Whitecrossed Grasshopper

Aulocara femoratum Scudder

Distribution and Habitat

The whitecrossed grasshopper is an inhabitant of western grasslands. Although widely spread, its distribution includes only 60 percent of that of its congener, the bigheaded grasshopper, *Aulocara elliotti*. The whitecrossed grasshopper occurs most frequently in vegetation types of the mixedgrass prairie in which the mid grasses, western wheatgrass and needleandthread, are abundant as well as the short grass, blue grama. The species also occurs in the bunchgrass, shortgrass, and desert prairies, but no descriptions of specific habitats in these prairies have been published.

Economic Importance

Because the whitecrossed grasshopper feeds on valuable forage grasses and increases to high densities in certain habitats of the mixedgrass prairie, it is occasionally an important pest species. It is usually a subdominant member of an outbreak assemblage in which *A. elliotti* is often the dominant species, but it may also become the dominant species with densities as high as 13 adults per square yard. The whitecrossed grasshopper is slightly smaller than *A. elliotti*. Live weight of males from the mixedgrass prairie of eastern Wyoming averages 141 mg and females 460 mg (average dry weight of males 42 mg, females 137 mg). It is a less injurious species than *A. elliotti* because of its smaller size, lower densities, less frequent occurrence, and thriftier feeding habits (i.e., little clipping of grass leaves).

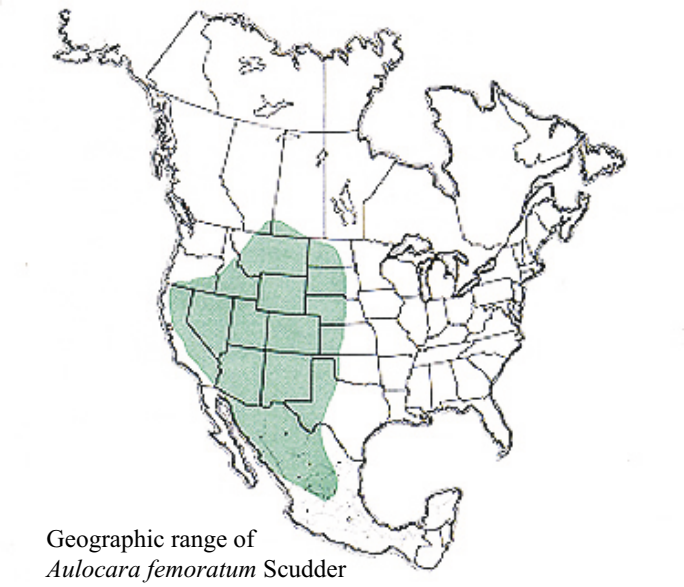
Food Habits

The whitecrossed grasshopper is a general grass feeder. Examination of crop contents of late instars and adults inhabiting a site in the mixedgrass prairie of eastern Wyoming revealed that all eight species of the perennial grasses and sedges growing at the site had been exploited for food (Table 1). Only the senescent annual grasses, such as downy brome, were lacking in the crop contents. The greatest utilization was made of western wheatgrass and needleleaf sedge. This study also revealed a remarkable difference in the diets of adult males and females. The males ingested much larger amounts of short grasses and sedge, while the females ingested more of the mid grasses. These results appear to be due to differences in behavior. The males walk extensively on the ground, presumably to find and court females, and thereby make contact with short grasses more often than the females, which are more sedentary and usually climb mid grasses close by in order to feed.

The majority of crops contained two to three species of grasses and sedge, but a relatively large number contained only one species. Of 22 male crops, nine were found to contain only sedge and one only western wheatgrass. Of 16 female crops, five were found to contain only western wheatgrass and one only sedge.

Examination of crop contents of the whitecrossed grasshopper collected in desert prairie of southwest Texas revealed that buffalograss and blue grama were the main host plants. Other grasses found in the crops were burrograss, fall witchgrass, sideoats grama, hairy grama, and Sporobolus sp.

Direct observations have been made of feeding by the late instars and adults on several species of plants: western wheatgrass, needleandthread, blue grama, prairie junegrass, and needleleaf sedge. The usual method of attack is for grasshoppers to climb a mid grass, turn around head down, and feed on an edge leaving a narrow opposite edge standing as they progress toward the base. On blue grama they may turn around without climbing, because of its shortness, and feed toward the leaf base. They may also feed from a horizontal position on the grazed end of a leaf or stem, ingesting the whole width as they consume it to the base. Infrequently, grasshoppers have been observed to feed on dry fallen grass and on dry cow dung from a horizontal position. The whitecrossed grasshopper feeds on bran bait.



