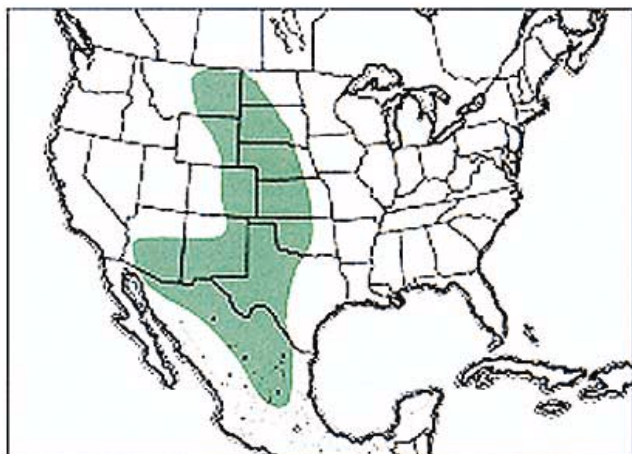


Ebony Grasshopper

Boopedon nubilum (Say)

Distribution and Habitat

The ebony grasshopper ranges widely in the grasslands of the West from Montana to Mexico. The species lives in several types of grasslands including the mixedgrass, shortgrass, sand, and desert prairies, preferring to occupy the more luxuriant stands of these habitats.



Geographic range of *Boopedon nubilum* (Say)

Economic Importance

The ebony grasshopper at high densities can be a pest of rangeland forage. Injurious infestations usually consist of an assemblage of grasshoppers in which the ebony grasshopper is one of several abundant species. Irruptions of the ebony grasshopper occur most often in the southern mixedgrass and desert prairies and may last for several consecutive years. The affected region includes the states of Arizona and New Mexico and western Kansas, Oklahoma, and Texas.

In 1955 a severe outbreak of grasshoppers occurred on rangeland of western Oklahoma in which four species were dominant: *Ageneotettix deorum*, *Aulocara elliotti*, *Boopedon nubilum*, and *Phliobostroma quadrimaculatum*. Rangeland grasshoppers became abundant again in 1973-79 on 1.5 million acres of prairie in western Oklahoma in which the ebony grasshopper was again a prominent member of the assemblage.

In 1956 an irruption occurred on the desert prairie of San Rafael Valley, Arizona. The assemblage of grasshoppers numbered 46 young adults per square yard and consisted of five principal species. Density of young adults per square yard were estimated to be 13.4 *Boopedon flaviventris*, 4.2 *Boopedon nubilum*, 4.6 *Phliobostroma quadrimaculatum*, 2.6 *Trachyrhachys kiowa*, 19 *Melanoplus lakinus*, and 2.6 *Melanoplus* spp. The loss of grass forage due to the whole assemblage of grasshoppers amounted to an estimated 600 lb

dry weight per acre. In Arizona the ebony grasshopper has been found also in cultivated areas of corn, sorghum, and wheat.

The ebony grasshopper is a large species. Live weight of young males collected in bunchgrass prairie of northcentral Wyoming averaged 580 mg and of young females 1,452 mg.

Food Habits

The ebony grasshopper is a fastidious grass feeder. In the desert prairie of southwestern Texas, ebony grasshoppers have been found to consume large amounts of blue grama. Examination of crops of adults revealed that contents consisted of 57 percent blue grama, 17 percent buffalograss, 9 percent common fallwitchgrass, 8 percent bristlegrass, 6 percent common burrograss, and 3 percent hairy grama. From pastures of the Nebraska North Platte Agricultural Experiment Station, a huge number of crops (1,379) were examined to disclose a 72 percent preponderance of western wheatgrass fragments. Other grasses detected in the crops were: needleandthread, 7 percent; blue grama, 5 percent; sand dropseed, 4 percent; prairie sandreed, 4 percent; threadleaf sedge, 3 percent; and witchgrass, 1 percent.

More discriminating than most grass-feeding grasshoppers, ebony grasshoppers in two-choice tests showed decided preferences for certain species of grasses and refused others. Young adults collected from a bunchgrass prairie site 1 mile east of Shell, Wyoming preferred the leaves of blue grama, needleandthread, downy brome, and young wheat. When these plants were available in two-choice tests, the grasshoppers refused to feed on western wheatgrass, crested wheatgrass, Kentucky bluegrass, and foxtail barley. Paired with young wheat (variety Buckskin), the grasshoppers ate less than 5 percent of young cultivated barley (variety Klages). The observation that this grasshopper fed heavily on western wheatgrass in central Nebraska but refused it in food preference tests in Wyoming is perplexing.

