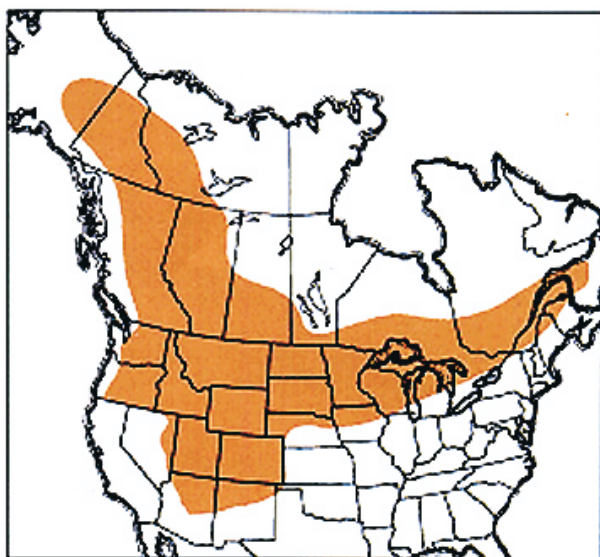


Bruner Spurthroated Grasshopper

Melanoplus bruneri Scudder

Distribution and Habitat

The Bruner spurthroated grasshopper ranges widely in North America, inhabiting arctic tundra, northern sections of western prairies, herb-grasslands of the Northeast, and mountain meadows of the West. In mountain meadows it often coexists with the northern grasshopper, *Melanoplus borealis*. The northern grasshopper characteristically resides in wetter, more luxuriant habitats while the Bruner spurthroated grasshopper lives in adjacent upland with drier conditions and thinner vegetation. Remarkably, the Bruner spurthroated grasshopper often inhabits the grass-herb undergrowth of quaking aspen groves and the adjoining open grassland.



Geographic range of *Melanoplus bruneri* Scudder

Economic Importance

The Bruner spurthroated grasshopper is primarily a pest of rangeland forage. A polyphagous species, it prefers to feed on forbs but also eats grasses. During outbreaks the grasshoppers may exhaust their preferred host plants of certain forbs by the end of the nymphal period and feed heavily on grasses as adults. Records of damage to forage appeared early in this century. In 1920 and 1921 huge numbers of this grasshopper and *Camnula pellucida* devastated grazing land of the Riske Creek Range of British Columbia. Surrounded by forests, the range is an undulating plateau of 300 square miles that lies between 3,000 and 3,500 feet elevation. In 1921 the Bruner spurthroated grasshopper was also reported as causing damage in the tallgrass prairie of northcentral Minnesota (near Grand Rapids, elevation 1,280 feet).

In the western United States, the species inhabits mountain meadows where populations irrupt at irregular intervals and cause severe damage to forage. An early record of forage destruction tells of the impact of a heavy infestation of *M. bruneri* in eastcentral Nevada in the Humboldt National Forest. The infested area consisted of tableland lying at an elevation of 11,000 feet, vegetated by bunch grasses and forbs, and grazed by sheep. High numbers of grasshoppers were reported from 1936 to 1938. In mid September 1937, densities were estimated at 20 adults per square yard. In an attempt to control this infestation, poison bait was transported to the sheep range by pack mules in 1937 and spread by hand. A large population, still present in 1938, was decimated by a midsummer hail storm. Records reveal outbreaks and damage in the mountains of