Geographic range of *Aulocara femoratum* Scudder

Dispersal and Migration

In spite of their relatively short wings, whitecrossed grasshoppers have the capacity to fly and disperse. In flushed flight they cover distances of 2 to 6 feet at heights of 4 to 10 inches. The flight is silent and straight with the grasshopper facing away from the intruder upon landing. Evidence for dispersal is the discovery of an “accidental” in a mountain site (altitude 8,500 feet) approximately 10 miles west of the closest resident site (altitude 5,450 feet) near Boulder, Colorado.

Identification

The whitecrossed grasshopper (Fig. 6 and 7) is a medium-sized species with a general appearance similar to *A. elliotti*. The head is noticeably large; most individuals have a dark vertical streak above the front articulation of the

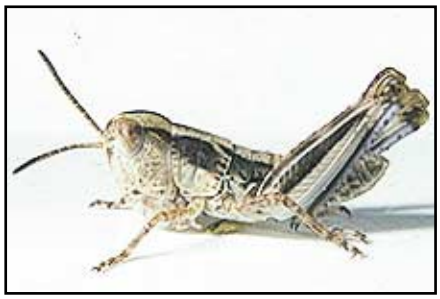
Instar 1

1. BL 6-6.8 mm FL 3.2-3.8 mm AS 13.

Instar 2

2. BL 6.8-8.6 mm FL 4.6-5 mm AS 16-17.

Instar 3

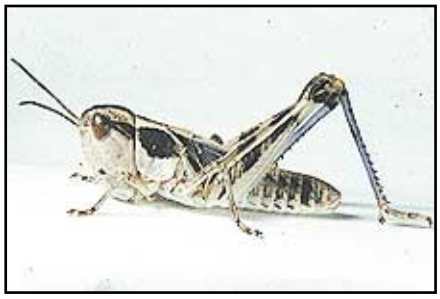


3. BL 9.1-9.9 mm FL 6.1-6.6 mm AS 20-21.

Female Instar 4

4. Males: BL 13-15 mm FL 7.8-8.3 mm AS 22-23.
Females: BL 11.9-15 mm FL 8.4-8.6 mm AS 22-23.

Female Instar 5



5. Females: BL 15-18.6 mm FL 10.5-11.5 mm AS 24.

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

mandible (short distance below the compound eye). The disk of the pronotum is dark and marked by light lines forming an X-like figure.

The wings usually do not reach the end of the abdomen; rare individuals have wings that extend past the abdomen. The posterior margin of the eighth abdominal sternum of the females has two deep clefts (Fig. 9), which is easily distinguishable from the eighth abdominal sternum of *Aulocara elliotti*. The hind femur is cream and conspicuously marked by three dark bands; the hind tibia is blue.

The nymphs (Fig. 1-5) are identifiable by their color patterns, structures, and shape.

1. Head with face moderately slanting; lateral feveolae quadrilateral, visible from above; antennae filiform; dorsum of head light tan, with fuscous middle band divided by narrow light tan stripe.
2. Pronotum with disk chiefly solid light tan in instars I to III, X-figure visible and fuscous triangle on each side of posterior area of disk in instars IV and V; lateral lobes fuscous dorsally and light tan or cream ventrally (Fig. 5).
3. Hind femur with fuscous dorsal stripe entire in instars I to III; broken or interrupted by light patches in instars IV and V; hind tibia of instars I and II two-toned gray, of instars III to V light blue.
4. Top of abdomen with light tan band continuing from disk of pronotum. Posterior margin of eighth abdominal sternum cleft in female instars IV and V, nearly as clear as in the adult female (Fig. 9).
5. General body color light tan or cream with highly contrasting fuscous markings.

Compared with nymphs of *A. elliotti*, the nymphs of the whitecrossed grasshopper are lighter colored with greater contrast between the background color and the fuscous markings. Nymphs of *A. elliotti* are mainly drab gray, which renders fuscous markings less contrasting.

Hatching

The whitecrossed grasshopper is an intermediate-hatching species. Emergence of first instars occurs 10 to 14 days after the appearance of A. elliotti in the habitat. In the mixedgrass prairie of Montana and Wyoming, hatching normally begins during the first week of June. The cause of the later hatch is due, at least partly, to the greater depth of whitecrossed grasshopper eggs in the soil relative to those of A. elliotti.