Observation of feeding by three instar V females in the Shell, Wyoming site revealed that they climbed an inch or two onto the grass leaf, bit through the leaf, held onto the cut section with the front tarsi, and consumed it entirely. While feeding, the nymph was vertical, head-up on the leaf, but one nymph turned around, head-down, and fed close to the leaf base. The ebony grasshopper was not observed to clip and waste leaves.

Dispersal and Migration

Wings of the male ebony grasshopper are long and functional but the female's are usually short and flightless. In spite of the female's lack of ability to fly,

Instar 1



1. BL 6.4-8.1 mm FL 3.7-4.4 mm AS 13-14.

Instar 2



2. BL 9-11 mm FL 5.3-6.8 mm AS 16-17.

Instar 3



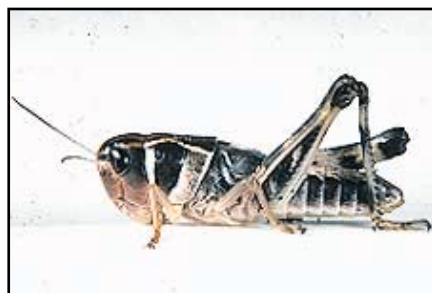
3. BL 11-15 mm FL 9 mm AS 19-21.

Instar 4



4. BL 12-24 mm FL 8.4-11.8 mm AS 21-23.

Instar 5



5. BL 17.8-29 mm FL 10.4-14.5 mm AS 23-25.

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

whole populations can disperse or migrate by walking. Displacements of late instars and adults were observed in San Rafael Valley, Arizona in 1956, 1965, and 1966. In the wet season of 1966 the grasshoppers carried out a gradual dispersal, but after denuding their habitat in the dry seasons of 1956 and 1965, they rapidly migrated across low hills to other sources of forage.

A small percentage of females possess long wings that may surpass the tip of the abdomen. Presumably these females are capable of flight. Flying females would account for the widespread occurrence of the species. Males have already been found to disperse long distances. An "accidental" male was captured July 1959, 8 miles west of a pasture north of Boulder, Colorado harboring a resident population. Flushed flight of the males is swift and strong. They fly straight and silently at heights of approximately 12 inches and for distances of 6 to 9 feet.

Identification

The male (Fig. 7) is a strikingly black grasshopper with functional wings (Fig. 9). The disk of the hind wing is pale blue and the apical area black. The hind tibia may be entirely black or multi-colored, and either black and red, or cream, black, and red. The female is a large, pale brown grasshopper with short, nonfunctional wings (Fig. 8). A small percentage of females may possess long wings. The sulci of lateral lobes of females are black as are the crescents of the hind knees. A few females of each population are dark brown or black.

The nymphs are identifiable by their shape, structures, and color patterns (Fig. 1-6).

1. Head large with face moderately slanted; face tan, side of the head black, triangular black spot above base of each antenna, top of head tan.
2. Pronotum without lateral carinae but position indicated by light lines; lateral lobe with inverted black triangular marking, upper side 2/3 or less width of lobe, lateral sides straight, not incurved.
3. Hind femur with dorsal stripe of medial area nearly solid black; tibia with three rings of pale yellow and three rings of black, sometimes tinged with red.
4. Dorsum with a wide tan band; venter is pale yellow.

Figures 6-10. Appearance of the black female fifth instar, adult male, adult female, detached wings of male, and egg pod and loose eggs.

Hatching

The ebony grasshopper is a late-hatching species. In the mixedgrass prairie of eastern Colorado and western Kansas, the eggs begin to hatch the last of May or the first half of June, about two to three weeks after *Melanoplus sanguinipes*. In Larimer County, Colorado, at an altitude of 5,200 feet, hatching began 22 June 1993. In the San Rafael Valley of Arizona (elevation 5,000 feet) hatching did not begin until 22 July 1965, about ten days after 1.24 inches of rain fell, providing the eggs with a good wetting, and in 1966 July 28 ten days after 1.67 inches of rain fell. In Arizona the ebony grasshopper is classified as a summer-developing grasshopper along with several other species that delay hatching until rains soak the eggs thoroughly.

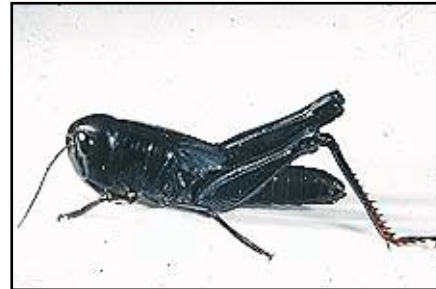
Nymphal Development

Nymphs of the ebony grasshopper develop through five instars. In 1993 in the mixedgrass prairie of eastern Colorado, the nymphal period took a minimum of 40 days. In the San Rafael Valley, Arizona ebony nymphs completed development in only 27 days in 1965 and 31 days in 1966.