Montana, Utah, and Wyoming. In the Crazy Mountains of Park County, Montana, severe damage to meadow grasses was inflicted by high numbers of *Camnula pellucida* and *M. bruneri* in 1954. This assemblage ranged from 15 to 50 adults per square yard. During the same year a study of food selection by *M. bruneri* was conducted in one of the infested meadows. A population of 15 adults per square yard exhausted the supply of preferred food plant, *Lupinus sericeus*, inducing the grasshoppers to feed on timothy and the heads of yarrow. Prolonged feeding on the leaves of timothy resulted in extensive damage to this grass. In 1962 and 1964, *M. bruneri* again irrupted in the mountains of Montana, this time in Madison County, and caused extremely heavy damage to meadow grasses. Utah records show populations of *M. bruneri* and *M. borealis* in excess of 100 adults per square yard infesting meadows of Fish Lake National Forest in 1959, 1961, and 1963. The meadows, lying at 10,500 feet elevation, were devastated by the grasshoppers. In 1963, 4,000 acres were baited to control a part of the infestation. In an adjacent area of Utah, the Manti-LaSal National Forest, *M. bruneri* was the dominant grasshopper infesting 75,400 acres on which controls were applied in 1959. Outbreaks of *M. bruneri* were discovered in meadows of the Big Horn Mountains of northern Wyoming in 1995. One of the infested sites was studied briefly on 10 August 1995. The site, called South Park and located on the western slope of the Big Horn Mountains in Big Horn County (T 50N R88W Sec23 SW), lies at an elevation of 8,600 feet and represents a typical mountain meadow vegetated by Idaho fescue and other high-altitude grasses. It was infested with weeds and forbs, many serving as preferred food plants for *M. bruneri* (See Table 1).

Cattle had not yet grazed the meadow. An examination of the vegetation revealed much consumption of forbs but none of grasses. Analyses of crop contents, however, showed that some feeding on grasses had occurred. Forbs comprised 68 percent of the diet and grasses 21 percent (Table 1). The evidence suggests that small numbers of the Bruner spurthroated grasshopper in a mountain meadow are beneficial as they feed principally on their preferred forbs, many of which are toxic to livestock, but that large numbers are destructive as they feed heavily on forage grasses and may devastate a meadow. The Bruner spurthroated grasshopper has occasionally infested fields of alfalfa in Saskatchewan and has caused harm to seed crops of alsike, timothy, and alfalfa in British Columbia and to oats in Alberta. The Bruner spurthroated grasshopper is a medium-sized species slightly larger than the migratory grasshopper, *M. sanguinipes*. In a collection from the South Park meadow of the Big Horn Mountains, live weight of males averaged 429 mg and females 535 mg (dry weight 120 mg and 160 mg, respectively).

Food Habits

The Bruner spurthroated grasshopper is a polyphagous species. Several studies reveal that it feeds on many kinds of plants growing in widespread habitats. It prefers certain forbs, but it also feeds on grasses. An analysis of crop contents of adults in the summer of 1995 from a heavily infested meadow of the Big Horn Mountains in northern Wyoming (South Park) indicated that the grasshoppers consumed 68 percent forbs, 21 percent grasses, 7 percent moss, 3 percent fungus, and 1 percent pollen (Table 1). Of 24 crops examined, 13 contained more than one food item and 11 contained a single item. The number of food items per crop ranged from 1 to 6 and averaged 2.3. Of the crops containing a single item, four contained common yarrow, two a perennial herb, *Arnica sororia*, and two a grass, Idaho fescue.

The diet of this grasshopper has been found to change with the advance of summer. In a mountain meadow of northern Colorado, this grasshopper in early August fed principally on *Astragalus*, but later in the month it consumed large amounts of *Astragalus* along with common dandelion and cinquefoil, *Potentilla* spp. (Table 1).

Instar 1



1. BL 4.4-5.8 mm FL 2.4-2.6 mm AS 12-13.

Instar 2



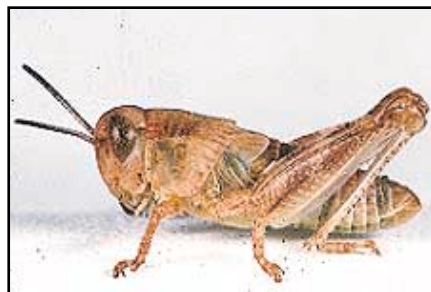
2. BL 5.6-8.3 mm FL 3.2-3.6 mm AS 16.

