes with a few small spots centrally; face and eyes slanting back (fig. 187); antennae long and heavy, darker distally; widespread but rarely common; usually in foothills and mountains.

Chorthippus curtipennis (Harris)

[Chortophaga viridifasciata will key to this point if the face is determined to be slanted back, Chortophaga has tegmina that exceed the tips of the hind femora, and pale yellow and black wings. Chorthippus has tegmina that do not reach the tips of the hind femora, and colorless wings.]
Fig. 182-Head of Aeropedellus clavatus.

Fig. 183-Head of Boopedon nubilum.

Fig. 184-Antenna of Aeropedellus clavatus.

Fig. 185-Bottom view of abdomen tip of female Aulocara femoratum.

Fig. 186-Bottom view of abdomen tip of female Aulocara elliottii.

Fig. 187-Head of Chorthippus curtipennis.

Fig. 188-Top view of pronotum of Stenobothrus brunneus.

Fig. 189-Hind femur of Stenobothrus brunneus.

Fig. 190-Tegmen of Stenobothrus brunneus.

Fig. 191-Top view of pronotum of Ageneotettix deorum.

Fig. 192-Tegmen of Ageneotettix deorum.
E' Hind femora, and usually tegmina, with dark bands and spots.

F Hind tibiae orange or red.

G Lateral carinae of pronotum well marked by structure (fig. 188); hind femora with dark bands on outer face (fig. 189); tegmina with large rectangular cells in marginal field, especially in males (fig. 190); dark areas on dorsal pronotum and on lateral lobes; uncommon; central mountains of Colorado.

Stenobothrus brunneus (Thomas)
[Hind tibiae of specimens of Psoloessa spp. from Arizona occasionally are orange; Psoloessa lacks large rectangular cells on tegmina and has dark spots largely confined to a longitudinal central row; spots on tegmina of Stenobothrus are scattered.]

G' Lateral carinae of pronotum absent, or marked by color but not by structure.

H Lateral carinae of pronotum well marked by color but not by structure (fig. 191); hind femora usually without dark bands on outer face; rectangular cells rarely present in marginal field of tegmina (fig. 192); but many cells of tegmina regularly quadrilateral; pronotum rarely with dark areas; wings colorless; widespread and abundant, especially in eastern Colorado.

Ageneotettix deorum (Scudder)
[Philobostroma quadrimaculatum may key to this point if the lateral foveolae of vertex are determined to be visible from above. The three or four large, distinct, dark spots on the tegmina will indicate P. quadrimaculatum.]

H' Lateral carinae absent (fig. 193); hind femora usually with bands on outer face (fig. 194); cells of tegmina irregular in shape; pronotum may be dark brown; wings may be pale blue or colorless; widespread in eastern Colorado but usually not abundant.

Heliaula rufa (Scudder)
Fig. 193-Top view of pronotum of *Heliaula rufa*.

Fig. 194-Hind femur of *Heliaula rufa*.

Fig. 195-Top view of pronotum of *Psoloessa delicatula*.

Fig. 196-Tegmen of *Psoloessa delicatula*.

Fig. 197-Head of *Psoloessa texana*.

Fig. 198-Head of *Psoloessa texana*.

Fig. 199-Top view of pronotum of *Cibolacris parviceps*.

Fig. 200-Tegmen of *Cibolacris parviceps*.

Fig. 201-Bottom view of thorax of male *Arphia conspersa*.

Fig. 202-Bottom view of thorax of female *Arphia conspersa*.
F' Hind tibiae brown, tan or white; adults present in early spring.

G Size small; lateral carinae of pronotum distinct and usually well marked by color (fig. 195); hind tibiae brown or tan; tegmina with a row of dark spots on blotches (fig. 196); wings colorless.

H Frontal costa with strong lateral ridges, depressed between ridges (fig. 197); widespread and common.  
**Psoloessa delicatula** (Scudder)

H' Frontal costa without strong lateral ridges (fig. 198); eastern Colorado.  
**Psoloessa texana** (Scudder)

G' Size medium; lateral carinae absent (fig. 199); hind tibiae white (sometimes tinted with lavender); tegmina with scattered brown spots (fig. 200); background color cream; wings colorless to pale yellow or blue; uncommon.  
**Ciboacris parviceps** (Bruner)

**SUBFAMILY ROMALEINAE**

Only a large species in the subfamily Romaleinae occurs in Colorado. This species is large, red-brown and green-brown, with abbreviated tegmina red in color and spotted with black. It is found throughout eastern Colorado and sometimes is common.  
**Brachystola magna** (Girard)
Fig. 203-Hind femur of *Arphia pseudonietana*.

Fig. 204-Wing of *Arphia pseudonietana*.

Fig. 205-Hind femur of *Arphia conspersa*.

Fig. 206-Hind tibia of *Arphia simplex*.

Fig. 207-Wing of *Arphia simplex*.

Fig. 208-Wing of *Arphia xanthoptera*.

Fig. 209-Wing of *Arphia conspersa*.

Fig. 210-Pronotum of *Chortophaga viridifasciata*. 
SUBFAMILY OEDIPODINAE

A Intermetasternal space longer than broad in males (fig. 201), quadrate in females (fig. 202).

B Wings brightly colored: red, orange or yellow; tegmina dark, lacking bands.

C Inner face of hind femora with one light band distally (fig. 203); tegmina usually grey-brown mottled with dark spots, spots sometimes merging to solid grey-black; wings orange-red; orange-red area in front of spur at least width of spur (fig. 204); widespread and common late summer and fall.
   Arphia pseudonietana (Thomas)

C' Inner face of hind femora with at least two light bands (fig. 205); tegmina variable; wings orange-red to yellow.

D Hind tibiae with distinct light band proximally (fig. 206); tegmina variable; wings usually yellow, sometimes orange; colored area in front of spur about twice width of spur (fig. 207); not reported from Colorado but may occur at the eastern borders.

E Spur extending more than one-half of the distance to wing base (fig. 207).
   Arphia simplex Scudder

E' Spur extending less than one-half of the distance to wing base (fig. 208).
   Arphia xanthoptera (Burmeister)

D' Hind tibiae usually light throughout, distinct band lacking; tegmina variable; wings yellow or red; colored area in front of spur less than width of spur (fig. 209); posterior edge of tegmina often light, forming distinct light stripe down center of back; common and widespread early spring and summer.
   Arphia conspersa Scudder

B' Wings colorless or only faintly colored.

C Distinct bands absent from tegmina; median carina strongly elevated, but incision of median carina weak (fig. 210); wings yellow basally, smoky distally; eastern Colorado; adults present in early spring.
   Chortophaga viridifasciata (DeGeer)
   [Psoloessa, Aulocara, and Stenobothrus will key to this point, if the face is determined to be vertical. Psoloessa spp. are small. Chortophaga is medium sized; hind tibiae are bright blue in Aulocara, but grey-brown in Chortophaga; Stenobothrus is small to medium sized with orange-brown hind tibia; all the Gomphocerinae that key to this point have colorless wings; see subfamily Gomphocerinae.]
Fig. 211-Tegmen of *Encoptolophus sordidus*.

Fig. 212-Pronotum of *Encoptolophus sordidus*.

Fig. 213-Pronotum of *Encoptolophus subgracilis*.

Fig. 214-Bottom view of thorax of male *Camnula pellucida*.

Fig. 215-Bottom view of thorax of female *Camnula pellucida*.

Fig. 216-Pronotum of *Leprus cyaneus*.

Fig. 217-Pronotum of *Leprus cyaneus*.

Fig. 218-Pronotum of *Leprus robustus*. 
C’ Distinct bands present on tegmina (distal portion may be mottled) (fig. 211); median carina slightly elevated, but incision of median carina pronounced (figs. 212, 213).

[Phlibostroma may key to this point, if the face is determined to be vertical; the wings of Phlibostroma are colorless; wings of Encyrtolophus are smoky distally.]

D Median carina pronounced on metazona (fig. 212); generally dark colored; pronounced bands on tegmina; widespread and common, late summer and fall.

Encyrtolophus sordidus (Burmeister)

D’ Median carina reduced on metamorpha (fig. 213); generally dark colored; weak bands on tegmina; uncommon.

Encyrtolophus subopacus Caudell

A’ Intermetasternal space quadrate in males (fig. 214), wider than long in females (fig. 215).

B Median carina with not more than one transverse incision (figs. 216, 217, 218, 219); median carina usually distinct to high.

C Median carina weak (figs. 217, 218); tegmina with distinct bands.

D Wing discs yellow; hind tibiae orange; inner face of hind femora mostly dark blue-black; widespread.

E Inner face of hind femora blue-black basally.

Hadrotettix trifasciatus (Say)

E’ Inner face of hind femora orange-red basally.

Trimerotropis magnifica Rehn

D’ Wing discs blue to green-blue; hind tibiae grey to blue; inner face of hind femora light to dark blue; uncommon (and difficult to distinguish from one another).

E Lower portion of lateral lobes of pronotum distinctly wider than upper portion (fig. 217); hind tibiae usually dark blue; wing discs blue to green; southern Colorado.

Leprus cyaneus Cockerell

E’ Lower portion of lateral lobes of pronotum not distinctly wider than upper portion (fig. 218); hind tibiae usually light blue to grey; wing discs to blue; southwestern Colorado.

Leprus robustus Hebard
Fig. 219-Pronotum of Camnula pellucida.

Fig. 220-Pronotum, tegmen and wing of Dissosteira carolina.

Fig. 221-Tegmen and wing of Dissosteira longipennis.

Fig. 222-Pronotum of Tropidolophus formosus.

Fig. 223-Pronotum of Spharagemon equale.

Fig. 224-Tegmen of Spharagemon humile.

Fig. 225-Tegmen of Spharagemon equale.

Fig. 226-Pronotum of Spharagemon collare.

Fig. 227-Tegmen of Spharagemon collare.
C' Median carina well marked (fig. 220); tegmina variable.

D Wings lacking dark band, usually colorless; tegmina spotted; lateral carinae not cut by transverse suture (fig. 219); throughout Colorado except far eastern plains.

*Camnula pellucida* Scudder

D' Wing with dark band.

E Dark band of wings not reaching posterior margin (figs. 220, 221).

F Tegmina almost uniform in color, bands not prominent (fig. 220); inner margin of wings black (fig. 220); widespread.

*Dissosteira carolina* (L.)

F' Tegmina with bands consisting of spots or blotches (fig. 221); inner margin of wings pale yellow or colorless, surrounded by a broad black band that does not reach the posterior margin (fig. 221); eastern Colorado.

*Dissosteira longipennis* (Thomas)

E' Dark median band extending entirely across wings (fig. 228).

F Hind tibiae without a distinct dark ring at the proximal end.

G Median carina extremely elevated and arched, lacking transverse incision (fig. 222); general color green; wing disc orange; plains of eastern Colorado.

*Tropidolophus formosus* (Say)

G' Median carina not extremely elevated and arched, with transverse incision; wing disc not orange.

H Tegmina with bands or speckles (figs. 224, 225, 227); tegmina when folded without light colored "V"; band on wings with short spur (fig. 228).

I Hind tibiae pale yellow or tan; size large; wing discs colorless or pale yellow; wing band often pale, spur short or absent; tegmina with spots forming bands (occasionally uniform); median carina more elevated on prozona than on metazona; not reported from Colorado but may occur in the northwest portion of the state.

*Dissosteira spurcata* Saussure
Fig. 228-Wing of *Spharagemon collar*.

Fig. 229-Tegmina folded showing light colored "V".

Fig. 230-Wing of *Hippiscus ocelote*.

Fig. 231-Head of *Hippiscus ocelote*.

Fig. 232-Pronotum of *Hippiscus ocelote*.

Fig. 233-Head of *Pardalophora haldemanii*.

Fig. 234-Pronotum of *Pardalophora haldemanii*.

Fig. 235-Tegmen of *Pardalophora haldemanii*.

Fig. 236-Head of *Pardalophora haldemanii*.

Fig. 237-Tegmen of *Pardalophora apiculata*.

Fig. 238-Head of *Pardalophora apiculata*.
I’ Hind tibiae orange or coral; medium to large size; wing discs white or pale to bright yellow; wing bands dark.

J Median carina well marked but not high (fig. 223), often more elevated on prozona than metazona; bands on tegmina fairly distinct; face not distinctly mottled; eastern Colorado.

K Bands on tegmina separated by more than the width of a band; bands usually distinct and solid (fig. 224).

**Spharagemon humile** (Morse)

K’ Bands on tegmina not separated by more than the width of a band; bands less distinct and usually composed of spots (fig. 225).

**Spharagemon equale** (Say)

[Trimerotropis spp. sometimes will key to this point because the anterior incision of the median carina may be weak.]

J’ Median carina strikingly elevated (fig. 226); bands on tegmina indistinct and composed of many spots (fig. 227); face distinctly mottled; common in eastern Colorado.

**Spharagemon collare** (Scudder)

H’ Tegmina with large spots; tegmina when folded with light colored “V” (fig. 229); band on wings with long spur (fig. 230).

I Sides of frontal costa nearly parallel throughout (fig. 231); prozona and metazona approximately equal to length (fig. 232); eastern Colorado.

**Hippiscus ocelote** (Saussure)

I’ Sides of frontal costa considerably narrowed between or above antennae (fig. 233); metazona longer than prozona (fig. 234).

J Spots on tegmina numerous (fig. 235); light colored “V” formed when tegmina folded (fig. 229); area between arms of “V” is dark; anterior extremity of vertex not prolonged (fig. 236).

**Pardalophora haldemanii** (Scudder)

[Xanthippus and Cratypedes will key to this point if the anterior incision of the median carina is very weak; the middle of the pronotum is collapsed between the two incisions in Xanthippus, or anterior to the incision if only one incision is visible; the median carina is distinct and not crumpled or collapsed except for one distinct incision in Pardalophora. Cratypedes can be distinguished from Pardalophora by the pattern on the tegmina. Pardalophora has discrete, fairly large dark spots; Cratypedes tends to have indistinct, irregular spotting patterns.]

J’ Spots on tegmina few (fig. 237); dark area within “V” not present; anterior extremity of fastigium of vertex prolonged (fig. 238).

**Pardalophora apiculata** (Harris)

F’ Hind tibiae with a distinct dark ring at the proximal end (fig. 239); uncommon.

**Spharagemon bolli** Morse
Fig. 239-Hind tibia of *Spharagemon bolli*.

Fig. 240-Tegmen tip of *Hadrotettix trifasciatus*.

Fig. 241-Tegmen of *Heliaula rufa*.

Fig. 242-Tegmen of *Hadrotettix trifasciatus*.

Fig. 243-Tegmen tip of *Conozoa sulcifrons*.

Fig. 244-Pronotum of *Trimerotropis pallidipennis*.

Fig. 245-Tegmen and wing of *Cibolacris parviceps*.

Fig. 246-Tegmen of *Conozoa sulcifrons*.

Fig. 247-Tegmen of *Conozoa texana*.

Fig. 248-Head and pronotum of *Mestobregma plattei*.
B' Median carina with two transverse incisions (fig. 244); median carina usually reduced to moderately high.

C Fewer than half of the cells in the distal half of the tegmina regularly quadrilateral (fig. 240).

D Wings colorless or pale blue, without dark bands; head appearing disproportionately large; tegmina without bands, usually spotted (fig. 241); length 20-25 mm; eastern Colorado. (Now considered to be a Gomphocerine.)

**Heliaula rufa** (Scudder)

D' Wing disc faintly to strongly colored yellow and with dark band present; tegmina with bands (fig. 242); head appearing small to normal in size; inner face of hind femora dark blue; length 29-46 mm; eastern Colorado (in some specimens the cells of the tegmen are regularly quadrilateral).

**Hadrotettix trifasciatus** (Say)

[If wing disc is blue refer back to *Leprus*; if inner face of hind femora are orange or red basally see *Trimerotropis magnifica*.]

C' Most of the cells of the distal half of the tegmina regularly quadrilateral, and arranged in rows on either side of spurious veins (fig. 243).

D Metazona at least 1½ times as long as prozona, often more than twice as long (fig. 244).

E Tegmina with several scattered brown spots throughout and lacking bands (fig. 245); background color of head, thorax and tegmina is cream; wings colorless to pale yellow or blue with black veins (but lacking bands) (fig. 245); hind tibiae white or lavender; uncommon. (Now considered to be a Gomphocerine.)

**Cibolacris parviceps** (Bruner)

E' Tegmina with bands, spots forming bands, large spots on costal margin, occasionally without spots or very small spots; many common species.

F Tegmina with bands or large spots on costal margin only (figs. 246, 247).

G Hind tibiae brown to blue; distinct dark band usually present on face below antennae and on lateral lobes of pronotum (fig. 248); common throughout Colorado.

**Mestobregma plattei** Thomas

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Fig. 249 - Tegmen and wing of *Circotettix rabula*.

Fig. 250 - Wing of *Circotettix carlinianus*.

Fig. 251 - Wing of *Xanthippus corallipes*.

Fig. 252 - Pronotum of *Xanthippus corallipes* or *X. montanus*.

Fig. 253 - Tegmen of *Xanthippus corallipes*.

Fig. 254 - Tegmen of *Xanthippus montanus*.

Fig. 255 - Pronotum of *Cratypedes neglectus*.

Fig. 256 - Tegmen of *Cratypedes neglectus*.

Fig. 257 - Pronotum of *Trimerotropis agrestis*.
G' Hind tibiae orange or yellow; distinct bands not present on face and pronotum.

H Hind tibiae orange; pronotum with weak incisions on median carina; western Colorado; uncommon.  
   *Conozoa sulcifrons* Scudder

H' Hind tibiae yellow; pronotum with distinct incisions on raised median carina (fig. 270); western Colorado.  
   *Conozoa texana* (Bruner)

F' Bands crossing the tegmina, fading in some cases at the posterior border, or tegmina spotted or speckled throughout, or appearing uniform (fig. 249).

G Radiate veins of anal field of wings distinctly swollen (figs. 249, 250).

H Swollen veins prominent only in anterior one-half or two-thirds of anal field (fig. 249); wing discs yellow; common throughout Colorado.  
   *Circotettix rabula* Rehn and Hebard

H' Swollen veins prominent in entire anal field (fig. 250); wing discs colorless or blackish; widespread but uncommon.  
   *Circotettix carlinianus* (Thomas)

G' Radiate veins of anal field of wings not distinctly swollen (fig. 251).  
   [Some specimens of *Leprus* may key to this point but can be distinguished easily by the blue or green wing disc.]

H Light colored "V" present on tegmina when viewed from above (fig. 229).

I Two transverse incisions in median carina, anterior incision not showing clearly and carina not elevated between incisions (fig. 252); tegmina mottled or spotted throughout; size variable, often large; adults present in early spring.

J Tegmina markings clearly defined with large pale areas between (fig. 253); widespread and common.  
   *Xanthippus coralipes* Haldeman

J' Tegmina markings weakly defined (fig. 254); uncommon.  
   *Xanthippus montanus* (Thomas)

I' Two transverse incisions, anterior incision often distinct; carina elevated between incisions (fig. 255); spots on tegmina less distinct and more irregular than on *X. coralipes* (fig. 256); (occasional specimens lack the light colored "V"); common in mountains; size medium.  
   *Cratypedes neglectus* (Thomas)

H' Light colored "V" not present on tegmina.

I Metazona usually about twice as long as prozona (figs. 257, 258); posterior angle of lateral lobe of pronotum rounded; widespread, sometimes common.  
   *Trimerotropis* spp.  
   [See key to this large genus which follows this section.]

I' Metazona about 1½ times as long as prozona (figs. 259, 260); posterior angle of lateral lobes of pronotum not rounded, often acute; this may be *Trachyrhachys* spp. (see D', below).

D' Metazona not much longer than prozona, usually less than 1½ times as long (figs. 259, 260, 261, 262) (in *Trachyrhachys* some specimens have metazona 1½ times as long).

E Generally larger than other species in this group, male about 26 mm long, female about 34 mm; light bands on tegmina which form "V"; tegmina spotted irregularly (fig. 263); male hind tibiae blue, female hind tibiae blue-grey; widespread in eastern Colorado.  
   *Metator pardalinus* (Saussure)
Fig. 258-Pronotum of Trimerotropis citrina.

Fig. 259-Pronotum of Trachyrhachys kiowa.

Fig. 260-Pronotum of Trachyrhachys aspera.

Fig. 261-Pronotum of Hippopedon capito.

Fig. 262-Pronotum of Derotmema haydeni.

Fig. 263-Tegmen of Metator pardalinus.

Fig. 264-Tegmen of Trachyrhachys aspera.

Fig. 265-Tegmen of Trachyrhachys coronata.

Fig. 266-Tegmen of Hippopedon capito.

Fig. 267-Tegmen of Derotmema haydeni.
[The only other large species in this group with a light colored “V” is Hippopedon capito, which has distinct bands or large spots on the tegmina, and yellow hind tibiae.]

E' Smaller species, lacking “V” except in Hippopedon capito and the much smaller Trachyrhachys coronata.

F Anterior and posterior margins of lateral lobes of pronotum nearly or quite parallel (figs. 248, 259, 260).

G Dark bands present on face below antennae and on lateral lobes of pronotum (fig. 248); posterior angle of lateral lobes of pronotum usually broadly rounded; broad bands distinct on costal margin of tegmina; wing discs yellow or pink; widespread.

Mestobregma plattei (Thomas)
[Occasional specimens with lateral lobes of pronotum not broadly rounded, resembling Trachyrhachys kiowa; the curved dark band on the lateral lobes of the pronotum will indicate Mestobregma.]

G' Dark band absent below antennae and lateral lobes of pronotum; posterior angle of lateral lobes of pronotum not broadly rounded (figs. 259, 260); tegmina usually with irregular bands or mottled.

H Median carina of pronotum raised on metazona.

I Tegmina irregularly marked and blotched with dark brown, not more than two or three large blotches (fig. 264).

J Wing discs usually colorless with black veins, occasionally yellow with black bands; lateral lobes of pronotum usually with acute posterior angle (fig. 259); tegmina with blotches forming rather distinct bands; widespread and common.

Trachyrhachys kiowa Thomas

J' Wing discs yellow or red with apical one-third dark; lateral lobes of pronotum less acute than in T. kiowa, sometimes approaching a 90° angle posteriorly (fig. 260); tegmina with spots forming irregular bands; eastern foothills, extending to plains in northern Colorado.

Trachyrhachys aspera (Scudder)

I' Tegmina regularly and evenly marked throughout with large dark patches (fig. 265); wing discs pale yellow, wings with black band; mountains and foothills along the front range in Colorado; uncommon.

Trachyrhachys coronata (Scudder)

H' Median carina of pronotum very low on metazona (fig. 261); tegmina with light colored “V” and large dark spots (fig. 266); hind tibiae yellow; southern and central Colorado.

Hippopedon capito (Stal)
[Heliaula rufa occasionally will key to this point. Heliaula lacks light colored “V” and dark spots and usually has a grey-colored, disproportionately large head.]

F' Anterior and posterior margins of lateral lobes of pronotum not parallel (fig. 262); tegmina brown with darker spots, especially along edges (fig. 267); wing discs yellow or red with black band; eyes disproportionately large; hind tibiae yellow-brown; size small to medium; widespread.

Derotmema haydeni (Thomas)

Key to Trimerotropis Species

The members of the genus Trimerotropis are brightly colored and often noisy. Thus, they are readily observed and frequently collected. They never reach the levels of abundance nor inflict the level of damage observed among such grasshoppers as the Melanoplines. The indications of abundance in this section of the key are relative to other Trimerotropis spp., not other genera.

A Wings colorless or tinged with blue, brown, green or pink.

B Dark bands of wings absent to narrow and weak; bands on tegmina absent to weak; found principally in western Colorado.

Trimerotropis sparsa (Thomas)

B' Dark band present on wings; bands on tegmina fairly distinct; may occur in western Colorado.

Trimerotropis cyaneipennis Bruner

A' Wings with discs yellow (may be pale yellow); dark bands on wings present.

B Tegmina without distinct bands and without spots grouped to form bands.

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Fig. 268-Head of *Trimerotropis cincta*.

Fig. 269-Head of *Conozoa texana*.

Fig. 270-Pronotum of *Conozoa texana*.

Fig. 271-Pronotum of *Trimerotropis pallidipennis*.

Fig. 272-Wing of *Trimerotropis pallidipennis*.

Fig. 273-Tegmen showing distinct bands.

Fig. 274-Tegmen of *Trimerotropis pallidipennis*.

Fig. 275-Wing of *Trimerotropis fratercula*.

Fig. 276-Pronotum of *Trimerotropis inconspicua*.

Fig. 277-Wing of *Trimerotropis inconspicua*.
C Tegmina chocolate brown; tip of wings dark or clouded; hind tibiae brown to blue; common in mountainous areas. *Trimerotropis verruculatus* Scudder

C' Tegmina light to medium brown or grey; tip of wings colorless but veins dark.

D Hind tibiae orange to red.

E Posterior angle of lateral lobes of pronotum a rounded point (fig. 257); inner face of hind femora usually orange-red; locally common. *Trimerotropis agrestis* McNeill

E' Posterior angle of lateral lobes of pronotum rounded but not pointed (fig. 258); inner face of hind femora usually with yellow; uncommon. *Trimerotropis citrina* Scudder

D' Hind tibiae yellow, sometimes mottled with brown; locally common. *Trimerotropis gracilis* (Thomas)

B' Tegmina with distinct bands (fig. 273) or small spots grouped to form bands (fig. 274).

C Front of head with dark bands below and above antennal bases (fig. 268); median carina not extremely elevated on prozona, two lobes not prominent; hind tibiae blue or yellow-brown; usually associated with forested areas; locally common. *Trimerotropis cincta* (Thomas)

[Conozoa texana may key to this point but band above antennal bases weak to absent (fig. 269); two lobes are prominent on the median carina of the pronotum (fig. 270).]

C' Front of head without a band.

D Hind tibiae blue; uncommon. *Trimerotropis fontana* Thomas

D' Hind tibiae not blue.

E Hind tibiae yellow, yellow-brown, grey or green.

F Median carina of pronotum higher on prozona than on metazona (fig. 271); bilobate on prozona; wing bands in the middle or beyond, dark colored, not narrowing toward the spur (fig. 272); spur reaches one-half the distance to the wing or more; widespread and common. *Trimerotropis pallidipennis* (Burmeister)

[T. fratercula sometimes is bilobate or prozona, but wing bands are weak and narrow decidedly toward spur (fig. 275); Conozoa texana similarly has weak wing bands and usually has a blunt protuberance near the posterior angle of lateral lobes of pronotum (fig. 270).]

F' Median carina low throughout (fig. 276); not bilobate on prozona.

G Wing bands decidedly narrowing toward spur (fig. 275); band margins irregular; bands weak; spur long; wing apex smoky; inhabits moderate elevations of mountains. *Trimerotropis fratercula* McNeill

G' Wing bands narrow only slightly (fig. 277); band margins usually regular; wing apex colorless; spur short; inhabits river valleys of western Colorado. *Trimerotropis inconspicua* Bruner

E' Hind tibiae orange or red.

F Lower border of lateral lobes of pronotum with tooth (fig. 278); common in western Colorado. *Trimerotropis californica* Bruner

F' Lower border of lateral lobes of pronotum without tooth (fig. 279).

G Wing bands two-thirds as broad as length of wing (fig. 280); inner border of bands not strongly curved; spur lacking; inner face of hind femora mostly black; sometimes common in eastern Colorado. *Trimerotropis melanoptera* McNeill
Fig. 278-Pronotum of Trimerotropis californica.

Fig. 279-Pronotum of Trimerotropis melanoptera.

Fig. 280-Wing of Trimerotropis melanoptera.

Fig. 281-Wing of Trimerotropis latifasciata.

Fig. 282-Tegmen of Trimerotropis pistrinaria.

Fig. 283-Wing of Trimerotropis magnifica.

Fig. 284-Tegmen of Spharagemon humile.

Fig. 285-Tegmen and wing of Trimerotropis tolteca.

Fig. 286-Tegmen of Trimerotropis campestris.

Fig. 287-Tegmen of Trimerotropis tolteca.
G' Width of wing bands less than two-thirds wing length.

H  Wing bands wider, as wide, or nearly as wide, as yellow wing discs; inner border of wing bands strongly curved (fig. 281); inner face of hind femora with two or three orange bands; red on abdomen of fresh specimens; widespread and common.  
   *Trimerotropis latifasciata* Scudder  
   [*T. laticincta* Saussure, which has narrower wing bands, keys to this point; we consider it synonymous with *T. latifasciata*, as does Coppock (1962).]

H'  Wing bands narrower than yellow wing discs.

I  Tegmina with basal median crossbands distinct; bands usually separated by more than the width of one band (fig. 282).

J  Basal and median bands of tegmina solid, not formed by groups of spots (fig. 282).

K  Large size, male over 30 mm long; antennae long; spur of wing bands absent to not reaching over one-fourth the distance from band to base (fig. 283).  
   *Trimerotropis magnifica* Rehn  
   [*Hadrotettix trifasciatus* (Say) sometimes will key to this point; it can be differentiated by the dark blue-black color throughout the inner face of the hind femora; *T. magnifica* with orange or red basal portion of the inner face of hind femora.]

K'  Not with above combination of characters.

L  Inner face of hind femora orange; bands on tegmina discrete and narrow (fig. 282); median carina extremely reduced; inhabits rocky areas with little cover; widespread; locally common.  
   *Trimerotropis pistrinaria* Saussure  
   [Some specimens of *Spharagemon equale* and *S. humile* appear to have two notches in the median carina and may key to this point, but tegmental bands are wider and irregular or composed of spots (fig. 284).]

L'  Inner face of hind femora yellow.  
   *Trimerotropis tolteca* Bruner  
   [*T. inconspicua* from Arizona have orange hind tibiae. Such specimens could key to this point, but can be distinguished from *T. tolteca* by the width of the wing bands. The wing bands in *T. inconspicua* are narrow, often not much wider than the tegmental bands; in *T. tolteca* the wing bands are often twice the width of the tegmental bands (fig. 285).]

