Differential Grasshopper

Melanoplus differentialis (Thomas)

Distribution and Habitat

The differential grasshopper, *Melanoplus differentialis* (Thomas), ranges widely in North America. Originally restricted to tall herbaceous vegetation growing in wet meadows, swales, and creek bottom lands, the species spread into the weedy vegetation of crop borders, roadsides, and reversions brought about by settlement and agricultural development. In the United States large populations develop in extensive areas of cropland located between the Rocky Mountains and the Mississippi River. Populations east and west of these landmarks are spotty and discontinuous.

Economic Importance

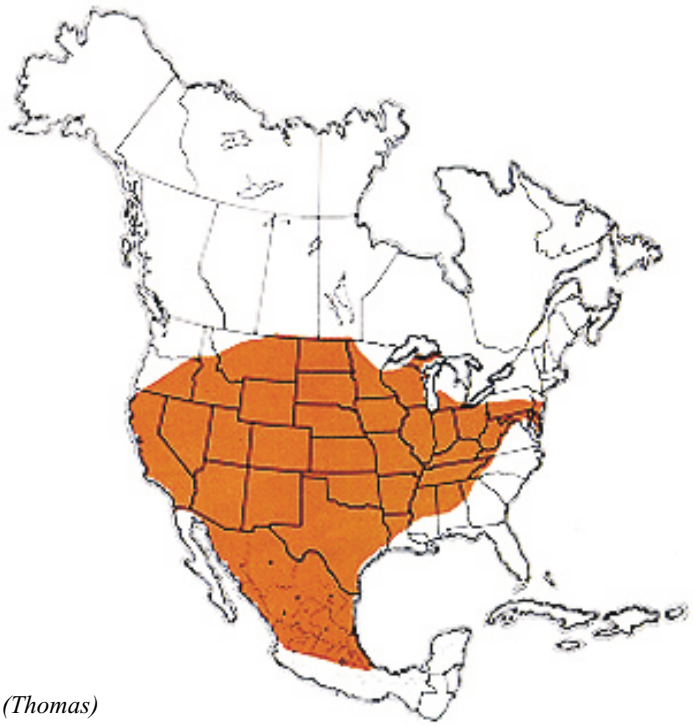
The differential grasshopper is a severe pest of crops including small grains, corn, alfalfa, soybeans, cotton, various vegetables, and deciduous fruit trees. During outbreaks in northern states such as Nebraska and South Dakota, it and the twostriped grasshopper may increase in nearly equal numbers. The nymphs attack small grains, alfalfa, and other hay crops. After they become adults and have destroyed these crops, the grasshoppers fly into corn. A dense swarm will destroy a young cornfield in just three or four days. In southern states, such as Oklahoma and Missouri, the differential grasshopper outnumbers the twostriped and is responsible for much damage of alfalfa, corn, and cotton.

Food Habits

The differential grasshopper is a polyphagous insect feeding on both grasses and forbs. Microscopic examinations of crop contents show that it usually consumes more forbs than grasses. When fed a mixture of forbs in the laboratory, the differential grasshopper develops faster, grows larger, and produces more eggs than when fed a mixture of grasses. It also does well on single plant diets of common sunflower, soybean, and wheat plants, but not alfalfa. In laboratory tests the differential grasshopper readily eats several species of forbs and grasses while it rejects others. Among its host plants are representatives from several plant families, but members of the Compositae appear to be the most important, including giant ragweed, blood ragweed, common sunflower, and prickly lettuce. The preference of the differential grasshopper for wilted or damaged sunflower, often observed in the field, is probably due to chemical changes in the wilted tissues such as increases in sugar and in amino acids.

Migratory Habits

The differential grasshopper is a mobile insect in both its nymphal and adult stages. After hatching from eggs concentrated in field borders and roadsides, the nymphs, third instars and older, often move into fields of barley,



Geographic range of
Melanoplus differentialis (Thomas)

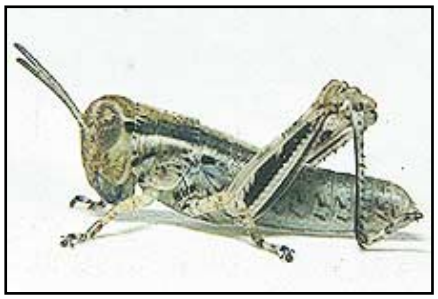
Instar 1

1. BL 5.3-6 mm FL 2.2-2.4 mm AS 12-14.

Instar 2

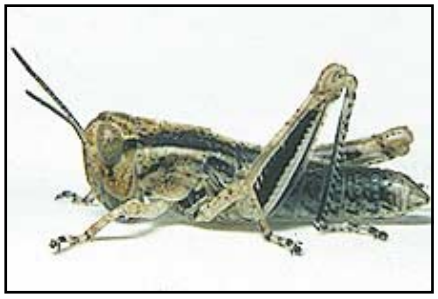
2. BL 5.2-6.8 mm FL 3.4-3.6 mm AS 14-17.