Instar 3



3. BL 7.7-9.4 mm FL 5-5.3 mm AS 18-20.

Instar 4



4. BL 10-11.6 mm FL 6.2-7.2 mm AS 20-21.

Instar 5



5. BL 15.5-27 mm FL 8.8-13.9 mm AS 22-24.

Figures 1-5. Appearance of the five nymphal instars of *Melanoplus bruneri* - their sizes, structures, and color patterns. Notice progressive development of the wing pads. BL = body length, FL = hind femur length, AS = antennal segments number.

A seasonal change of diet was likewise observed in the dense population inhabiting a meadow in the Crazy Mountains of southwestern Montana. The nymphs were observed to feed principally on *Lupinus sericeus*. This plant was almost completely defoliated by 22 July 1956, a time when nearly all the grasshoppers had molted to the adult stage. They then began to feed on common yarrow and timothy. When these plants became desiccated by 13 August, the grasshoppers began to feed on sticky geranium, *Geranium viscosissimum*, as a last resort.

Although in the Montana study dandelion was not seen to be a chosen food plant, observations of adults feeding in Wyoming mountain meadows and crop analyses of adults collected from a northern Colorado mountain meadow showed it was eaten in substantial amounts. Results of laboratory two-choice tests demonstrated that adults ate dandelion in preference to wheat, downy brome, Kentucky bluegrass, Idaho fescue, spike fescue, alfalfa, and red clover. The adults consumed false dandelion, *Agoseris glauca*, equally as well as common dandelion.

The method of attacking the host plant by the Bruner spurthroated grasshopper has received little attention. Three observations were made in 1996 in a mountain meadow of the Laramie Range (Pole Mountain). In late morning hungry grasshoppers were observed to stir, then to crawl along the ground surface in search of food. Possibly by chance, all three adults contacted dandelion plants. Still on the ground surface, they palpated the leaves and oriented themselves to feed on the leaf edges. No report has been made of how the grasshoppers feed on erect plants like lupine. They may crawl up the stem or jump onto the plant to reach the leaves on which they feed.

Dispersal and Migration

The Bruner spurthroated grasshopper possesses long wings and well-developed wing muscles enabling it to fly, disperse, and migrate. Only a small amount of information, however, is available on its flight behavior. A pertinent observation of migration by this grasshopper was made in the Big Horn Mountains of Wyoming on 15 August 1995 by grasshopper surveyor, Robert Stuckey. He monitored a large population of adults with a density ranging from 10 to 30 per square yard. The population was moving downwind and down slope in a southwesterly direction as the wind blew at 3 to 6 miles per hour. The grasshoppers were observed between 10 a.m. and 12 p.m. DST flying at heights of 2 to 10 feet and traveling 20 to 100 feet each time they flew. The morning was clear and air temperatures were estimated to range from 60° to 70° F. The grasshoppers were leaving a stock drive, 10 miles long and 3 miles wide lying at 6,700 to 7,800 feet, in which the vegetation was very short from heavy grazing by livestock and grasshoppers. The cessation of flight and the destination was not observed.

Further evidence of movement by flight was obtained upon the discovery in 1988 of 5 males and 18 females on the ice surface of Grasshopper Glacier in the Crazy Mountains of Montana. The preserved grasshoppers may have come from an adjoining mountain meadow, which harbored the species, or from a more distant meadow.

Flushed flight of the Bruner spurthroated grasshopper is silent, short, 3 to 4 feet in length, and at heights of 6 to 12 inches. In early morning when temperatures are low (less than 60°F), the adults jump to evade an intruder, but when morning temperatures have risen flushed adults usually take flight.

Identification

The Bruner spurthroated grasshopper is a medium-sized, fully winged, pale to dark brown species (Fig. 6 and 7). The wings reach or exceed from 1 to 3 mm the apex of the hind femur. Adult males possess a distinctive large, flat cercus; at its base the dorsal and ventral sides lie straight and parallel to each other, apically the cercus curves upward (Fig. 9). Arms of the furcula are large, reaching half the length of the supraanal plate and are nearly parallel. The subgenital plate of the male is long, the end curving noticeably upward; the apex is bilobed and shallowly notched. The mesosternum of the male has a prominent hump

Figures 6-10. Appearance of the adult male and female of *Melanoplus bruneri*, male hindleg, end male abdomen, and egg pod and exposed eggs.

like that of its close relative, *Melanoplus sanguinipes*. The medial area of the hind femur of both sexes is almost entirely fuscous or distinctively marked (Fig. 8 and see Fig. 4 for clear delineation of pattern). The hind tibia is usually pink or red; less often it is pale greenish yellow. The venter is usually bright yellow but may be pale or greenish yellow.

