

Bigheaded Grasshopper

Aulocara ellioti (Thomas)

Distribution and Habitat

The bigheaded grasshopper, *Aulocara ellioti* (Thomas), distributed widely in western North America, inhabits a variety of grasslands from southern Canada to central Mexico. Large populations develop in the desert, mixedgrass, shortgrass, and bunchgrass prairies.

Economic Importance

The bigheaded grasshopper is a serious pest of grasses. It is often the dominant species in outbreaks on rangeland. Survey records reveal that it may reach densities of 20 per square yard in the mixedgrass prairie and 40 per square yard in desert grassland. Such high densities destroy the value of rangeland for grazing of livestock and may even lay the land bare, opening it to wind and water erosion. More often, the bigheaded grasshopper is destructive at lesser densities as a dominant member of an assemblage of species. Although medium sized for a grasshopper, it is one of the largest of the graminivorous species. Live weights of females inhabiting the mixed-grass prairie range from 285 to 663 mg (average 476 mg) and of males 131 to 230 mg (average 189 mg). Dry weights of females average 144 mg and of males 52 mg. In the desert grasslands of Arizona the bigheaded grasshopper grows even larger.

This grasshopper not only reduces grass forage by consuming it but also by cutting it down. The cut grass may become litter but it may also be used for food by

grasshoppers including the bigheaded grasshopper and by other insects that feed on the ground. Field cage tests run in Montana and in Wyoming have demonstrated that the feeding activity of one bigheaded grasshopper per square yard reduces grass forage equal to 20 pounds dry weight per acre. In this area of the mixedgrass prairie, annual forage production averages 600 pounds dry weight per acre.

Food Habits

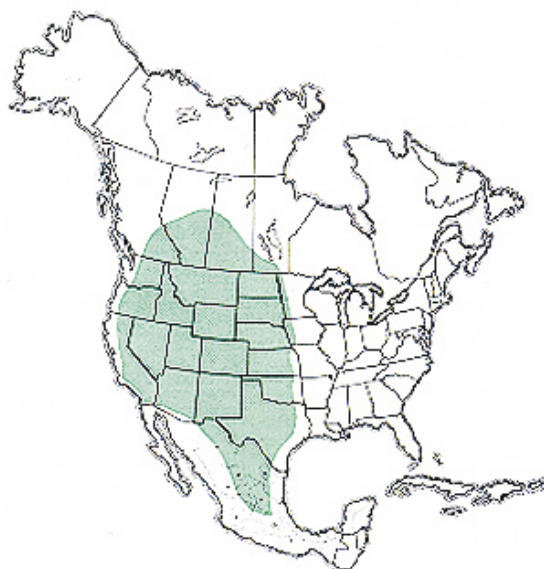
The bigheaded grasshopper feeds mainly on the green leaves of grasses and sedges. It often attacks a plant by climbing a blade, turning around head down, and chewing into the leaf at various distances from the tip. The grasshopper frequently cuts the leaf, which drops to the ground. The insect may then continue to feed on the attached section of the leaf. The bigheaded grasshopper also feeds on ground litter - cut grass leaves (green or dry), seeds, bran, and even dead grasshoppers. It searches these out while crawling about on bare ground.

Microscopic examinations of crop contents of older nymphs and adults show that the majority of crops contain fragments of more than one plant species (average 2.2). Although these determinations indicate that the bigheaded grasshopper is obtaining a mixed diet, one species of plant is most abundant in a crop. Depending on availability, the bigheaded grasshopper grazes heavily on blue grama, western wheatgrass, needleandthread, thread-leaf sedge, and needleleaf sedge. Crested wheatgrass, an introduced forage plant, is a preferred and nutritious host. From direct observations and crop examinations, this grasshopper is known to feed on two species of sedges and 22 species of grasses.