J'  Bands of tegmina formed by grouping of spots (fig. 286); lower half of face and posterior half of pronotum often lighter in color; plains to moderate elevations in mountains; widespread and common.  
   *Trimerotropis campestris* McNeill  
   [Occasional specimens of *Cratypedes neglectus* lacking light bands on the tegmina will key to this point. The metazona of *T. campestris* has a much reduced median carina, is bordered by black spots and is usually lighter in color than the prozona. Also, the sides of the lateral lobes of the pronotum are somewhat parallel. In *C. neglectus* the metazona has a pronounced median carina and is entirely dark. The lateral lobes of the pronotum are expanded posteriorly.]

I'  Tegmina with basal and median crossbands not distinct (figs. 286, 287); bands usually closer together than width of one band.

J  Tip of wings cloudy; inner face of hind femora yellow; southwestern Colorado.  
   *Trimerotropis tolteca* Bruner

J'  Tip of wings not cloudy.

K  Inner face of hind femora mostly red or orange; found from the eastern plains to the mountains at moderate elevations; widespread and common.  
   *Trimerotropis campestris* McNeill  
   [See note above concerning *Cratypedes neglectus*.

K'  Inner face of hind femora black with orange-red at base; large; male over 30 mm long.  
   *Trimerotropis magnifica* Rehn
PHOTOGRAPHS OF COMMON GRASSHOPPER SPECIES

The following photographs represent most of the common species and all of the economically important species occurring in Colorado. The photos will enable the user to confirm identification based on use of the dichotomous key. The photographs are not designed as a substitute for the key. Identifications derived from comparison of specimens with photographs will be erroneous.

Fig. 288-Schistocerca alutacea, female.

Fig. 292-Hesperotettix speciosus, male.

Fig. 289-Hypochloria alba, male.

Fig. 293-Hesperotettix speciosus, female.

Fig. 290-Dactylotum bicolor, female.

Fig. 294-Aeoloplides tenuipennis, female.

Fig. 291-Hesperotettix viridis, female.

Fig. 295-Aeoloplides turnbulli, female.
Fig. 296—*Aeoloplides chenopodii*, male.

Fig. 297—*Phoetaliotes nebrascensis*, female.

Fig. 298—*Melanoplus lakinus*, male.

Fig. 299—*Melanoplus occidentalis*, male.

Fig. 300—*Melanoplus bowditchi*, male.

Fig. 301—*Melanoplus flavidus*, male.

Fig. 302—*Melanoplus femurrubrum*, male.

Fig. 303—*Melanoplus sanguinipes*, male.
Fig. 312-Pseudopomata brachyptera, female.

Fig. 313-Mermiria picta, male.

Fig. 314-Mermiria bivitatta, male.

Fig. 315-Paropomala wyomingensis, male.

Fig. 316-Acrolophitus hirtipes, female.

Fig. 317-Opeia obscura, female.

Fig. 318-Amphitornus coloradus, male.

Fig. 319-Philobostroma quadrimaculatum, female.
Fig. 320-Eritettix simplex, female.

Fig. 321-Boopedon nubilum, male.

Fig. 322-Boopedon nubilum, female.

Fig. 323-Chloealtis conspersa, male.

Fig. 324-Chloealtis conspersa, female.

Fig. 325-Cordillacris occipitalis, female.

Fig. 326-Cordillacris crenulata, female.

Fig. 327-Aeropedellus clavatus, male.
Fig. 328 - Aeropedellus clavatus, female.

Fig. 329 - Aulocara femoratum, female.

Fig. 330 - Aulocara elliotti, female.

Fig. 331 - Chorthippus curtipennis, male.

Fig. 332 - Chorthippus curtipennis, female.

Fig. 333 - Ageneotettix deorum, female.

Fig. 334 - Psoioessa delicatula, female.

Fig. 335 - Brachystola magna, male.
Fig. 336 - *Arphia pseudonietana*, male.

Fig. 340 - *Leprus robustus*, male.

Fig. 337 - *Arphia conspersa*, female.

Fig. 341 - *Camnula pellucida*, female.

Fig. 338 - *Chortophaga viridifasciata*, female.

Fig. 342 - *Dissosteira carolina*, female.

Fig. 339 - *Encoptolophus sordidus*, female.

Fig. 343 - *Dissosteira longipennis*, female.
Fig. 344 - Tropidolophus formosus, male.

Fig. 345 - Spharagemon collare, female.

Fig. 346 - Hippiscus ocelote, female.

Fig. 347 - Pardalophora haldemanii, male.

Fig. 348 - Heliaula rufa, female.

Fig. 349 - Hadrotettix trifasciatus, female.

Fig. 350 - Mestobregma plattei, female.

Fig. 351 - Conozoa texana, male.
Fig. 352 - *Circotettix rabula*, female.

Fig. 353 - *Circotettix carlinianus*, female.

Fig. 354 - *Xanthippus corallipes*, female.

Fig. 355 - *Metator pardalinus*, female.

Fig. 356 - *Trachyrhachys kiowa*, female.

Fig. 357 - *Trachyrhachys aspera*, female.

Fig. 358 - *Trachyrhachys coronata*, female.

Fig. 359 - *Derotmema haydeni*, female.
Fig. 360-Trimerotropis cyaneipennis, male.

Fig. 364-Trimerotropis californica, male.

Fig. 361-Trimerotropis verruculatus, female.

Fig. 365-Trimerotropis latifasciata, male.

Fig. 362-Trimerotropis agrestis, female.

Fig. 366-Trimerotropis magnifica, male.

Fig. 363-Trimerotropis pallidipennis, female.

Fig. 367-Trimerotropis campestris, female.
GRASSHOPPER BIOLOGY

SYNOPSIS OF GRASSHOPPER BIOLOGY

Grasshoppers are a diverse group of insects. This section presents an overview of grasshopper biology and stresses the features common to most species. The generalizations that follow provide insight into grasshopper development, behavior and population dynamics, but many exceptions exist. For a comprehensive review of grasshopper biology, see Uvarov (1966, 1977).

Grasshopper Development

Developmental stages in grasshoppers include the egg, immature (nymph) and adult. Each individual progresses through these stages in the order presented, but the length of each stage and the time of year when a given stage occurs varies with species.

Most species pass the winter as eggs. Eggs are deposited by females during the summer and autumn. Embryological development occurs as long as weather is favorable but ceases at some point. The point of arrested development is variable, but commonly 80% or 90% of development has been completed. The grasshopper embryo remains in a state of arrested development, or diapause, until spring when a combination of temperature and moisture stimulates egg hatch, or eclosion. Usually a lengthy cold period is required before embryos respond to favorable environmental stimuli and complete their development; this prevents eclosion from occurring during abnormally warm periods in the winter when food is not available.

The length of time required between completion of diapause and eclosion is largely a function of temperature, with higher temperatures promoting earlier eclosion. Eclosion date can be estimated from soil temperature accumulations. For example, Hewitt (1979) indicated that approximately 2,500 degree hours (number of degrees each hour that soil temperature exceeded a developmental threshold of 15.6°C) were required for hatching of Melanoplus sanguinipes. Mukerji and Gage (1978) developed a procedure based on soil temperature and moisture that explains 99% of the variance in eclosion. Much more information on grasshopper development is needed to predict eclosion and to allocate resources for grasshopper sampling and control efforts more effectively.

Eggs usually are produced in groups and in structures called egg pods. According to Onsager and Mulkern (1963) four basic types of egg pods occur, and these are distinguished primarily by characteristics of the frothy secretion associated with the eggs. The froth may be found around and among the eggs, causing the eggs to adhere to one another and soil particles to adhere to the eggs. Type I egg pods are characterized by froth surrounding the mass of eggs but not between individual eggs. Thus, the froth forms a hollow receptacle in which the eggs are deposited. Type II egg pods have froth surrounding eggs and between eggs. Type III egg pods have froth between eggs, but froth does not completely surround the pod. Type IV egg pods contain little froth, and it occurs only adjacent to the last-deposited eggs. Thus, egg pods may be found as hardened, soil-covered pellets (often bean-shaped), or as rather loose collections of eggs or as something in between.

Egg pods commonly contain four to 40 eggs. Females may produce four to 25 egg pods, and total egg production is commonly 100 to 200 eggs, but 500 eggs is not unusual (Criddle, 1933a). Characteristics of eggs and egg pods can provide valuable clues to the identity of grasshoppers; Onsager and Mulkern (1963) provide a key to eggs of North Dakota grasshoppers.

Eggs usually are deposited in soil, but some species prefer to oviposit among roots of plants, in wood or in cow dung. Females may be very selective in oviposition site and commonly will insert their ovipositor numerous times before locating a satisfactory site. Soil texture, temperature, vegetation conditions and moisture level commonly influence site choice. During the early part of the egg-laying season when temperatures are high, level ground or eastern slopes frequently are chosen as oviposition sites. Toward autumn as temperatures become cooler, grasshoppers frequently deposit their eggs on sunny southern and western slopes. Obviously, the oviposition site of a grasshopper species is associated with its seasonal history (Criddle, 1933a).

Egg hatch is not always synchronous because species-specific differences exist and oviposition sites may be exposed to different temperatures. Also, some species produce eggs that diapause through two winters and the intervening summer. Or, a species that normally survives the winter as a nymph may diapause throughout the winter and hatch during the following season.

Not all species overwinter as eggs. In a few species, winter is passed in the nymphal stage, and adults are present early in spring. Species that probably overwinter as nymphs in Colorado include Arphia conspersa, A. simplex, A. sulphurea, Chortophaga viridifaciata, Cibolacris parviceps, Eritettix simplex, Pardalophora apiculata, P. haldemani, Psoloesa delicatula, P. texana, Trachyrachys coronata, Xanthippus corallipes and X. montanus. Other grasshoppers, especially high-altitude species, may overwinter as nymphs. Xanthippus corallipes is known to pass the first winter in the egg stage and a second winter as a nymph. Adults occasionally survive the winter.

Following egg hatch, nymphs undergo a series of molts accompanied by changes in appearance and size. Nymphal instars vary in number among and within species but usually number five or six. Females sometimes have one more instar than do males. A natal molt also occurs immediately after eclosion, but this is not included in computations. Molting usually takes less than 30 minutes to complete, resulting in escape from the old skin, or integument. The rate at which development occurs is governed principally by temperature and food quality; favorable conditions increase development rate. Most species attain the adult stage in 30 to 50 days.

Changes in morphology, which accompany grasshopper growth, include an increase in number of antennal segments, growth of wings and appearance of external adult genitalia. Antennal segments increase in number from 12 to about 23 in regular increments in some Melanoplus spp. Wings increase in size (rudimentary wings are called wing pads), develop venation and change orientation as the nymphs develop toward adulthood. Genitalia, especially male cerci, change in appearance and are useful for identification of the nymphs develop toward adulthood. Genitalia, especially male cerci, change in appearance and are useful for identification of the Melanoplus spp. Wing structure is most useful for instar identification, and a key is provided in the section on grasshopper identification. Extra instars, when they occur, appear after the third instar (Shotwell 1941).

Adults appear following the final molt. In some species considerable sexual dimorphism occurs while in others both sexes are very similar. Adults may be long-lived. Late developing species commonly survive until the first severe frost.
while adults of early developing species may die in mid-summer. Occurrence of adults and other stages of development of common Colorado grasshopper species are shown in table 1. Many of these data were collected in Wyoming, but conditions are similar in Colorado. Table 1 shows division of species into early, intermediate and late-hatching groups, but considerable variation exists in appearance of developmental stages.

Grasshopper Behavior

Daily and seasonal shifts in grasshopper behavior are related to effects of weather, the need to propagate and available food. Grasshoppers sometimes exhibit complex behaviors; among the most important are those related to mating, flight and feeding.

Grasshopper dispersion is not uniform. Most species tend to occur in aggregations. Thus, it may be necessary to bring potential mates together although in the case of species occurring at very low densities considerable searching may be required. Visual, tactile, acoustic and olfactory stimuli play roles in courtship behavior. Males commonly produce signals that attract and excite females; other males also may be attracted. Common mating displays include flashing of brightly colored wings and production of whirring or snapping noises. Pair formation and copulation also may result from chance encounter. In Melanoplus spp., a male usually approaches a female stealthily and pounces on her. The male of all species invariably mounts the female from behind, lowers the tip of his abdomen below hers and attaches the genitalia. This is followed by sperm transfer, and the female remains unresponsive to further copulation attempts until she has absorbed the sperm packet. Mating displays and genital differences insure effective reproductive isolation (Otte, 1981).

Movement of grasshoppers may occur as Nymphs hatch in areas that lack suitable food. Also, since large numbers of eggs may be deposited in the same location, food can be depleted quickly, which necessitates movement. Drought often makes forage unpalatable, and both nymphs and adults walk or fly to more succulent plant material (fig. 368). These displays of movement reflect movement by individuals in response to organic needs — the necessity to find food or oviposition sites. However, not all movements are made on an individual basis, nor are they made for feeding or oviposition.

Swarms of grasshoppers are dreads by agriculturalists. Some species of grasshoppers, such as Melanoplus sanguinipes and Dissosteira longipennis, may on occasion become gregarious and form swarms. Large numbers may take flight simultaneously, fly long or short distances and descend and destroy agricultural crops. Swarms usually take flight during periods of hot, dry weather and are blown in the direction of the prevailing wind.

The Rocky Mountain locust, Melanoplus spretus, caused extensive damage to the central and north central states in the 1800s. Swarms were so abundant and inflicted such severe damage that many settlers left their homes convinced that agriculture would never be possible in the middle west. Yet M. spretus no longer occurs, and it is now believed to be only a swarming phase of M. sanguinipes.

Swarms of M. sanguinipes have been reported to travel 66 miles per day and eventually settle 200 to 300 miles from their point of origin (Parker et al., 1955). Grasshopper densities following swarm descent increased from one to five grasshoppers per square yard to 32 or more per square yard or even to several hundred per square yard. Swarms may land and take flight repeatedly and may cause immense damage, depending upon the length of their stay. Flights terminate when temperature decreases or the sun is obscured by clouds. Females eventually mature reproductively, settle and begin egg deposition. M. sanguinipes swarms apparently favored cropland and barren land over rangeland for oviposition, but eggs were distributed widely. Nymphs hatching from eggs deposited by swarming adults demonstrated greatergregarious tendencies and more often formed bands compared to nymphs of the same species developing from eggs deposited by non-swarming adults. An interesting and thorough description of a swarming species, D. longipennis, is given by Wake-land (1958).

Factors responsible for the transition of M. sanguinipes from a solitary, non-swarming state to gregarious, swarming populations are not understood fully. Certain physical and behavioral characteristics of swarming and non-swarming grasshoppers can be inferred from environmental conditions and density (Bret, 1947). Solitary and gregarious "phase" development has been studied for a number of years in African locusts, and evidence exists for the importance of weather, food, density and conditioning in development of swarms (Uvarov, 1966, 1977). Similar mechanisms probably induce swarm development in North American species. Grasshopper swarms have not been a problem since about 1940 probably because of widespread use of effective insecticides. Brett (1947) suggested that extensive alfalfa plantings might be responsible for keeping M. sanguinipes from attaining swarm densities. This species is highly attracted to alfalfa, but growth and development is impaired by consumption of this forage.

Feeding behavior in grasshoppers is diverse but somewhat predictable. Polyphagous species, such as many melano-
plines, have extensive host plants. Such oligophagous species as Hypochlora alba feed only on a few plants, in this case Artemisia spp. Some species are strictly graminivorous, other are only fruit feeder and many are mixed feeders. Plant debris and insect materials are fed upon; cannibalism is common. Most Gomphorcerinae are grass feeders as are many Oedopodinae. Catantopinae, especially Melanoplus spp., tend to be mixed feeders but prefer forbs. Broad food preferences are correlated somewhat with mouth structures. The incisor teeth of mandibles are relatively blunt in graminivorous species but are pointed in forbivorous species; intermediates between each type are common (Isely, 1944). Specific food preferences for common Colorado grasshoppers are provided in this section.

Visual and olfactory stimuli are important in host recognition, but even foliage with proper color and odor may be rejected after tasting. Foliage may be completely devoured or only nibbled. Partial feeding is common, if plants are not preferred hosts, and grass commonly is fed upon only at the base of a stalk or leaf; the distal portion may be severed and not consumed.

Food preference is determined by a number of factors. Such physical factors as leaf toughness or hairiness and water content are believed to influence feeding behavior, but chemical differences are more important. Sugars, phospholipids, organic nitrogen compounds, tannins and others influence host preference. Although some exceptions exist, grasshoppers generally prefer plants that are most suitable for their growth and survival. Feeding generally is limited to temperatures between 15° and 30°C. Relatively little time is spent in feeding, approximately 15% (Uvarov, 1977).
Table 1. Seasonal history of common Colorado grasshoppers. Table shows occurrence of hatching (H) and adult (A) stage; nymphs occur between hatch and adult, but appearance overlaps both hatching and adult periods because of asynchronous development (taken largely from Newton et al., 1954).

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Population Dynamics

Grasshopper populations are characterized by violent oscillations between endemic (low) and epidemic or outbreak (high) densities. Populations can establish an equilibrium state at either density and remain there for as long as 20 years. Populations at any site may shift from one equilibrium state to another, and this almost always is due to weather changes. The endemic equilibrium state tends to be more stable than the epidemic state. In addition to weather-related direct effects on population transition to the endemic state, weather-induced disease epizootics sometimes are important. Agricultural practices may modulate natural transitions by, for example, providing green forage during drought. Insecticides may protect crops from grasshoppers but do not actually affect population patterns (Turnock, 1977).

Grasshopper populations commonly require about five years to move from endemic (less than 1 per square yard) to epidemic (24 to 32 per square yard) densities, but they return to endemic densities in one or two years. Pfadt (1977) suggests that population densities double each year until the fifth when densities triple or quadruple. Most species at a site increase or decrease in abundance simultaneously. Certain species are well adapted for a site and remain numerically dominant over long periods of time.

It probably is unrealistic to expect one factor to totally account for trends in grasshopper abundance, but weather appears to be the driving force behind increases in grasshopper number. Weather directly affects survival of young nymphs; first-instar grasshoppers are easily killed by heavy rainfall (Cridde, 1933a). Weather indirectly affects survival of young grasshoppers because young insects are especially susceptible to nitrogen shortage in food (White, 1976). Favorable weather in autumn allows a prolonged oviposition period, resulting in more eggs per female. Epizootics of fungal disease also are related to precipitation. Abundance of horsehair worms, which inhibit reproduction when they parasitize grasshoppers, is correlated with presence of water.

Population increases follow abnormally warm and dry periods, and grasshopper numbers usually decrease with the onset of moist, cool conditions. Edwards (1960) analyzed weather data and grasshopper abundance in Canada for the period 1930 to 1958 and reported a strong correlation between high mean monthly temperatures during July to September for three years and subsequent grasshopper numbers. A weaker but significant correlation was found between two years of low precipitation during April to August and subsequent grasshopper abundance. Gage and Mukerji (1977) conducted another evaluation for the period 1943 to 1974 and reached similar conclusions. A common but erroneous assumption is that severe winter weather will affect grasshopper survival. However, diapausing grasshopper eggs seem to be relatively impervious to weather conditions.

Trends in grasshopper abundance in Colorado for the period 1933 to 1981 are given in fig. 369. Major epidemics occurred in 1936-8, 1957-8 and 1980-2. This disease has on some occasions decimated grasshopper numbers, but high humidity usually is required (Pickford and Reigert, 1964).
Fig. 368-Dissosteira longipennis nymphs in search of forage, southeast Colorado, 1939. Photo courtesy Colo. State Univ. Archives.

Fig. 369-Number of square miles (in 1000's) of Colorado infested by grasshoppers at a density of three or more grasshoppers per sq. yd. during the period 1933 to 1961. Source: Cooperative Economic Insect Report.
Fig. 370-Typical seasonal pattern of grasshopper abundance and biomass in northeast Colorado (modified from Van Horn, 1972).
BIOLOGY OF COMMON COLORADO GRASSHOPPERS

The following compilation of biological information on grasshoppers will provide the user with specific information on description, seasonal history, distribution, host plant preferences and damage potential. Additional information is available in the references cited. Most species have been known by several scientific names over the last 100 years, but no attempt is made to provide complete synonymy. Synonymy is provided only if there is considerable recent literature that employs a former scientific name. Included in this compilation is biological information on all common Colorado grasshoppers; those not included are rare in Colorado or poorly known.

**Acrolophitus hirtipes** (Say)

**Common name** - Green fool grasshopper (Helfer, 1972) or Crested-kee grasshopper (Pfadt, 1972).

**Geographic distribution** - Discontinuous distribution in Alberta and Saskatchewan (Canada), Montana, North Dakota, South Dakota, Nebraska, Wyoming, Kansas, Colorado, New Mexico, Oklahoma, Texas and Mexico (Brooks, 1958; Otte, 1981). In Colorado it is found on the plains and eastern mountain valleys (Hebard, 1929).

**Habitat** - Sandy areas, areas of dry, low herbage or gently sloping, gravelly, southern exposures (Anderson and Wright, 1952; Brooks, 1958; Hebard 1928).

**Food habits** - Forbivorous and prefers such plants of the Borage family as gromwell, stickseed, cryptantha and plants of the genus Phasola (Brooks, 1958).

**Eggs** - Egg pods do not contain froth. An average of six light-tan eggs per pod are arranged in two columns of three eggs each. Average egg length, 6.4 mm; average diameter, 1.5 mm (Onsager and Mulkern, 1963).

**Nymph** - Five instars (Brunsven, 1967).

**Adult** - Medium size to large. General color is pale green without distinct spots. Antennae are red. Face is long and slanted and widens from the eyes to the clypeus. Top of head ends in a pointed knob. Pronotum is slightly compressed at the sides; high semicircular crest is on the top of the posterior two-thirds of the pronotum; the dorsal posterior margin is a right angle. Tegmina are long, opaque and finely veined, sometimes with indistinct spots. Wings have a pale yellow-green disc and a broad, transverse, black band that diminishes and curves inward on the posterior border. Apical third of wing is clear. Hind femora are slender. Legs are covered with tiny hairs. Male length, 25 mm; female, 30 mm (Brooks, 1958; Thomas, 1873).

Adults stridulate loudly in the field (Pfadt, 1972).

**Oviposition** - Eggs are laid just below the soil surface (Onsager and Mulkern, 1963).

**Seasonal history** - Adults occur from early June to late August (Newton et al., 1954).

**Abundance and importance** - Moderately abundant on the plains of eastern Colorado (Hebard, 1929).

**Aeoloplides turnbulli** (Caudell)

**Common name** - Thistle grasshopper (Coppock, 1962).

**Recent synonymy** - **Aeolopus turnbulli** Caudell.

**Geographic distribution** - North Dakota, South Dakota, Wyoming, Kansas, Nebraska, Colorado, New Mexico and Texas (Brooks, 1958). The subspecies **A. turnbulli bruneri** is common on the plains of eastern Colorado. **A. turnbulli turnbulli** is found in the mountains of the Colorado Front Range. **A. turnbulli** also is found in the northwest corner of the state (Alexander, 1941).

**Habitat** - Dry alkaline areas in eroded, mixed prairie; often found on such dry herbage as the plants of the goosefoot family (Brooks, 1958; Hebard, 1928).

**Food habits** - A forb feeder that eats mainly Russian thistle, belvedere summervypress, white sage, saltbush, black greasewood and other plants of the goosefoot family (Anderson and Wright, 1952; Gillette, 1904; Rottman, 1980). Occasionally it may feed on sugarbeet (Smith, 1954).

**Eggs** - Females lay about 18 tan eggs per pod. Eggs are arranged in two columns with froth between the eggs. Average egg length, 4.2 mm; average diameter, 1.2 mm (Onsager and Mulkern, 1963).

**Adult** - Medium size. General color is grey-green. Face is slightly slanted back. Vertex is rounded. Antennae are slender and red. Head is yellowish with a green stripe on top, which continues along the top of the pronotum but is wider and yellow in the middle. Lateral lobes of pronotum also have broad green stripes. Dorsal posterior margin of pronotum is at an obtuse angle. Spine between front legs is more slender and sharply conical than in Melanoplus. Tegmina are pale green. Wings are clear. Hind femora are yellowish with brown-green zig-zags on the outer face. Hind tibiae are light blue-green. Male cerci are very narrow and sharply pointed. Subgenital plate of male has a subapical tubercle. The subspecies **A. turnbulli bruneri** has the male cerci tapering almost uniformly through the basal three-fourths; **A. turnbulli turnbulli** has the male cerci tapering only in the basal half. Male length, 16 mm; female, 20 mm (Alexander, 1941; Ball et al., 1942).

**Seasonal history** - Adults are present from mid-July to mid-September (Newton et al., 1954).

**Abundance and importance** - A common species in eastern Colorado. Feeds mainly on weeds and would cause damage only if it moved to sugarbeet, which is closely related to its preferred foods (Gillette, 1904; Smith, 1954).

**Aeropedellus clavatus** (Thomas)

**Common name** - Club-horned grasshopper (Helfer, 1972) or Slant-faced grasshopper (Pfadt, 1972).

**Geographic distribution** - An alpine and boreal grasshopper found from Minnesota and southern Canada to the Yukon and Alaska. It also is found in Iowa, the Dakotas, Montana, Idaho, Nebraska, Colorado, Wyoming, Utah, Arizona and New Mexico (Brooks, 1958; Otte, 1981). In Colorado it is found from the lower edge of the foothills to above timberline and occasionally on the Colorado plains. It lives at a higher altitude than any other Acridian (Alexander and Hilliard, 1964).

**Habitat** - Prefers the lower hills and grassy plains of North Dakota (Mulkern et al., 1964). In Canada it has been seen frequently on sandy soil (Brooks, 1958). Colorado habitat is mainly the alpine tundra (Alexander and Hilliard, 1964).

**Food habits** - Grasses and sedges are preferred foods with bluegrass being the main food in North Dakota. Other preferred foods are threadleaf sedge, sandberg bluegrass, Idaho fescue, Junegrass, rubber rabbit brush, scarlet globemallow, sand dropseed, cheatgrass brome, western wheatgrass and sixweeks fescue (Anderson and Wright, 1952; Brooks, 1958; Kumar et al., 1976; Mulkern et al., 1964; Ueckert, 1968).

**Eggs** - Eggs are whitish, three to seven per pod. They are arranged in two rows within the dark brown pod. Average egg length, 5.5 mm; average diameter, 1.5 mm (Alexander and Hilliard, 1964; Onsager and Mulkern, 1963).

**Nymph** - Four instars (Alexander and Hilliard, 1964).
Adult - medium size. General color is green or brown. Face is slightly slanted back. Vertex is rounded. Antennae are slender and yellow with dark-brown tip enlarged to a club. Dorsal posterior margin of pronotum is rounded. Lateral carinae of pronotum are strongly constricted anterior to middle. Wings and tegmina are the same length as abdomen in male. Females are short winged. Tegmina and wings are clear. A dark patch is on the sides of each abdominal segment. Hind tibiae are yellow to brown. Male length, 19 mm; female, 28 mm (Ball et al., 1942; Froeschner, 1954).

Males are easily frightened and seem to be constantly flying or crawling rapidly on the ground. Females are much slower and remain motionless for long periods of time (Anderson and Wright, 1952).


Seasonal history - eggs hatch from mid-May to early June. Adults are abundant in mid- to late-July with some persisting through September (Mulkern et al., 1964).

Abundance and importance - abundant in alpine tundra (Alexander, 1964). In Canada it occasionally has caused extensive damage to range grasses (Brooks, 1958).

Ageneotettix deorum (Scudder)

Common name - White-whiskers grasshopper (Hantsbarger, 1979) or Sand grasshopper (Pfadt, 1972).

Geographic distribution - British Columbia, Alberta, Saskatchewan and Manitoba (Canada); south to Mexico; east to Michigan; Indiana, Oklahoma and Texas (Brooks, 1958; Otte, 1981). In Colorado, the subspecies A. deorum deorum is widespread. The subspecies A. deorum curtipennis is found in southwestern Colorado (Alexander, 1941).

Habitat - sandy soil with sparse vegetation such as blowouts, abandoned fields and native grassland (Anderson, 1964; Blatchley, 1920; Brooks, 1958).

Food habits - feeds on grasses and sedges with no preference for any particular species. Some of the plants eaten are western wheatgrass, Sandberg bluegrass, sand dropseed, blue grama, threeawn, needleandthread grass, prairie sandreed grass, crested wheatgrass, cheatgrass brome, bluebunch wheatgrass and hairy grama. A. deorum also eats large amounts of dry plant debris (Anderson, 1964; Anderson and Wright, 1952; Campbell et al., 1974; Hewitt, 1977; Kumar et al., 1976; Mulkern et al., 1964; Mulkern et al., 1969; Ueckert and Hansen, 1971.)

Eggs - four eggs per pod. Average egg length, 5.3 mm; average diameter, 1.6 mm; color, pearly white. Pods are small and tough (Onsager and Mulkern, 1963; Shotwell, 1941).

Nymph - four or five instars (Ramsay, 1964).

Adult - medium size. General color is brownish-yellow with two brown stripes running from the top of the head, broadening and fading toward the tip of the tegmina. Face is slightly slanted back. Antennae are slender. Dorsal posterior margin of pronotum is rounded. Median carina of pronotum is distinct; lateral carinae indistinct. Tegmina are unspotted with a whitish line on the basal third. Wings are clear. Hind femora are banded with black on the upper and inner faces. Knees are black. Hind tibiae are bluish. Male length, 20 mm; female, 25 mm (Brooks, 1958; Hantsbarger, 1979; McNeill, 1896).

Adult females are inactive most the time and stay on one plant. Males are more active and move from plant to plant (Anderson and Wright, 1952).

Oviposition - eggs are laid in the crowns of grasses, especially needleandthread grass (Pfadt, 1972).

Seasonal history - eggs overwinter and hatch at the end of May. First instars can be seen until the middle of June. Adults can be found from late June to early October (Mulkern et al., 1964; Newton et al., 1954; Pfadt, 1972).

Abundance and importance - very common throughout eastern Colorado (Gillette, 1904). It can cause heavy losses on the native grasslands (Blatchley, 1920).