The nymphs are identifiable by their structures and color patterns (Fig. 1-5). Among montane *Melanopli* a distinctive characteristic of the nymphs is their body color, commonly brown and tan; however, some III to V female nymphs are green with faint, reduced dark markings.

1. Head with face nearly vertical; compound eyes brown with light tan spots; crescent faint or absent. Color bar behind eye is fuscous or brown, sometimes faint.
2. Pronotum with tail of crescent faint or completely absent. Medial area of hind femur with a distinctive color pattern; instar I frequently without this pattern, mainly fuscous but with light herring-bone stripes. Inner side of hind femur of instar I dark with three light bars; the light area increases in instars II to V with two dark patches remaining, one apically and one dorsally in the middle. Tibia in instar I is fuscous with a light basal annulus; in instars II to V it is tan or gray with front fuscous and spines black.
3. Venter of abdomen in instar I is shiny black, in instars II to V it is olive or yellowish green.
4. Body color brown and tan and spotted darker brown. Instar I often dark, chiefly fuscous. Some females of instars II to V are green.

Hatching

The Bruner spurthroated grasshopper is an early-hatching mountain species. Along with *M. alpinus*, *M. borealis*, and *Camnula pellucida*, first instar nymphs appear in the habitat during the first and second weeks of June in both Montana and Wyoming. A cool season, however, may delay hatching until the last week of June and first week of July. Normally hatching takes three weeks to complete, but if it is delayed by a late spring it may be concentrated into one week.

In mountain meadows, eggs of *M. bruneri* require two years of development in the soil before they hatch and some may even require three years. In a USDA study, eggs that did not hatch after two years contained fully developed embryos. These eggs required another exposure to a cold period before hatching when brought back to 85°F.

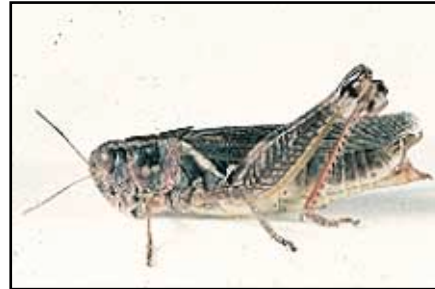
Results of laboratory rearing of this species at the Wyoming Agricultural Experiment Station suggest that under warmer conditions at low altitudes eggs may require only one year of development in the soil before hatching. A collection of three young males and seven young females was made on 29 July 1994 from a site in the Big Horn Mountains. On 31 July 1994 the grasshoppers were confined in the laboratory at an average temperature of 87°F for 12 hours during the day and 73°F during the night. The grasshoppers were fed dandelion and provided with a container (5 x 7 x 3 inches deep) of soil for oviposition. The adults were kept until all had died by 16 October 1994. Several pods were recovered from the oviposition container and placed in a mixture of sand and vermiculite. The eggs were exposed to cold, 36° to 40°F, for 83 days after which they were incubated at 82°F for 12 hours each day and 73°F for 12 hours at night. Emergence of 30 nymphs occurred after 8 days of incubation, 5 nymphs after 30 days, and 8 nymphs after 36 days. The results show that under favorable temperatures, some eggs can hatch in one year.

Nymphal Development

The nymphs make their appearance in the habitat usually by the first or second week of June. At this time they have available an abundance of preferred food plants. Although temperatures may be relatively low with peak air and soil surface temperatures of 71°F and 103°F, respectively, the nymphs' behavioral responses to temperature allow them to develop rapidly. Based on the time from first appearance of nymphs to first appearance of adults, the nymphal period lasts from 31 to 35 days. Both male and female nymphs require five instars to reach the adult stage.