Migration and Dispersal

With fully developed wings, adults of the bigheaded grasshopper are able to fly evasively, to disperse, and to migrate. Flushed by an intruder, the adults fly straight, silently, low (4 to 12 inches), and short distances (2 to 7 feet). Evasive flights may be with the wind, into the wind, or across the wind.

Although no specific investigations of dispersal and migration of the bigheaded grasshopper have been made, evidence of long distance movements has been found incidental to other studies. At two locations, one in Arizona and one in Wyoming, sites that were found with no or few bigheaded grasshoppers at one sampling date had high densities of adults a few days later. Migrants in Arizona have been recorded as traveling



Geographic range of *Aulocara ellioti* (Thomas)

Instar 1



1. BL 5-6.3 mm FL 3.3-3.6 mm AS 14.

Instar 2



2. BL 6.6-9.8 mm FL 4.5-5.3 mm AS 18-19.

Instar 3



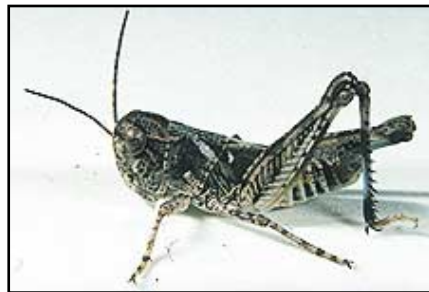
3. BL 9.8-12.2 mm FL 6.3-7.2 mm AS 20-21.

Instar 4



4. BL 12.5-16 mm FL 8.3-9 mm AS 22-23.

Instar 5



5. BL 14.5-19.5 mm FL 9.5-11.1 mm AS 22-25.

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

distances of one to seven miles. Evidence of mass migration by the bigheaded grasshopper is provided by the recent discovery of large numbers of adults preserved on the ice of Grasshopper Glacier in the Crazy Mountains of Montana. Presumably swarms of the bigheaded grasshopper arose from areas of the mixedgrass prairie lying northeast of the mountains at lower altitudes, where outbreaks occur repeatedly.

Identification

Adults of the bigheaded grasshopper are of medium size and usually colored gray with fuscous markings. They possess relatively large heads with slightly slanted faces and have spotted forewings that extend slightly beyond the abdomen. The disk of the pronotum is distinctively marked by light lines that give the appearance of an "X"; several other patterns, however, exist in every population (Fig. 8). The hind femur has two black bars on the upper part of medial area; bars continue on upper marginal area, and around onto inner medial area; the knee is black. The hind tibia is medium blue. The male (Fig. 6) is smaller than the female (Fig. 7).

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

- (1) Head with lateral foveolae triangular and visible in dorsal view; antennae filiform but flattened; face moderately slanted.
- (2) Pronotum with disk patterns like the adults, chiefly with light lines in form of an "X."
- (3) Hind femur with two dark bars on upper part of medial area and four to seven dark spots on lower carinula. Hind tibia blue with three dark annuli.
- (4) Color drab gray and tan with fuscous markings.

A. eliotti nymphs can be separated from *A. femoratum* nymphs mainly through differences in coloration. Adult females of *A. eliotti* and *A. femoratum* are distinguishable by the shape of the posterior margin of the eighth abdominal sternum. In *A. eliotti* the posterior margin is without deep clefts (Fig. 9); in *A. femoratum* the posterior margin has two deep clefts.

Figures 6-10. Appearance of the adult male and female of *A. eliotti*, diagnostic characters, and the egg pod and several eggs shown in situs in the opened pod.

Hatching

The bigheaded grasshopper is an early-hatching species. Eggs begin embryonic growth in the summer of deposition and continue until they attain 50 percent of development (stage 19 embryo). Because the eggs are laid in early summer and at a shallow depth (average depth three-eighths inch), they are exposed to warm temperatures and most reach the advanced stage before they diapause. Eggs are able to survive desiccation during drought periods of summer and fall, but predators - birds, rodents, beetles, bee flies, and others - take a large toll. Due to predation, density of eggs decreases 54 percent between fall and spring.