Anabrus simplex (Haldeman)

Common name - Mormon cricket (Anderson, 1941).

Geographic distribution - west of the Missouri River to the Cascade and Sierra Nevada ranges and from the Canadian border south to California and northern Arizona (Swan and Papp, 1972). In Colorado, A. simplex can be found from the eastern plains to the mountains above timberline (Hebard, 1929).

Habitat - grassy areas, usually in brush (Hebard, 1928).
Food habits - feeds on over 250 species, mostly range plants but also cultivated crops. It prefers the flower and seed parts of plants and is often cannibalistic (Swan and Papp, 1972; Wakeland, 1952).

Eggs - color, dark brown turning grey. Eggs are 7 mm long and crescent shaped. They are deposited singly, but as many as 100 eggs may be closely grouped (Corkins, 1923; Swan and Papp, 1972).

Nymph - seven instars. Color black with white markings on pronotum (Ramsay, 1964; Swan and Papp 1972). Adult - stout bodied. General color is brown, yellowish, green or black. Sometimes irregularly mottled or distinctly marked. A. simplex is wingless. In the male the tegmina extend a little beyond the pronotum and are used for chirping. In the female the tegmina are concealed by the pronotum. Females have a sword-like ovipositor curved upward. Head is large. Antennae are longer than body. Length, 24 to 62 mm (Helfer, 1972; Swan and Papp, 1972).

Oviposition - barren slopes and open spots among sagebrush, fields and along roads are common oviposition sites. Oviposition commonly takes place in the early morning, late afternoon or on cloudy days. Eggs are deposited just below the soil surface in firm but not hard soil, free from roots (Corkins, 1923; Swan and Papp, 1972).

Seasonal history - eggs are deposited in mid-summer. They overwinter and hatch the following spring. Adults appear in late June and early July (Swan and Papp, 1972).

Abundance and importance - in Colorado, A. simplex is most common in the northwestern part of the state. Bands migrate on foot, moving up to a mile a day. They do their greatest damage to range forage (Anderson, 1941; Swan and Papp, 1972; Wakeland, 1952).

Arphia conspersa (Scudder)

Common name - Speckled rangeland grasshopper (Helfer, 1972).

Geographic distribution - Alaska to Colorado, Utah, New Mexico and Arizona; east to Minnesota, Iowa and Nebraska (Brooks, 1958). In Colorado it is widespread at all altitudes (Hebard, 1929).

Habitat - forest clearings and grasslands. A. conspersa prefers sandy or gravelly soil (Brooks, 1958).

Food habits - a mixed feeder, preferring grasses and sedges, especially needlegrass, western wheatgrass, needle-and-thread, sixweeks fescue, bluegrass and Junegrass. It also eats cheatgrass brome, crested wheatgrasses, Russian thistle, sand dropseed, Indian ricegrass, threeawn, belvedere summer cypress, scarlet globemallow, fringed sage, fourwing saltbush, rush skeleton-plant and prickly pear (Kumar et al., 1976; Mulkern et al., 1964; Mulkern et al., 1969; Uckert and Hansen, 1971).

Eggs - eggs are deposited 13 to 20 per pod. They are light brown with prominent reddish-brown thickenings. Eggs are arranged in two or three columns within the pod. Average egg length, 4.1 mm; average diameter, 1.1 mm (Ball et al., 1942; Onsager and Mulkern, 1963). Nymph - five instars (Ramsay, 1964). Adult - medium size. Male sometimes are nearly black. Both sexes often are greyish-brown with many spots giving a mottled look. Face is vertical. Vertex is rounded. Antennae are slender. Dorsal posterior margin of pronotum forms a rounded right angle. Median carina of pronotum has a slight notch. Wings are bright red-orange. Hind femora have pale rings near the knee. Hind tibiae are blackish with a pale ring near the knee. Abdomen is dark, usually with pale vertical stripes. Male length, 25 mm; female, 30 mm (Blatchley, 1920; Hewitt and Barr, 1967).

Often clicks in flight. If so, flight is irregular and butterfly-like. Without clicking, flight is direct and controlled. Flight is followed by rapid crawling on the ground. Adults are easily frightened and constantly moving (Anderson and Wright, 1952; Blatchley, 1920).

Oviposition - eggs are laid in areas of sparse vegetation in hard clay-like soil (Criddle, 1918).

Seasonal history - overwintering occurs in the egg stage; the first instar nymphs appear in June. Adults appear in late summer (Ball et al., 1942; Mulkern et al., 1969).

Abundance and importance - eats important range grasses but rarely becomes numerous (Mulkern et al., 1969).

Arphia pseudonietana (Thomas)

Common name - Northwestern red-winged locust (Blatchley, 1920).

Geographic distribution - British Columbia (Canada) south to Texas and New Mexico and east to Ontario, Michigan, Iowa, Nebraska, Kansas and Oklahoma (Froeschner, 1954). Colorado range is from the eastern plains to the mountain foothills (Hebard, 1929) and occasionally in western Colorado.

Habitat - dry areas with little vegetation, especially sandy or gravelly hills (Froeschner, 1954).

Food habits - a mixed feeder preferring grasses. Some of the preferred grasses are needlegrass, western wheatgrass, needleandthread, bluegrass and Junegrass. It also eats blue gra- ma, sunsedge, sand dropseed, scarlet globemallow, crested wheatgrasses and threeawn (Kumar et al., 1976; Mulkern et al., 1964; Mulkern et al., 1969; Uckert and Hansen, 1971).

Eggs - pods contain about 20 light brown eggs arranged in two or three columns. Average egg length, 4.6 mm; average diameter, 1.2 mm (Onsager and Mulkern, 1963). Nymph - five instars (Ramsay, 1964). Adult - medium size. Male sometimes are nearly black. Both sexes often are greyish-brown with many spots giving a mottled look. Face is vertical. Vertex is rounded. Antennae are slender. Dorsal posterior margin of pronotum forms a rounded right angle. Median carina of pronotum has a slight notch. Wings are bright red-orange. Hind femora have pale rings near the knee. Hind tibiae are blackish with a pale ring near the knee. Abdomen is dark, usually with pale vertical stripes. Male length, 25 mm; female, 30 mm (Blatchley, 1920; Hewitt and Barr, 1967).

Often clicks in flight. If so, flight is irregular and butterfly-like. Without clicking, flight is direct and controlled. Flight is followed by rapid crawling on the ground. Adults are easily frightened and constantly moving (Anderson and Wright, 1952; Blatchley, 1920).

Oviposition - eggs are laid in areas of sparse vegetation in hard clay-like soil (Criddle, 1918).

Seasonal history - overwintering occurs in the egg stage; the first instar nymphs appear in June. Adults appear in late summer (Ball et al., 1942; Mulkern et al., 1969).

Abundance and importance - eats important range grasses but rarely becomes numerous (Mulkern et al., 1969).

Aulocara elliotti (Thomas)

Common name - Big-headed grasshopper (Pliadt, 1949a) or the Elliott grasshopper (Ball et al., 1942).
Geographic distribution - British Columbia to Manitoba (Canada), south to Mexico (Brooks, 1958; Otte, 1981). In Colorado it is found mainly in the eastern portion of the state from the foothills to the Kansas border but also may be found in the western portion of the state (Pfadt, 1943a).

Habitat - lives in open, dry grasslands, mostly on the short grass plains where soil is coarse (Hantsbarger, 1979; Pfadt, 1949a).

Food habits - eats many different grasses but prefers blue-grass, blue grama, needleandthread, beardgrass, cheatgrass brome and western wheatgrass (Brooks, 1958; Hewitt, 1977; Mulkern et al., 1969; Pfadt, 1949a).

Eggs - pods are small, tough and truncate at one end and contain three to 11 pearly white eggs. Average egg length, 5 mm; average diameter, 1 mm (Ferkovich, 1965; Hastings and Pepper, 1964; Roemhild, 1967; Shotwell, 1941).

Nymph - five instars (Scoggan and Bruven, 1972).

Adult - small to medium size. General color is dull, reddish-brown. Face is slightly slanted back. Vertex is rounded. Head appears large in relation to body. Dorsal posterior margin of pronotum is rounded. Pronotum has two diagonal light stripes forming an "X" dorsally. Tegmina are opaque tan with brown spots. Wings are clear. Hind tibiae are blue. Male length, 20 mm; female, 30 mm (Ball et al., 1942; Hantsbarger, 1979).

Oviposition - after maturing there is a preoviposition period of two weeks. Then the females lay their eggs in the upper \( \frac{1}{4} \) in. crust of undisturbed, open, packed ground or in bare spots of grainfields, native grasslands or hayfields. Egg pods usually are attached to solid objects such as roots or small stones. Egg deposition continues until early autumn (Anderson and Hastings, 1966; Ferkovich, 1965; Shotwell, 1941).

Seasonal history - overwinters in the egg stage. In Colorado adults appear from mid-June to August, 30 to 50 days after hatching. They feed until the first heavy frost (Ferkovich, 1965).

Abundance and importance - common on the grasslands. Damaging outbreaks occasionally occur (Hantsbarger, 1979; Pfadt, 1949a).

**Aulacora femoratum** (Scudder)

Common name - White cross grasshopper (Helfer, 1972).

Recent synonymy - *Drepanoptera femoratum* (Scudder).

Geographic range - the western plains from Saskatchewan and Alberta (Canada) south to Mexico (Hebard, 1928; Helfer, 1972). Colorado range generally is from the plains to the mountain foothills in the eastern part of the state (Hebard, 1929).

Habitat - found in areas of dry, short grass (Hebard, 1928).

Food habits - eats grasses and has a preference for western wheatgrass (Anderson and Wright, 1952).

Eggs - about 10 whitish eggs are deposited in each pod. Average egg length, 5.2 mm; average diameter, 1.3 mm (Olsager and Mulkern, 1963).

Adult - males small; females medium size. General color is brownish-yellow. Head is rather large, antennae are slender, vertex is rounded and face is slanted back slightly. Median carina of pronotum is cut by one sulcus. Dorsal posterior margin of pronotum is slightly rounded. Top of pronotum has two diagonal, white lines that make an "X." Lateral lobe of pronotum has a black patch. Tegmina are brown, opaque and closely veined, having several small dark specks. Wings are clear. Hind femora are pale with conspicuous black bands, both on the inner and outer surfaces. Hind tibiae are blue.

Male length, 15 mm; female, 25 mm (Ball et al., 1942; Brooks, 1958).

Seasonal history - overwinters in the egg stage. Adults can be seen from mid-July to October (Ball et al., 1942; Newton et al., 1954).

Abundance and importance - occasionally common enough to be destructive to rangeland (Helfer, 1972).

**Boopedon nubilum** (Say)

Common name - Black males grasshopper (Helfer, 1972) or Boopoe (Ball et al., 1942).

Geographic distribution - the Great Plains of Montana and South Dakota to Arizona and Texas (Hebard, 1928; Helfer, 1972). Colorado range is eastern, especially southeastern Colorado (Alexander, 1941).

Habitat - areas of high grasses and moist ground in prairie valley bottoms (Gillette, 1904; Hebard, 1928; Helfer, 1929).

Food habits - a grass feeder preferring blue grama (Fry et al., 1979).

Eggs - 12 eggs are deposited in each pod. Color is white turning dark reddish-brown. Average egg length, 6.5 mm; average diameter, 1.5 mm (Olsager and Mulkern, 1963).

Adult - female large; male medium to large size. Face is almost vertical, vertex is rounded, antennae are slender. Dorsal hind margin of pronotum is rounded. Wings are clear blue and clouded at the tip.

Female: head is conspicuously large. Body is dusky and greenish colored, marked with yellow or black. Tegmina usually are short and ringed with a light band. Lateral carinae are well marked by light-colored band but not by structure. Hind tibiae are rose colored. Female length, 31 to 44 mm. Females cannot fly and will dive down and hide.

Male: shining black. Hind tibiae are red. Male length, 20 to 27 mm. Males jump vigorously and are able to fly (Ball et al., 1942; Gillette, 1904; Hebard, 1928; Helfer, 1972).

Seasonal history - adults are present from early July to early September (Newton et al., 1954).

Abundance and importance - often moderately abundant locally in Colorado (Hebard, 1928).

**Brachystola magna** (Girard)

Common name - Lubber grasshopper (Hantsbarger, 1979); Plains lubber (Ball et al., 1942) or the Homesteaders (Tinkham, 1948).

Geographic distribution - east of the Rocky Mountains from North Dakota south to Texas and Mexico and eastward with isolated populations as far as Minnesota, Iowa, Kansas and Oklahoma (Froeschner, 1954). In Colorado, found from the plains to the foothills in the eastern part of the state. Occasionally seen in the hills on open, grassy areas (Gillette, 1904).

Habitat - inhabits the rank vegetation of weedy roadsides, vacant lands and field margins but may move to crops if the rangeland becomes dry. Prefers rocky or gravelly soil in areas of sparse grass and coarse weeds (Ball et al., 1942; Hantsbarger, 1979; Mulkern et al., 1969).

Food habits - voracious, preferring coarse forbs. Large amounts of arthropod parts have been found in their crops, indicating that they eat live or dead insects in addition to forbs. Preferred foods are sunflower, blanket flower, ragweed, cotton, lettuce and feverfew (Alexander and Hilliard, 1969; Isely, 1944; Mulkern et al., 1969).

Eggs - pods are large, gourd-shaped and contain about 20
large eggs. Eggs are yellow when deposited but turn dark reddish-brown later with even darker pigmentation at both tips. Average egg length, 10 mm; average diameter, 2.7 mm (Ball et al., 1942; Onsager and Mulkern, 1963).

**Adult** - large size. The largest species occurring in Colorado. General color is reddish-brown marked with greenish-brown. Body is robust. Antennae are slender. Tegmina are very small and reddish with black spots. Legs are robust with tibiae strongly spined almost the entire length. Each abdominal segment is marked with a row of light dots. Male length, 40 mm; female, 50 to 60 mm. *B. magna* is flightless (Ball et al., 1942; Hantsbarger, 1979; Scudder, 1876).

**Seasonal history** - eggs hatch in June. Adult *B. magna* are present from late June to October (Newton et al., 1954).

**Abundance and importance** - common throughout eastern Colorado (Gillette, 1904). *B. magna* is of little importance in grasslands (Mulkern et al., 1969).

**Camnula pellucida** (Scudder)

**Common name** - Clear-winged or Warrior grasshopper (Hantsbarger, 1979).

**Geographic distribution** - southern Canada, the western half of the United States and in northeastern United States. Distribution also extends south along the Appalachians as far as Virginia (Brooks, 1958). In Colorado it is found from the mountain foothills to the mountains above timberline (Hebard, 1929) and throughout western Colorado.

**Habitat** - short, thick grasses of damp meadowlands among hills and mountains. When the population increases, it sometimes moves to nearby grainfields, gardens and pastures (Bruner, 1897; Hebard, 1928).

**Food habits** - graminivorous, preferring western wheatgrass, Idaho fescue, smooth brome, Sandberg bluegrass, yarrow, carex, Junegrass, foxtail barley, needle grass, quackgrass and bluegrass; it sometimes eats bluegrass to the ground. These damaged areas are where aggregations are found during mating and oviposition (Anderson, 1964; Banfi and Brusven, 1973; Brooks, 1958; Criddle, 1933b; Hewitt, 1977; Mulkern et al., 1964).

**Eggs** - 25 to 30 light brown eggs per pod. Pods are not firmly cemented. Eggs are arranged in two columns. Average egg length, 4.7 mm; average diameter, 1.5 mm (Blatchley, 1920; Bruner, 1897; Onsager and Mulkern, 1963).

**Nymph** - five instars (Parker, 1924).

**Adult** - small to medium size. General color is yellowish to grey-brown. Face is almost vertical. Vertex is rounded. Antennae are slender, yellow at the base, with the remainder dark. Behind the eye is a dark triangular spot. Dorsal posterior margin of pronotum forms an obtuse angle or right angle, and the median carina is slightly notched. The lateral lobes of the tegmina have a dark vertical, oblong spot. Two amber lines extend along the tegmina and converge in a “V” when the tegmina are closed. Tegmina have round or oval splotches. Wings are clear. Male length, 20 mm; female, 25 mm (Blatchley, 1920; Hantsbarger, 1979).

Flight is direct, low and short; sometimes rustling and sometimes silent (Blatchley, 1920).

**Oviposition** - the grasshoppers gather on unplowed land by crop edges, pastures, ditches or banks, small or overgrazed pastures. They quickly eat the grass and mate. Eggs are deposited below the soil surface in crowns of short bunchgrass. Eggs are produced every eight to 14 days (Blatchley, 1920; Bruner, 1897; Criddle, 1933b; Shotwell, 1941).

**Seasonal history** - overwinters in the egg stage with hatching occurring in early spring. Nymphs are not common after mid-July. Adults are present from late June to late August (Bruner, 1897; Newton et al., 1954).

**Migratory tendencies** - nymphs may migrate in swarms. Adults may take flight in swarms but do not migrate long distances (Ball, 1942).

**Abundance and importance** - common at higher altitudes in Colorado (Caudell, 1903). It may move into cultivated areas and cause serious damage to vegetables and other crops, especially grain. Range grasses are its most important food (Ball et al., 1942).

**Ceuthophilus and related spp.**

**Common name** - Camel crickets.

**Habitat** - Camel crickets are nocturnal. During the day they hide in damp places, usually under rocks or logs (Blatchley, 1920).

**Description** - thick-bodied and wingless. Back is arched. Head is large, oval and bent backward between the front legs. Antennae are long and slender, tapering to a fine point. Eyes are somewhat pear shaped, the narrow end downward. Front and middle femora are slender and short. Hind femora are thick and bowed inward slightly. Anal cerci usually are hairy (Blatchley, 1920).

**Oviposition** - eggs are deposited in the ground (Blatchley, 1920).

**Seasonal history** - eggs overwinter and hatch in April (Blatchley, 1920).

**Common species of camel crickets:**

- *Udeopsylla robusta* (Haldeman) - the Robust camel cricket. General color black, brown or mottled brown. Commonly found in burrows it digs under rocks and logs. Sometimes found on plowed ground at dawn, dusk or on cloudy days. Inhabits the plains of eastern Colorado (Hebard, 1929; Hefler, 1972).


- *Ceuthophilus utahensis* Thomas - the Utah camel cricket. General color is yellowish-brown with faint patterning and a banded abdomen. Inhabits open aspen and conifer woods. Lives under rocks, bark and in holes. Often found in base- ments and in wells. Can become a health problem by polluting well water with their dead bodies (Hefler, 1972).

- *Ceuthophilus fusiformis* Scudder - the Fusiform camel cricket. General color is brownish or straw colored. Sometimes patterned with black. Common on grasslands and in the mountains above timberline. They occur on the ground, in rodent burrows and among sedges in swampy areas. Adults are present from March to December (Hebard, 1929; Hefler, 1972).

- *Ceuthophilus alpinus* Scudder - inhabits the mountains up to 13,000 feet (Anderson, 1941).

**Chloealtis conspersa** (Harris)

**Common name** - Sprinkled locust (Somes, 1914).

**Geographic distribution** - Maine to Ontario and Alberta in southern Canada and south to North Carolina, Arkansas and Colorado (Froeschner, 1954). In Colorado it is found in the foothills of the northern part of the state (Alexander, 1941).

**Habitat** - lives in dense vegetative cover as occurs at fence rows and in woods (Froeschner, 1954).
**Food habits** - feeds on grasses; its preferred grass is bluegrass (Mulkern et al., 1969; Uvarov, 1977).  
**Eggs** - about 10 creamy white eggs are produced per pod. Average length, 5 mm; average diameter, 1 mm (Onsager and Mulkern, 1963).  
**Nymph** - five instars (Cantrall, 1943).  
**Adult** - small to medium size. General color is brown. Face is slightly slanted. Vertex is rounded. Antennae are slender. Dorsal posterior margin of pronotum is straight to weakly curved. Lateral carinae are prominent on head and pronotum. Median carina is not as noticeable.  
Males: brown, mottled with fine black spots. Lateral lobes of pronotum are shining black. Ventral surface is rich, reddish-brown. Tegmina are expanded distally. Wings are colorless. Length, 19 mm.  
Females: larger and duller. Lateral lobes of pronotum are not black. Wings and tegmina usually are short and abortive. Length, 22 mm (Somes, 1914).  
**Oviposition** - female drills holes in wood and deposits her eggs there. She will deposit eggs in soil and dung when wood is unavailable (Somes, 1914).  
**Seasonal history** - adults appear in late June and remain until early September (Hubbel, 1922b).  
**Abundance and importance** - local distribution near wooded areas keeps *C. conspersa* from being an economic pest (Brusven, 1967).  

**Chorthippus curtipennis** (Harris)  
**Common name** - Marsh meadow locust (Blatchley, 1920).  
**Recent synonymy** - *Chorthippus longicornis* (Latreille)  
**Geographic distribution** - Europe and northern Asia; Alaska, Canada and the northern half of the United States but south to California, Arizona and New Mexico in western U.S. (Otto, 1981). In Colorado it primarily can be found from the mountain foothills to timberline (Hebard, 1929).  
**Habitat** - damp meadows, swales and low, wet prairies (Blatchley, 1920; Hebard, 1922b).  
**Eggs** - small pods contain five to eight light brown eggs. Average egg length, 4 mm; average diameter, 1 mm (Ball et al., 1942; Onsager and Mulkern, 1963).  
**Nymph** - four instars (Uvarov, 1966).  
**Adult** - small and slender to medium size. Color is variable. Face is slanted, and vertex is rounded. Antennae are long and slender, yellow at the base, blending to black at the tip. Dorsal posterior margin of pronotum is rounded. Female is short-winged. Male wings are as long or longer than the abdomen. Color is usually light brown on top with a black bar on each side extending back from the eyes and along the upper half of the lateral lobes of the pronotum. Yellowish color below. Face and lower sides of pronotum are sometimes grey or green. Wings are clear. Sides of abdomen have black patches. Male, 12 mm; female, 20 mm (Blatchley, 1920; Brooks, 1958).  
Males are active and noiseless. Females leap and tumble to escape (Blatchley, 1920).  
**Oviposition** - eggs are deposited in or near clumps of grass and sometimes in decaying wood (Criddle, 1933a).  
**Seasonal history** - eggs overwinter and hatch in June. Adults can be found in late July, August and September (Ball et al., 1942; Mulkern et al., 1964).  
**Abundance and importance** - occurs at a wider range of altitudes than any other Colorado grasshopper but occurs only occasionally. Grain fields around marsh edges sometimes are injured by this grasshopper (Banfill and Brusven, 1973; Criddle, 1933a).  

**Chorthophaga viridifasciata** (DeGeer)  
**Common name** - Northern green-striped locust (Blatchley, 1920).  
**Geographic distribution** - found from Montana and British Columbia (Canada) to New Mexico and Utah. East to Ontario (Canada) and south to the Gulf Coast (Brooks, 1958). Its Colorado range is from the plains of the northern part of the state to the eastern mountain valleys (Hebard, 1929).  
**Habitat** - dry, grassy areas and areas of low weeds (Blatchley, 1920; Hebard, 1928). In the Fort Collins, Colo., area it is commonly associated with wet areas.  
**Food habits** - feeds principally on grasses but will eat forbs. Bluegrass is its preferred food. It also eats blue grama, western wheatgrass and sunsedge (Cantrall, 1943; Gangwere, 1961; Kumar et al., 1976).  
**Eggs** - eggs are laid in large pods and are bound with whitish mucus. Each pod contains about 25 light-brown eggs arranged in three or four columns. Average egg length, 4.5 mm; average diameter, 1 mm (Onsager and Mulkern, 1963; Somes, 1914; Tuck and Smith, 1939).  
**Nymph** - five instars (Cantrall, 1943).  
**Adult** - medium size. Color is green or brown. Face is slightly slanted. Vertex is rounded. Antennae are red, flattened and rather short. A strongly pronounced median carina extends the entire length of the pronotum and is slightly arched. Dorsal posterior margin of pronotum is an acute angle.  
Green form: marginal field of tegmina is green, the remainder is grey-brown to colorless; a grey-brown wedge forms on the dorsal tegmina when folded. Abdomen is reddish-brown.  
Brown form: apical half of tegmina is darker, often with light spots. In both forms the apical half of the tegmina is membranous. Wings have the apical portion smoky and the basal half yellow-green. Hind tibiae are brown or light blue with white rings near the knees. Male length, 22 mm; female, 32 mm (Blatchley, 1920; Brooks, 1958).  
In flight males make a rattling or shuffling sound. Females fly noiselessly, more directly and for greater distances (Blatchley, 1920).  
**Oviposition** - eggs are deposited in sand (Somes, 1914).  
**Seasonal history** - first-instar nymphs hatch in August. Later-instar nymphs overwinter and adults appear in April or May and are present till July (Mulkern et al., 1964; Newton et al., 1954).  
**Abundance and importance** - reported to be common in northern Colorado near Fort Collins and moderately abundant in the foothills. It sometimes increases in favored localities and does noticeable damage to crops (Gillette, 1904; Somes, 1914).  

**Circotettix rabula** Rhen and Hebard  
**Common name** - Wrangler grasshopper (Helfer, 1972).  
**Geographic distribution** - British Columbia to Manitoba (Canada), Oklahoma, New Mexico and Arizona (Helfer, 1972). In Colorado the subspecies *Circotettix rabula rabula*
is found from the foothills to timberline. *C. rabula alterior* lives at a higher altitude than *C. rabula rabula* (Hebard, 1929). *C. rabula* has been recovered from most areas of the state.

**Habitat** - arid areas. Gravelly clearings among pines and dry clay banks facing the sun. Usually associated with rivers and ravines (Criddle, 1933a).

**Food habits** - a mixed feeder often eating moss and low-growing weeds. It specifically prefers loco, vetch, sandwort and bladderpod (Ball et al., 1942; Criddle, 1933a; Scoggan and Brusven, 1972; Ueckert, 1968).

**Eggs** - pale yellow. About 30 eggs are arranged in three or four columns within the pod. Egg length, 5.2 mm; diameter, 1.1 mm (Onsager and Mulkern, 1963).

**Nymph** - five instars (Scoggan and Brusven, 1972).

**Adult** - large. General color is pale greyish-brown with small darker markings. Face is vertical. Vertex is rounded. Antennae are slender. Dorsal posterior margin of pronotum forms a rounded right angle. Median carina is cut by two sulci. Tegmina are opaque with traces of a black band and spur. Parallel band and spur. Hind femora are banded with brown and yellow on the upper and inner surfaces. Hind tibiae are buff, sometimes tinged with blue. Male length, 45 mm; female, 52 mm (Ball et al., 1942).

**Oviposition** - oviposition takes place on bare flat areas or rolling open hills (Onsager and Mulkern, 1963).

**Seasonal history** - nymphs overwinter and emerge from May to mid-June. Adults appear in mid-June and can be seen until early August (Scoggan and Brusven, 1972).

**Abundance and importance** - rarely becomes numerous and seldom competes with domestic livestock (Scoggan and Brusven, 1972).

### Cordillacris crenulata (Bruner)

**Common name** - Crenulated grasshopper (Helfer, 1972).

**Geographic distribution** - found from Montana and the Dakotas south to Texas and west to Wyoming, Nevada and California (Otto, 1981). Its Colorado range is from the plains to the eastern mountain foothills as high as 8,000 ft. and includes some of the western slope (Gillette, 1904; Hebard, 1929).

**Habitat** - dry grass areas (Gillette, 1904).


**Nymph** - five instars (Brusven, 1967).

**Adult** - small size. General color is brownish-yellow. Face is slightly slanted back. Antennae are slender. Dorsal posterior edge of pronotum is rounded. Brown lateral stripes start at the vertex of the head, pass through the eye and widen toward the back of the head. The stripes continue along the lateral lobes of the pronotum and the sides of the thorax, curved downward and stop at the attachment of the middle femur. The head has a brown dorsal stripe. Tegmina are opaque with a conspicuous brown stripe that has a very definite and wavy margin. Hind femora and tibiae are buff colored. Hind femora have a brown stripe on the outer side. Male length, 13 mm; female, 18 mm (Brooks, 1958).

**Seasonal history** - eggs overwinter. Adults are present from late June to mid-September (Gillette, 1904; Pfadt, 1972).

**Abundance and importance** - common on the prairie (Tinkham, 1948). In Arizona it has been known to seriously hinder reseeding of range grasses (Helfer, 1963). In Kansas, however, it is not economically important (Brusven, 1967).

### Cordillacris occipitalis (Thomas)

**Common name** - Spotted wing grasshopper.

**Geographic distribution** - from Alberta, Saskatchewan and Manitoba (Canada) south to Texas, New Mexico, Arizona, California and Oregon (Otto, 1981). Its Colorado range is the eastern plains and eastern mountain valleys (Hebard, 1929).

**Habitat** - eroded areas, sandy areas, river valleys and areas of scant, dry, low vegetation (Brooks, 1958; Hebard, 1929).

**Food habits** - a graminivorous species that prefers succulent blue grama, moderately wilted needleandthread and severely wilted western wheatgrass. It also consumes prairie sandreed grass, threeawn and sand dropseed (Kumar et al., 1976; Ueckert and Hansen, 1971).

**Eggs** - three whitish eggs are deposited in each pod (Onsager, 1963).

**Nymph** - five instars (Scoggan and Brusven, 1972).

**Adult** - small size. General color is dull, yellowish-brown. Face is slanted back slightly. Vertex is rounded. Antennae are slender. Dorsal posterior margin of pronotum is rounded. Lateral brown stripes extend from the vertex of the head, through the eyes, widen across the head and extend along the pronotum without curving downward. Tegmina are opaque with a row of brown spots. Wings are clear. Hind femora are buff with a brown stripe on the outer face. Hind tibiae are light orange. Male length, 15 mm; female, 19 mm (Ball et al., 1942; Brusven, 1967; Helfer, 1972).

**Oviposition** - occurs on such bare sites as pocket gopher mounds and eroded areas (Onsager, 1963).

**Seasonal history** - eggs overwinter (Scoggan, 1972). Adults are present from late June to early September (Newton et al., 1954).