6. BL 18-22 mm FL 10-12.5 mm AS 24-25.



7. BL 22-27 mm FL 11.8-13.9 mm AS 24-25.



8. Hindleg of adult male.



9. End of male abdomen showing the cercus, long arms of the furcula, and subgenital plate.



10. Egg pod and five loose eggs.

Male

Female

Hindleg

Cercus

Eggs

Adults and Reproduction

The adult stage of the Bruner spurthroated grasshopper is reached early in summer. In 1956 in the Crazy Mountains, Montana, adults began to appear July 16, while in 1994 in the Big Horn Mountains, Wyoming, they began to appear July 11. In the Pole Mountain study meadow in southeastern Wyoming, adults appeared 27 July 1996 but not until 5 August in 1995, a seasonally late year.

When food supply and other conditions are favorable, the adults remain in the habitat in which they have developed as nymphs. For example, the adults of a small population residing in the Pole Mountain meadow remained and survived well into October 1996, but none survived a hard freeze during the first week of November.

In habitats where the food supply of large populations becomes exhausted, adults are induced to disperse to "greener pastures." The emigrations usually occur after egg deposition has begun but not ended. The females continue to oviposit in the new habitat and thereby initiate new populations in areas previously devoid of the species. Such behavior apparently occurred in 1994 and 1995 between two study meadows lying 1 mile apart in the Big Horn Mountains.

Mating, gravid females, and egg laying were observed in the meadow in the Crazy Mountains of Montana by 1 August 1956. This evidence indicates maturation of females took approximately 16 days. A late observation of mating was made in a meadow of the Laramie Range in southeastern Wyoming on 1 October 1996. Presumably oviposition may likewise occur late in the season.

No description of where and how females oviposit in nature is available. In laboratory cages, females readily oviposit into bare soil. A female that had just finished ovipositing on 17 August 1995 at 3:51 p.m. DST was observed to brush soil particles over the resulting aperture with her ovipositor. At the same time, two other females were observed to be in the process of ovipositing into the bare soil. The pod, 1 to 1¼ inches long and curved at the bottom, contains 21 to 22 eggs (Fig. 10). The eggs are tan and 3.9 to 4.2 mm long.

Population Ecology

The Bruner spurthroated grasshopper is a common inhabitant of western mountain meadows with a high frequency of occurrence in the many disjunct meadows. This grasshopper was present in 14 of 19 study sites in the Big Horn Mountains indicating a 74 percent frequency. The species' ability and propensity to fly and disperse appear to account for its general distribution in mountain meadows.

The species develops particularly large populations in weedy mountain meadows. Observations have revealed that high-density populations deplete native host plants early in the grasshoppers' adult stage. The grasshoppers must then exploit other plants for food. Weeds such as dandelion and brome and forage grasses such as timothy provide the adults with a steady supply of nutritious food into late summer. Weedy sites are characterized by an abundance of interspersed bare ground providing the grasshoppers with another requirement for prolific reproduction—accessible basking spots. Sites with heavy populations of *M. bruneri* on which notes of vegetation and grasshopper densities have been noted were discovered 40 years apart in Montana and Wyoming. In 1956 a weedy meadow in the Crazy Mountains of Montana harbored a population estimated to have a density of 15 young adults per square yard. Three weedy meadows with 30 to 38 young adults of *M. bruneri* per square yard were discovered in 1995 in the Big Horn Mountains of Wyoming. For comparison, 15 well-vegetated sites surveyed in 1994 and 1995 in the Big Horn Mountains harbored from less than 0.1 to 1 young adult per square yard.

Several nymphal color forms of this grasshopper are present in populations. Of 87 nymphs collected from a mountain meadow (Pole Mountain) in 1996, 62 (71 percent) were of the normal pale brown or tan color, 11 (13 percent, all males) were dark (mainly fuscous), and 11 (13 percent, all females) were green. These forms have been found also in meadows of the Big Horn Mountains of northern Wyoming.

