Field studies on the biology of range grasshoppers of southeastern Montana
by Norman L Anderson

A THESIS Submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree of Master of Science in Entomology at Montana State College
Montana State University

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Range grasshopper studies were carried out in 1949 and 1950 in southeastern Big Horn County, Montana, Daily observations of grasshopper activities were made from the time of the first hatch in the spring until a majority of the grasshoppers had disappeared in the fall.

Observations on thirty-eight grasshopper species found in the area of. study are reported. In addition, to observations on localized movements and feeding habits, a list of the types of food and the instar of each species eating the food is included.

On winter range, representative areas of the two most important vegetational types from the standpoint of grazing value were selected for grasshopper damage studies, A report of the damage measurements involving these areas is given.

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OF SOUTHEASTERN MONTANA

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NORMAN L. ANDERSON, JR.

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ABSTRACT

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INTRODUCTION

During the past three years, large scale control operations have been carried out against range grasshoppers in Montana and Wyoming. In view of the high cost of these control operations and the varied results obtained, the Department of Zoology and Entomology, Montana State College, recognized the need for information on the biology of range grasshoppers and therefore established a range grasshopper research program in the spring of 1949.

Hanson and Vorhies (1938), in their report prepared for the Committee on Ecology of Grasslands of North America of the National Research Council, clearly pointed out the need for more complete knowledge of grasslands and their fauna. Under point none of their proposed grassland study they state: "In grassland regions, most insect pests such as grasshoppers are native species, and measures for their efficient control must be based upon exact knowledge of interrelationships, behavior, life history, and protection in the natural environment."

Very little information appears in the literature concerning the biology of range grasshoppers in their natural environment. The best information has come from the detailed field observations by Griddle (1933) in Canada. Limited field observations in southwestern United

States by Ball (1936) in Wyoming by Pfadt (1949b and 1949c), and in Alberta by White and Rock (1945) have added to the knowledge of the biology of these insects.

Studies of grasshoppers subjected to cage and laboratory conditions have evidently been more popular with entomologists. Numerous references to life history and physiological studies under cage and laboratory conditions may be found. In addition, intensive studies of the food preferences of caged grasshoppers have been made by Isely (1938, 1944, and 1946) and by Pfadt (1949c)

This report is based upon field studies during 1949 and 1950 in a small area of southeastern Montana. It is realized that many of the observed grasshopper activities could possibly be changed under environmental conditions different from those present at the time this study was made. It is felt, however, that this study has brought to light indications of grasshopper behavior which, when studied under different environmental conditions over a period of years, will add much to the knowledge of the biology of range grasshoppers.

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AREA OF STUDY

Range grasshopper studies were carried out in 1949 and 1950 on the Kendrick Cattle Company OW Ranch, Decker, Montana. The ranch is located on Hanging Woman Creek in southeastern Bighorn County, Montana. The approximate elevation of the ranch is 3800 feet. The May 1 - August 31, 1949 and 1950, OW Ranch precipitation records were as follows:

	1949	1950
May 1-31	2.17 inches	Not Recorded
June 1-30	1.32 inches	1.36 inches
July 1-31	1.32 inches	2.59 inches
August 1-31	2.51 inches	1.17 inches

The distribution of vegetation in the region is determined by topography and soils. A resistant sandstone stratum caps the higher plateaus and upon weathering produces sandy loam soils. The dominant vegetation on these soils is big sagebrush, Artemisia tridentata Nutt.. Sparse stands of ponderosa pine, Pinus ponderosa Doug., occur along the edges of the plateaus and ravines which cut into them.

The steep slopes below the pines are thinly populated with such plants as big sagebrush, broom snakeweed, Gutierrezia sarothrae (Pursh) B. & R., small soapweed, Yucca glauca Nutt., blue grama, Bouteloua gracilis (HBK) Lag., side-oats grama, Bouteloua curtipendula (Michx.) Torr., little bluestem, Andropogon scoparius Michx., mat muhly, Muhlenbergia richardsonis Merr., june grass, Koeleria cristata (L.) Pers., red three-awn, Aristida longiseta Steud., and various herbaceous plants.

such as slim-flower scurfpea, Psoralea tenuiflora Pursh, prairie clovers, Petalostemon spp., and asters, Aster spp.

The deep, well-drained alluvial deposits which slope gently downward from the steeper eroded slopes support a dominant stand of big sagebrush with june grass, needle-and-thread, Stipa comata Trin. & Rupr., and blue grama.