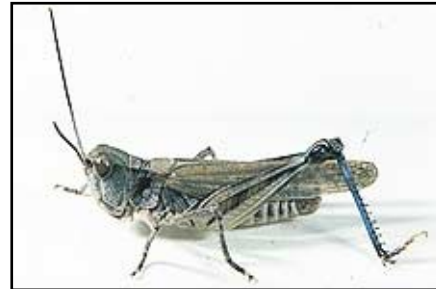
Exposed to low soil temperatures, eggs break diapause during winter. In the laboratory eggs held at 37° to 41°F break diapause in 80 days. With warming spring temperatures, the soil temperature rising to 50°F and above, the eggs resume embryonic development. They complete the process after exposure to 450 day-degrees (base 50°F) of heat and are ready to hatch. Emergence of the first instars occurs in mid-spring mainly during morning hours, and especially when the temperature is rising rapidly and the soil is moist. Eggs of a particular pod hatch in succession within seconds of each other. On the surface of the soil the young grasshopper squirms to free itself from the embryonic membrane. It usually takes six to eight minutes to complete this process and crawl away. During this time the young grasshopper is vulnerable to predation by ants.

Nymphal Development

Nymphs emerge in mid-spring over a period of three to four weeks. They feed and develop in the same area as they hatch. Nurtured by warm spring weather and nutritious green grass, they complete nymphal development in 36 to 42 days. The males, usually with only four instars, reach the adult stage sooner than the females with five instars.

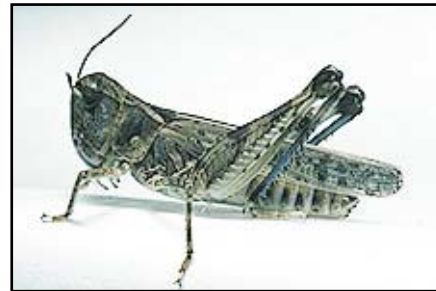
Adults and Reproduction

Adults of the bigheaded grasshopper may disperse to new habitats, but most often they remain in the same area where the nymphs hatched and developed. There they feed, mature, reproduce, and eventually are eaten by a predator or die from other causes.



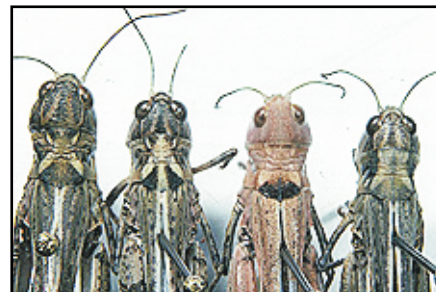
Male

6. BL 17-20 mm FL 9.5-11.3 mm AS 23-24.



Female

7. BL 20.5-22 mm FL 12.3-14.3 mm AS 24-25.



Patterns

8. Dorsal view, pattern variations of pronotal disk.



Sternum

9. Ventral view, shape of eighth abdominal sternum.



Egg Pods

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

Female adults become receptive to mating when they are six to eight days old. Pair formation and courtship consists primarily of visual cues. Normally the male makes a quick approach to the female and silently displays himself by tipping the hind femora and waving the antennae. Once the male mounts and succeeds in making genital contact, copulation lasts 40 to 70 minutes.

Females deposit their first group of eggs when they are 12 to 20 days old (average 15 days). When ready to lay eggs a female will select one of the many bare areas in her habitat and work her ovipositor into the soil. She then deposits in the top one-half inch of soil seven to nine eggs, which become enclosed in a tough pod. Immediately after ovipositing a female spends a minute actively sweeping soil particles over the hole left by the extraction of her ovipositor. She performs this final act of maternal care with her hindlegs using the tarsi as brushes.