Instar 3



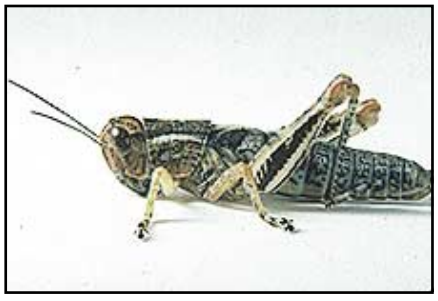
3. BL 9.4-12.6 mm FL 5.0-5.1 mm AS 19-20.

Instar 4



4. BL 12-14 mm FL 5.9-7.1 mm AS 21-22.

Instar 5



5. BL 18-21.5 mm FL 10.5-11 mm AS 25-26.

Figures 1-6. Appearance of the six nymphal instars of *M. differentialis* - their sizes, structures, and color patterns. Notice progressive development of the wing pads. BL = body length, FL = hind femur length, AS = antennal segments number.

wheat, and alfalfa by crawling and hopping. All go in the same direction as a cohesive band.

Adults display strong powers of flight. In search for green food, they may move upwind in short, low flights of 10 to 100 yards toward green corn. These flights begin around 9 a.m. and reach a peak when temperatures rise to 81°F.

Flight also provides escape from extreme heat of temperatures above 86°F. Grasshoppers rise and mill about in calm air or fly with the wind. They have been seen by airplane pilots as high as 1,400 feet above the ground, but most have been seen below 600 feet. In 1939 the differential grasshopper migrated northward by successive short flights from along the Missouri River in southeastern South Dakota to as far north as Pierre, South Dakota, a distance of 130 miles. In North Dakota one differential grasshopper of a marked group was recovered 20 miles from the point of release two days after its liberation. During outbreaks of this species adults have longer wings and slimmer bodies.

Identification

The adult differential grasshopper is a large yellow insect with black markings. The chevron-like markings on the hind femur are diagnostic as is also the shape of the male cercus. A few individuals in populations are melanistic (black) through their nymphal and adult stages (Fig. 8).

The adult male (Fig. 7) is identifiable by the shape of the cercus (Fig. 9) and both male and female by the black chevrons on the hind femur. A melanistic female is pictured in Figure 8. The majority of females are yellow with black markings like the male shown in Figure 7.

The nymphs (Fig. 1-6) are identifiable by their spots, stripes, and color patterns:

(1) Compound eye brown with light tan spots; lacking transverse dark band.

(2) Front of head green, yellow, or tan often with dark spots and a few larger markings.

(3) Pronotum with pale yellow, horizontal stripe at top of lateral lobe; brown band at edge of pronotal disk; narrow, median pale yellow stripe on pronotum, mesonotum, metanotum, and continuing on to abdomen various distances.

(4) Gena with short, pale yellow band below compound eye and continuous with pale yellow stripe of lateral lobe. Band faint or lacking in fifth and sixth instars.

Figures 7-10. Appearance of the adult male and a melanistic female of *M. differentialis*, the male cercus, a diagnostic character, and the egg pod and several loose eggs.

(5) Black stripe of hind femur occupying center of medial area in first to fourth instars; black chevrons beginning to be evident in fifth and sixth instars. Black stripe in first instar often interrupted by pale band.

(6) Hind tibia light green or light gray to gray.

(7) General color pale green, pale yellow, or tan; many fuscous markings.

Hatching

Eggs of the differential grasshopper begin to hatch in late spring about two weeks after eggs of the migratory grasshopper and three weeks after eggs of the twostriped grasshopper. The eggs start embryonic growth in the summer of deposition and attain a maximum development of 54 percent at which point they diapause. The majority of eggs hatch within a period of two weeks.

Nymphal Development

Exposed to high temperatures of early summer, the nymphs grow rapidly and become adult after about 32 days. Because development is well synchronized, a large percentage of the nymphs transform to winged adults in just a few days.