The hills and benches of lower elevation are capped with beds of baked shale which is called "clinker" or "scoria" by the residents of the area. Practically pure stands of bluebunch wheatgrass, Agropyron spicatum (Pursh) Scribn. & Smith, grow on the gravelly sands, weathered from the "scoria" parent material, present on top of the hills and benches and on steep north-facing slopes.

The sandy loam soils on top of the benches and on the gentler slopes support a dominant stand of needle-and-thread and bluestem, Agropyron smithii Rydb., with some june grass, green needlegrass, Stipa viridula Trin., and blue grama.

Gravelly soils on the steep western and southern slopes are populated with little bluestem, side-oats grama, red three-awn, mat muhly, blue grama, broom snakeweed, and small soapweed.

The clay soil flats and valley bottoms are dominated by bluestem. On the lighter soils surrounding the clay soil flats, green needlegrass becomes more abundant and forms dominant stands. On deep clay soils at lower elevations where subsoil moisture is present, stands of silver sagebrush, Artemisia cana Pursh, and black greasewood, Sarcobatus vermiculatus (Hook.) Torr., are found.

BEHAVIOR STUDIES

Range grasshopper studies commenced in 1949 and 1950 with the first hatch of nymphs in the spring and continued throughout the summer and early fall.

The procedure adopted was to spend as many hours as possible each day observing and recording the behavior of the grasshoppers in the area.

In order to reduce the affect of the observer, it was found that it was necessary to remain as motionless as possible. It was often necessary for the observer to wait as long as 30 minutes after assuming a prone or sitting observational position before the behavior of the grasshoppers in the immediate area returned to what could be considered as normal.

After grasshopper activities returned to normal, the observer remained quiet as long as possible before recording his observations. A new area of observation was then selected and the observational procedure was repeated.

In recording the observations of grasshopper activities care was taken to include only those observations which were not motivated by the presence of the observer and false impressions of feeding caused by the presence of grasshoppers on vegetation were not recorded.

In the discussion of the observed grasshopper activities which follows, the term forb is used to indicate any of the sagebrushes, Artemisia spp., in addition to any broad-leaved herbaceous plant.

Grasshopper populations were measured by the cage method described in the section on grasshopper damage studies.

Following the discussion of each individual species will be found a list of the foods which individuals of the species were observed eating. The list is qualitative and does not indicate the number of individuals which were observed feeding, nor the amount consumed. Numbers are used to indicate all instars except the adult which is designated by an "A".

ACRIDINAE

Pseudopomala brachyptera (Scudder):

In 1949 and 1950, Pseudopomala brachyptera (Scudder) was not found on the range study area. An occasional individual was seen, however, in a moist bluestem, Agropyron smithii Rydb., meadow adjacent to the area of study.

P. brachyptera was seen only as an adult. The few individuals observed were found eating succulent bluestem growing near a creek which bounded the meadow.

Mermiria maculipennis macclungi Rehn:

Mermiria maculipennis macclungi Rehn was found in small numbers in the area of study in 1949 and 1950. The 1949 hatching date of this grasshopper was not recorded. In 1950, the first hatch of M. macclungi was approximately June 1, and the first adult was found July 25.

M. macclungi was found to be a grass-feeding grasshopper which fed on many of the grass species found in the area. It was most numerous, however, on the tall bunch grasses of the side hills and on the tall grasses growing in the deep coulees.

The nymphs and adults generally remained high on vegetation during periods of reduced light or low temperatures when the majority of other grasshoppers were found inactive on the ground.

The adult males appeared to spend very little time feeding as compared to the time spent feeding by the females. The males moved constantly from plant to plant and quickly responded to the presence of the observer while the females of this species apparently did not react in this manner.

Instar	Food
4th, 5th	Dry cow manure
A	Soil
	Family: Gramineae
4th through A	1. Mat Muhly, Muhlenbergia richardsonis Merr. a. Green leaves
3rd through A 3rd	2. Green Needlegrass, Stipa viridula Trin. a. Green leaves b. Green head
2nd through A 4th	3. Needle-and-Thread, Stipa comata Trin. & Rupr. a. Green leaves b. Dry leaf
A	4. Prairie Sand Reedgrass, Calamovilfa longifolia (Hook.) Scribn. a. Green leaves
A	5. Red Three-awn, Aristida longiseta Steud. a. Green leaves
A	6. Sand Dropseed, Sporobolus cryptandrus (Torr.) A. Gray a. Green leaves