Fecundity of the bigheaded grasshopper is less than that of the migratory grasshopper. When pairs were reared individually in field cages and fed leaves of western wheatgrass, females lived an average of 72 days and produced 76 eggs per female. When they were fed wheat leaves, females lived an average of 87 days and produced 116 eggs. The greatest reproduction - 161 eggs - was achieved by a female fed wheat leaves. Unprotected from predators in their natural habitat, individuals have a shorter life and lower fecundity. Under natural conditions, research suggests an average adult longevity of approximately 20 days and a fecundity of 15 eggs per female. There is one generation annually.

The pod is slightly curved, one-half to five-eighths inch long and three-sixteenths inch in diameter (Fig. 10). The pod cap has a short nipple in the center. Eggs are pale yellow and 5.2 to 5.5 mm long.

Population Ecology

Populations of the bigheaded grasshopper irrupt frequently in the mixedgrass and desert prairies. Populations may increase gradually, doubling their numbers each year for a period of three or four years. Then in one year they may increase their densities by

three or four fold precipitating an outbreak. Several hypotheses have been proposed to explain these outbreaks - increase in physiological vigor of the grasshopper, changes in nutritive composition of the vegetation, and environmental release (favorable weather and fewer enemies). Scientists doing research on population ecology have yet to gather enough data to make firm conclusions on the causes of these outbreaks.

Once the bigheaded grasshopper has reached an outbreak condition, the population may continue at high densities for five or more years. For generally unknown reasons, populations eventually decline or crash. In a few cases, however, causes are apparent. Naturally occurring diseases such as *Nosema* may decimate populations, and insecticidal control can reduce densities much below the economic level.

Daily Activity

The bigheaded grasshopper is a ground-loving insect whose activities are influenced greatly by temperature and light. Individuals rest on the ground at night. One to two hours after sunrise they begin basking by resting perpendicular to the rays of the sun (side exposed to sun), lowering the associated flexed hindleg to expose more of the abdomen, and hugging the ground surface. They bask for about an hour, then around 70°F air and 95°F soil surface temperatures, the adults begin their normal activities of pottering (intermittent wandering with frequent changes in direction), feeding, mating, and egg laying. Activity slows when air temperatures rise to 90°F and soil temperatures to 120°F. First, they may stilt by raising up on their legs and holding their bodies off the hot ground. As temperatures rise they leave the bare ground and move into shade of small shrubs. There they rest quietly on the bare soil or litter. When temperatures decline in the afternoon, they again take up normal activities. Two to three hours before sunset they begin basking once more on the ground surface. After sunset they remain on the ground without cover through the night.

Selected References

- Fisher, J.R. 1992. Location of egg pods of *Aulocara elliotti* (Orthoptera: Acrididae) in a field of crested wheatgrass in Montana. *J. Kansas Entomol. Soc.* 65: 416-420.
- Hewitt, G. B. 1978. Reduction of western wheatgrass by the feeding of two rangeland grasshoppers, *Aulocara elliotti* and *Melanoplus infantilis*. *J. Econ. Entomol.* 71: 419-421.
- Hussain, N. and R. E. Pfadt. 1976. The utilization of food by bigheaded grasshopper, *Aulocara elliotti* (Thomas). *Pakistan J. Forestry* 26: 171-176.
- Kemp, W. P. and N. E. Sanchez. 1987. Differences in post-diapause thermal requirements for eggs of two rangeland grasshoppers. *Can. Entomol.* 119: 653-661.
- Onsager, J. A. and G. B. Hewitt. 1982. Rangeland grasshoppers: average longevity and daily rate of mortality among six species in nature. *Environ. Entomol.* 11: 127-133.
- Pfadt, R. E. 1949. Food-plants, distribution, and abundance of the big-headed grasshopper, *Aulocara elliotti* (Thos.). *J. Kansas Entomol. Soc.* 22: 69-74.
- Van Horn, S. Neumann. 1966. Studies on the embryogenesis of *Aulocara elliotti* (Thomas) (Orthoptera, Acrididae). I. External morphogenesis. *J. Morph.* 120: 83-114.