**Abundance and importance** - often common (Helfer, 1972). Along with several other species, it can form a complex that is damaging to sagebrush grasslands (Scoggan and Brusven, 1972).

### Cratypedes neglectus (Thomas)

**Common name** - Pronotal range grasshopper (Helfer, 1972).

**Geographic distribution** - Canada to southern California and west to Wyoming (Scoggan and Brusven, 1972). Distributed throughout Colorado and but most common in the mountains.

**Habitat** - grassy hills and prairies, sandy blowouts and small clearings in pine forests (Alexander and Hilliard, 1969; Criddle, 1933a; Helfer, 1972).

**Food habits** - a mixed feeder. It eats range grasses and occasionally cultivated grain (Ball et al., 1942; Brooks, 1958).

**Nymph** - five instars (Scoggan and Brusven, 1972).

**Adult** - medium to large size and robust. General color is dark grey-brown. Face is vertical. Vertex is rounded. Antennae are slender and darkening toward the tip. Median carina of pronotum has 2 notches. Dorsal posterior margin of pronotum forms a right angle (sometimes a rounded right angle). Lateral lobes of pronotum are wider ventrally than in the middle. Tegmina have indistinct bands and usually pale dorsal stripes that converge on top of the back when wings are folded, forming an elongated "V." Wing has a yellow disc, clear apex and spurred black band. Hind tibiae are bright reddish-orange. Male length, 32 mm; female, 45 mm (Alexander and Hilliard, 1969; Ball et al., 1942).

**Seasonal history** - overwinters in the egg stage. Nymphs hatch from early May to mid-June. Adults appear from mid-June to August, depending on altitude (Scoggan and Brusven, 1972).
Abundance and importance - a potential economic pest but only as a member of a damaging complex of grasshopper species. *C. neglectus* itself probably would not reach damaging numbers, but it does dwell on prime range land (Scoggin and Brusven, 1972).

**Dactylotum bicolor** (Thomas)

**Common name** - Pictured grasshopper (Heifer, 1972) or Barber pole grasshopper.

**Geographic distribution** - The subspecies *D. bicolor pictum* occurs from northern Texas and northeastern New Mexico to Montana (Heifer, 1972). In Colorado it can be found on the eastern plains and foothills. The subspecies *D. bicolor variegatum* doesn't occur in Colorado (Alexander, 1941; Heifer, 1972).

**Habitat** - dwells in areas of sparse, low vegetation (Hebard, 1928; Mulkern et al., 1969).

**Food habits** - forbivorous, eating such low-value forbs as false boneset, scarlet globemallow, prairie clover and scurf-pea (Mulkern et al., 1969).

**Eggs** - 15 to 25 eggs are deposited in three or four disorderly columns within the pod. Average egg length, 5.3 mm; average diameter, 1.4 mm. Color, brownish-yellow (Onsager and Mulkern, 1963).

**Adult** - medium size. Brilliantly marked with reddish-orange, black and yellow. Face is vertical; vertex is rounded; antennae are slender. Pronotum is somewhat cylindrical and textured with small punctures. Top of pronotum has three transverse incisions. Dorsal posterior margin of pronotum is rounded. Tegmina and wings are very small. Tegmina are black with fine yellow veins. Body is distinctly banded with black and yellow. Midline of pronotum and abdomen and parts of the face, pronotum and thorax are marked with red-orange. Hind femora are banded with black and red-orange. Hind tibiae are yellow and green. Male length, 25 mm; female, 32 mm. (Coppock, 1962; Heifer, 1972; Thomas, 1873).

**Oviposition** - shown experimentally to prefer creek loam and fine sand for oviposition (Isely, 1938).

**Seasonal history** - adults are present in August and September (Newton et al., 1954).

**Abundance and importance** - of very little importance in the grasslands (Mulkern et al., 1969). It is sometimes numerous in alfalfa fields (Heifer, 1972).

**Derotema haydeni** (Thomas)

**Common name** - Hayden's grasshopper (Heifer, 1972).

**Geographic distribution** - From Alberta and Saskatchewan (Canada) to New Mexico and east to the Dakotas, Nebraska and Kansas (Brooks, 1958). Its Colorado range generally is from the Great Plains to the eastern mountain valleys (Hebard, 1929), but it occasionally is recovered in western Colorado.

**Habitat** - sandy and gravelly soil along rivers and on margins of wet spots in sandy, alkaline areas. It is found largely on sagebrush, often simulating its color (Brooks, 1958; Bruner, 1897; Scudder, 1900).

**Food habits** - a mixed feeder, preferring grasses. It has been observed feeding on bahia, scarlet globemallow, sunsedge, fringed sage, threawn, blue grama, sand dropseed and forwing saltbush (Brooks, 1958; Kumar et al., 1976).

**Eggs** - females produce about 16 pale yellow eggs arranged in two columns within the pod. Average egg length, 4.3 mm; average diameter, 1.1 mm (Onsager and Mulkern, 1963).

**Nymph** - five instars (Scoggin and Brusven, 1972).

**Adult** - small to medium size. General color is brownish. Face is almost vertical. Vertex is rounded. Eyes are bulging. Antennae are slender. Pronotum has short ridges and wrinkles, the dorsal posterior margin forms an obtuse angle. Lateral lobes of pronotum are rounded. Median carina of pronotum has two distinct transverse incisions. Tegmina are brownish with darker brown markings. Wings are yellow or red with a broad black band and a clear apex. Male length, 22 mm; female, 25 mm (Ball et al., 1942; Hewitt and Barr, 1967).

In flight *D. haydeni* makes a series of six to 10 short, sharp clicks in rapid succession (Scudder, 1900).

**Seasonal history** - overwinters in the egg stage. Adults can be found from late June to early July (Ball et al., 1942; Newton et al., 1954).

**Abundance and importance** - very common in most areas of Colorado (Caudell, 1903). It inhabits the poorer parts of the rangeland (Scoggin and Brusven, 1972).

**Dissosteira carolina** (Linneaus)

**Common name** - Carolina grasshopper or Dust grasshopper (Osborn, 1939).

**Geographic distribution** - Nova Scotia to British Columbia (Canada) and Alaska; south to northern Florida, central Alabama, southeastern Mississippi, northern Texas, northern New Mexico, Arizona and California (Brooks, 1958). It is found throughout Colorado.

**Habitat** - often found on bare earth in cultivated patches, dark shaly outcrops, roadsides, parking lots and gardens. It thrives best where people live (Blatchley, 1920; Brooks, 1958).

**Food habits** - feeds on mixed grasses and forbs. It prefers bluegrass and is also known to feed on sand dropseed, belvedere sumac-cypress and prairie sunflower (Kumar et al., 1976; Wakeland, 1958; Tyrkus, 1971).

**Eggs** - egg pods are about 5 cm long and contain 30 to 72 eggs in three or four columns. Eggs are yellow, turning reddish-brown. Average egg length, 5.5 mm; average diameter, 1.2 mm (Criddle, 1918; Onsager and Mulkern, 1963).

**Nymph** - five instars, rarely six (Shotwell, 1941).

**Adult** - large. General color varies from light greyish-yellow to bright reddish-brown. It often is sprinkled with small dusky spots. Face is vertical. Vertex is rounded. Antennae are slender. Median carina of pronotum is a sharp ridge with a notch anterior to the middle. Dorsal posterior margin of pronotum is a right angle. Body is slender and compressed. Tegmina are semitransparent, finely speckled and long. Wings are long, wide and black with a narrow yellow-green outer border. Apex of wings is clear to smoky and spotted with black. Hind femora are reddish-brown with three broad black bands on the inner face. Hind tibiae are yellowish or dusky. Male length, 24-33 mm; female, 33-40 mm (Blatchley, 1920).

*P. carolina* is gregarious. Flight is a noiseless zig-zag. In courtship, males hover and make a sharp see-sawing sound (Blatchley, 1920; Heifer, 1972).

**Oviposition** - eggs are deposited in blown sand ridges, banks, silt runoff from fields and along roadsides as long as the area is free from vegetation and is fully exposed to the sun. Only rarely will *P. carolina* oviposit among plant roots (Criddle, 1918; Osborn, 1939; Shotwell, 1941).

**Seasonal history** - eggs are deposited in the autumn and hatch in spring. Adults are found from early July through late September (Gillette, 1904; Osborn, 1939).
Abundance and importance - common throughout Colorado and able to consume large amounts of forage (Caudell, 1903; La Rivers, 1948).

**Dissosteira longipennis** (Thomas)

**Common name** - High plains grasshopper, Long-winged plains grasshopper or Long-winged locust (Wakeland, 1958).

**Geographic distribution** - A native of the high plains in the United States, including eastern Colorado, southwestern Nebraska, western Kansas, the panhandles of Texas and Oklahoma and eastern New Mexico (Wakeland, 1958). In Colorado it is found from the eastern plains to the eastern mountain valleys (Hebard, 1929).

**Habitat** - occurs in areas of short grass, mainly between 4,000 ft. and 6,000 ft. altitude. Breeding occurs only in areas where grama grass is dominant or subdominant (Wakeland, 1958).

**Food habits** - eats grama grasses and buffalo grass. Short grasses are preferred, but it will readily feed on many cultivated crops (sudan, millet, maize, corn and beans). Alfalfa is fed upon but not seriously damaged (Wakeland, 1958). Grasses are preferred, but it will readily feed on many cultivated crops (sudan, millet, maize, corn and beans). Alfalfa is fed upon but not seriously damaged (Wakeland, 1958).

**Eggs** - arranged in a nearly horizontal position 1 to 2 in below the ground. Flight is accompanied by sharp, rapid clicking (Bailey and Riegert, 1972).

**Nymph** - five instars (Ramsay, 1964).

**Adult** - medium size. General color is brownish. Face is vertical, and vertex is rounded. Antennae expand slightly toward the tip. Median carina of pronotum is well developed with a sharp ridge with a deep sulcus anterior to middle. Dorsal posterior margin of pronotum is a right angle. Tegmina are three dark bands. Wings are nearly transparent but smoky near the edge. Hind tibiae are brown to lavender. Male length, 40 mm; female, 50 to 60 mm (Wakeland, 1958).

**D. longipennis** often aggregates at lights at night (Caudell, 1903).

**Oviposition** - eggs are deposited in limited areas where many egg pods are concentrated to make egg beds. These beds occur in field margins of crops, grassland, pastures, bottom land, hills, waste land and restoration areas. More than 90% occur in grama and buffalo grass range. Eggs are deposited in sandy, loam soil around the edges of grasses and in bare spots usually on exposed slopes (Wakeland, 1958).

**Seasonal history** - eggs are laid in the fall and hatch in spring. Adults appear in early summer (Wakeland, 1958).


**Abundance and importance** - common and abundant in Colorado during the 1930s (Hinkle, 1938). Outbreaks are infrequent but when they do occur, *D. longipennis* is the most destructive of range grasshoppers (Shotwell, 1941). Outbreaks follow drought and subside when precipitation is above normal (Wakeland, 1958).

**Eritettix simplex** (Thomas)

**Common name** - Velvet-striped grasshopper (Helfer, 1972).

**Recent synonymy** - *Eritettix variabilis* Bruner.

**Geographic distribution** - Alberta and Saskatchewan (Canada), North Dakota and Wisconsin south to Mexico. Also from Rhode Island to Tennessee, Alabama and Georgia (Otte, 1981). Its Colorado range includes the eastern grasslands and the eastern mountain valleys (Hebard, 1929).

**Habitat** - grassy hillsides and areas of dense vegetation (Anderson et al., 1979; Brooks, 1958).

**Food habits** - graminivorous, preferring blue grama, hairy grama, sunseedge, cheatgrass brome, side-oats grama, threeawn, needleandthread, sand dropseed, Sandberg bluegrass. Indian ricegrass and prairie sandreed grass (Brooks, 1958; Campbell et al., 1974; Kumar et al., 1976; Mulkern et al., 1969; Ueckert and Hansen, 1971).

**Eggs** - 12 to 20 pale yellow eggs are arranged in two columns within each pod. Average egg length, 4.4 mm; average diameter, 1.4 mm (Onsager and Mulkern, 1963).

**Nymph** - five instars (Ramsay, 1964).

**Adult** - small to medium size. Face is slanted back. Vertex is
rounded. Antennae are clubbed at tip. Dorsal posterior margin of pronotum is rounded. Wings are clear. Lateral carinae are white and constricted near middle.

Male: general color is grey to greyish-brown. Two dark narrow lines are on head and pronotum. Tegmina are uniform, dark grey with pale streaks in the costal region and toward the apex. Lateral lobes of pronotum and thorax are darker than the rest of the body. Male length, 16 mm. Males fly noisily.

Female: long and robust. General color is grey with contrasting yellowish-white and dark markings, or bright green with yellowish white and dark lines. Tegmina are brown to green with a row of dark markings. Lower surfaces of hind femora are pale; outer surfaces are discolored longitudinally but not banded. Hind tibiae are buff with brown splotches. Female length, 16 to 24 mm (Brooks, 1958; Bruner, 1897).

**Oviposition** - occurs on both bare and vegetated sites (Onsager, 1963).

**Seasonal history** - an early season grasshopper that overwinters as a nymph. In the early spring it is found in the third or fourth instar. Adults are present from late May until late July. Eggs are produced early in the summer and hatch in late July (Anderson et al., 1979; Mulkern et al., 1964; Newton et al., 1954).

**Abundance and importance** - common and economically important on Colorado rangeland. It is abundant in early summer and fall but not during midsummer (Anderson et al., 1979; Gillette, 1904; Rottman, 1980).

**Gryllus spp.**

**Common name** - Field crickets and house crickets (Helfer, 1972).

**Geographic distribution** - found throughout North America (Swan and Papp, 1972). Their Colorado range extends from the eastern plains to the mountain foothills (Hebard, 1929).

**Habitat** - live alone or in pairs in burrows that they dig. They move to above-ground shelters in mid-summer and remain there until autumn (Blatchley, 1920).

**Food habits** - will feed on cotton seedlings, alfalfa seeds, cereals, tomatoes, cucurbits, beans and peas. Indoors, they may feed on wool and fur (Swan and Papp, 1972).

**Eggs** - eggs are elongate, cylindrical and shiny, cream-yellow. Length, 3 mm; diameter, 0.8 mm (Criddle, 1925).

**Nymph** - eight to 11 instars but usually nine (Ramsay, 1964).

**Adult** - size is variable. Color is black or brown. The different species are difficult to distinguish. Head is large, nearly spherical and slightly broader than the pronotum. Antennae are slender and longer than the body. Eyes are round. Pronotum is shorter than it is wide with the dorsal posterior margin rounded; lateral lobe curves inward as if to tighten around thorax. Hind femora are large. Hind tibiae are armed with two rows of stout spines. Both sexes have long anal cerci. Female has a long, branched ovipositor (Blatchley, 1920; Swan and Papp, 1972).

**Oviposition** - eggs are deposited in loose, damp sand. They are deposited singly rather than in clusters or pods (Blatchley, 1920; Criddle, 1925; Swan and Papp, 1972).

**Seasonal history** - adults generally appear in July and August. Eggs overwinter in the north but in the southern states overwintering may be as nymphs or adults (Swan and Papp, 1972).

**Abundance and importance** - occasionally are abundant enough to cause damage (Swan and Papp, 1972).

**Hadrotettix trifasciatus (Say)**

**Common name** - Three-banded range grasshopper (Helfer, 1972).

**Geographic distribution** - Saskatchewan (Canada), Montana, Colorado and Arizona, south and east to South Dakota, Iowa, Missouri, Oklahoma and Texas (Froeschner, 1954). Its Colorado range is from the eastern plains to the eastern mountain valley grasslands (Hebard, 1929).

**Habitat** - high, bare hill slopes, rocky areas and areas of short grass and gravelly soil (Bruner, 1897; Froeschner, 1954; Mulkern et al., 1969).

**Food habits** - no distinct food preference, but forbs are prefered over grasses. Some of the plants eaten are western wheatgrass, blue grama, threadleaf sedge, Missouri loco, scarlet globemallow, stork's bill, sunflower, red sprangletop, little barley, saltgrass, prickly poppy, stinkgrass, curly mesquite, peppergrass, scurfea and scarlet gaura. Arthropod parts have been found in some of their crops, and there is record of cannibalism (Anderson and Wright, 1952; Mulkern et al., 1969; Nerney, 1960).

**Eggs** - 18 to 26 eggs are arranged in two or three disorderly columns within each pod. They are tan colored, turning reddish-brown later. Average egg length, 8 mm; average diameter, 2 mm (Onsager and Mulkern, 1963).

**Nymph** - five instars (Ramsay, 1964).

**Adult** - large size. General color is tan. Face is vertical; vertex is rounded. Antennae are long, black and slender. Median carina of pronotum is faint. Dorsal posterior margin of pronotum is a right angle. Tegmina are tan with three broad, solid, dark bands. Wings are pale yellow with a black band and clear apex. Hind femora are robust; the inner surface is blue-black with a light band near the knee. Outer surface of femora has one dark band. Hind tibiae are orange. Male length, 25 to 30 mm; female, 35 to 40 mm (Ball et al., 1942).

**Oviposition** - egg beds usually are on hilltops and ridges. Females were shown experimentally to prefer coarse chalk, course sand or marl for oviposition (Isely, 1938).

**Seasonal history** - overwinters in the egg stage. Adults are present from early July to mid-September (Ball et al., 1942; Newton et al., 1954).

**Abundance and importance** - very common in Colorado but is of little economical importance since it eats mostly low-value forbs (Caudell, 1903; Mulkern et al., 1969).

**Heliaul a rufa (Scudder)**

**Common name** - Rufous grasshopper (Helfer, 1972).

**Geographic distribution** - Texas, New Mexico and Arizona to Utah, Colorado and Nebraska (Helfer, 1972; Otte, 1981). In Colorado **H. rufa** is found on river cliffs or outcrops of the plains. It is most common in southeastern Colorado (Alexander, 1941; Hebard, 1924).

**Habitat** - grassy areas of gravelly soil (Tinkham, 1948).

**Food habits** - a grass feeder that prefers grama grasses but also feeds on threawn (Fry et al., 1978; Joern, 1978; Kumar et al., 1976).

**Adult** - small to medium size. General color is cream or reddish. Head is usually grey and lighter than body. Face is vertical, and vertex is rounded. Antennae are slender. Head is large. Pronotum is smaller than head. Dorsal posterior fourth of pronotum is darker, giving the impression of a dark crescent laid across the back. Dorsal posterior margin of pronotum intermediate between a right angle and a curve. Tegmina are
opaque and spotted with brown. Wings are clear to pale blue. Hind femora have two dark bands on the upper and outer surfaces. Hind tibiae are pink to orange. Male length, 20 mm; female, 25 mm (Ball et al., 1942).

Seasonal history - adults are present from late July to late September (Newton et al., 1954).

Abundance and importance - generally an uncommon grassland species; however, it may be common in southeastern Colorado (Alexander, 1941; Helfer, 1972).

**Hesperotettix speciosus (Scudder)**

Geographic distribution - ranges from southern Illinois west to Colorado and Montana and southwest to Texas and New Mexico (Blatchley, 1920). In Colorado it occurs in the eastern part of the state and into the foothills (Gillette, 1904).


Food habits - forbivorous preferring western ragweed, common sunflower and goldenrod (Mulkern et al., 1969).

Eggs - 15 eggs are deposited within a pod. Average egg length, 5 mm; average width, 1.5 mm (Isely, 1938).

Adult - medium size. General color is uniform green. Median carina is pink or red. Antennae are red. Face is moderately slanted back. Tegmina are somewhat reduced, not reaching the tip of the abdomen. Pronotum is roughly sculptured; dorsal posterior margin is rounded. Wings are clear. Hind femora are reddish dorsally. Hind tibiae are pale green. Male length, 20 mm; female 28 mm (Coppock, 1962).

**Hesperotettix viridis (Scudder)**

Common name - Green-streak grasshopper (Ball et al., 1942).

Geographic distribution - found throughout the United States although subspecies differ in their distribution. It is found throughout Colorado but is recovered most frequently in the eastern part of the state.

Habitat - low, marshy meadows (Frosencher, 1954).

Food habits - an oligophagous feeder, feeding only on a select few plants in a geographic area. In Arizona* H. viridis* is known to feed on snakeweed, burrow weed and rabbit brush. In Idaho it eats plants of the composite family, especially goldenrod and western ragweed (Ball, 1936; Brusven, 1972).

Eggs - eight to 18 eggs are laid in two columns. Color is tan. Average egg length, 4.5 mm; average diameter, 1.1 mm (Onsager and Mulkern, 1963).

Nymph - five instars (Brusven, 1972).

Adult - medium size. General color is green. Face is somewhat slanted back. Vertex is rounded and very narrow between the eyes. Antennae are slender. Pronotum is long and slender, the sides almost parallel when viewed from above. Pronotum may have black transverse incisions (subspecies *viridis*) and a pale streak along the median carina. Tegmina and hind wings are narrow. Tegmina are opaque, pale green, clear at the tip with a pale longitudinal streak in subspecies *viridis*. Streak may be absent and tegmen tip darker in other subspecies. Wings are clear. Front and middle femora often are tinted with orange. Hind femora have orange band near knee. Hind tibiae are light blue-green. Male length, 16 to 20 mm; female, 25 mm (Somes, 1914).

Oviposition - female digs into soil by holding onto an upright plant and sitting erect. Eggs are deposited while sitting up with the hind femora held at a sharp angle (Criddle, 1933a).

Seasonal history - adults are present from August through October (Van Horn, 1972).

Abundance and importance - common throughout the Great Plains. It generally causes little damage and may even increase the quality of rangeland in some areas by its feeding habits (Hubbell, 1922a; Brusven, 1972).

**Hippiscus ocelote (Saussure)**

Common name - Wrinkled grasshopper (Helfer, 1972).

Recent synonymy - *Hippiscus rufus* (Scudder).

Geographic distribution - Texas, Arizona and northern Mexico to Montana, Idaho and the Atlantic coast (Helfer, 1972). It is found in the eastern half of Colorado.

Habitat - grassy areas, especially those in open woods (Helfer, 1972).

Food habits - a mixed feeder preferring grasses. It especially prefers bluegrass and Japanese brome. Blue grama and little bluestem are preferred to a lesser extent (Campbell et al., 1974; Mulkern et al., 1969).

Eggs - pale yellow turning reddish brown. 30 eggs are arranged in three columns. Average egg length, 6.8 mm; average diameter, 1.7 mm (Onsager and Mulkern, 1963).

Adult - large and robust. General color is light to dark brown. Face is brownish-yellow and vertical. Vertex is rounded. Antennae are yellow at the base, brown at the tip and slender. Pronotum has a wrinkled appearance. Top of pronotum has a pale "X" shaped stripe, which is not always present in the female. Sides of pronotum have two yellowish spots, one above the other. Tegmina have distinct dark brown splotches and pale stripes converging in a "V" on top of the back. Wing disc is pale yellow to deep orange with a clear apex and a curved black band with a long spur. Abdomen is yellowish-brown. Inner face of hind femora is bright yellow with three black bands; outer face is clay yellow with three less distinct grayish-brown bands. Hind tibiae are yellow with a pale area at the base. Male length, 28 mm; female, 37 mm (Beamer, 1917; Blatchley, 1920).

Seasonal history - nymphs are present from mid-June to late August. Adults can be seen from July to November and are most common from September to November. *H. ocelote* is one of the last grasshoppers to disappear in the autumn (Coppock, 1962).

Abundance and importance - seldom becomes numerous and, therefore, is not an economic pest (Ball et al., 1942; Mulkern et al., 1969).

**Hypochlora alba (Dodge)**

Common name - Sage grasshopper (Helfer, 1972).

Geographic distribution - Alberta to Manitoba (Canada) and south to Texas. Inhabits the Great Plains (Coppock, 1962; Helfer, 1972). In Colorado it is found on the plains of the eastern half of the state (Hebard, 1929).

Habitat - bushes, especially sagebrush (Helfer, 1972).

Food habits - monophagous, feeding almost exclusively on cudweed (Mulkern et al., 1969).

Eggs - eggs are tan colored. Pods contain 12 eggs arranged in two columns. Average egg length, 4 mm; average diameter, 1 mm (Onsager and Mulkern 1963).

Nymph - five instars (Ramsay, 1964).

Adult - small to medium size. General color resembles the host plant (Mulkern et al., 1964), which is grey to green. Face is moderately slanted back. Pronotum is slightly wider posteriorly, dorsal posterior margin is rounded. A brown band extends from the eyes back across the lateral lobes of the
pronotum. Tegmina are uniform green, short and pointed. Occasional long-winged forms are reported (Helfer, 1972). Hind tibiae are blue-green (Coppock, 1962). Male length, 15 mm; female, 20 mm.

Oviposition - in digging the hole for egg laying, the female holds on to some upright foliage and sits erect with the hind femora held high. She remains in a vertical position while depositing her eggs in the soil (Cridde, 1933a).

Seasonal history - adults are present from July to October but are most abundant in July and August (Campbell et al., 1974; Helfer, 1972).

Abundance and importance - possibly beneficial since it feeds on undesirable forbs. It is common over the plains region of Colorado where its food plants occur (Gillette, 1904).

**Melanoplus angustipennis** (Dodge)

Common name - Narrow-winged spur-throated grasshopper (Helfer, 1972).

Geographic distribution - distributed throughout the Great Plains from Alberta and Manitoba (Canada) to Arizona, Texas, North Carolina and Georgia (Hebard, 1929; Helfer, 1972). In Colorado it is found primarily in the eastern half of the state (Alexander, 1941).

Habitat - usually confined to areas of sandy soil, especially in association with grass and the edges of low bushes. Also commonly collected on old, plowed sod land and on pastures grazed heavily for many years (Cridde, 1918; Helfer, 1972; Scudder, 1897; Sorens, 1914).

Food habits - in food preference studies, *M. angustipennis* appeared to be polyphagous with a certain tendency expressed toward forbs. Forbs made up 52% of its diet and grasses 28% of its diet while feeding on 38 different kinds of food. Major food items (presented in mean percent dry weight of food in diet) consisted of western ragweed, 13%; moss, 12%; fungus, 8%; arthropod parts, 7%; and blue grama, 6%.

In addition to western ragweed, *M. angustipennis* showed a preference toward such plants as wavyleaf thistle, sand dropseed, western wheatgrass and the seeds of vetch and sand dropseed. Plants that were eaten in amounts less than their availability included sand sagebrush, *Artemisia tridentata* var. wyomingensis, 13%; deertail, *Hesperomyces arizonicosa*, 13%; and blue grama, 6%.

Eggs - eggs range in color from tan to cream yellow. Average egg length, 4.79 mm; average diameter, 1.33 mm. Egg pods usually contain 14 to 18 eggs arranged in two columns (Onsgard and Mulkern, 1963; Tuck and Smith, 1939).

Nymph - five instars.

**Adult** - medium size. Female is slightly larger than the male. Color is variable, often dark grey to dark brown with a red-brown tinge and pale underneath. Top of the head and anterior pronotum dark brown with posterior pronotum and lateral lobes paler; lower face dull yellow. Pronotum may be dull yellow on top. Broad, black bands are below the lateral carinae on the anterior two-thirds of the pronotum. Dorsal posterior margin of pronotum is a rounded right angle. Legs are slender and tapers, reaching or slightly surpassing tips of the hind femora. Wings are colorless. Hind femora are dull yellow-brown. Hind tibiae are either pale greenish blue or dull red; spines black. Cerci are short and spatulate at tip; middle third is the narrowest with apical one-third as broad as base. Furculae are slender and somewhat cylindrical, divergent and not more than one-third as long as supraanal plate. Supraanal plate strongly and abruptly narrowed at apical third and notched. Male length, 19 to 22 mm; female, 21 to 22 mm (Blatchley, 1920; Scudder, 1897; Sorens, 1914).

**Oviposition** - females seem to prefer cleared areas of sandy soil (Cridde, 1918).

**Seasonal history** - in eastern Colorado, adults are present from July through mid-September (Ueckert and Hansen, 1971).

**Abundance and importance** - this grasshopper is, at times, quite abundant on the Great Plains, forming a high percentage of the swarms of grasshoppers. However, typically it is of little economic importance in grassland habitats (Hebard, 1929; Mulkern et al., 1969).

**Melanoplus bivittatus** (Say)


Geographic distribution - common throughout most of the United States, ranging from Canada to the Gulf but not found along the Atlantic seaboard (Bruner, 1897; Helfer, 1972; Scudder, 1897). In Colorado it is widely distributed (Alexander, 1941).

Habitat - found in a variety of habitats, showing a decided preference towards rank and succulent vegetation found in bottom lands, edges of streams, marshes, roadsides, cultivated fields, the margins of woodlands and shaded mountain slopes. Also found associated with areas of open weeds and cultivated habitats, especially cultivated land that has been deserted for a number of years. A major pest in suburban areas (Bruner, 1897; Hart, 1906; Helfer, 1928; Helfer, 1897; Scudder, 1897; Uvarov, 1966).

**Food habits** - polyphagous in its feeding habits. Although it feeds on both grasses and forbs, it seems to be associated mainly with forbs and does poorly in their absence. In a particular study it preferred stickseed, cheatgrass brome and plants of the mustard family early in the season but preferred lettuce and verbena later in the season. Other preferred foods are needleleaf sedge, sand dropseed, Canadian thistle, common sunflower, vetch, wavyleaf thistle, green barley, oats, wheat kernels in the dough stage, rye, alfalfa, corn silk, cabbage, beets, potatoes, onions and a variety of trees and shrubs. A common pest in vegetable gardens and ornamental plantings (Corkins, 1921; Corkins, 1922a; Gillette, 1904; Helfer, 1972; Kumar et al., 1976; Mulkern et al., 1969; Rotman, 1960; Shotwell, 1941).

Eggs - eggs range in color from olive to light or yellowish-brown. Average egg length, 4.45 mm; average diameter, 1.2 mm. Females generally deposit one or two egg pods. The number of eggs per pod ranges from 43 to 135, and they are arranged in columns of four within the pod (Drake, 1945; Onsgard and Mulkern, 1963; Shotwell, 1941; Tuck and Smith, 1939).