Nymphal Development

The nymphs emerge over a period of two weeks. They normally have plenty of green grasses available for food, and warm weather predominates during their development. The males have four nymphal instars and take a minimum of 30 days to become adults, while the females have five nymphal

Figures 6-10. Appearance of the adult male and female of *Aulocara femoratum*, color patterns of pronotal disk, eighth abdominal sternum showing deep clefts, egg pod and eggs.

instars and take a minimum of 42 days to become adults. Because the sizes at which males and females start out the nymphal stage are the same, the females require more developmental time and an additional instar to reach the female adult size, which is over threefold that of the male.

Adults and Reproduction

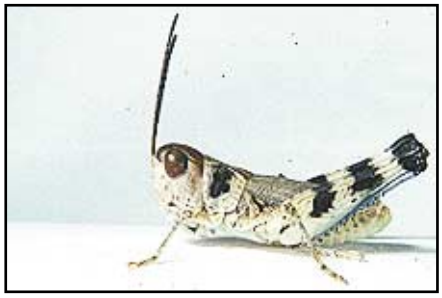
The adults remain in the same habitat in which the eggs hatched and the nymphs developed. In the mixedgrass prairie of Montana and Wyoming, the adult stage is reached during the first and second weeks of July. The males fledge first, and then the females. Upon maturing, the adults begin to mate and reproduce. Weekly observations in a mixedgrass prairie site (Goshen County, Wyoming T20N R60W Sec 3 NE) indicated that mating began three weeks after the fledging of females. During the morning hours the males chase after females, courting those that stop or are sitting quietly. The males court by movements of the hindlegs that resemble stridulation. Although sounds of stridulation have not been heard by human observers, female grasshoppers, which are within 2 inches of the source, may hear courtship signals or may visually detect movement of the hindlegs. No observation of successful engagement of the genitalia has been made. Pairs in copulo, however, have been seen during the morning as early as 10:30 a.m. and as late as 1:30 p.m., and attempts by the males to mate have been observed as late as 5:30 p.m. DST. For oviposition, a female selects a small (1 to 6 square inches), secluded, bare area surrounded by blue grama or other short grass, and faces into one of the plants. One observation of the entire process of oviposition, which took one hour, was made in a laboratory terrarium. The female selected bare ground and worked her abdomen into the soil to a depth of three-quarters inch. After extracting her ovipositor, she spent two minutes brushing soil and litter over the hole with her hind tarsi, and then she walked away. In nature, pods lie in the soil with the long axis oriented vertically and are inserted one-eighth inch below the ground surface and to a depth of three-quarters inch. The pods are nine-sixteenths to ten-sixteenths inch long and one-quarter inch in diameter (Fig. 10). The walls are unusually strong and thick. The cap is without a nipple (present in pods of *A. elliotti*). The egg mass, numbering 9 to 11 eggs, rests in the bottom half of the pod. The eggs are pale yellow and 4.7 to 5.2 mm long.

Overwintering of the species occurs in the egg stage; there is probably one generation annually. The fecundity of the whitecrossed grasshopper has not been studied.

Population Ecology

In the mixedgrass prairie, the whitecrossed grasshopper inhabits the more luxuriant vegetation types where there is a greater abundance of mid grasses such as western wheatgrass and needleandthread in addition to the dominant short grass, blue grama. Often associated with *A. elliotti* or *Metator pardalinus*, it is usually a subdominant member of a diverse assemblage of grasshoppers. As a subdominant it ranges in

Male

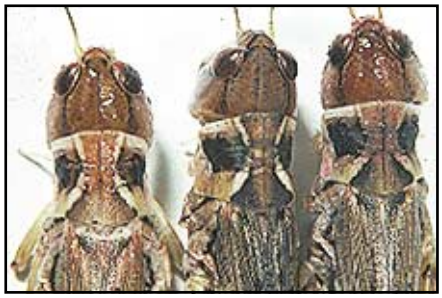


6. BL 15.1-17 mm FL 9.8-10.7 mm AS 24.

Female

7. BL 20-25 mm FL 12.2-14.6 mm AS 25.

Patterns



8. Variations of color patterns of pronotal disk.

Sternum

9. Shape of eighth abdominal sternum showing deep clefts.

Egg Pods

10. Two egg pods, one opened to show eggs.

density from 0.1 to 2 adults per square yard. It occasionally becomes the dominant species in Montana and Wyoming, ranging from 8 to 13 adults per square yard in assemblages of 20 to 25 per square yard. In a mixedgrass prairie site near Edgemont, South Dakota the species built up high numbers, reaching estimated densities of 10.5 late nymphs and adults per square yard in an assemblage of 21 grasshoppers per square yard.