	7.	Bluestem, Agropyron smithii Rydb.
2nd through A		a. Green leaves
A		b. Dry leaves
	8.	Bluebunch Wheatgrass, Agropyron spicatum (Pursh) Scribn. & Smith
1st through A		a. Green leaves
	9.	Side-oats Grama, Bouteloua curtipendula (Michx.) Torr.
1st through A		a. Green leaves
	10.	Blue Grama, Bouteloua gracilis (HBK) Lag.
2nd, A		a. Green leaves
	11.	Little Bluestem, Andropogon scoparius Michx.
3rd through A		a. Green leaves

Opeia obscura (Thomas):

The 1949 hatching date of Opeia obscura (Thomas) in the area of study was not recorded. In 1950, the first hatch of this grasshopper was June 21, and the first adult was noted July 21.

Criddle (1933) lists O. obscura as a grass-feeding species whose food preference is bluestem. Isely (1946), from cage studies of differential feeding by grasshoppers, states that O. obscura ate buffalo grass, Bermuda grass, Andropogon, Stipa, and Aristida. He further states that this insect inhabits "short and procumbent grasses and lives upon or underneath these grasses."

The field observations made in 1949 and 1950 confirm the statements that O. obscura is a grass-feeding species. Bluestem, however, was not the preferred food-plant of this species. Both the nymphs and adults preferred blue grama and were always more numerous in the areas in which this plant grew.

In addition to feeding on blue grama, O. obscura was observed eating some of the other grasses found in the blue grama areas. It was never seen feeding on plant debris and only two nymphs were observed feeding on dry cow manure.

Instar	Food
4th	Dry cow manure
	Family: Gramineae
	1. Mat Muhly, Muhlenbergia richardsonis Merr.
A	a. Green leaf
	2. Junegrass, Koeleria cristata (L.) Pers.
3rd	a. Green leaf
	3. Green Needlegrass, Stipa viridula Trin.
4th through A	a. Green leaf
	4. Needle-and-Thread, Stipa comata Trin. & Rupr.
4th through A	a. Green leaves
	5. Bluestem, Agropyron smithii Rydb.
2nd through A	a. Green leaves
A	b. Dry leaf
A	c. Dry stem
A	d. Green stubble
	6. Sand Dropseed, Sporobolous cryptandrus (Torr.) A. Gray
A	a. Green leaves
	7. Blue Grama, Bouteloua gracilis (HBK) Lag.
1st through A	a. Green leaves

Aeropedellus clavatus (Thomas):

Aeropedellus clavatus (Thomas) was found in very low numbers in the area of study in 1949 and 1950. Adults of this species were present when observations started April 22, 1949, and May 19, 1950.

A. clavatus macropterous and brachypterous individuals were found. Macropterous forms were dispersed throughout the study area while brachypterous individuals were confined mainly to the clay soil-bluestem flats.

Macropterous individuals were easily frightened and appeared to be constantly flying or crawling rapidly on the ground. Brachypterous forms were slower in their movements and remained motionless on the ground for long periods of time.

The few observations of feeding by A. clavatus indicate that, as an adult, it is a grass-feeding species. No information on nymphal feeding was obtained.

Instar	Food
	Family: Gramineae
A	1. Sandberg Bluegrass, Poa secunda Presl. a. Green leaves
A	2. Bluestem, Agropyron smithii Rydb. a. Green leaves
A	3. Little Bluestem, Andropogon scoparius Michx. a. Green leaves

Ageneotettix deorum (Scudder):

Ageneotettix deorum (Scudder) was one of the most numerous grasshoppers found in the study area. During both years of observation, this species could be found in any of the vegetational types of the area. The adults and particularly the nymphs were found in greater numbers on the clay soil-bluestem flats.

A. deorum was one of the first grasshoppers to hatch in the spring. The first hatch noted in 1949 was April 28, and the first hatch in 1950 was May 19. The first adult found in 1950 was on July 12.

The feeding habits and activities of this species appeared to be the same during the two summers they were observed. The first four instars were rather unique in their apparent reluctance to crawl upon plants. They devoured large amounts of dry material found on the ground and, while some green vegetation was consumed, it was usually obtained by reaching as far as possible without allowing the hind legs to leave the ground. Occasionally they crawled upon the plants but the time spend feeding there was short in comparison to that spent by other grasshoppers. If upon a plant, when feeding was completed they returned immediately to the ground and did not rest upon the plant as was the case with many other species observed.