Nymph - five to six instars.

**Adult** - rather large and robustly built, females much larger than males. Coloration is dull olive or greenish-yellow on top; pale yellow to dull greenish-yellow beneath. Face is either yellow or olive-green; top part of head and pronotum are dark olive-brown. Narrow but distinct pale yellowish stripe extends back from side of head behind the eyes, along sides of pronotum to tip of tegmina. On the head and lateral lobes of pronotum these stripes are usually bordered below with black. Dorsal posterior margin of pronotum is curved. Tegmina reach or slightly surpass the hind femora and are sometimes a little shorter in the female, tapering regularly and gradually. Hind
femora are dull yellow with a dark longitudinal band on the outer face. Inner face is variable. Hind tibiae are variable — reddish, blue, or yellow — and have black spines. Cerci are very short, large, and broad-shaped. Tegmina are very short and triangular and widely separated. Subgenital plate is short and narrow, apex is slightly elevated and somewhat prolonged. Male length, 23 to 29 mm; female, 29 to 40 mm (Blatchley, 1920; Helfer, 1972; Somes, 1914; Uvarov, 1928).

**Eggs** - eggs are deep yellow in color. Average egg length, 4.37 mm; average diameter, 1.13 mm. The egg pod usually contains about 12 eggs arranged in two columns (Onsager and Mulckern, 1963; Tuck and Smith, 1939).

**Nymph** - five instars.

**Adult** - medium size. Color is dull yellowish-brown to darkish brown often with a reddish-brown tinge and pale underneath. Top of head and anterior pronotum usually are darker than posterior pronotum. A dark brown median stripe is on top of head, and a pair of posteriorly enlarging stripes are on upper one-third of lateral lobes of pronotum. Dorsal posterior margin of pronotum is curved. Tegmina are rather long and slender and reach or extend beyond tips of hind femora. Wings are colorless. Hind femora are brownish-yellow. Hind tibiae usually are pale blue, pinkish at tip, sometimes red or dull yellow; spines are black. Cerci are basally rectangular; apical portion is bent slightly upward and inward; dorsal margin is rounded and outer face concave; apex is broadly rounded. Falcurea are well separated and one-fourth the length of supraanal plate. Subgenital plate is very short and rounded at apex, apical margin is thickened and slightly prolonged. Male length, 16 to 18 mm; female, 19 to 24 mm (Blatchley, 1920; Helfer, 1972; Scudder, 1897).

**Geographic distribution** - found throughout the United States from New England to British Columbia (Canada), south to North Carolina, Oklahoma and Arizona (Heifer, 1972). Its Colorado distribution is primarily the eastern part of the state (Alexander, 1941).

**Habitat** - prefers open locations. Commonly found in pastures, roadsides, borders of cultivated fields and on grass in open woods, especially in areas of sandy or gravelly soil (Blatchley, 1920; Criddle, 1933a; Hebard, 1928; Helfer, 1972).

**Food habits** - polyphagous in its feeding habits but displays a preference toward forbs. In one study it fed on 24 different plants with forbs making up 85% of its diet while grasses contributed 13%. Major foods included prairie spiderwort, 37%; unknown forbs, 13%; sand sagebrush, 12%; wavy leaf thistle, 6%; and western wheatgrass, 6% (Mulkern et al., 1969; Ueckert and Hansen, 1971).

**Melanoplus bowditchi Scudder**

**Common name** - Sagebrush grasshopper (Anderson and Wright, 1952).

**Geographic distribution** - Alberta and Saskatchewan (Canada) to Arizona and Oklahoma (Helfer, 1972). In Colorado it is found in the eastern half of the state and in the western mountain valleys and foothills (Gillette, 1904; Hebard, 1929).

**Habitat** - short-grass ranges and dry, open woods (Coppock, 1962; Froeschner, 1954).

**Food habits** - forbivorous, feeding only on plants of the genus Artemisia. It especially prefers dwarf sage and sand sagebrush (Mulkern et al., 1969; Onsager and Mulkern 1963).

**Eggs** - eggs are tan colored. Average egg length, 4.8 mm; average diameter, 1.1 mm (Onsager and Mulkern, 1963).

**Nymph** - five instars (Ramsay, 1964).

**Adult** - *M. bowditchi* is almost identical to *M. flavidus*; see description of *M. flavidus*. However, the tegmina tend to be more spotted in *M. bowditchi*, and the aedeagus is not cup-shaped at the tip (Coppock, 1962).

**Seasonal history** - July to September (Froeschner, 1954).

**Abundance and importance** - common in southeastern Colorado. Occurs in small numbers in northeastern Colorado (Gillette, 1904).

**Melanoplus differentialis**

**Common name** - Differential grasshopper (Hantsbarger, 1979).

**Geographic distribution** - can be found throughout the United States but is highly discontinuous in the far East and far West and seldom is found farther north than the southern borders of North Dakota and Minnesota (Froeschner, 1954; Parker, 1952). Found throughout eastern Colorado (Alexander, 1941; Bruner, 1897) and occasionally in western Colorado.

**Habitat** - found on cultivated crops growing on low, moist ground and on plowed fields (Bruner, 1897).

**Food habits** - a mixed feeder preferring grasses. It also prefers rank growing, juicy foods such as corn, clover, alfalfa.
and various garden products. It frequently is found eating belvedere summerycypress (Bruner, 1987; Mulkern et al., 1969).

**Eggs** - females have been known to deposit up to 156 eggs in one pod. Some pods contain 70 to 90 eggs and others as low as 36. It is likely that a single female makes three pods with about 250 total eggs. Eggs are olive colored, about 4.6 mm long and 1 mm in diameter. They are arranged in four columns within the pod (Carothers, 1924; Corkins, 1921; Onsager and Mulkern, 1963).

**Nymph** - six instars (Shotwell, 1941).

**Adult** - large. General color is yellow to yellowish-brown with contrasting black markings; sometimes black. Tegmina are uniform. Wings are colorless. Outer face of hind femora has distinctive black bars arranged in a herringbone pattern. Dorsal posterior margin of pronotum is curved. Hind tibiae are yellow with black spines and a narrow black ring near the knee. These characteristics are less visible in a black morph. Cerci are distinctly boot-shaped; subgenital plate tapers to a point; furculae are very reduced. Male length, 30 mm; female, 40 mm (Blatchley, 1920; Hansburger, 1979).

**Oviposition** - eggs are deposited in raised plant crowns of somewhat isolated clumps of sod. Common oviposition sites are compact roads, deserted fields, edges of weed patches and well-grazed areas near weedy ravines (Bruner, 1897; Shotwell, 1941).

**Seasonal history** - adults are common in the latter part of July. They deposit eggs from mid-August to October, and the eggs overwinter (Bruner, 1897; Corkins, 1921).

**Abundance and importance** - abundant and destructive in Colorado's lower elevations but has not been collected above 5,500 ft. Although it is a destructive pest of cultivated crops, it is of little importance in grasslands. It is sometimes a serious pest in suburban areas (Blatchley, 1920; Mulkern et al., 1969).

**Melanoplus fasciatus** (Walker)

**Common name** - Huckleberry spur-throat grasshopper (Helfer, 1972).

**Geographic distribution** - Newfoundland and Labrador to British Columbia (Canada), south to Alabama, Arkansas and New Mexico (Helfer, 1972). In Colorado it is found from the foothills up to 11,000 ft. in the Rockies (Hebard, 1929; Helfer, 1972).

**Habitat** - dry, open woods especially on huckleberry or blueberry bushes in sunlit spots (Helfer, 1972).

**Food habits** - mixed feeder preferring forbs (Criddel, 1933a).

**Nymph** - five instars (Ramsay, 1964).

**Adult** - small to medium size. General color is brown, yellow below. Face is nearly vertical to moderately slanting. A weak, dark band extends back from the eye, crossing part of the lateral lobes of the pronotum. Dorsal posterior margin of pronotum is rounded. Tegmina are about twice the length of pronotum; uniform dark brown in color. Hind femora usually have three dark bands, but sometimes bands are absent. Hind tibiae are red. Male cerci are three to four times as long as width at constriction; expansion beyond middle is about as wide as base. An occasional specimen may have long tegmina. Male length 17 mm; female, 20 mm.

**Seasonal history** - adults are present from June to September (Helfer, 1972).

**Abundance and importance** - not abundant in Colorado (Gillette, 1904; Hebard, 1929).

**Melanoplus femurrubrum** (DeGeer)

**Common name** - Red-legged or Garden grasshopper (Somes, 1914).

**Geographic distribution** - widely distributed, inhabiting parts of Canada and all of the United States. Also present south of the United States extending into central Mexico (Bruner, 1897; Helfer, 1972; Scudder, 1897). Widely distributed throughout Colorado (Alexander, 1941; Hebard, 1929).

**Habitat** - found among dense stands of grass and weeds, common in cultivated fields, field margins, roadsides, pastures, meadows, lawns and open woods. In the more arid portions of its habitat, it occurs only near water (Cowan, 1934; Hart, 1906; Hebard, 1928; Helfer, 1972; Uvarov, 1928).

**Food habits** - polyphagous in its feeding habits. In one study it fed upon eight species of grass, three sedges and 28 forbs. Bluegrass was the predominant grass eaten while western ragweed and summerycypress were the main forbs eaten. It also has been shown to prefer sweet clover, alfalfa, vetch, *Erigeron bellidiastum*, wavyleaf thistle, Russian thistle, smooth brome and fleabane (Hewitt, 1977; Kumar et al., 1976; Mulkern et al., 1969).

**Eggs** - eggs range in color from light brown, pale yellow, brownish-yellow to cream white. Average egg length, 4.37 mm; average diameter, 0.85 mm. 20 to 29 eggs are arranged in two columns within the egg pod (Onsager and Mulkern, 1963; Shotwell, 1941; Tuck and Smith, 1939).

**Nymph** - five instars.

**Adult** - size medium but variable. Dull reddish or greyish-brown in color. Pronotum usually is more lightly colored on top than on the lower parts of the lateral lobes. Upper part of the lateral lobe is crossed by a broad black band on the prozona. Dorsal posterior margin of pronotum is curved or a rounded right angle. Tegmina are narrow and gradually tapering; brownish to dark brown, usually with faint brownish spots in median area. Tegmina surpass tip of abdomen and usually the
hind femora. Wings are colorless. Hind femora are a blend of olive-green and dull yellowish-brown, sometimes with a grey-brown or blackish tinge. Hind tibiae usually are deep red but sometimes yellowish-green. Furculae are long and narrow, about one-half the length of the supraanal plate. Cerci are strongly narrowed on basal half with apical one-half narrowed. Subgenital plate is short apically with apical margin strongly elevated and rounded. Male length, 17 to 23 mm; female, 18 to 27 mm (Blatchley, 1920; Helfer, 1972; Scudder, 1897; Somes, 1914; Uvarov, 1928).

Oviposition - ovipositional habits are similar to those of *M. bivittatus* and *M. sanguinipes*.

**Seasonal history** - overwintering occurs as eggs, and adults are present from July to the first frost (Hart, 1906; VanHorn, 1972).

**Abundance and importance** - the most generally distributed grasshopper in Colorado after *M. sanguinipes* and the most injurious *Melanoplus* species in Colorado after *M. bivittatus*. *M. femurrubrum* has exhibited slight tendencies toward mass flights during severe outbreaks. However, this species generally is solitary and seldom exhibits any migratory behavior. *M. femurrubrum* acts as an intermediate host to a poultry tapeworm, *Choanoctenia infundibulum* and to globular stomach worm, *Tetramerus americana*, which affects turkeys and quail. It also acts as an intermediate host to a tapeworm, *Metrosisth lucida*, which occurs in the intestines of turkeys and guinea fowl. It is the most common grasshopper found in the United States. It is common in disturbed areas and sometimes becomes a suburban pest (Bruner, 1897; Cowan, 1934; Hebard, 1929; Helfer, 1972; Uvarov, 1928).

**Melanoplus flavidus Scudder**

**Common name** - Yellowish spur-throat grasshopper (Helfer, 1972).

**Geographic distribution** - Alberta to Manitoba (Canada), south to Arizona, Texas and Illinois (Helfer, 1972). In Colorado it occurs in low numbers in the southern part of the state and is abundant along the foothills and plains near Fort Collins, Colo. (Blatchley, 1920; Gillette, 1904).

**Habitat** - prefers grass in sandy or blowout areas and yucca clumps (Helfer, 1972).

**Food habits** - voracious, preferring sunflower and western ragweed. *M. flavidus* feeds on alfalfa, cabbage, plum leaves and cherry leaves when the native food supply is short (Blatchley, 1920; Mulkern et al., 1969).

**Eggs** - pods contain 14 yellow eggs arranged in two or three disorderly columns. Average egg length, 5 mm; average diameter, 1.2 mm (Onsager and Mulkern, 1963).

**Nymph** - five instars (Ramsay, 1964).

**Adult** - medium size. General color is olive to red-brown. Face is nearly vertical. Dark band extends back from eyes across lateral lobes of pronotum. Dorsal posterior margin of pronotum usually is rounded. Tegmina are uniform color. Tegmina extend to or beyond tip of abdomen. Hind femora are yellow with two brown bands on outer and upper faces. Hind tibiae are grey-blue. Male cerci taper to a rounded point. Best distinguished from *M. bowditchi* by the aedeagus, which has a cup-shaped depression at the tip. Male length 20 mm; female, 25 mm (Coppock, 1962).

**Seasonal history** - eggs hatch in early June. Adults appear in late July and are present until mid-September (Gillette, 1904; Mulkern et al., 1964).

**Abundance and importance** - abundant near Fort Collins, Colo. If the native food plants become scarce *M. flavidus* is likely to become a serious pest of cultivated crops (Blatchley, 1920).

**Melanoplus foedus (Scudder)**

**Geographic distribution** - found west of the Mississippi River, occurring in Kansas, Nebraska, Wyoming, Utah, New Mexico, Nevada, Montana and the Dakotas (Scudder, 1897). In Colorado it is distributed throughout the eastern portions of the state (Alexander, 1941).

**Habitat** - associated with sandy uplands and dank vegetation of river bottoms. Two subspecies are found in Colorado — *M. foedus foedus* and *M. foedus fluviatilis*. *M. foedus foedus* is common in plains areas while *M. foedus fluviatilis* is commonly associated with river bottoms (Alexander, 1941; Criddle, 1933a; Scudder, 1897).

**Food habits** - polyphagous feeder, showing a preference for forbs. In a study conducted in Colorado, *M. foedus* ate a total of 34 different foods with forbs making up 59% of its diet; grasses, 23%; and arthropod parts, 12%. Major plant species included: ragweed, 9%; nutall evolvulus, 8%; blue grama, 6%; wavy leaf thistle, 6%; scurpea, 6%; prairie sandreed, 5%; and fungus, 5%. Other preferred foods are leadplant, cudweed, cheatgrass, brome, hairy goldaster, alfalfa, needlethread, scarlet globemallow, bahia, sand dropseed, milkvetch, prairie sunflower and Russian thistle (Bannill and Brusven, 1973; Hewitt, 1977; Kumar et al., 1976; Mulkern et al., 1969; Ueckert, 1969).

**Eggs** - eggs deep yellow in color. Average egg length, 4.98 mm; average diameter, 1.16 mm. Egg pod quite variable in structure, usually containing 20 eggs arranged in two or three columns (Onsager and Mulkern, 1963; Tuck and Smith, 1939).

**Nymph** - five instars.

**Adult** - medium to large size. Brownish-yellow to red-brown in color. Dorsal posterior margin of pronotum is curved or a rounded right angle. Dark stripe on lateral lobe of pronotum behind eye usually is present. Tegmina are slightly longer than tips of hind femora and are pale grey or red-brown in color. Wings are colorless. Hind tibiae are red. Cerci are short and spatulate. Furculae are short, divergent and widely separated. *M. foedus* is closely related to and very similar in appearance to *M. packardi*, and it is generally a bit larger and lighter in color than *M. packardi*. Stripes on top of pronotum and bands on lateral lobes are absent (Alexander, 1941; Blatchley, 1920; Helfer, 1972; Scudder, 1897; Somes, 1914).

**Oviposition** - eggs are deposited in semi-soft ground often in cultivated grain fields, stubble fields and in old pocket gopher mounds (Criddle, 1933a).

**Seasonal history** - adults present from mid-July through mid-September in Colorado (Ueckert, 1969).

**Abundance and importance** - of little economic importance in grassland habitats (Mulkern et al., 1969).

**Melanoplus gladstoni Scudder**

**Common name** - Gladston's spur-throat grasshopper (Helfer, 1972).

**Geographic distribution** - found throughout the prairies and Great Plains from Alberta to Manitoba (Canada) and south to Arizona, Texas and Mexico (Hebard, 1928; Helfer, 1972). Widely distributed in Colorado (Alexander, 1941) but is especially common in eastern Colorado.
Flabellate
Common name - Tiny spur-throated grasshopper (Helfer, 1972).

Geographic distribution - extends eastward across the Great Plains, ranging from Manitoba (Canada) and Minnesota to Montana and British Columbia (Canada); south to Colorado and Nebraska (Hebard, 1928; Hebard, 1929; Helfer, 1972). Found primarily in central Colorado extending onto the plains along the front range.

Habitat - commonly found in open, grassy areas and sandy or gravelly soils. Present from the plains to the foothills and mountains up to 8,000 ft. (Alexander, 1941; Criddle, 1933a; Hebard, 1928; Hebard, 1929; Helfer, 1972; Somes, 1914). Found in dry areas among short grasses and weeds and in uplands associated with sandy or gravelly soils (Criddle, 1933a; Hebard, 1928; Helfer, 1972).

Food habits - polyphagous in its feeding habits, exhibiting a preference toward forbs. Major food items are alfalfa and western wheatgrass. It also feeds on fringed sage, scarlet globemallow, slimflower scurfpea, milkvetch, blue grama, bahia, sand dropseed, needleandthread and Russian thistle (Criddle, 1933a; Kumar et al., 1976; Mulkern et al., 1969).

Eggs - egg color ranges from tan to brownish-yellow, to brown with a greenish tinge. Average egg length, 4.87 mm; average diameter, 1.04 mm. Egg pods contain about 16 eggs arranged in two columns (Onsager and Mulkern, 1963; Tuck and Smith, 1939).

Oviposition - egg pods are commonly deposited in moist clay (Somes, 1914).

Seasonal history - in northern Colorado nymphs are present from June through August; adults are found from August through October.

Abundance and importance - common in Colorado, especially in the northeastern section of the state (VanHorn, 1972).

Melanoplus lakinus (Scudder)

Geographic distribution - common throughout the Great Plains (Hebard, 1929). Found from the plains to the foothills in eastern Colorado (Alexander, 1941; Gillette, 1904) and occasionally in western Colorado.

Habitat - common on ground covered by native grasses and where tumbleweeds grow (Gillette, 1904).

Food habits - monophagous to oligophagous in its feeding habits. It has been noted feeding on plants of the Goosefoot family, sugarbeet, and Russian thistle (Gillette, 1904; Mulkern et al., 1969).

Eggs - eggs are light brown in color. Average egg length, 4.53 mm; average diameter, 1.02 mm (Tuck and Smith, 1939).

Seasonal history - in northern Colorado nymphs are present from June through August; adults are found from August through October.

Abundance and importance - one of the more common species of the Great Plains. M. lakinus is not an economically important species in grassland habitats (Hebard, 1929; Mulkern et al., 1969).

Melanoplus occidentalis (Thomas)

Common name - Flabellate grasshopper (Ball et al. 1942).

Geographic distribution - found throughout the Great Plains, extending from British Columbia to Saskatchewan (Canada) and south to Arizona and Texas (Hebard, 1929; Helfer, 1972). Two subspecies occur in Colorado: M. occidentalis occidentalis, which is found primarily on the eastern plains; and M. occidentalis brevipennis, which occurs in western Colorado (Alexander, 1941).
Habitat - common in open grassland areas, often extending its range above timberline (Hebard, 1928; Hebard, 1929; Helfer, 1972).

Food habits - a polyphagous feeder, exhibiting a preference toward forbs. Its preferred food plants are scarlet globemallow, western wheatgrass and sida. It also feeds on bahia, blue grama and threeawn (Kumar et al., 1976, Mulkern et al., 1969).

Eggs - eggs are yellow in color. Average egg length, 5.31 mm; average diameter, 1.24 mm (Tuck and Smith, 1939).

Nymph - five instars.

Adult - small to medium in size. Color is reddish-brown. Dorsum is strongly mottled with dark backish-brown spots; light brown color underneath. Blackish-brown median stripe broadens posteriorly, passing from between the eyes to the back of the head but seldom continuing onto the pronotum. Dorsal posterior margin of pronotum is a rounded right angle. Head is yellow to yellowish-brown. Black patch is present on the upper part of the anterior half of the lateral lobes. Tegmina extend to or a little beyond the tip of the abdomen and are slender and tapering. Tegmina are brown in color with a slender, median, yellow stripe and frequently are marked with squarish, dark spots. Wings are colorless. Hind femora are variable in color with oblique pale patches on a dark background or the reverse. Hind tibiae are light blue. Cerci are large and triangular, wide at base, slightly tapering and rounded at apex. Furculae are very small and triangular. Subgenital plate has a small conical tubercle below apical edge. Male length, 18 mm; female, 25 mm (Scudder, 1897; Somes, 1914).

Seasonal history - hatching occurs from late May to mid-June. Adults are present from late June to the middle of October (Newton et al., 1954).

Abundance and importance - frequently a pest of cultivated crops but usually of little economic importance on grasslands (Mulkern et al., 1969).

**Melanoplus packardii Scudder**

Common name - Packard's grasshopper (Helfer, 1972).

Geographic distribution - distributed throughout the Great Plains west of the Mississippi River, north to Saskatchewan, Alberta and British Columbia (Canada) (Cridle, 1933a; Hebard, 1929; Helfer, 1972). In Colorado it is most common in the eastern portion of the state.

Habitat - a true prairie species commonly associated with grasses and cultivated fields in areas of sandy soil. Present in the foothills up to elevations of 8,000 ft. and common on the sides and summits of low hills (Cridle, 1933a; Gillette, 1904; Hebard, 1929; Helfer, 1972; Scudder, 1897).

Food habits - a polyphagous species, exhibiting a preference toward legumes. Alfalfa, western ragweed, leadplant, Artemisia sp., cudweed and slimmerf flower are among the highly preferred plants. Blue grama also is consumed (Anderson and Wright, 1952; Cridle, 1933a; Hewitt, 1977; Mulkern et al., 1964, Mulkern et al., 1969).

Eggs - egg color is variable, ranging from pale tan, brown, yellowish-brown to cream white. Average egg length, 5.18 mm; average diameter, 1.41 mm. Egg pod contains between 17-29 eggs arranged in 2 or 3 columns (Onsager and Mulkern, 1963; Shotwell, 1941; Tuck and Smith, 1939).

Nymph - five instars.

Adult - medium to large size. Color is brownish-yellow or pale reddish-brown and dull, yellow underneath. Face is dull yellow. Usually a dark reddish-brown or brown stripe extends from the top of the head along the midline to the posterior margin of the pronotum. Dorsal posterior margin of pronotum is curved to a rounded right angle. Below the lateral carinae is a dark stripe that runs from behind the eye and along the anterior two-thirds of the pronotal lobes. Tegmina are slightly longer than tips of hind femora; pale greyish or reddish-brown in color. Wings are colorless. Hind tibiae are whitish-blue or bright red. Cerci are short and spatulate. Furculae are short, divergent and widely separated. Male length, 22 to 30 mm; female, 26 to 33 mm (Blatchley, 1920; Helfer, 1972; Scudder, 1897; Somes, 1914).

Oviposition - preferred sites are cultivated fields, open ledges of soil washed down from a cut bank or a blown sand ridge of a fence row (Cridle, 1933a; Shotwell, 1941).

Seasonal history - in northern Colorado nymphs are found from June through August; adults are found from August through October.

Abundance and importance - an abundant species in Colorado (Hebard, 1929). This grasshopper species has the potential for becoming a serious pest on the range and in cultivated fields such as grain, legumes, cotton and vegetables (Alexander, 1941; Coppock, 1962; Cridle, 1933a; Hebard, 1929; Helfer, 1972).

**Melanoplus sanguinipes (Fabricius)**

Common name - Lesser migratory grasshopper (Shotwell, 1930).

Recent synonymy - Melanoplus mexicanus mexicanus (Saussure).

Geographic distribution - this species of Melanoplus has a broader geographic range than any other species in the genus. It is distributed throughout the United States except for peninsular Florida and California west of the Sierra Nevada Mountains. It extends its range as far north as southern Canada and the Yukon River and as far south as the tropical lowlands of Mexico (Shotwell, 1930). Generally distributed throughout Colorado (Alexander, 1941; Hebard, 1929).

Habitat - found in open grassland on areas of fairly compact soils, short grasses and in areas with large populations of annual weeds (Scharff, 1954; Shotwell, 1941).

Food habits - an omnivorous species exhibiting a preference toward forbs. Some food preferences are dandelion, tansy mustard, nuttall violet, Sandberg bluegrass, needleleaf sedge, wheat, alfalfa, sweet clover, fanweed, carrot, potato, leadplant, blue grama grass, stork's bill, cheatgrass brome, smooth brome, Medicago lupulina, cudweed, western ragweed, corn, shepherd's purse, pepper grass, blue grass, rabbitbrush, western wheatgrass and needlegrass (Anderson and Wright, 1952; Campbell et al., 1974; Cridle, 1933a; Hewitt, 1977; Mulkern et al., 1964; Mulkern et al., 1969; Pfadt, 1949; Rottman, 1990; Scharff, 1954; Shotwell, 1930).

Eggs - eggs variable in color ranging from pale yellow, yellowish-brown, yellowish-brown-purple to cream white. Average egg length, 4.8 mm; average diameter, 1.1 mm. Egg pods are variable in shape, cylindrical or more or less curved and thickened toward the end. The egg pod wall is thin and made of earth. The stopper is formed of a spongy mass occupying one-fourth to one-half of the pod. The number of eggs per pod ranges from 5 to 18, arranged in two columns (Onsager and Mulkern, 1963; Tuck and Smith, 1939).

Nymph - five instars.

Adult - (solitary phase; normal). Medium size. Color is dark greyish-brown often tinged with reddish-brown. Broad black
band extends from behind the eyes along the lateral lobes of the prozona. Dorsal posterior margin of pronotum a rounded right angle. Tegmina extend beyond the hind femur by 2 to 3 mm. Tegmina are brown in color often with dark brown spots; slender and gradually tapering. Wings are colorless. Hind femora are light yellow or sulfur brown often with two oblique, broad, dark-brown bands. Hind tibiae usually are bright red but occasionally light blue. Cerchi are compressed, about two times as long as broad and obliquely rounded. Furculae are small, slender and diverging and between one-fourth and one-third the length of the supraanal plate. Apical margin of subgenital plate is abruptly elevated, thickened and notched in the middle. Male length, 17 to 21 mm; female, 16 to 27 mm (Helfer, 1972; Somes, 1914; Uvarov, 1928).

(Migratory phase; extinct.) The gregarious and migratory phase of *M. sanguinipes* is known also as *M. spreitus*. It is very difficult to separate the two, but *M. spreitus* has not been found in present times. Major differences exist in the wing length and shape of pronotum. In *M. spreitus* the wings usually are longer, and the posterior part of the pronotum is more expanded than in *M. sanguinipes*. The coloration of the two species also is different at times with *M. spreitus* normally being light greyish-brown and tinged with red in color while *M. sanguinipes* is usually dark greyish-brown and also tinged red in color.

**Oviposition** - oviposition occurs 1 to 2 in. below the surface of the ground, usually in light, sandy loam along fence rows that are protected by Russian thistle, and around the base of wheat stubble and alfalfa. Other favorite oviposition sites include areas near grain or alfalfa stacks, edges of fields and in crowns of wheat, alfalfa, or grass plants (Shotwell, 1930; Shotwell, 1941).

**Seasonal history** - in northern Colorado nymphs are found from June through August; adults are found from August through October.

**Abundance and importance** - one of the most widespread and abundant grasshoppers in Colorado and one of the most destructive grasshoppers to grassland and the native range. At times this grasshopper can be a serious agricultural pest. When it occurs in large numbers, it displays migratory tendencies. adults migrate in large swarms and are very strong fliers capable of migrating long distances. *M. sanguinipes* usually is more destructive in dryland sections than in irrigated areas. It is common in disturbed areas and becomes a suburban pest (Alexander, 1941; Cowan, 1934; Cridde 1933a; Hebard, 1929; Mulkern et al., 1969; Shotwell, 1930).

**Mermiria bivittata** (Serville)

*Common name* - Mermiria grasshopper (Heller, 1972).

*Recent synonymy* - *Mermiria maculipennis* Rehn.

*Geographic distribution* - the prairies and Great Plains from Alberta to Saskatchewan (Canada) and south to Texas, Arizona and Mexico. It also is found in Illinois, Missouri, Arkansas, Tennessee, Mississippi, Alabama, Georgia and North and South Carolina (Heller, 1972; Otte, 1981; Tuck and Smith, 1939). In Colorado *M. bivittata* can be found from the plains to the mountain valleys of the eastern part of the state (Hebard, 1929).

*Habitat* - lush high grasses (Hebard, 1928).

*Food habits* - a grass feeder, preferring sacaton grass, needleandthread, wheat, rye, oats, wild rye, Johnson grass, prairie sandreed, bluestem and grama grasses (Ball et al., 1942; Brooks, 1958; Ueckert and Hansen, 1971).

**Eggs** - about 14 eggs are deposited in each pod. Color is white turning dark brown. Average egg length, 7.2 mm; average diameter, 1.5 mm (Ball et al., 1942; Onsager and Mulkern, 1963).

**Adult** - medium to large size. General color is brownish to greenish, yellowish-brown underneath. Face is strongly slanted. Antennae are long and sword-shaped. Vertex is cone-shaped. Pronotum is slender and without lateral carinae. Dorsal posterior margin of pronotum is rounded. Sides of head and pronotum have a broad, dark stripe. Thorax is slender. Prosternum has a small tubercle. Tegmina are pale with an opaque, yellowish subcostal stripe on the basal third. Wings are clear. Hind legs are long and slender. Hind tibiae are reddish. Male length, 38 mm; female, 51 mm (Ball et al., 1942; Brooks, 1958; Heller, 1972).