Adults and Reproduction

Adult ebony grasshoppers usually remain in the same habitat in which they develop as nymphs. Apparently preferring thick stands of mixedgrass prairie for habitation and an abundance of green grass for food, they are not prone to wander or disperse unless food shortages occur. In mixedgrass prairie of Larimer County, Colorado, the adults begin to emerge from mid to late July. In this study site five adult males and three adult females, in addition to 57 nymphs, were captured on 15 July 1987, while on 31 July 1993 only one adult female and three nymphs were captured. The appearance of adults is delayed in the San Rafael Valley because of the late hatch. The nymphs, however, develop rapidly and in 1965, adults appeared by 18 August.

Only a few isolated facts are known about the maturation of adults. An examination of the ovaries of 20 females revealed eggs present 21 days after the adults began to appear in the San Rafael Valley. Collected from bunchgrass prairie in northcentral Wyoming, a female fifth instar and two male adults were caged, fed young wheat leaves (Buckskin), and allowed to reproduce. The female laid a pod of 44 eggs by the age of 40 days. During her adult lifetime of 62 days, she produced three pods for a total of



6. Black female nymph, instar V.

Instar 5



7. BL 22-22.5 mm FL 15 mm AS 24-25.

Male



8. BL 36-38 mm FL 19.5-21 mm AS 25-26.

Female



9. Detached wings of male.

Wings



10. Egg pod and several loose eggs.

Egg pod

134 eggs. Females caged in San Rafael Valley produced multiple pods that contained from 38 to 62 eggs each.

Females in San Rafael Valley have been observed to deposit pods in bare soil between clumps of grass and sod during summer and autumn. The eggs overwinter and hatch the following summer. The pods are large, 1 7/8 to 2 inches long and 3/16 to 1/4 inch in diameter. The dark brown eggs are 6.5 to 7.7 mm long. Covered by secretions of the female, the lower section of the pod is dark brown (Fig. 10).

Population Ecology

The ebony grasshopper inhabits western grasslands in company with several other rangeland grasshoppers. Its widespread distribution places many populations in dissimilar environments and under different environmental stresses. In southern Arizona, drought and parasites cause significant mortality. A ten-year study (1956-1965) of the population ecology of the ebony grasshopper disclosed significant annual fluctuations in density (Table 1). Six out of ten years the population was depressed apparently by heavy burdens of the parasite *Neorhynchocephalus*

Table 1. Population density of the ebony grasshopper on rangeland of San Rafael Valley, Arizona (Adapted from Nerney and Hamilton)

Year	No/sq yd	Percent parasitized by
		<i>Neorhynchocephalus sackenii</i>
1956	4.20	21
1957	.09	17
1958	.08	23
1959	.05	0
1960	.13	0
1961	.28	0
1962	.62	0
1963	2.96	17
1964	2.11	40
1965	.48	33

sackenii. This dipterous larval parasite feeds on the internal organs of the grasshopper, preventing the female from developing eggs and eventually killing its host. Application of insecticide caused the drastic reduction of density in 1956.

The ebony grasshopper is normally subdominant numerically in an assemblage of rangeland grasshoppers. Smaller species are usually more numerous, such as *Ageneotettix deorum*, *Opeia obscura*, *Amphitornus coloradus*, and *Aulocara elliotti*. Because of the large size of the ebony grasshopper, it may, however, exceed the total biomass of a smaller species.

One record of the ebony grasshopper being numerically dominant occurred in 1995 in an assemblage inhabiting the bunchgrass prairie of northcentral Wyoming. Four species of the assemblage were estimated to have the following densities of young adults per square yard: *B. nubilum*, 5.2; *Aulocara femoratum*, 1.2; *Ageneotettix deorum*, 0.4; and *Melanoplus occidentalis*, 0.2.

Daily Activities

In its northern range, the ebony grasshopper takes shelter at night in canopies of grasses and low shrubs. Shortly after sunrise, individuals emerge and begin to bask. They turn a side perpendicular to the sun but have not been seen to lower the associated hindleg to expose more of the abdomen as do many other species of grasshoppers. Basking may continue for two hours after which late nymphal females do much stirring, preening of the compound eyes, vibrating of the hindlegs, and intermittent walking with distances ranging from 2 to 12 inches. When soil temperatures rise to 90°F and air to 80°F, at about 9 a.m. DST, the grasshoppers take evasive action. They may remain on the ground and face directly into or away from the sun or they may seek the shade of vegetation by crawling into clumps of grass or into the canopy of small shrubs. Feeding has been observed only three times and only in the evening from 5:30 to 6:30 p.m. Because the female nymphs were close to molting to the adult stage, they probably were not feeding with normal duration and frequency. Shortly before sunset the grasshoppers enter shelters for the night.

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