After reaching the fourth instar, A. deorum was more often observed on the plants, and a greater proportion of green vegetation was consumed. They continued, however, to eat dry materials on the ground.

It was a very restless grasshopper. When other species were observed resting in the sun, or remaining quiescent on the ground when the sun was obscured, A. deorum continued to move around on the ground. This was particularly true of adults. When frightened they would jump or fly short distances.

As has been previously mentioned, A. deorum consumed great quantities of dry material on the ground. Usually it was not possible to ascertain whether any specific component of the plant debris was being eaten.

However, in late summer, when grass seeds were being dispersed, the adults were seen eating seeds on the ground.

Allred (1936), in his report of the destruction of big sagebrush by drouth and grasshoppers, quotes Dr. J. R. Parker as saying that the '...two dominant species of grasshoppers were Aulocara elliotti (Thomas) and Ageneotettix deorum (Scudder).', and that: 'It has been our experience that these species will eat sagebrush only as a last resort.'

Only three cases were seen during the two summers of observation which indicate that A. deorum would eat any other vegetation than grass. One fifth instar nymph was seen eating the bark of a big sagebrush plant, one adult was seen eating the spines of plains prickly pear and another adult ate the spines of wavyleaf thistle.

A. deorum was listed by Criddle (1933) as a grass-feeding species which ate "several species" of grass. Observations during the two summers covered by this report agree fully with Criddle's statement. This species was noted feeding on bluestem more than on any other species of grass but there is not sufficient evidence to indicate bluestem as the preferred food-plant.

When the grasses on the clay soil-bluestem flats became very dry in 1949, there was some movement of A. deorum adults away from the flats to the sidehills. There appeared to be no movement into the gullies where the grasses remained green.

After a late summer rain August 18, 1949, the grasses on the flats again became green and A. deorum again returned to the clay soil-bluestem

flats. The adults were particularly fond of the new green growth of A. smithii and were often seen eating it down to the soil surface.

Instar	Food
1st through A	Plant debris
1st through A	Dry cow manure
3rd through A	Soil

Family: Gramineae

	1. Japanese Chess, Bromus japonicus Thunb.
A	a. Dry leaves
A	b. Dry stem
5th	c. Dry head on the ground
	2. Downy Chess Brome, Bromus tectorum L.
A	a. Dry stem
	3. Sandberg Bluegrass, Poa secunda Presl.
A	a. Green leaves
	4. Bluestem, Agropyron smithii Rydb.
2nd through A	a. Green leaves
4th through A	b. Dry leaves
3rd, A	c. Green stem
A	d. Dry stem
A	e. Base of green stem
A	f. Green base of drying stem
A	g. Green stubble
A	h. Dry stubble
	5. Bluebunch Wheatgrass, Agropyron spicatum (Pursh) Scribn. & Smith
4th through A	a. Green leaves
	6. Needle-and-Thread, Stipa comata Trin. & Rupr.
3rd through A	a. Green leaves
A	b. Fallen fruit
	7. Green Needlegrass, Stipa viridula Trin.
3rd through A	a. Green leaves

8. Mat Muhly, Muhlenbergia richardsonis Merr.
A a. Green leaves
A b. Head

9. False Buffalo Grass, Munroa squarrosa (Nutt.) Torr.
A a. Green leaves

10. Tumblegrass, Schedonnardus paniculatus (Nutt.) Trel.
A a. Green stems

11. Blue Grama, Bouteloua gracilis (HBK.) Lag.
3rd through A a. Green leaves
A b. Drying leaves

12. Side-oats Grama, Bouteloua curtipendula (Michx.) Torr.
A a. Green leaves

13. Red Three-awn, Aristida longiseta Steud.
A a. Green leaves.

Family: Cyperaceae

1. Threadleaf Sedge, Carex filifolia Nutt.
A a. Drying stem

Family: Cactaceae

1. Plain Prickly Pear, Opuntia polycantha Haw.
A a. Spines

Family: Compositae

1. Big Sagebrush, Artemisia tridentata Nutt.
5th a. Bark

2. Wavyleaf Thistle, Cirsium undulatum (Nutt.) Spreng.
A a. Spines

Drepanopterna femoratum (Scudder):

Drepanopterna femoratum (Scudder) nymphs and adults were found chiefly on the clay soil-bluestem flats during the two summers they were observed. The 1949 population was low but in 1950 it was one of the most numerous grasshoppers found in the study area.

The approximate hatching date of D. femoratum in 1949 was May 12, The 1950 hatching date was June 1, and the first adult of this species was found July 12.