*Seasonal history* - overwinters as an egg. Adults appear late in July (Anderson and Wright, 1952; Ball et al., 1942).

*Abundance and importance* - sometimes abundant enough to cause damage to range and cultivated areas (Heller, 1972).

**Mermiria picta** (Walker)

*Recent synonymy* - *Mermiria neomexicana* (Thomas).

*Geographic distribution* - the prairies, Great Plains, Southwest and the Southeast to Virginia (Hebard, 1925; Otte, 1981). Its Colorado range is the eastern mountain foothills (Hebard, 1929) and the eastern plains.

*Habitat* - found on coarse grasses in dry areas of the plains (Hebard, 1925).

**Eggs** - eggs are purplish with white longitudinal stripes. Average egg length, 7.2 mm; average width, 1.4 mm (Tuck and Smith, 1939).

**Adult** - medium to large size. General color is pale brown; the head, pronotum and costal margin of tegmina often are tinged with red. Face is strongly slanted back. Vertex is cone shaped, and antennae are sword shaped. Lateral carinae of pronotum are distinct. Dorsal posterior margin of pronotum is rounded. Dark stripe extends from behind the eye to the end of the pronotum. Prosternum has a small tubercle. Tegmina are without a pale stripe. Wings are clear. Hind legs are long and slender. Hind tibiae are reddish. Male length, 38 mm; female, 51 mm (Ball et al., 1942; Brooks, 1958; Coppock, 1962).

*Seasonal history* - adults appear in July (Ball et al., 1942).

*Abundance and importance* - *M. picta* often is abundant locally (Hebard, 1925).

**Mermiria texana** Bruner

*Geographic distribution* - Colorado to southern California, Arizona, New Mexico, Texas and Mexico (Heller, 1972; Otte, 1981). Its Colorado range is the southeastern part of the state (Anderson, 1941).

*Habitat* - often found under the protection of brush (Ball et al., 1942).

*Food habits* - prefers grasses (Ball et al., 1942).

*Eggs* - 16 to 24 eggs per pod (Ball et al., 1942).

*Adult* - large size. General color is brown or green. Face is strongly slanted. Antennae are sword shaped. Dorsal posterior margin of pronotum is rounded. Head and pronotum have dark brown and yellow longitudinal stripes that extend onto the tegmina. Dark brown stripe extends along the midline of the back to the tegmina tips. Tegmina also have light yellow stripes in the subcostal area of the basal half. Tips of tegmina are rounded. Prosternum has a small tubercle. Wings are
clear. Hind femora have dark, incomplete bars on upper surface. Hind femora and tibiae are slender. Male length, 32 mm; female, 45 mm (Ball et al., 1942; Brooks, 1958; Coppock, 1962).

**Seasonal history** - adults appear in June (Ball et al., 1942).

**Mestobregma plattei** (Thomas)

**Common name** - Platt range grasshopper (Helfer, 1972).

**Geographic distribution** - in Colorado it is found primarily in the southwestern foothills and eastern plains (Gillette, 1904; Hebard, 1929).

**Habitat** - tall sparse grass on rocky hilltops, hillsides or on outcrops with scattered trees. Found from 5,000 to 6,000 ft. elevation (Hebard, 1931; Tinkham, 1948).

**Food habits** - has been observed feeding on fourwing saltbush (Kumar et al., 1976).

**Adult** - medium size. General color is brown. Head is large. Eyes are rather small. Face is vertical. Dark band runs across face below antennae. Vertex is rounded and with ridges. Antennae are slender. Dorsal posterior margin of pronotum is a right angle. Lateral lobes of pronotum have curved dark bands. Median carina of pronotum is moderately high with two deep notches. Tegmina and wings are long. Tegmina have two broad, black bands that often fade posteriorly. Wings are yellow or pink with a spurred black band and a clear apex. Hind tibiae are yellow-brown or blue. Male length, 25 mm; female, 28 mm (Ball et al., 1942; Scudder, 1876).

**Seasonal history** - adults are present during August and September (Ball et al., 1942).

**Abundance and importance** - rather common on the eastern Colorado plains (Gillette, 1904).

**Metator pardalinus** (Saussure)

**Common name** - Pard grasshopper (Helfer, 1972).

**Geographic distribution** - Alberta and Manitoba (Canada), to Arizona and Texas (Helfer, 1972). In Colorado it is found throughout the eastern half of the state.

**Habitat** - arid prairies and sub-arid areas. Found on clay-like soil, grasses and sedges (Criddle, 1933a; Helfer, 1972).

**Food habits** - graminivorous preferring carex, wheatgrass, beardgrass and needlegrass (Brooks, 1958; Criddle, 1933a).

**Eggs** - 14 eggs are arranged in two to three disorderly columns within a pod. Egg color is light yellow turning reddish-brown. Average egg length, 7.3 mm; average diameter, 1.3 mm (Onsager and Mulken, 1963).

**Nymph** - five instars (Ramsay, 1964).

**Adult** - medium to large. General color is grey or brown, mottled with black. Face is vertical. Vertex is rounded. Antennae are slender and long. Dorsal posterior margin of pronotum is a right angle. Tegmina are long with distinct brown splotches and pale dorsal stripes converging in a “V” on top of the back. Wings are yellow, orange or red. Apex is clear and banded with a long spur. Inner faces of hind femora and hind tibiae are blue. Male length, 26 mm; female, 34 mm (Beamer, 1917; Helfer, 1972).

**Seasonal history** - overwinters as an egg. Adults can be seen from June to September (Criddle, 1933a; Helfer, 1972).

**Oecanthus spp.**

**Common name** - Tree crickets (Ball et al., 1942).

**Geographic distribution** - some species are widely distributed in North America (Ball et al., 1942). In Colorado **Oecanthus niveus** (DeGeer) (snowy tree cricket) and **Oecanthus quadripunctatus** Beutenmuller (four-spotted tree cricket) are found on the eastern plains and foothills. **Oecanthus argentinus** Saussure (prairie tree cricket) is found from the eastern plains to the eastern mountain foothills. **Oecanthus californicus** Saussure (western tree cricket) is found in the western foothills and western mountain valleys (Ball et al., 1942; Hebard, 1929).

**Habitat** - on trees, bushes, alfalfa and weeds. Often found on goldenrod, wild sunflowers and scrub oak (Ball et al., 1942; Blatchley, 1920; Hebard, 1929).

**Food habits** - omnivorous, feeding upon leaves, flowers, fruit, fungi and such small insects as aphids, and scales (Ball et al., 1942).

**Eggs** - eggs are deposited singly and irregularly in tree or shrub bark or singly and in fairly regular rows in the pith of twigs, berry stems, grape vines and weed stems. The eggs of **O. quadripunctatus** are bright yellow with one end white (Blatchley, 1920; Cantrall, 1943).

**Nymph** - five instars (Ramsay, 1964).

**Adult** - small, slender and delicate. Color is light. Wings are fully developed. Male tegmina are paddle shaped, flattened, firm in texture and semi-transparent. Female tegmina are narrow and wrapped around the body. Her ovipositor is straight and shorter than the hind femora. It is blunt and tipped with black. Body length, 19 mm. It is active at night but can be seen in the day. Song is loud (Ball et al., 1942; Blatchley, 1920).

**Oviposition** - eggs are deposited in the stems of trees, shrubs and smaller plants with a soft fiber and pithy interior. The female chews into the outer covering of the plant. She gives a series of quick thrusts into this pit with her ovipositor. Eggs then are deposited in the soft interior. She then plugs the hole with excrement or chewed bark (Ball et al., 1942; Froeschner, 1954).

**Seasonal history** - overwinters in the egg stage and hatches in spring (Froeschner, 1954).

**Abundance and importance** - oviposition habits are damaging to plants, but the harm is offset by the good done by the tree crickets feeding on harmful insects (Ball et al., 1942; Blatchley, 1920).

**Oepia obscura** (Thomas)

**Common name** - Obscure grasshopper (Helfer, 1972).

**Geographic distribution** - Alberta, Saskatchewan and Massachusetts (Canada) and western Wisconsin south to Mexico. Also in California and Nevada (Otte, 1981). **O. obscura** is found primarily in eastern Colorado (Alexander, 1941).

**Habitat** - eroded ground in areas of short grass (Brooks, 1958; McNeill, 1996).

**Food habits** - graminivorous, preferring buffalo grass, sunnegde, prairie sandreed, threeawn, sixweeks fescue, muhy, saltgrass, Sandberg bluegrass, dropseed, blue grama and western wheatgrass (Ball et al., 1942; Brooks, 1958; Brusven, 1967; Hewitt, 1977; Kumar et al., 1976; Mulken et al., 1969).

**Eggs** - 8 whitish eggs are deposited in two columns within the pod. Average egg length, 4.2 mm; average diameter, 1.1 mm (Onsager and Mulken, 1963).
**Nymph** - five instars (Ramsay, 1964).

**Adult** - small to medium size. Face is slanted back. Vertex is rounded. Median carina of head is distinct. Antennae are sword-shaped. Dorsal posterior margin of pronotum is rounded. Coloration is extremely variable. Typically, the back is brown or green and nearly plain. Sometimes a dark streak runs along the median carina of the pronotum. The grasshopper's sides have a stripe that runs backward from the eye, widens and becomes more obscure. This stripe is below the lateral carinae and varies in color and intensity. Tegmina of females have an irregular, dark longitudinal stripe or series of spots. Below the dark stripe is a whitish streak. Wings are clear. Male length, 16 mm; female, 25 mm (Ball et al., 1942; McNeill, 1896).

**Seasonal history** - overwinters in the egg stage. Adults are found in late summer and autumn (Ball et al., 1952; Bhatnager and Pfadt, 1973).

**Abundance and importance** - sometimes common. Eats high-value forage and is of economic importance to grasslands (Helfer, 1972; Mulkern et al., 1969).

**Paropomala wyomingensis** (Thomas)

**Common name** - Wyoming toothpick grasshopper (Helfer, 1972).

**Geographic distribution** - from Wyoming spreading south to southern California, Mexico, western Texas, Oklahoma, Kansas and Nebraska (Otte, 1981). In Colorado *P. wyomingensis* can be found from the valley bottoms of the eastern plains to the eastern mountain valleys (Hebard, 1929).

**Habitat** - tall grass in low, wet areas (Ball et al., 1942).

**Food habits** - eats coarse grasses, especially western wheatgrass and bluegrass. Also observed eating needleandthread, blue grama, sand dropseed, threeawn, sunseede, Indian ricegrass and milkvetch (Ball et al., 1942; Hebard, 1925; Kumar et al., 1976).

**Nymph** - five instars (Scoggan and Brusven, 1972).

**Adult** - medium size. Shape is slender and grass-like. Color is variable but is uniform and light; either light-green, grey, light-brown, pink or yellow. Face is extremely slanted. Vertex is cone-shaped, elongate and extends a considerable distance in front of eyes. Eyes are oblong. Antennae are sword-shaped and close to eyes. A whitish stripe extends from the lower border of the eyes to the bases of the middle legs. Dorsal posterior edge of pronotum is rounded. Tegmina are lance-shaped and abbreviated, reaching the fifth abdominal segment. Tegmina are transparent to weakly colored. Wings are transparent. Abdomen is long, cylindrical. Subgenital plate of male is very pointed (Coppock, 1962).

**Seasonal history** - adults can be found from July to October (Ball et al., 1942).

**Abundance and importance** - common over most of the Great Plains. It seldom occurs in high densities and is of little economic importance (Hebard, 1925; Scoggan and Brusven, 1972).

**Phlibostroma quadrimaculatum** (Thomas)

**Common name** - “P-quad” grasshopper or Four-spotted grasshopper (Hantsbarger, 1979; Helfer, 1972).

**Geographic distribution** - the Great Plains from Alberta, Saskatchewan and Manitoba (Canada) to Mexico. Also in Arizona (Otte, 1981). Its range in Colorado is from the eastern grasslands to the eastern mountain valleys (Hebard, 1929).

**Habitat** - dry, mixed prairie (Brooks, 1958).

**Food habits** - feeds on grama and buffalo grasses, but especially blue grama. It also has been observed feeding on sun-seede, textile onion, sand dropseed, fringed sage and scarlet globemallow (Brunner, 1897; Kumar et al., 1976; Mulkern et al., 1969).

**Eggs** - six tan eggs are deposited in two columns within a pod. Average egg length, 4.8 mm; average width, 1.3 mm (Onsager and Mulkern, 1963).

**Nymph** - four instars (Ramsay, 1964).

**Adult** - small to medium size and robust. General color is brownish-green. Face is nearly vertical. Vertex and back of head are strongly curved. Head is unusually large. Antennae are thread-like. Lateral carinae are light colored and distinctly constricted near middle. Dorsal posterior margin of pronotum is a rounded right angle. Tegmina have four distinct crenulate markings. Wings are colorless. Posterior femora are banded on upper and outer faces. Posterior tibiae are red-orange to tan. An active grasshopper. Male length, 12 mm; female, 18 mm (Ball et al., 1942; Hantsbarger, 1979; McNeill, 1896).

**Seasonal history** - adults can be found from July through September or October (Ball et al., 1942).

**Abundance and importance** - common and destructive to pastures and rangelands (Hantsbarger, 1979).

**Phoetaliotes nebrascensis** (Thomas)

**Common name** - Large-headed locust, Big head or Red-nosed grasshopper (Ball et al., 1942; Blatchley, 1920; Tinkham, 1948).

**Geographic distribution** - Alberta (Canada) to central Mexico, east to Indiana, Illinois, Oklahoma and Texas. West to British Columbia (Canada), California, New Mexico and Arizona (Brooks, 1958). In Colorado it is found on the eastern plains (Hebard, 1929).

**Habitat** - lives in sparsely vegetated areas (Mulkern et al., 1964).

**Food habits** - a mixed feeder but prefers grasses. Specific foods are western wheatgrass, Sandberg bluegrass, little bluestem, bluebunch wheatgrass, sand dropseed, needleandthread, blue grama, big bluestem, cheatgrass brome, intermediate wheatgrass and bluegrass (Banfill and Brusven, 1973; Campbell et al., 1974; Hebard, 1929; Kumar et al., 1976; Mulkern et al., 1964; Mulkern et al., 1969).

**Eggs** - 24 tan eggs are produced in two columns within the pod. Average egg length, 4.3 mm; average diameter, 1 mm (Onsager and Mulkern, 1963).

**Nymph** - five instars (Cantrall, 1943).

**Adult** - medium size. General color is olive-green with dark, brown markings. Head is large and prominent. Antennae are slender, reddish and dusky toward the tip. Dorsal posterior margin of pronotum is rounded. Broad blackish band extends behind the eye and along all but the posterior third of pronotum. Tegmina and wings usually are short. Tips of tegmina when short are pointed. Abdomen of male has greenish sides; the posterior third of each segment is brownish and more brown in female. Front and middle femora are reddish-yellow. Hind femora are green tinted with brownish-red and with lower surface reddish-yellow. Knees are black. Hind tibiae are dull green or blue with black spines. Male length, 22 mm; female, 28 mm (Blatchley, 1920).

Males are strong and active jumpers. They often leap to a clump of weeds or grass and slide down to sit close to the ground. Females move sluggishly (Blatchley, 1920).
Oviposition - occurs in vegetated areas. Eggs have been seen in the crowns of grass clumps (Onsager, 1963).

Seasonal history - hatching occurs from late June to late July. Adults appear in late July (Mulkern et al., 1964; Newton et al., 1954).

Abundance and importance - common in eastern Colorado and can be destructive to grassland and some cultivated crops (Gillette, 1904; Mulkern et al., 1969).

Psoloessa delicatula (Scudder)

Common name - Brown-spotted range grasshopper (Helfer, 1972).

Geographic distribution - from Manitoba (Canada) to Texas; west to British Columbia (Canada), Washington, Oregon and California (Otto, 1981). In Colorado it is found throughout the state.

Habitat - found in areas of short grass with many bare patches and in dense sagebrush (Anderson et al., 1979; Scoggan and Brusven, 1972).

Food habits - feeds on grasses and sedges. Some of its preferred foods are blue grama, sand dropseed, cheatgrass brome, threawn, needlegrass, wheatgrass, needleand-thread, sedges and fescue (Brooks, 1958; Hewitt, 1977; Kumar et al., 1976).

Eggs - eggs are tan and arranged in two columns, 18 per pod. Average egg length, 4.9 mm; average diameter, 1.3 mm (Onsager and Mulkern, 1963).

Nymph - five instars (Scoggan and Brusven, 1972).

Adult - small size. General color is dark grey to green. Face is nearly vertical. Vertex is rounded. Antennae are slender. Lateral carinae of pronotum are constricted in middle. Median carina is slightly notched in middle. Dorsal posterior margin of pronotum is an obtuse angle. Conspicuous black markings usually run behind eyes, on sides of pronotum and near lateral carinae. Tegmina are brownish-grey with a row of four to six lateral carinae on the midline. Wings are clear. Hind tibiae have two or three black bands on upper surface; the middle band is triangular. Hind tibiae are red or yellowish. Male length, 12 mm; female 18 mm (Brooks, 1958; McNeill, 1986).

Seasonal history - an early-season grasshopper that overwinters as a third-instar nymph. Adults are present from May to July and lay their eggs in early summer. They are not abundant during mid-summer, but their numbers increase as nymphs hatch in the autumn (Anderson et al., 1979; White and Rock, 1945).

Abundance and importance - common on the grassland but rarely becomes a pest (Brusven, 1967; Helfer, 1972).

Schistocerca alutacea Scudder

Common name - Spotted bird grasshopper (Helfer, 1972).

Geographic distribution - the subspecies Schistocerca alutacea lineata is found from Alberta (Canada) and Washington south to Arizona and east to the Dakotas, Michigan, Ohio and Florida. It generally is a Great Plains subspecies. The subspecies S. alutacea shoshone is found from California, Oregon and Washington east to Montana, Nebraska, Oklahoma and Texas (Dirsh, 1974). S. a. shoshone is found along rivers at low elevations in Colorado. S. a. lineata is found in the eastern half of the state.

Habitat - S. a. shoshone lives in high herbage near water or in shady moist ravines where shrubs grow. S. a. lineata lives in dry shrubby areas and areas of large weeds (Anderson and Wright, 1952; Hebard, 1928).

Food habits - forbivorous, especially preferring legumes. American licorice, vetch, pea, milkvetch and the crowns of side-oats grama reportedly are ingested (Anderson and Wright, 1952; Brooks, 1958). In North Dakota, it feeds primarily on leadplant although ragweed and other forbs are eaten. Grasses sometimes are fed upon, especially bluegrass (Mulkern et al., 1964).

Eggs - 50 to 60 eggs are arranged in whorls within each pod. Egg color is yellow turning brownish-red. Average egg length, 6.0 mm; average diameter, 1.2 mm (Onsager and Mulkern, 1963).

Nymph - five instars (Ramsay, 1964).

Adult - large size. S. a. shoshone generally is green with red tibiae. S. a. lineata generally is yellowish brown with purplish, yellow or brown tibiae. Face is nearly vertical. Antennae are slender, and vertex is rounded. Dorsal posterior margin of pronotum is rounded. Pronotum has light yellow spots. A pale yellow streak starts on top of the head and extends along the midline of the back and to the tip of the tegmina. Hind tibiae have long white spurs tipped with black. Subgenital plate of male has a distinct, U-shaped notch at the tip. Male length, 45 mm; female, 60 mm.

S. alutacea is a strong flier often covering 100 yd. or more in a single flight (Ball et al., 1942; Brooks, 1958; Helfer, 1972; Mulkern et al., 1964).

Oviposition - eggs are deposited in small, undisturbed bare sites, pocket gopher mounds or in places where sand has drifted over vegetation (Onsager, 1963).

Seasonal history - adults can be found from mid-July to mid-October (Newton et al., 1954).

Abundance and importance - potentially damaging to forage legumes, trees and shrubs but rarely abundant.

Spharagemon collare (Scudder)

Common name - Mottled sand grasshopper (Helfer, 1972).

Geographic distribution - southern Ontario to Alberta (Canada), Montana and Wyoming. South to the Gulf coast, Utah and southeastern Arizona (Brooks, 1958). Its Colorado range is primarily from the eastern plains to the mountain foothills (Hebard, 1929).

Habitat - sparsely vegetated, sandy areas and areas of short grass (Hebard, 1928; Mulkern et al., 1969).

Food habits - eats grasses especially the spikelets. Preferred grasses are western wheatgrass, blue grama, needleandthread and sand dropseed. It also shows carnivorous tendencies (Gangwere, 1961; Eckert and Hansen, 1971).

Eggs - eggs are pinkish to pale tan. Pods contain 22 eggs in two or three disorderly columns. Average egg length, 5 mm; average diameter, 1.2 mm (Onsager and Mulkern, 1963).

Nymph - five instars (Ramsay, 1964).

Adult - medium to large size. General color is greyish-brown with small dark brown patches. Face is vertical and speckled. Vertex is rounded. Antennae are slender. Dorsal posterior margin of pronotum is an acute angle. Median carina is a sharp ridge cut by a deep, narrow sulcus. Tegmina are opaque with three dark, indistinct bands. Wings are yellow with black and white stripes. Inner face of hind femora has three black bands; bands are faintly indicated on outer face. Hind tibiae are red-orange. Male length, 32 mm; female, 36 mm (Ball et al., 1942).

Oviposition - females deposit eggs close to vegetation in sandy soil and on pocket gopher mounds (Cridde, 1918;
**Spharagemon equale (Say)**

**Common name** - Say's grasshopper (Helfer, 1972).

**Geographic distribution** - British Columbia (Canada), South Dakota, southern Minnesota, Iowa, Kansas, Colorado, Oklahoma, Texas and Utah (Brooks, 1956). Colorado range is from the eastern plains to the eastern mountain foothills (Hebard, 1929).

**Habitat** - sandy areas with scattered, short, dry grasses (Hebard, 1928; Somes, 1914).

**Food habits** - feeds on mixed grasses and forbs. Its preferred foods are members of the mustard family. It also has been observed feeding on milkvetch, sunsedge, blue grama, scurf-pea, common starlily, fringed sage and fourwing saltbush (Kumar et al., 1976; Mulkern et al., 1969).

**Eggs** - eggs are light brown. Each pod has 24 eggs arranged in three or four columns. Average egg length, 5 mm; average diameter, 1.3 mm (Onsager and Mulkern, 1963).

**Nymph** - five instars (Ramsay, 1964).

**Adult** - medium to large size. General color is greyish-brown with darker brown markings. Face is vertical. Vertex is rounded. Antennae are slender. Dorsal posterior edge of pronotum is a right angle. Median carina is visible but not a sharp ridge. It is cut in the middle by a small notch that is shallow in comparison with the pronotal notch of *Spharagemon collare*. Tegmina have three moderately distinct, dark brown bands. Wings are yellow to almost white with a large, dark crossband and a clear apex. Inner faces of hind femora have three black bands; bands are faintly visible on outer face. Hind tibiae are reddish-orange. Male length, 25 to 32 mm; female, 30 to 40 mm (Brooks, 1958).

*S. equale* is alert, active and strong in flight. Upon landing it immediately runs along the ground. It is sluggish in the early morning or late evening. Adults can be seen congregated in small groups on vegetation-free areas. They fly away when frightened, but quickly reassemble (Anderson, 1952; Somes, 1914).

**Seasonal history** - adults can be found from early July to mid-September (Gillette, 1904).

**Abundance and importance** - a restricted range and seldom numerous (Mulkern et al., 1969).

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**Trachyrhachys kiowa (Thomas)**

**Common name** - Kiowa range grasshopper (Helfer, 1972).

**Geographic distribution** - Manitoba to British Columbia (Canada) and south to Mexico (Helfer, 1972). In Colorado it can be found throughout the state.

**Habitat** - sandy blowouts (Mulkern et al., 1969).

**Food habits** - eats grasses and has a preference for blue grama, sand dropseed, western wheatgrass, quackgrass and Sandberg bluegrass (Anderson and Wright, 1952; Kumar et al., 1976; Mulkern et al., 1964; Mulkern et al., 1969).

**Eggs** - 16 dark-brown eggs are arranged in two columns. Average egg length, 4.7 mm; average diameter, 1.3 mm (Onsager and Mulkern, 1963).

**Nymph** - five instars (Ramsay, 1964).

**Adult** - very similar to *Trachyrhachys aspera*. Medium size. Color is grey to brilliant green. Head and pronotum are grey, brown or greenish yellow with definite contrasting pale and dark markings. Head is higher than pronotum. Antennae are slender. Face is vertical; vertex is rounded. Median carina of pronotum is deeply cut by two sulci. Pronotum is constricted laterally. Dorsal posterior margin of pronotum is a right angle. Posterior angle of lateral lobe of pronotum usually is distinctly acute. Tegmina are long and brown with two distinct dark transverse bands and a faint indication of a third band. Wings usually are colorless with dark veins but occasionally with pale yellow basally and with a dark crossband. Hind femora have high fins, the upper one suddenly decreasing near the middle of the femora. Outer surface of hind femora is brown with darker or white markings. Inner surface is black on the basal half, the apical half usually is yellow with a black band. Hind tibiae usually are blue, pale or brown basally. Male length, 12 to 20 mm; female, 22 to 25 mm (Ball et al., 1942).

**Oviposition** - eggs are deposited in bare, compact soil (Onsager, 1963).

**Seasonal history** - adults are present from early July to mid-October (Newton et al., 1954).

**Abundance and importance** - often abundant and can be of economic importance to grasslands (Hantsbarger, 1979; Mulkern et al., 1969).

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**Trimerotropis campestris McNeill**

**Common name** - McNeill campestral grasshopper (Helfer, 1972).

**Recent Synonymy** - *Trimerotropis monticola* Saussure.
Geographic distribution - Manitoba to British Columbia (Canada); south to the Dakotas, Montana and Colorado (Brooks, 1958). In Colorado it can be found along the eastern foothills and across the plains in the northern part of the state. It occurs in the mountains of central Colorado up to 9,000 ft. (Gillette, 1904).

Habitat - Open areas of short grass, gravelly areas and dry hillside (Brooks, 1958; Hebard, 1926).

Food habits - a mixed feeder preferring grasses. It also shows preference for milkvetch. It has been observed feeding on blue grama and suncsedge (Anderson, 1954; Criddle, 1933a; Kumar et al., 1976).

Eggs - eggs are deposited 14 per pod; color is tan turning dark brown. Average egg length, 5.9 mm; average diameter, 1.3 mm (Onsager and Mulkern, 1963).

Nymph - five instars (Scoggan and Brusven, 1972).

Adult - medium size, slender. General color is greyish brown. Medium carina of pronotum is light-colored with a few small spots. Band on tegmina are irregular and composed of dark spots. Wings are yellow with broad black band. Spur of wing extends halfway to wing attachment. Hind femora have three bands on inner face. Bands are faintly visible on outer face. Hind tibiae are red or orange. Male length, 25 mm; female, 32 mm (Ball et al., 1942; Brooks, 1956; Hewitt and Barr, 1967).

Seasonal history - adults are present in August and September (Ball et al., 1942).

Abundance and importance - common along eastern Colorado foothills and the northern Colorado plains. Occurs in the central Colorado foothills but is not common (Gillette, 1904).

Trimerotropis cincta (Thomas)

Geographic range - the western half of the United States (Coppock, 1962). In Colorado it is found between 6,000 and 10,000 ft. (Gillette, 1904).

Habitat - moderate elevations on volcanic sand, gravel and rocky soil with sparse vegetation usually near trees (Ball et al., 1942; Hebard, 1972).

Adult - medium size. General color is brown. Face has dark bands below and above antennae. Band extends from eye across lateral lobes of pronotum. Dorsal posterior angle of pronotum is variable but usually is a rounded right angle. Tegmina have two or three solid dark bands. Wings are yellow basally with a weak, dark band. Hind femora have two dark bands on outer faces. Hind tibiae are yellow or orange. Male length, 25 mm; female, 32 mm (Ball et al., 1942; Brooks, 1956; Hewitt and Barr, 1967).

Seasonal history - adults are found from July to September (Alexander and Hilliard, 1969).

Abundance and importance - sometimes common in mountainous areas but not abundant enough to be damaging.

Trimerotropis lati fasciata Scudder

Common name - Broad-banded grasshopper (Helfer, 1972).

Recent synonymy - Trimerotropis laticincta (Saussure).

Geographic distribution - Great Basin, Alberta (Canada) to Washington and California, Arizona, Texas and Iowa (Helfer, 1972). It is found throughout the state in Colorado.

Habitat - sandy, alkaline flats where the main vegetation is greasewood and sagebrush (Brooks, 1958).

Food habits - granivorous, preferring western wheatgrass (Brooks, 1968).

Nymph - five instars (Scoggan and Brusven, 1972).

Adult - large size; robust. General color is grey or brown to blackish. Antennae are slender and dark. Face is vertical; vertex is rounded. Sculpturing on head is sharply defined. Dorsal posterior margin of pronotum is a rounded right angle. Median carina is very faint on the posterior two-thirds of the pronotum. Pronotum is darkly, delicately textured. Tegmina have prominent crossbands. Wing disc is yellow to whitish; band is black and wider than disc; spur is short; veins bordering crossbands are mostly white. Hind tibiae are orange, often yellow near the attachment to the femora. Ventral surfaces of thorax and abdomen are often tinged with red (Beam-er, 1917; Helfer, 1972; Hewitt and Barr, 1967; Scoggan and Brusven, 1972).

Seasonal history - overwinters as an egg. It hatches from May to early June. Adults are present from July to August (Scoggan and Brusven, 1972).

Trimerotropis melanoptera McNeill

Common name - Black-winged grasshopper (Helfer, 1972).

Geographic distribution - Colorado and Utah south to Mexico (Hebard, 1929; Helfer, 1972). In Colorado it can be found from the eastern plains to central Colorado (Hebard, 1929).