It is of less frequent occurrence in mixedgrass prairie sites than *A. elliotti*. Of 278 sites surveyed in the mixedgrass prairie of Wyoming in 1990, five sites were inhabited by *A. femoratum* and 86 sites by *A. elliotti*. In 1991, of 419 sites surveyed, four sites were inhabited by *A. femoratum* and 47 sites by *A. elliotti*. The species appears to be more prevalent in Montana than in Wyoming. Of 38 study sites in the mixedgrass prairie of Montana, it inhabited nine sites and was dominant in two of these.

A three-year study (1949-51) of rangeland grasshopper populations in Montana revealed that the whitecrossed grasshopper can increase from low to high densities in one year, and then fall as suddenly the next year.

Daily Activities

The whitecrossed grasshopper is a geophilous insect spending most of the day and all of the night on the ground. At night both nymphs and adults rest on bare areas of 1 to 10 square inches interspersed among the grassy vegetation. They do not seek shelter under a canopy of vegetation, but are surrounded closely by the dominant short grasses and sedges. Environmental temperatures decline during the night and by early morning, before sunrise, reach lows around 60°F. Under these relatively cold conditions, the grasshoppers are immobile. About two hours after sunrise when the rays of the sun strike the grasshoppers on the ground, they stir and turn a side perpendicular to the rays and usually lower the associated hindleg to expose the abdomen. During this period they are mainly quiescent, but occasionally they walk to another location, turn around to expose the other side, or they may preen their antennae or compound eyes with the front tarsi. During the basking period, soil surface temperatures range from 60° to 90°F and air temperatures at the 1-inch level from 61° to 82°F. After their body temperatures rise to some preferred level, they become active and begin to walk, feed, court, and mate. The morning period of activity lasts for about two hours. Increasing temperatures cause activities to slow down and finally the grasshoppers are compelled to take protective measures. Several behavioral responses keep their body temperatures within tolerable levels. First, they may "stilt," raising up on their legs to hold their bodies off the hot soil surface. They may use all three pairs of legs, or they may use only the first two and raise the flexed hindlegs from contact with the soil. As temperatures rise still further, they may crawl onto a short grass or sedge and rest diagonally facing the sun. In this position they expose the least body surface to the rays of the sun and are 1 inch above the ground and away from hot, bare areas. They also may climb stems of mid grasses, such as western wheatgrass, to heights of 2 to 7 inches. Less often, they crawl into the shade of vegetation.

When temperatures decline in the afternoon, the grasshoppers again become active and when temperatures drop further, they bask. Finally, as the sun begins to set and shadows engulf the habitat, the grasshoppers take their nighttime positions on the ground or litter.

Table 1. Mean percent dry weight of plant fragments in crops of late nymphal and adult *Aulocara femoratum* collected during late morning in the mixedgrass prairie (Wyoming, Goshen County, T20N R60W Sec 3 NE).

	Mean percent dry weight food fragments		
Food Plant	**Instars IV & V**	**Adult males**	**Adult females**
needleleaf sedge	40	37	20
western wheatgrass	32	9	53
needleandthread	17	11	12
blue grama	4	23	1
buffalograss	1	19	9
red theeawn	5	0	0
Sandberg bluegrass	1	0	0
green needlegrass	0	0	5
number crops examined	23	22	16

Selected References

Alexander, G. and J. R. Hilliard, Jr. 1969. Altitudinal and seasonal distribution of Orthoptera in the Rocky Mountains of northern Colorado. Ecol. Monogr. 39: 385-431.

Anderson, N. L. 1973. The vegetation of rangeland sites associated with some grasshopper studies in Montana. Montana Agr. Exp. Stn. Bull. 668.

Anderson, N. L. and J. C. Wright. 1952. Grasshopper investigations on Montana range lands. Montana Agr. Exp. Stn. Bull. 486.

Fry, B., A. Joern and P. L. Parker. 1978. Grasshopper food web analysis: use of carbon isotope ratios to examine feeding relationships among terrestrial herbivores. Ecology 59: 498-506.

Larsen, J. C., J. A. Hutchason, and T. McNary. 1988. The Wyoming Grasshopper Information System. Cooperative Agricultural Pest Survey, University of Wyoming, Laramie.

Otte, D. 1970. A comparative study of communicative behavior in grasshoppers. Univ. Michigan Mus. Zool. Misc. Publ. 141.