Daily Activity

The Bruner spurthroated grasshopper is a geophilous species, resting, basking, walking, feeding, and performing other activities on the ground. Around sunset it seeks shelter for the night to protect itself from cold mountain temperatures. In early morning before sunrise, no

individuals are seen on vegetation or the ground surface. A search for their location in a low-density population of the Pole Mountain study meadow was largely unsuccessful except for the discovery of two adult males clinging to the underside of dry cattle dung. Grasshoppers of other montane species were discovered sheltered under dry dung in this meadow including *M. alpinus*, *M. infantilis*, and *Camnula pellucida*.

Bruner spurthroated grasshoppers begin to bask on bare ground approximately one hour after sunrise. They turn a side perpendicular to the sun's rays and lower the associated hindleg to expose the abdomen. Basking lasts from one to three hours depending on temperature, usually shorter in August and longer in September. At the end of basking, when temperatures of the soil surface have reached 93°F and air 65°F, they may continue to rest horizontally on the soil facing directly into the sun or directly away. At this time, approximately 10 to 11 a.m. DST, normal activities may start such as feeding, stridulating by males, mating, walking, and flying. If midday temperatures rise unusually high, the grasshoppers may climb vegetation to remove themselves from the hot soil surface. In the South Park study meadow on 10 August 1995 at 12:22 p.m. DST, a female was discovered vertically head-up on the shady side of the stem of *Arnica sororia* at a height of 12 inches (ground surface temperature 119°F and air 81°F). A second period of basking occurs during late afternoon before the grasshoppers seek shelter for the night near sunset.

| Item | Colorado 8/10/67 | Colorado 8/23/67 | Wyoming 8/10/95 |
|---|---------------------|---------------------|--------------------|
| <i>Achillea millefolium</i> | 0.1 | 3.2 | 26.7 |
| <i>Agoseris glauca</i> | 0.0 | 0.0 | 9.1 |
| <i>Arenaria fendleri</i> | 8.5 | 7.6 | 0.0 |
| <i>Arnica sororia</i> | 0.0 | 0.0 | 12.5 |
| <i>Artemisia frigida</i> | 2.5 | 0.0 | 0.0 |
| <i>Artemisia tridentata</i> | 0.0 | 0.0 | 4.4 |
| <i>Aster</i> sp. | 0.0 | 0.0 | 2.6 |
| <i>Astragalus</i> spp.- <i>Oxytropis</i> spp. | 70.4 | 18.6 | 6.2 |
| Composite flower | 0.0 | 0.0 | 0.9 |
| <i>Allium</i> sp. | 0.0 | 0.0 | 5.2 |
| <i>Lupinus argenteus</i> | 0.2 | 8.3 | 0.0 |
| <i>Orthocarpus luteus</i> | 0.0 | 4.8 | 0.0 |
| <i>Penstemon</i> sp. | 0.4 | 5.6 | 0.9 |
| <i>Potentilla</i> spp. | 2.9 | 11.9 | 0.0 |
| <i>Taraxacum officinale</i> | 0.1 | 17.9 | 0.0 |
| <i>Carex</i> sp. | 0.0 | 0.0 | 6.3 |
| <i>Danthonia parryi</i> | 0.1 | 2.3 | 0.0 |
| <i>Danthonia unispicata</i> | 0.0 | 0.0 | 1.9 |
| <i>Festuca idahoensis</i> | 0.1 | 2.2 | 12.1 |
| <i>Juncus confusus</i> | 0.0 | 0.0 | 0.2 |
| <i>Poe</i> sp. | 0.0 | 0.0 | 0.3 |
| Fungi | 5.5 | 4.7 | 3.0 |
| Moss | 0.0 | 0.0 | 7.3 |
| Pollen | 0.0 | 0.0 | 1.3 |
| Arthropod parts | 2.5 | 3.7 | 0.9 |
| Number crops | 25 | 57 | 24 |

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