Habitat - distribution is discontinuous. Prefers small, bare alkaline areas and openings of tall grass (Hebard, 1929; Mul-kern et al., 1964).

Adult - medium size, slender. General color is greyish brown. Face is vertical; vertex is rounded. Antennae are slender. Dorsal posterior margin of pronotum is a rounded right angle. Median carina of pronotum is cut by two sulci. Tegmina have three indistinct bands. Wings are black with the basal fourth yellow and the apex clear. Inner face of hind femora is black with a pale band near the knee. Hind tibiae are orange. Lower surfaces of thorax and abdomen are tinged with red. Male length, 32 mm; female, 38 mm (Ball et al., 1942).

Seasonal history - adults can be found from June to September (Mulkern et al., 1964).

Trimerotropis pallidipennis (Burmeister)

Common name - Pallid-winged grasshopper (Helfer, 1972).

Geographic distribution - British Columbia (Canada), Montana, Colorado and Texas, south to Mexico and South America (Brooks, 1958). Its Colorado range includes the plains of the northern part of the state and the mountain valleys to timberline (Hebard, 1929).

The subspecies Trimerotropis pallidipennis salina occurs from Alberta, Saskatchewan and Manitoba (Canada) to Oklahoma and Colorado (Helfer, 1972). In Colorado it is found in the eastern areas while T. pallidipennis pallidipennis is found throughout the state (Alexan-der, 1941).

Habitat - bare, waste areas of thin soil and sparse vegetation (Ball et al., 1942; Hebard, 1929). The subspecies T. palli-dipennis salina is found in alkaline areas (Alexander, 1941).

Food habits - feeds on cultivated crops especially vegetables, alfalfa, milo, barley, cotton and corn. It also eats cheatgrass, Sisymbrium altissimum, bluebunch wheatgrass, timothy and Plantago purshii (Ball et al., 1942; Banfill and Brusven, 1973; Hewitt, 1977).

Eggs - eggs are pale yellow, 18 per pod. Average egg length,
Trimerotropis pistrinaria Saussure

Common name - Barren land grasshopper (Helfer, 1972).
Geographic distribution - Alberta (Canada), Montana and the Dakotas to Mexico (Helfer, 1972). In Colorado it is found primarily on the plains of the eastern part of the state (Alexander, 1941), and occasionally in the west.
Habitat - occurs on dry, gravelly plains and hillsides and on eroded barren lands (Helfer, 1972).
Food habits - a mixed feeder, feeding mostly on milkvetch and plants of the genus Hymenopappus (Criddle, 1933a; Joern, 1979b).
Eggs - pods contain 12 eggs. Color is tan, turning dark brown. Average egg length, 5.6 mm; average diameter, 1.3 mm (Onsager and Mulkern, 1963).
Nymph - five instars (Ramsay, 1964).
Adult - medium size. General color is tan, gray or reddish brown with dark brown markings. Face is vertical. Antennae are slender. Dorsal posterior edge of pronotum is a right angle. Coloration is yellowish to dark brown. Hind femora have three dark bands on outer face. Hind tibiae are yellow distally. Dorsal posterior margin of pronotum is an acute angle. The dominant structural characteristic is the strongly elevated dorsum of the pronotum, which forms a crest. The posterior of the crest is toothed. Hind femora have three dark bands on outer side. Hind tibiae have strong spines. Male length, 35 mm; female, 45 mm (Ball et al., 1942).
Seasonal history - overwinters as an egg. Nymphs occur in May and June. Adults occur from June to August (Ball et al., 1942).
Abundance and importance - does not occur commonly in Colorado. Because of its food habits and infrequent occurrence, it is not considered damaging.

Trimerotropis verruculatus Scudder

Common name - Crackling forest grasshopper (Helfer, 1972).
Recent synonymy - Trimerotropis suffusa Scudder.
Geographic distribution - British Columbia and Alberta (Canada) to New Mexico, Arizona and California (Helfer, 1972). In Colorado it is found mostly from the mountain foot-hills to timberline (Hebard, 1929).
Habitat - occurs in a wide variety of habitats at high and low altitudes, including forest and rocky areas (Helfer, 1972).
Food habits - a mixed feeder, preferring forbs; it feeds on lupine, yarrow and fescue (Banfill and Brusven, 1973; Hewitt and Barr, 1967).
Nymph - five instars (Scoggin and Brusven, 1972).
Adult - medium size. General color is dark-brown to black. Face is vertical. Antennae are slender. Dorsal posterior margin of pronotum is an acute angle. Tegmina are without bands and sometimes speckled. Wings are yellow, the apical half blackish. Hind femora are faintly banded on outer surface, more distinctly banded on the inner surface. Hind tibiae are blue to brown. Male length, 30 mm; female, 35 mm.
Seasonal history - eggs hatch in June, and adults are present from late July to mid-September (Alexander and Hilliard, 1969).
Abundance and importance - abundant throughout most of its range but has never been numerous enough to be considered an economic pest (Hewitt and Barr, 1967).

Tropidolopus formosus (Say)

Common name - Great crested grasshopper (Helfer, 1972).
Geographic distribution - found from Arizona to Wyoming, and east to Kansas, Oklahoma and Texas (Helfer, 1972). In Colorado it is found on the plains in the eastern part of the state.
Habitat - areas of sparse to dense grass and usually associated with buffalo bur and plants of the Malvaceae family (Helfer, 1972).
Food habits - in Arizona, T. formosus feeds on low-growing Malvaceae such as Sphaeralcea (Ball et al., 1942).
Adult - medium size. General color is pale green. Head is yellow-brown. Antennae are heavy and yellow distally. Dorsal posterior margin of pronotum is an acute angle. The dominant structural characteristic is the strongly elevated dorsum of the pronotum, which forms a crest. The posterior of the crest is toothed. Hind femora have about six large brown spots. Wings are orange with an incomplete brown band. Hind femora have three dark bands on outer side. Hind tibiae have strong spines. Male length, 35 mm; female, 45 mm (Ball et al., 1942).
Seasonal history - overwinters as an egg. Nymphs occur in May and June. Adults occur from June to August (Ball et al., 1942).
Abundance and importance - does not occur commonly in Colorado. Because of its food habits and infrequent occurrence, it is not considered damaging.

Xanthippus corallipes Haldeman

Common name - Red shanks (Ball et al., 1942).
Geographic distribution - British Columbia to Manitoba (Canada), Oregon, Texas, Minnesota and Iowa (Helfer, 1972). There are four major subspecies of Xanthippus corallipes. Their range differs somewhat. Size and color pattern is variable among them and even within a subspecies. However, distinctive looking populations develop in different habitats. The Colorado range differs for the four subspecies:
Xanthippus corallipes pantherinus — Great Plains of southern Colorado;
Xanthippus corallipes latefasciatus — Great Plains of north and central Colorado;
Xanthippus corallipes leprous — mountain foothills;
Xanthippus corallipes altivolus — foothills to timberline (Hebard, 1929).

Habitat - dry, sandy areas, clay or gravel (Cridde, 1933a).

Food habits - feeds on grasses, especially western wheatgrass, needleandthread, blue grama and sixweeks fescue. Western wheatgrass is a consistently preferred food of adults. It also has been observed feeding on sunsedge, cheatgrass brome, sand dropseed, needleandthread and smooth brome (Kumar et al., 1976; Ueckert and Hansen, 1971).

Eggs - 30 brown eggs are deposited in three or four columns in a pod. Average egg length, 6.1 mm; average diameter, 1.7 mm (Onsager and Mulkern, 1963).

Nymph - five instars (Scoggan and Brusven, 1972). Five instars (male), six instars (female) (Pickford, 1953).

Adult - medium to large size. General color is tan. Face is vertical, and vertex is rounded. Antennae are slender. Head and pronotum are roughly textured. Dorsal posterior margin of pronotum is a right angle. Tegmina have definite brown splotches. Wings are pink, orange or yellow with a dark band near the middle, and the apex is clear. Outer face of hind femora has definite brown splotches. Inner face of hind femora is red. Hind tibiae are orange (Ball et al., 1942; Froeschner, 1954; Helfer, 1972).

Flight is loud (Cridde, 1933a.)

Oviposition - X. c. pantherinus deposits eggs in calcareous soil usually on hilltops and ridges (Isely, 1938).

Seasonal history - adults are found from early May to late July (Ueckert, 1971). The subspecies X. c. latifasciatus has a two-year life cycle, the first winter passing in the egg and the second winter as a late instar nymph (Banfill and Brusven, 1973; Hewitt and Barr, 1967).

Abundance and importance - X. corallipes is common and destructive on grasslands (Helfer, 1972).
DISTRIBUTION OF COLORADO GRASSHOPPERS

The following distribution records are provided so the user can determine where specific grasshopper species are known to occur. Each dot represents a county record. The dot does not indicate the exact location within the county where a specimen was found. There is no reason to believe that these distribution records are complete; however, they represent our current knowledge.

Distribution data were obtained primarily from the entomological museums at Colorado State University and University of Colorado, from Cooperative Economic Insect Reports for 1956 and 1957 and from the personal collection of David Ferguson.

Principal topographic features influencing grasshopper distribution. NO. PK., North Park; MID. PK., Middle Park; SO. PK., South Park; S. L. VAL., San Luis Valley.
Acrolophitus hirtipes (Say)

Acrolophitus nevadensis (Thomas)

Aeoloplides chenopodii (Bruner)

Aeoloplides tenuipennis (Scudder)
Aeoloplides turnbulli (Caudell)

Aeropedel/us clavatus (Thomas)

Ageneotettix deorum (Scudder)

Amphitornus coloradus (Thomas)
Arphia conspersa Scudder

Arphia pseudonietana (Thomas)

Arphia simplex Scudder

Arphia xanthoptera (Burmeister)
Chorthippus curtipennis (Harris)

Cibolacris parviceps (Bruner)

Chortophaga viridifasciata (DeGeer)

Circotettix carlinianus (Thomas)
Circotettix rabula Rehn and Hebard

Conozoa sulcifrons Scudder

Conozoa texana (Bruner)

Cordillacris crenulata (Bruner)
Cordillaridcris occipitalis (Thomas)

Cratypedes neglectus (Thomas)

Dactylotum bicolor (Thomas)

Derotmema haydeni (Thomas)
Dissosteira carolina (L.)

Dissosteira longipennis (Thomas)

Dissosteira spurcata Saussure

Encoptolophus sordidus (Burmeister)
Hypochloria alba Dodge

Lepturus cyaneus Cockerell

Lepturus robustus Hebard

Melanoplus alpinus Scudder
Melanoplus angustipennis (Dodge)

Melanoplus arizonae Scudder

Melanoplus bispinosus Scudder

Melanoplus bivittatus (Say)
Melanoplus borealis (Fieber)

Melanoplus bruneri Scudder

Melanoplus bowditchi Scudder

Melanoplus complanatipes Scudder
Melanoplus confusus Scudder

Melanoplus dawsonii (Scudder)

Melanoplus differentialis (Thomas)

Melanoplus discolor (Scudder)
Melanoplus dodgei (Thomas)

Melanoplus fasciatus (F. Walker)

Melanoplus femurrubrum (DeGeer)

Melanoplus flavidus Scudder
Melanoplus keeleri (Thomas)

Melanoplus kennicotti Scudder

Melanoplus lakinus (Scudder)

Melanoplus occidentalis (Thomas)
Melanoplus oregonensis Thomas

Melanoplus ponderosus (Scudder)

Melanoplus packardii Scudder

Melanoplus regalis (Dodge)
Melanoplus sanguinipes (Fabricius)

Melanoplus splendidus Hebard

Melanoplus tristis Bruner

Melanoplus yarrowii (Thomas)
Metator pardalinus (Saussure)

Oedaloenotus enigma (Scudder)

Opeia obscura (Thomas)

Orphulella pelidna (Burmeister)
Orphulella speciosa (Scudder)

Pardalophora apiculata (Harris)

Pardalophora haldemanii (Scudder)

Paropomala virgata (Scudder)
Psoloessa delicatula Scudder

Psoloessa texana (Scudder)

Schistocerca alutacea Scudder

Spharagemon bolli Morse
Spharagemon collare (Scudder)

Spharagemon equale (Say)

Spharagemon humile (Morse)

Stenobothrus brunneus Thomas
Stethophyma gracile (Scudder)

Syrbula montezuma (Saussure)

Syrbula admirabilis Uhler

Trachyrhachys aspera (Scudder)
Trachyrhachys coronata (Scudder)

Trachyrhachys kiowa Thomas

Trimerotropis agrestis McNeill

Trimerotropis californica Bruner
Trimerotropis fontana Thomas
Trimerotropis gracilis (Thomas)
Trimerotropis fratercula McNeill
Trimerotropis inconspicua Bruner
Trimerotropis latifasciata Scudder

Trimerotropis melanoptera McNeill

Trimerotropis pallidipennis (Burmeister)
Troplolohus formosus (Say)

Xanthippus montanus (Thomas)

Xanthippus corallipes Haldeman
MANAGEMENT OF GRASSHOPPERS

THE ECONOMIC BASIS FOR GRASSHOPPER SUPPRESSION

Grasshoppers have been of economic concern in the western United States since settlers established farming and ranching operations there in the 1800s. Settlers in northeastern Colorado suffered severe hardship in 1864 because grasshoppers ruined crops. In 1873 Fort Collins, Colorado lost many of its homesteaders who were discouraged by economic conditions and grasshopper hordes (Tresner, 1981). During the 1870s, the Rocky Mountain locust, Melanoplus spretus (Walsh), destroyed crops throughout the West, and in 1877 the U.S. Entomological Commission was created to investigate the problem. Although Rocky Mountain locust problems subsided in the 1880s, interest and concern regarding grasshopper damage have not subsided.

The expansion of Colorado’s urban areas into foothills, prairie, and farmland has increased concern over grasshoppers. Grasshopper numbers build to high levels in weedy areas and migrate to yards where they destroy vegetable and flower gardens and ornamental shrubs. While extreme economic loss may not be associated with this situation, the aesthetic value of homes and the happiness of homeowners are threatened.

Current emphasis of large-scale grasshopper management efforts has shifted from crop protection to rangeland protection. This shift has occurred because farmers can use numerous insecticides to effectively suppress grasshoppers, and, perhaps more important, they have the economic incentive to affect control. Other factors also work to reduce impact of grasshoppers on cropland. Insecticide applications directed toward the myriad of other insect pests associated with crops help keep grasshopper numbers low. Such practices associated with crop production as tillage, ditch burning and weed control also reduce grasshopper abundance. Ranchers, on the other hand, also have effective insecticides at their disposal, but low productivity of rangeland relative to cropland precludes their investment in expensive control procedures.

In addition to yield reduction in forage, the cost of grasshopper control is an important direct cost ranchers must incur; indirect costs include reduction in weight gain by cattle and relocation costs. Grasshoppers consume from 6% to 12% of the available forage in the western United States although in some localities they consume essentially all available forage. Grasshoppers eat approximately one-half of their body weight in green forage per day. With a grasshopper population of seven or eight per square meter in a four hectare field, grasshoppers consume as much forage as a cow (Hewitt, 1977). The U.S. Department of Agriculture suggests that treatment is justified when grasshopper numbers (adults or late instar nymphs) reach approximately nine per square meter.

Few grasshopper control recommendations consider forage condition, grasshopper species and other important variables. When forage density or biomass is low, small numbers of grasshoppers per unit area can be damaging. Thus, during dry periods, when grasshopper numbers often are highest, fewer grasshoppers can be tolerated. When the price of cattle is high, ranchers can better afford grasshopper suppression costs, and control operations are more likely instigated.

Grasshoppers differ significantly in their damage potential. Forage loss stems from both consumption and clipping without consumption (wastage). The amount of foliage consumed by a number of common species is given in table 2. Studies such as these suggest that over a season, mixed populations of grasshoppers destroy approximately 44 mg (dry weight) of foliage per grasshopper per day. Wastage by clipping may represent up to 50% of total forage reduction attributable to grasshoppers. Both consumption and wastage rates are influenced by grasshopper preference for a plant species; favored plants are more heavily damaged.

A more reliable approach to estimation of forage loss and to initiation of suppression activities is needed (Hewitt et al., 1976). Grasshopper damage potential, rangeland forage production; control effectiveness and cost must be integrated into the decision-making process. The grasshopper-feeding-day approach of Hewitt et al. (1976), which can integrate species specific consumption, mortality rates and forage availability, shows considerable promise especially when combined with control costs (see table 4). This, and the similar approach of White (1974) have proved useful experimentally. For practical, state-wide survey, however, better grasshopper identification and forage biomass estimation techniques are needed.

Table 2. Forage consumption and wastage by grasshopper nymphs and adults in laboratory and field trials (from Hewitt, 1977).

<table>
<thead>
<tr>
<th>Study</th>
<th>Stage</th>
<th>Species</th>
<th>Forage reduction* (mg/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laboratory</td>
<td>Nymph</td>
<td>Camnula pellucida</td>
<td>11.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Melanoplus sanguinipes</td>
<td>27.9, 19.2</td>
</tr>
<tr>
<td>Adult</td>
<td></td>
<td>Camnula pellucida</td>
<td>38.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Melanoplus sanguinipes</td>
<td>83.0, 42.3, 9.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Melanoplus foedus</td>
<td>150.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Autocara elioti</td>
<td>143.0</td>
</tr>
<tr>
<td>Field</td>
<td>Nymph</td>
<td>Camnula pellucida</td>
<td>14.2, 13.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ageneotettix deorum</td>
<td>10.1, 19.3</td>
</tr>
<tr>
<td></td>
<td>Adult</td>
<td>Camnula pellucida</td>
<td>13.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Amphitornus coloradus</td>
<td>53.0</td>
</tr>
</tbody>
</table>

*different values represent results of separate studies.

GRASSHOPPER SUPPRESSION METHODS

Sampling Grasshopper Abundance

The decision to initiate grasshopper suppression efforts should not be made unless impending crop or forage loss is evident. If expected losses do not equal or exceed control costs, suppression efforts probably are not warranted. Crop or forage loss estimates are made primarily on the basis of grasshopper abundance although other factors should be considered, as discussed previously. Abundance of adults and nymphs is commonly determined; egg pod sampling is extremely labor-intensive and rarely is done.

Grasshopper abundance is determined on a density per unit-area basis. Sweep net samples generally do not provide useful population estimates because relating catches to area is difficult and sweep net catches are especially influenced by plant height and density and by meteorological conditions. An exception occurs when plant biomass is very high as in alfalfa fields; in this case, sweep net samples are used to relate grasshopper density to catches in other alfalfa fields, or to catches at other times, but not to other crops.
Estimates of grasshopper numbers usually are presented as number per square yard, although counts may be made on a square foot basis, depending on grasshopper density. In conducting a survey, the surveyor selects the area to be checked from a distance. The margins of the square yard or square foot are estimated visually, and grasshoppers are counted as they leave the area in response to the approach of the surveyor. This method is not exceptionally accurate because boundaries are only estimated. However, on rangeland this method is preferable to sweep net sampling. Also, if the surveyor takes the time to examine the foliage carefully to avoid underestimating grasshopper numbers, the technique is acceptable. As with any sampling technique, weather conditions will influence counts. Details on grasshopper survey procedures are presented by the USDA (undated) and Hantsberger (1979).

Grasshopper adult surveys are conducted by the Colorado Department of Agriculture with assistance of the USDA in late summer and early autumn. Based on adult counts, grasshopper population estimates are made for the subsequent summer. Grasshopper adult counts of eight or more per square yard are considered threatening. Suppression programs should not be initiated without confirmation of high grasshopper densities in spring nymphal surveys.

Predators and parasites often affect the potential number of grasshoppers in an area, as do low numbers of eggs produced by the adults observed; consequently, abundance can decrease precipitously between adult and nymphal surveys. Nymphal surveys are conducted in the same manner as adult surveys. Care must be taken to ascertain that egg hatch has occurred prior to the survey. Considering the wide variety of grasshopper species often present in an area, this is a formidable task. Also, young grasshoppers are readily confused with leafhoppers unless they are examined closely. Care must be taken so that grasshopper counts are not inflated.

An improvement on grasshopper density estimates can be obtained by establishing definite boundaries for the square yard or square foot grasshopper counts. Richards and Waloff (1954) and Onsager and Henry (1977) recommend prior placement of hoops to mark boundaries. Grasshoppers are flushed from the hoops, and counted in the aforementioned manner. A wand is sometimes employed to aid in flushing grasshoppers. The size of the hoop can be varied with grasshopper density. The hoop count technique requires two visits to a site; hoops usually are positioned on the day preceding counts. Thus, twice as much labor is required although accuracy is enhanced.

Grasshopper sampling should include species determination in addition to total grasshopper abundance. Grasshopper damage potential differs significantly, and host plant associations often determine damage status. For example, *Aeolopilidesturnbulli*, one of the most common grasshoppers in Colorado, feeds primarily on Russian thistle and belevedere summecypres. Such species may be more beneficial than detrimental where grass production is important. The keys provided in this manual will greatly enhance species determination during adult surveys. However, nymph determinations remain difficult. Adult counts made in the summer preceding nymphal surveys should provide surveyors with reasonable data on species composition in an area.

**Chemical Suppression of Grasshoppers**

Chemical suppression of grasshopper populations involves application of insecticides to bait or foliage. In either case, mortality results primarily from grasshoppers ingesting food contaminated with insecticide. Each approach has advantages and disadvantages.

Poisoned baits were first used widely for grasshopper suppression about 1913. Baits were the dominant form of insecticide application by 1936 and were used extensively until the late 1940s. Traditionally, baits consisted of a carrier, usually such soil as wheat bran flakes, rolled barley or apple pomace; a toxicant, formerly an arsenical insecticide but now usually carbaryl; and a moistener, either water or molasses. Molasses frequently was added to make the bait more attractive, and ground corn cob or sawdust frequently was used as a diluent in place of up to one-half of the bran. Wheat bran flakes can be used alone with only a toxicant added (usually 1% to 2%) with good results.

Bait can be distributed by ground or air; in either case, the volume of material that must be applied poses significant problems. Procurement, mixing, storage and delivery of the vast quantities of bait required for treatment of large acreages make bait application a relatively expensive suppression tactic (see figs. 371, 372). Bait usually is applied at a rate of approximately 1.7 kg bait per hectare. Increasing the volume of bait or concentration of insecticide applied may increase degree of control, but usually it is not cost efficient (Mukerji et al., 1981). Only a portion of a grasshopper population is susceptible to bait treatment because (1) some species do not consume baits, (2) some members of the population are molting and, therefore, do not feed and (3) some individuals do not encounter bait or do not ingest enough bait to be killed (Onsager et al., 1980a). Mortality among some common rangeland grasshopper species exposed to insecticide treated bran bait is given in table 3. Grasshoppers vary significantly in acceptance of bait although most major pest species tested to date are susceptible to control through this suppressive tactic. In general, species in the subfamilies Gomphocerinae and Catantopinae are more susceptible than those in the subfamily Oedopodinae (Onsager et al., 1980b). Grasshopper species differ in susceptibility to insecticides (McDonald, 1967) in addition to differing in bait ingestion. The disadvantages associated with bait use are offset somewhat by the selectivity provided by baits. Such beneficial insects as biocontrol agents and pollinators, wildlife, and other animal life are less affected by this method of insecticide application. Also, Mukerji et al. (1981) reported that much less insecticide was required to achieve a satisfactory level of grasshopper suppression using bran bait compared to liquid formulation. For relatively safe application of insecticides on such small acreages as road- and fence rows or in vacant lots in suburban areas, bait applications are preferable.

Aerial application of liquid insecticide has largely replaced bait application for large-scale grasshopper suppression programs. Starting in the late 1940s and early 1950s, such chlorinated hydrocarbons as toxaphene and aldrin were widely used. They have been replaced by such organophosphates as malathion, and such carbamates as carbaryl. Although the chlorinated hydrocarbons have long residual action and provide a greater reduction in grasshopper populations, their residual nature allows the buildup of toxic residues in the food chain. The newer insecticides generally provide very acceptable levels of grasshopper suppression without buildup of toxic residues. Such modern insecticides as malathion are applied without dilution and at very low rates, a technique referred to as ultra-low volume (ULV). Others, such as carbaryl, usually are applied with oil and water to increase adhesion and to provide dilution, respectively. Malathion ULV ap-
Fig. 371-Sawdust being incorporated into grasshopper bait, 1938. Photo courtesy Colo. Dept. Agric.

Fig. 372-Loading grasshopper bait into trucks for distribution, 1939. Photo courtesy Colo. Dept. Agric.
lications are less expensive than other materials currently available, but ranchers often select more expensive materials such as carbarl because they seem to obtain slightly better grasshopper suppression. Whether the increased cost can be justified is debatable.

Onsager (1978) recently studied the characteristics of a carbarl formulation (Sevin-4 oil) and reported 85% to 98% mortality of grasshoppers treated at 0.56 and 1.12 kg AI per hectare. Malathion ULV provided an equivalent level of control at the same rate of application although under certain weather conditions (cool and wet) malathion was less effective. Higher rates of insecticide application gave more rapid mortality, but total mortality was not affected. Insecticide residue caused grasshopper mortality for at least 21 days although other studies (e.g., Lloyd et al., 1974) have suggested less persistence. An economic analysis of this insecticide comparison is summarized in table 4. A much better return of investment was obtained by initiating control during early instars; control of adults resulted in a net loss. In addition to saving more forage by surveying grasshoppers when they are young, it is important to recognize that large, mature grasshoppers are less susceptible to insecticides. Also, although the lowest rate of insecticide application took longer to realize maximum control, it yielded the highest percentage of return on investment.

Table 3. Mortality among grasshoppers exposed to insecticide-treated bran bait in laboratory and field trials (modified from Onsager et al., 1980b).

<table>
<thead>
<tr>
<th>Test</th>
<th>Grasshopper species</th>
<th>% mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laboratory</td>
<td>Aeneotettix deorum</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>Amphipollus coloradus</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Autocara eilotti</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Autocara femoratum</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>Boopedon nibulum</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>Melanoplus sanguinipes</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Metator pardalinus</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Oepia obscura</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Philoxystos quadricolatum</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Phoetalia nebrisnensis</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td>Trachykhyski kiwia</td>
<td>0</td>
</tr>
<tr>
<td>Field</td>
<td>Aeropedel/us clavatus</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>Aeneotettix deorum</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>Amphipollus coloradus</td>
<td>82</td>
</tr>
<tr>
<td></td>
<td>Autocara eilotti</td>
<td>72</td>
</tr>
<tr>
<td></td>
<td>Autocara femoratum</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Camnula praefecta</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Chortippus curtipennis</td>
<td>49</td>
</tr>
<tr>
<td></td>
<td>Encoptophorus sordidus</td>
<td>67</td>
</tr>
<tr>
<td></td>
<td>Hadrotettix trifasciatus</td>
<td>74</td>
</tr>
<tr>
<td></td>
<td>Hesperotettix viridis</td>
<td>75</td>
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<tr>
<td></td>
<td>Melanoplus spp.</td>
<td>68</td>
</tr>
<tr>
<td></td>
<td>Memiria bivittata</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Metator pardalinus</td>
<td>63</td>
</tr>
<tr>
<td></td>
<td>Orphulella peliana</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>Phoetalia nebrisnensis</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>Pseudopomala bracyptera</td>
<td>93</td>
</tr>
<tr>
<td></td>
<td>Spharagemon equale</td>
<td>67</td>
</tr>
</tbody>
</table>

The wisdom of striving for nearly complete destruction of grasshopper populations is questionable. In the short-term, obtaining 99% or 100% mortality might seem desirable, but if this occurs, natural mortality factors, including predators and parasites of grasshoppers, are deprived of food and also perish. Free from naturally occurring biological control, grasshoppers may be able to assume damaging numbers quickly. From a long-term perspective, selecting a suppression tactic that inflicts a lower level of mortality among grasshoppers and also preserves biological control agents may be more beneficial. Biological control agents presumably would act to suppress further grasshopper outbreaks or at least delay the resurgence of grasshopper populations.

Birds are important grasshopper predators and serve to exemplify some of the problems associated with insecticide use. Such materials as toxaphene and diazinon induce high levels of bird mortality following application to rangeland. Others, such as propoxur and azinphosmethyl, cause reduction in bird abundance without direct evidence of bird mortality; emigration from treated sites is implicated. Malathion and carbarl, both widely employed for rangeland grasshopper suppression, seem to have no direct effect on wildlife populations although emigration has occurred under some circumstances. Insecticides used for grasshopper control should degrade rapidly in the environment (McEwen et al., 1972).

Table 4. Costs* and returns associated with treatment of rangeland for control of grasshoppers (modified from Onsager, 1978).

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Instar Treated</th>
<th>Rate</th>
<th>Value</th>
<th>Net Return</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(kg AI/ha)</td>
<td>($/dry wt.)</td>
<td>($/ha)</td>
</tr>
<tr>
<td>carbary</td>
<td>3rd</td>
<td>0.56</td>
<td>252</td>
<td>12.30</td>
</tr>
<tr>
<td></td>
<td>4th, 5th</td>
<td>0.28</td>
<td>212</td>
<td>10.36</td>
</tr>
<tr>
<td></td>
<td>adult</td>
<td>0.56</td>
<td>227</td>
<td>11.11</td>
</tr>
<tr>
<td></td>
<td>malathion adult</td>
<td>0.56</td>
<td>242</td>
<td>11.81</td>
</tr>
<tr>
<td></td>
<td>untreated</td>
<td>0</td>
<td>132</td>
<td>6.44</td>
</tr>
</tbody>
</table>

*Costs of treatment per hectare were $3.95 for application plus $1.42, $2.84 and $5.68, respectively, for the 0.28, 0.56 and 1.12 kg dosages of carbary and $1.56 for malathion. Forage was valued at $44 per metric ton. Grasshopper density was 10 to 15 per m².