Adults and Reproduction

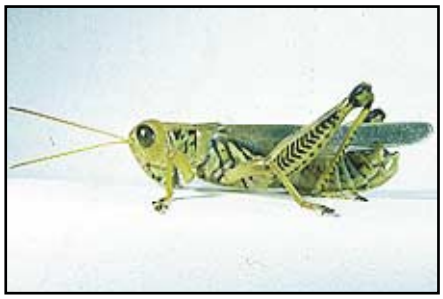
After fledging, the adults often fly into cornfields where for several weeks they feed and increase in weight. During this time their ovaries or testes mature. Pairs form in the morning and may often continue copulation for 20 to 24 hours. The females seek adjacent sod land or rank weeds for oviposition. A female ready to lay eggs may brace herself in a vertical position against a grass or weed stalk and work her ovipositor down into the soil. She then deposits from 45 to 194 eggs among the roots and forms a large pod for their protection (Fig. 10).

Egg pods of the differential grasshopper are curved, one and one-half inches long and one-quarter inch in diameter. They are fragile and easily broken in sifting them from the soil. The eggs are olive and 4.4 to 5.1 mm long. In separate laboratory experiments, females fed a single plant diet of soybeans averaged 305 eggs each while those fed common sunflower averaged 591 eggs each. The maximum number of eggs deposited by a single female fed soybean was 645 and the maximum number of pods was six. The number of eggs laid by females in nature is unknown. There is one generation annually.

Instar 6

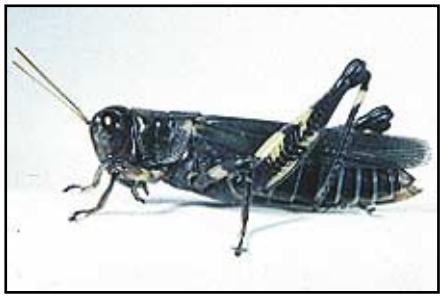
6. BL 22-32 mm FL 13-15.5 mm AS 26.

Male



7. BL 30-33 mm FL 15-17 mm AS 27-28.

Female



8. BL 32-41 mm FL 16.5-19 mm AS 26-28.

Note Cercus

9. Side view end of male abdomen.

Egg pod

10. Egg pod and several loose eggs.

Population Ecology

Comparison of the differential grasshopper's ecology with that of the twostriped grasshopper indicates that for several reasons the differential is better adapted to warmer climates: (1) even though the distributions of the two species overlap extensively, the differential grasshopper ranges farther south while the twostriped ranges farther north; (2) outbreaks of the differential grasshopper occur more frequently in the south, the twostriped occur more in the north; (3) the differential grasshopper requires more heat units for its development and tolerates higher temperatures than the twostriped.

The high biotic potential of the differential grasshopper is evident in the records of an outbreak that occurred more than 50 years ago in Missouri. In 1934 the differential grasshopper was present in noneconomic numbers. In 1935 this species became more numerous, damaging fall wheat and alfalfa. The warm, dry summer and fall of 1935 provided favorable conditions for egg production. The next year, 1936, spring rains and warm temperatures allowed a successful hatch and nymphal development that precipitated the worst outbreak of grasshoppers in Missouri since the years of the Rocky Mountain locust. Favorable weather continued and allowed the differential grasshopper to stay at outbreak numbers in 1937; the fall egg survey that year showed the greatest density of eggs ever. In 1937 the eggs hatched but this period was followed by rains and cool weather. The emerged nymphs died ending the outbreak.

Daily Activity

The differential grasshopper is inactive at night resting high up on vegetation. When temperatures reach 65°F on clear mornings, nymphs descend to the ground and bask in the sun. Feeding begins when temperatures reach 68°F; general feeding starts at 75°F. This activity continues until air temperatures reach 90°F and the soil surface is 112°F. Then to escape the heat, the nymphs climb vegetation and seek shade. Usually the nymphs are on the ground from 6 to 11 a.m. They may migrate in bands at air temperatures between 77° and 99°F beginning at 10 a.m. Under cloudy skies, irrespective of temperature, the nymphs remain inactive.

Like the nymphs the adults rest high on plants at night and descend only when temperatures are 68°F or above and the sun rises and strikes both them and the ground. Upon descending they begin to feed. Feeding slackens at 86°F and ceases at air temperatures above 90°F and soil surface temperatures above 112°F. At these high temperatures, air 86° to 90°F, adults seek shade or rise in flight. Table 1 summarizes information on the influence of temperature upon activities of nymphs and adults.

Table 1. Activity of nymphs and adults of the differential grasshopper, *Melanoplus differentialis* (Thomas), correlated with air and soil temperatures (after Parker and Shotwell 1932).

		Temperature °F			
		Nymphs		Adults	
Name of activity	**Description**	**Air**	**Soil**	**Air**	**Soil**
Beginning of activity	Start of descent	65		68	
Beginning of normal activity	Start of feeding	68		68	70
	Start of migration	75		78	
	Start of oviposition			70	
Beginning of escape from heat	Climbing and seeking shade on plants	90	112	90	112
	Flying in circles or flying with wind			90	112

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