D. femoratum is a grass-feeding species. The preferred food-plant appeared to be bluestem, although both the nymphs and adults were observed eating several grass species. Invariably, the nymphs and adults of this grasshopper, in crawling on plants to feed, were observed first climbing upon the plants and then turning around so that the head was toward the ground before feeding.

The nymphs and adults of this species also ate dry materials found on the ground. The older nymphs seemed to include more dry materials in their diet than did the adults.

The older nymphs and particularly the adults of D. femoratum are gregarious. No apparent change in the general feeding activity and movement accompanied the congregation of the nymphs. The adults, however, appeared to be much more active within a band. The males in particular seemed to move about constantly on the ground and all adults were more easily frightened when they were in these bands. When frightened the adults either flew for short distances or jumped and crawled on the ground. The movements of the bands were confined to the clay soil-bluestem flats. There was some movement toward the greener areas of the flats as the grasses became dry but there was little movement into the gullies and side hills as was noted with some of the other species of grasshoppers present.

Instar	Food
3rd through A	Plant debris
3rd through A	Dry cow manure
3rd through A	Soil

Family: Gramineae

	1. Junegrass, Koeleria cristata (L.) Pers.
4th through A	a. Green leaves
	2. Downy Chess Brome, Bromus tectorum L.
3rd through A	a. Drying leaves
	3. Japanese Chess, Bromus japonicus Thunb.
3rd, 4th	a. Dry heads
	4. Green Needlegrass, Stipa viridula Trin.
A	a. Green leaves
4th	b. Dry tip of leaf
	5. Needle-and-thread, Stipa comata Trin. & Rupr.
3rd through A	a. Green leaves
	6. Sandberg Bluegrass, Poa secunda Presl.
2nd	a. Green leaves
	7. Tumblegrass, Schedonnardus paniculatus (Nutt.) Trel.
4th	a. Green leaf
	8. Bluestem, Agropyron smithii Rydb.
1st through A	a. Green leaves
A	b. Dry leaves
A	c. Green stem
A	d. Dry stem
A	e. Green stubble
A	f. Dry stubble
	9. Bluebunch Wheatgrass, Agropyron spicatum (Pursh) Scribn. & Smith
5th	a. Green leaf
	10. Blue Grama, Bouteloua gracilis (HBK) Lag.
3rd through A	a. Green leaves
	11. Little Bluestem, Andropogon scoparius Michx.
A	a. Green leaf

Aulocara elliotti (Thomas):

The big-headed grasshopper, Aulocara elliotti (Thos.), was found in limited numbers in the area of study in 1949 and 1950. The nymphs and adults were confined mainly to the clay soil-bluestem flats and appeared to be more numerous in areas of lighter textured soil within the flats.

The approximate date of hatch for this species in 1949 was May 12. in 1950 the date of hatch was May 22, and the first adult was found July 6.

From field observations, both Criddle (1933) and Pfadt (1949b) have stated that A. elliotti is a grass-feeding species which feeds on several species of grass. Pfadt (1949b) has stated further that, from detailed observations in an area in which the two dominant grasses were bluestem and Sandberg bluegrass, the first two instars fed chiefly on Sandberg bluegrass and the older instars and adults fed almost entirely on bluestem.

A. elliotti nymphs and adults were observed in 1949 and 1950 feeding on several species of grass. In the areas in which observations were made, bluestem was the dominant vegetation and appeared to be the main food plant of both the nymphs and adults. Other grass species in the area were found in much less density than bluestem. Sandberg bluegrass could be considered to be rare. Nymphs and adults were never observed feeding on forbs or shrubs.

In 1949, it was noted that several of the grasshopper species which were numerous on the clay soil-bluestem flats moved to areas of green vegetation when the bluestem became dry. A. elliotti, however, remained

on the flats and ate dry bluestem until this grass again became green following a late summer rain.