Chemical suppression programs are expensive; nevertheless, they are routinely conducted. Part of their appeal stems from apparent long-term reduction in grasshopper abundance, control, or treatment. Chemical control undoubtedly provides temporary relief, but whether chemical control programs provide long-term suppression is open to question. To determine long-term effectiveness, populations must be followed over a several year period in treated and nearby untreated areas. Only rarely has any long-term population monitoring of treated sites with appropriate controls been conducted. Blickenstaff et al. (1974) reviewed several control programs, conducted principally in Wyoming. It appears that chemical control programs frequently do not provide long-term suppression. Failure of chemical control programs to provide for long-term suppression is due to a number of factors, including (1) reinvasion of treated areas from bordering untreated areas, (2) natural declines in grasshopper populations in untreated areas, (3) occurrence of diapausing eggs and (4) rapid reproduction in residual populations, which survive because of accidental or deliberate skips in treated acreage (Blickenstaff et al., 1974). Pfadt (1977) also conducted control studies in Wyoming and reported long-term suppression (five to six years) in some instances but only short-term suppression in others.
Cooperative Grasshopper Control Programs

Grasshopper population outbreaks can involve such large acreages that effective suppression is beyond the capabilities of a single landowner. Landowners can organize and form cooperative grasshopper control districts. Ranchland, but not cropland, grasshopper suppression programs are eligible for state and federal funding to defray costs. Costs of grasshopper suppression are divided equally among ranchers, the state and the federal government.

Procedures for formation of cooperative grasshopper control programs are provided by Sullivan et al. (1981). Important aspects include: (1) ranchers must form a pest control district; (2) cooperative control districts must be solid, contiguous areas; (3) degree of infestation must be determined by survey and must consist of an economically threatening population (usually more than eight grasshoppers per square yard); (4) at least 66% of the landowners in the proposed district must vote in favor of formation of the district, and the landowners voting must own at least 66% of the land in the proposed district; (5) operational aspects of grasshopper control programs will be managed by Colorado Department of Agriculture and USDA, APHIS personnel.

For cooperative programs to be successful, ranchers must organize early. There is considerable delay in obtaining insecticides and aircraft, and needs must be anticipated. Availability of trained personnel is limited, and programs are conducted on a first-come-first-served basis. Characteristically, ranchers delay district formation until a significant loss has already occurred, and grasshoppers are maturing. Not only are adult grasshoppers more difficult than immatures to kill, but once the adult stage is reached, oviposition begins. If significant egg deposition occurs before grasshoppers are killed, long-term suppression is unlikely.

Biological Suppression of Grasshoppers

Although grasshoppers are preyed upon by a wide variety of predators and parasites and are infected by a number of pathogens, these currently do not offer much potential for manipulation with subsequent suppression of grasshopper numbers. Naturally occurring biological control probably reduces the rate of population buildup and may even prevent buildup or cause population decrease in some localities. Until further information becomes available on the constraints and attributes of potential biological control agents, the biological control potential of grasshoppers must be viewed rather pessimistically; however, an important exception is use of the protozoan Nosema.

Considerable research has been conducted on Nosema locustae Canning. This pathogen occurs naturally and has a wide host range although some species of hosts are particularly susceptible and may be important in promoting disease development in less susceptible species. The natural incidence of infection generally is less than 10% (and often less than 1%) although epizootics occasionally occur. The pattern of occurrence is a characteristic lag-type host parasite density relationship (Henry, 1981).

For infection to occur, grasshoppers usually must ingest Nosema spores although spores also are found on or in the eggs. Fat body, neural and other tissues are infected. Infection slows grasshopper development, decreases activity, increases cannibalism, reduces fecundity and sometimes causes mortality. The deleterious effects of Nosema are enhanced by early infection and ingestion of a large number of spores. An optimal scenario might involve application of 1.12 to 1.68 kg wheat bran per hectare containing 1.6 x 10^9 to 2.3 x 10^8 spores, distributed while M. sanguinipes is predominantly in instar 3; grasshopper mortality should be 50% to 60% within four to six weeks, followed by 35% to 40% infection among survivors (Henry and Oma, 1981). Thus, mortality is not realized quickly, and high levels of mortality are not obtained. Over time (a minimum of one year), grasshopper populations could be reduced to low levels. While not suitable for short-term control, Nosema locustae should be useful for long-term management.

Nosema is compatible with low concentration of malathion. The insecticide kills rapidly (within 24 to 48 hours) while Nosema provides long-term control. Application of bait treated with insecticide and pathogen may prove useful for long-term population suppression where there also is potential for immediate damage (Mussung and Henry, 1979; Onsager et al., 1981).

Mass production of Nosema species is relatively easy, but it requires production of grasshoppers. Spores can be stored frozen for several months, but they degrade rapidly at field temperatures. Production and storage is discussed briefly by Henry and Oma (1981). Estimated costs of spore production are $0.21 per hectare, which makes Nosema application economically feasible. Several commercial firms currently market Nosema locustae, but product quality is variable. Homeowners in suburban areas will be disappointed by Nosema performance, if they treat small acreages. The combination of low immediate mortality and extensive immigration of healthy grasshoppers into treated areas will mask effectiveness of the product. Other Nosema species also are promising. N. acridophagus Henry and N. cuneatum Henry are more pathogenic than N. locustae. Development of these products as biological insecticides has been hampered by culture problems; mortality of grasshoppers occurred so rapidly that spore production was poor. Recent discovery of an alternate host, corn earworm, Heliothis zea (Boddie), in which spores could be produced effectively, suggests promising developments in the near future (Henry et al., 1979). N. acridophagus and N. cuneatum may provide effective, rapid knockdown of grasshoppers comparable to insecticides and may serve as an alternative to N. locustae, a substitute for insecticides or a replacement for insecticides in N. locustae-insecticide mixtures.

Poultry sometimes is promoted for home garden grasshopper suppression. Poultry will consume large numbers of grasshoppers. The turkey industry in Colorado reportedly was initiated, at least in part, because of the abundant supply of grasshoppers. A turkey supposedly will consume up to 100 grasshoppers per hour (Tresner, 1981).

MANAGEMENT OF GRASSHOPPERS IN DIFFERENT ENVIRONMENTS

Rangeland

Rangeland in Colorado, on an area basis, is characterized by low productivity. A cow and calf may require 40 to 60 acres of short-grass prairie grazing land. Nevertheless, since over 70% of Colorado's land is used for grazing, and livestock production accounts for the greatest dollar value in Colorado's
agricultural economy, rangeland is a valuable resource. Protection of this resource is vital to Colorado's economy, but any investment in protection should be followed by an increase in productivity that compensates for the protection cost. With current technology, insecticide application is the most economic pest suppression tactic. In the near future, however, use of *Nosema locustae* may prove to be more economic, if it proves to be more residual, even though initial application costs are higher. Long-term protection cannot be guaranteed following chemical suppression (see discussions of chemical and biological control).

Mormon cricket, which is actually a grasshopper, can be damaging to rangeland in northwest Colorado. Since this species is flightless and tends to aggregate in bands when numerous, unique management measures have been employed. In the past, barriers and ditches usually in combination with poison have been used to trap immigrating bands of crickets (figs. 373, 374, 375). This practice is now obsolete. Also, since mormon crickets aggregate, applying poisoned bait in the path of the migrating crickets is relatively easy, resulting in high levels of mortality. In recent years there has been a shift away from bait applications for cricket control, paralleling changes in grasshopper control. This unfortunate change in policy should be reversed. Mormon crickets are susceptible to *Nosema locustae*, and bait application would be required to infect these crickets.

The most economic future strategy may be prevention of grasshopper population buildup, which would alleviate the need for direct suppression costs. In a study conducted in northeast Colorado, total grasshopper numbers were highly correlated with forage biomass. Grasshopper numbers were lower in moderately to heavily grazed pastures, relative to ungrazed or lightly grazed pastures. This suggests that cattle grazing can be used to regulate grasshopper numbers. However, range depletion must be prevented, and excessive weed growth should be avoided because it favors increase in grasshopper populations; overgrazed land often supports high grasshopper numbers. Also, while total grasshopper numbers were lower in more heavily grazed pastures, grasshoppers in the subfamily Oedopodinae were more numerous (Capinera and Sechrist, unpublished). Oedopodines are less susceptible to *Nosema* infection than many other grasshoppers, so certain management options may be lost as a result of grasshopper species-complex shifts resulting from grazing management.

Irrespective of the management tactic chosen for rangeland grasshopper suppression, an economic basis for action should be ascertained. Grasshoppers often are numerous on Colorado's rangeland, but number should not be the sole basis for decision making (see economic basis for grasshopper suppression). The grasshopper species generally associated with rangeland grasshopper outbreaks in Colorado are listed in table 5. However, any species can become numerous enough to be damaging under certain circumstances; conversely, the presence of a pest species does not necessarily signify a problem.

![Fig. 373-Metal barrier with double entrance to pit for capturing Mormon crickets, 1938. Note accumulation of dead crickets in pit. Photo courtesy Colo. Dept. Agric.](image-url)
Fig. 375 - Hordes of dead Mormon crickets cleaned from barrier traps, 1938. Photo courtesy Colo. Dept. Agric.

Fig. 374 - Ditch or trench barrier for Mormon cricket control, 1938. Photo courtesy Colo. Dept. Agric.
Cropland

Cropland in Colorado usually is not severely damaged by grasshoppers. Most damage occurs to alfalfa and small grains. Grasshoppers rarely develop in crops; characteristically they develop in weeds growing along roadsides, fence rows and irrigation ditches and disperse to crops as the weeds become less palatable. Thus, damage to crops generally is restricted to field edges. Treatment of crop field margins with insecticide usually will be sufficient to prevent damage to the rest of the crop. If grasshoppers are extremely abundant, however, crop loss can ensue (fig. 376).

Damage to crops often can be prevented by treatment of adjacent weedy areas. It can be much more economic to treat localized grasshopper populations, especially while they are young and more susceptible; however, all too often grasshoppers in weeds are ignored until crop damage commences. *Nosema locustae* treatments would seem suitable for this application.

Grasshopper species associated with rangeland usually are not found in crops (table 5). The principal exception is *Melanoplus sanguinipes*, which feeds primarily on rangeland forbs but also attacks numerous crops. Weedy areas, but not well-managed rangeland, are the source of most crop feeding grasshoppers. However, if rangeland is over grazed and weeds become numerous, rangeland can provide a large inoculum of grasshoppers for crop infestation.

Roadsides in Colorado often are planted with crested wheatgrass. This is a vigorous bunchgrass that requires little maintenance and is effective for erosion control. Unfortunately, however, it is a highly favored food source of many grasshopper species, including many that attack crops. Farmers should be aware that the traffic on public highways also includes insect traffic, and that highway planners sometimes are not cognizant of agricultural concerns.

Table 5. Grasshopper species generally considered to be the primary pests in rangeland, cropland and suburban environments in Colorado.

<table>
<thead>
<tr>
<th>Rangeland</th>
<th>Cropland</th>
<th>Suburban</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ageneiotettix deorum</td>
<td><em>Melanoplus bivittatus</em></td>
<td><em>Melanoplus bivittatus</em></td>
</tr>
<tr>
<td>Amphitornus coloratus</td>
<td><em>Melanoplus differentialis</em></td>
<td><em>Melanoplus differentialis</em></td>
</tr>
<tr>
<td>Anabrus simplex</td>
<td><em>Melanoplus femurrubrum</em></td>
<td><em>Melanoplus femurrubrum</em></td>
</tr>
<tr>
<td>Aulocara elliotti</td>
<td><em>Melanoplus packardi</em></td>
<td><em>Melanoplus sanguinipes</em></td>
</tr>
<tr>
<td>Aulocara femoratum</td>
<td><em>Cordillacris occipitalis</em></td>
<td><em>Nosema locustae</em></td>
</tr>
<tr>
<td>Eritettix simplex</td>
<td><em>Melanoplus sanguinipes</em></td>
<td><em>Mermiria bivittata</em></td>
</tr>
<tr>
<td>Melanoplus sanguinipes</td>
<td><em>Opelia obscura</em></td>
<td><em>Phlibostroma quadrimaculatum</em></td>
</tr>
<tr>
<td>Melanoplus femurrubrum</td>
<td><em>Trachyrhachys kiowa</em></td>
<td></td>
</tr>
</tbody>
</table>

Fig. 376-Remains of corn field following grasshopper attack, 1939. Photo courtesy Colo. State Univ. Archives.
Suburban

The nature of grasshopper problems confronting the homeowner and home gardener are similar to those facing farmers. Grasshoppers do not build to large numbers in yards and gardens unless an abundance of weedy material exists. Rather, homeowners are confronted with dispersal of grasshoppers from undeveloped lots to vegetable and flower gardens and to ornamental shrubs. The species associated with suburban areas (table 5) are practically the same as those associated with commercial crop production. Homeowners also face the difficult task of attempting to control mature grasshoppers, but they are handicapped because access to the more toxic insecticides used by commercial agriculture is restricted.

Tactics used for protection of cropland are useful in suburban areas. For effective suppression with insecticides, infested areas should be treated while grasshoppers are still young and more susceptible. This may require treatment of vacant lots or other grasshopper sources. Landowners generally are cooperative and welcome attempts at grasshopper control. Suppression of grasshopper numbers before dispersal occurs is more effective than attempts at killing adults. Insecticide contamination is restricted to waste areas, where less contact by people and pets occurs. Bait formulations are very useful around the home. Since no formulation is required, there is less danger of accidental insecticide contamination or incorrect mixing. Also, Melanoplus spp. readily feed on bait, and most grasshoppers encountered by homeowners will be Melanoplus spp.

Many of the urban counties in Colorado have appointed pest inspectors or will appoint them upon request. County pest inspectors are authorized to examine grasshopper-infested property following written complaint. Landowners are responsible for suppression of grasshoppers on their property, if the grasshoppers pose a threat to adjacent property. Grasshoppers not controlled by landowners following proper notification may be controlled by the county at landowner expense, up to a maximum of $500 annually. Further information regarding the “Pest Control Act” can be obtained from the Board of County Commissioners and Colorado Department of Agriculture.

Alternatives to chemical control are limited. Valuable plants can be screened to prevent defoliation. Organic gardening enthusiasts sometimes recommend that marigolds or other “companion” plants be used to ward off insects; this will provide only temporary relief since grasshoppers will move to “protected” plants as soon as the companion plants are consumed. Nosema locustae will impose a relatively low level of mortality and, therefore, is limited in potential (see biological control of grasshoppers). Similarly, the insect parasitic nematode Neoaplectana carpocapsae, which kills a wide variety of insects, does not seem to be especially well suited for grasshopper control because nematode survival is poor in the hot, dry environments inhabited by grasshoppers.

Probably the most important aspect for homeowners to consider is that plants are very tolerant to defoliation. Perennials usually produce new foliage following grasshopper consumption and although growth is slowed, death is unusual. Annual crops such as peas, tomatoes and squash are less favored by grasshoppers than lettuce, spinach and onions. Gardeners may want to be selective in their planting during grasshopper outbreak years. It is not possible to have cosmetically perfect plants in the face of grasshopper invasion.
REFERENCES CITED


Knutson, H. 1940. A key to the Acrididae (Orthoptera) of Northeastern Texas with ecological notes. Field and Lab. 8:33-58.


GLOSSARY OF TERMINOLOGY

A - acre
AI - active ingredient
ABDOMEN - the posterior of the three main body divisions
ABORTIVE - arrested in development; rudimentary
ACCRE - 43,560 square feet or 0.4047 hectare
ACTIVE INGREDIENT - the amount of toxicant present in insecticide, usually expressed as % or lb/gal
ACUTE ANGLE - an angle less than 90°; pointed
Aedeagus - the intromittent organ of male insects; "penis"
ALPINE - growing or living in high altitudes above timberline
ANAL - pertaining to the last abdominal segment (which bears the anus); the posterior basal part (for example, of the wing)
ANTENNAE - (sing., antenna) a pair of segmented appendages located on the head above the mouthparts and sensory in function
ANTERIOR - front; in front of
APEX - (pl., apices) the end of a structure farthest from its base or point of attachment; "tip" of a structure
APICAL - at the end, tip or outermost part
APPENDAGE - any part, piece or organ attached by a joint to the body or to any other main structure
ARTHROPOD - any member of a large phylum (Arthropoda) of invertebrate animals with jointed legs and a segmented body, such as insects, crustaceans, spiders, centipedes and trilobites
AUDITORY ORGAN - any structure that functions as an ear; in Orthoptera, specialized structures covered by a tense membrane on the anterior tibiae or the base of the abdomen
BASAL - at the base; near the point of attachment (of an appendage)
BILOBATE - divided into two lobes
BOREAL - of or pertaining to the northern zone of plant and animal life lying just below the tundra
CALCAREOUS - of, like or containing calcium carbonate, calcium or lime
CANNIBALISTIC - feeding on other individuals of the same species
CARINA - (pl., carinae) an elevated ridge or keel, not necessarily high or acute
Cercus - (pl., cerci) an appendage (generally paired) near the end of the abdomen, often segmented but sometimes not and often important in insect classification
CLEF - split; partly divided longitudinally
CLUBBED - thickening gradually toward the tip
CLYPEUS - the lower portion of the face between the front and the labrum
COSTAL MARGIN - the anterior margin of a wing
COSTAL VEIN - a longitudinal wing vein, usually forming the anterior margin of the wing
Coxa - (pl., coxae) the basal segment of the leg
CRENULATE - having the margin cut into rounded scallops
CROP - the dilated posterior portion of the foregut, which serves to receive and hold food prior to its slower passage through the rest of the digestive tract
CUCURBITS - any plant of the gourd family (Cucurbitaceae) e.g., squash, melon, pumpkin, etc.
KILOCARAT - 1000 grams or 2204.6 lbs.
KNEE - the point of junction of the femur and the tibia
LABRUM - upper lip
LATERAL - relating, pertaining, or attached, to the side
LATERAL CARINA - (pl., carinae) in grasshoppers, carinae or ridges on pronotum extending along each lateral margin of the dorsal
LATERAL LOBES - side portions of pronotum which cover sides of prothorax
LB - pound
LONGITUDINAL - lengthwise of the body or of an appendage; in the direction of the long axis
MARGINAL FIELD - the anterior area of a wing or tegmen
MARL - a mixture of clay, sand, and limestone in varying proportions that is soft and crumbly
MED - prefix meaning middle
MEDIAN - in or at the middle; of or pertaining to the middle
MEDIAN CARINA - any keel or ridge set medially on a part of an insect; of the head, a ridge in center of vertex; of the pronotum, a ridge along the middle
MESOSTERNUM - bottom or ventral portion of the mesothorax
METAMORPHOSIS - a change in form during development
METATERNUM - bottom or ventral portion of metathorax
METAZONA - portion of the pronotum behind principal sulcus
METER - 3.2808 linear ft.; a square meter is 1.196 sq. yd.
MOLT - the process of shedding the integument
MONOPHAGOUS - feeding upon only one kind of food; this is usually interpreted to indicate feeding on one species of plant
NOCTURNAL - active at night
NOTCH - (pl., notches) a convave or V-shaped cut or incision in an edge or across a surface
NYMPH - a young stage of insects with incomplete metamorphosis; e.g., an immature grasshopper
OBLIQUE - slanting; any direction between perpendicular and horizontal
OBSTUSE ANGLE - an angle greater than 90° and less than 180°; not pointed
OCCELLUS - (pl., ocelli) a simple eye
OLIGOPHAGOUS - feeding upon a limited variety of food; feeding upon only a few species of plants, usually within a single family
OMNIVOROUS - eating any sort of food, especially both animal and vegetable food
OPAQUE - not letting light pass through; not transparent or translucent
ORTHOPERA - an ordinal group of insects that includes grasshoppers, cockroaches, crickets, katydids, praying mantids and others
OUNCE - 28.3495 grams
OVIPOSITOR - external egg laying apparatus of female insects
OZ - ounce
PHYLUM - (pl., phyla) any of the broad, principal divisions of the animal kingdom
POLYPHAGOUS - eating many kinds of food, usually plant species from several families
POSTERIOR - hind or rear
POUND - 16 oz. or 453.59 grams
PRONOTUM - shield-like cover of the prothorax
PROSTERNUM - bottom portion of prothorax; forebreast
PROXIMAL - nearer to the body, or to the base of an appendage
PROZONA - portion of the pronotum in front of the principal sulcus
PUNCTATE - with impressed dots or punctures
QUADRATATE - square or nearly square; rectangular
QUADRILATERAL - a four-sided area
RADIATE VEINS - the longitudinal veins spreading fan-like in the anal field of the hind wings
RIGHT ANGLE - an angle of 90°; an angle made by the meeting of two straight lines perpendicular to each other
SEDGE - any of a family (Cyperaceae) of grass-like plants often found on wet ground or in water, having usually triangular, solid stems, three rows of narrow, pointed leaves and minute flowers borne in spikelets
SPATULATE - spoon-shaped; broad and with a depression apically, and narrowed basally
SPECIES - groups of actually (or potentially) interbreeding natural populations which are reproductively isolated from other such groups
SPINE - a thorn-like outgrowth of the integument, usually associated with the leg segments
SPUR - of a leg segment: a movable "spine," usually larger than most spines and located at the apex of the segment; of wing: dark marking running toward base from band, near front of wing
SPURIOUS VEIN - certain folds or thickenings in the wing surface which resemble veins so nearly as to be readily mistaken for them
STRIDULATE - to make a sound by rubbing two structures or surfaces together
SUBAPICAL - near the apex
SUBGENITAL PLATE - a plate covering the genital opening from beneath, often scoop-shaped
SUBSPECIES - a geographically defined aggregate of local populations which differs from other such subdivisions of the species
SULCUS - (pl., sulci) a groove or furrow
SUPRANAL PLATE - a more or less triangular-shaped plate over the anus
SYMMETRICAL - having the two halves shaped as mirror images of each other
TARSUS - (pl., tarsi) the foot; the jointed appendage attached at the apex of the tibia, bearing the claws
TEGMEN - (pl., tegmina) the thickened or leathery front wing of an orthopteran
THORAX - the body region behind the head, which bears the legs and wings
TIBIA - (pl., tibiae) the fourth segment of the leg, between the femur and tarsus
TRANSVERSE - broader than long; running across
TROCHANTER - the second segment of the leg, between the coxa and femur
TRUNCATE - cut squarely across; shortened
TUBERCLE - a small knob-like or rounded protuberance
VENATION - the complete system of veins of a wing
VENTRAL - pertaining to the undersurface
VERTEX - the top of the head, including the region between the eyes
VERTICAL - perpendicular, or at a right angle, to the plane of the horizon; upright; straight up and down
WING DISC - the central area of a wing
WING PADS - the undeveloped wings of nymphs
YARD - 3 linear ft. or 0.9144 m; a square yard is 9 sq. ft. or 0.8361 sq. m.
GRASSHOPPER NAMES: SPECIES, GENUS

abdominalis, Chioeaaltis (Thomas)
admirabilis, Syraba Uhler
agrestis, Trimerotropis McNeill
alba, Hypochora Dodge
alpinus, Oeutophillus Scudder*
alpinus, Melanoplus Scudder
alutacea, Schistocerca Scudder
angustipennis, Melanoplus (Dodge)
apiculata, Pardalophora (Harris)
aridus, Oecanthus Saussure*
aroniae, Melanoplus Scudder
aspera, Trachyrhachys (Scudder)
bicolor, Dactylotum (Thomas)
bispinosus, Melanoplus Scudder
bivittata, Mermiria (Servile)
bivittata, Melanoplus (Say)
bolli, Spharagomen Morse
boreaalis, Melanoplus (Fieber)
broadtichi, Melanoplus Scudder
brachyptera, Pseudopomala (Scudder)
brevipes, Dahnia Haldeman*
bruneri, Melanoplus Scudder
brunneus, Stenobothrus Thomas
britannica, Trimerotropis Bruner
britannicus, Oecanthus Saussure
campestris, Trimerotropis McNeill
capito, Hippopedon (Stal)
carlinianus, Circotettix (Thomas)
carloina, Dissosteira (L.)
chenopodii, Aeoloplides (Bruner)
cincta, Trimerotropis (Thomas)
citrina, Trimerotropis (Bruner)
collare, Spharagomen (Scudder)
coloradus, Amphitornus (Thomas)
complanatipes, Melanoplus Scudder
confusus, Melanoplus Scudder
conspersa, Arphia Scudder
conspersa, Chioeaaltis (Harris)
coralipes, Xanthippus Haldeman
coronata, Trachyrhachys (Scudder)
crenulata, Cordillicrus (Bruner)
curtipennis, Chorthippus (Harris)
cyanepennis, Trimerotropis Bruner
cyneus, Leprus Cockeill
dawsonii, Melanoplus (Scudder)
delicalata, Psoloessa Scudder
deurum, Ageneotettix (Scudder)
differentialis, Melanoplus (Thomas)
discolor, Melanoplus (Scudder)
dodgii, Melanoplus (Thomas)
eliitti, Aulocara Thomas
enigma, Oedaloenotus (Scudder)
equale, Spharagomen (Say)
fasciatus, Melanoplus (F. Walker)
femoratum, Aulocara (Scudder)
femurrubrum, Melanoplus (DeGeer)
flavidus, Melanoplus Scudder
foedus, Melanoplus Scudder
fontana, Trimerotropis Thomas
formosus, Tropidopholus (Say)
fratercula, Trimerotropis McNeill
fusiformis, Oeutophillus Scudder*
gladstoni, Melanoplus Scudder
gracipes, Melanoplus (Scudder)
gracile, Stethophyma (Scudder)
gracilis, Trimerotropis (Thomas)
haldemanii, Pardalophora (Scudder)
haydeni, Derotoletma (Thomas)
hiripoes, Acrolophus (Say)
humile, Spharagomen (Morse)
inconspicua, Trimerotropis Bruner
infantilis, Melanoplus Scudder
keeleri, Melanoplus (Thomas)
kennicotti, Melanoplus Scudder
kiowa, Trachyrhachys Thomas
kiowanus, Melanoplus (Scudder)
latifasciata, Trimerotropis Scudder
longipennis, Dissosteira (Thomas)
magnanimus, Brachystola (Girard)
magnifica, Trimerotropis Rehn
mellanoepma, Trimerotropis McNeill
montanus, Xanthippus (Thomas)
monetum, Syraba (Saussure)
nebrascensis, Phicotalotes (Thomas)
eglectus, Cratypedes (Thomas)
nevadensis, Acrolophus (Thomas)
niveus, Oecanthus (DeGeer)*
rubrum, Boopedon (Say)
obscura, Opeia (Thomas)
occidentalis, Melanoplus (Thomas)
occipitalis, Cordillicrus (Thomas)
oculeote, Hippiscus (Saussure)
olivacea, Campylacantha (Scudder)
oregonensis, Melanoplus Thomas
packardi, Melanoplus Scudder
pallidipennis, Trimerotropis (Burmeister)
pardalinus, Metator (Saussure)
parviceps, Cibolacris (Bruner)
pelidna, Orphulella (Burmeister)
PELLUCIDA, CMMNLA Scudder
picta, Mermina (Walker)
pistrinaria, Trimerotropis Saussure
pliati, Mestobregma (Thomas)
ponderosus, Melanoplus (Scudder)
pseudonietana, Arphia (Thomas)
quadrimaculatum, Philobestrom (Thomas)
quadriplorquisa, Oecanthus Beutemuller*
rubula, Circotettix Rehn and Hebard
regalis, Melanoplus (Dodge)
robusta, Udeopsylla (Haldeman)*
robustus, Leprus Hebard
rufula, Heliaula (Scudder)
sanguinipes, Melanoplus (Fabricius)
simplex, Anabrus Haldeman*
simplex, Arphia Scudder
simplex, Eritettix (Scudder)
sordidus, Encoplotophus (Burmeister)
sorsa, Trimerotropis (Thomas)
speciosa, Ophulella (Scudder)
speciosus, Hesperotettix (Scudder)
splendidus, Melanoplus Hebard
spretus, Melanoplus (Walsh)
spurca, Dissosteira Saussure
subgracilis, Encoplotophus Caudell
sulcirostris, Conozoa Scudder
tenuipennis, Aeoloplides (Scudder)
texana, Conozoa (Bruner)

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texana, Mermiria Bruner
texana, Psoloessa (Scudder)
tolteca, Trimerotropis Brunner
trifasciatus, Hadrotettix (Say)
tristis, Melanoplus Brunner
turnbulli, Aeoloplides (Caudell)
utahensis, Ceuthophilus Thomas*
verruculatus, Trimerotropis Scudder
virgata, Paropomaia (Scudder)
viridifasciata, Chortophaga (DeGeer)
viridis, Hesperotettix (Scudder)
wyomingensis, Paropomaia (Thomas)
xanthoptera, Arphia (Burmeister)
yarrowii, Melanoplus (Thomas)

*These species are not true grasshoppers (Acrididae) but are discussed in this manual because they may be confused with grasshoppers.
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Sagebrush grasshopper
Sage grasshopper
Sand grasshopper
Say's grasshopper
Slant-faced grasshopper
Snowy tree cricket
Speckled rangeland grasshopper
Spoted bird grasshopper
Spotted wing grasshopper
Sprinkled locust
Striped slant-faced grasshopper
Thistle grasshopper
Three-banded range grasshopper
Tiny spur-throated grasshopper
Two-striped grasshopper
Utah camel cricket
Velvet-striped grasshopper
Warrior grasshopper
Western tree cricket
White cross grasshopper
White-whiskers grasshopper
Wrangler grasshopper
Wrinkled grasshopper
Wyoming toothpick grasshopper
Yellowish spur-throat grasshopper

Melanoplus bowditchi
Hypochlora alba
Ageneotettix deorum
Spharagemon equale
Aeropedellus clavatus
Oecanthus niveus
Arphia conspersa
Schistocerca alutacea
Cordillacris occipitalis
Chioealitis conspersa
Amphitornus coloradus
Aeolopilides turnbulli
Hadrotettix trifasciatus
Melanoplus infantilis
Melanoplus bivittatus
Ceuthophilus utahensis
Eritettix simplex
Cannula pellucida
Oecanthus californicus
Aulocara femoratum
Ageneotettix deorum
Circotettix rabula
Hippiscus ocelote
Paropomala wyomingensis
Melanoplus flavidus

PLANT NAMES: COMMON, SCIENTIFIC

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*These species are not true grasshoppers (Acrididae) but are discussed in this manual because they may be confused with grasshoppers.