Instar	Food
4th through A	Plant debris
4th through A	Dry cow manure
A	Soil
	Family: Gramineae
	1. Japanese Chess, Bromus japonicus Thunb.
3rd, 4th	a. Green leaves
	2. Green Needlegrass, Stipa viridula Trin.
A	a. Green leaves
	3. Needle-and-Thread, Stipa comata Trin. & Rupr.
3rd through A	a. Green leaves
	4. Junegrass, Koeleria cristata (L.) Pers.
3rd, 4th	a. Green leaves
	5. Bluestem, Agropyron smithii Rydb.
1st through A	a. Green leaves
3rd through A	b. Dry leaves
A	c. Green stems
A	d. Dry stems
A	e. Green stubble
A	f. Dry stubble
	6. Blue Grama, Bouteloua gracilis (HBK) Lag.
4th through A	a. Green leaves
	Family: Cyperaceae
	1. Threadleaf Sedge, Carex filifolia Nutt.
A	a. Stems

Eritettix tricarinatus (Thomas):

Few Eritettix tricarinatus (Thomas) were observed in the study area in 1949. No observations of its habits were made in 1950.

E. tricarinatus third instar nymphs were present when observations started April 22, 1949. These nymphs and the adults which followed were not observed feeding.

E. tricarinatus hatched approximately September 8, 1949. The first three instars of this species were observed eating the green leaves of blue grama, Bouteloua gracilis (HBK) Lag., before observations ended September 23, 1949.

Acrolophitus hirtipes (Say):

Only an occasional Acrolophitus hirtipes (Say) was seen in the area in 1949 and 1950. Most of those observed were on gently sloping, gravelly, southern exposures.

Criddle (1933) states: "Acrolophitus hirtipes (Say), so far as we have been able to ascertain, subsists almost exclusively upon members of the Boraginaceae."

Only two individuals of this species were observed feeding during the two years of observation. One was a fifth instar nymph and the other an adult. Both were eating the leaves of western tickweed, Lappula redowskii (Hornem.) Green, a member of the family Boraginaceae.

A. hirtipes adults were easily frightened. The early adults appeared to be poor fliers and, when frightened, jumped and crawled rapidly on the ground. It was noted, however, that the older adults observed at the time of oviposition were excellent fliers, and when frightened, rapidly flew away.

Amphitornus coloradus (Thomas):

The hatching date of Amphitornus coloradus (Thomas) was not recorded in 1949. The 1950 hatching date of this species was May 22, and the first adult was found July 8.

As has been stated by Criddle (1933), A. coloradus is a grass-feeding species which will eat several species of grass. During the two summers of observation this grasshopper, both as a nymph and as an adult, ate needle-and-thread in preference to any of the other grasses found in the area. A. coloradus was found only in needle-and-thread areas and the other grasses it was observed eating were found in these areas.

In addition to feeding on grass vegetation, the older nymphs and adults of A. coloradus were observed feeding occasionally on dry materials found on the ground.

Instar	Food
5th through A	Plant debris
5th	Dry cow manure
	Family: Gramineae
A	1. Mat Muhly, Muhlenbergia richardsonis Merr. a. Green leaves
4th	2. Junegrass, Koeleria cristata (L.) Pers. a. Green leaf
4th, A	3. Green Needlegrass, Stipa viridula Trin. a. Green leaves

	4.	Needle-and-Thread, Stipa comata Trin. & Rupr.
1st through A		a. Green leaves
A		b. Dry leaves
2nd, 3rd		c. Green stems
2nd, 3rd		d. Green sheaths
2nd, 3rd		e. New awns
	5.	Japanese Chess, Bromus japonicus Thunb.
1st		a. Green leaf
	6.	Bluestem, Agropyron smithii Rydb.
2nd through A		a. Green leaves
	7.	Blue bunch Wheatgrass, Agropyron spicatum (Pursh) Scribn. & Smith
A		a. Green leaf
	8.	Sand Dropseed, Sporobolus cryptandrus (Torr.) A. Gray
A		a. Green leaf
	9.	Side-oats Grama, Bouteloua curtipendula (Michx.) Torr.
5th, A		a. Green leaves
	10.	Blue Grama, Bouteloua gracilis (HBK) Lag.
5th, A		a. Green leaves
	11.	Red Three-awn, Aristida longiseta Steud.
A		a. Green leaf
3rd, 4th		b. Green stem

Family: Cyperaceae

	1.	Threadleaf Sedge, Carex filifolia Nutt.
A		a. Drying stem

Phlibostroma quadrimaculatum (Thomas):

Phlibostroma quadrimaculatum (Thomas) appeared in low numbers in the area of study in 1949 and 1950. The nymphs and adults of this species were confined to localized areas in which blue grama was the dominant vegetation.

In accordance with the work of Isely (1944) on the correlation between the morphology of grasshopper mandibles and food specificity

and the observations of Griddle (1933), P. quadrimaculatum was found to be a grass-feeding species. Blue grama was very definitely the preferred food-plant for both nymphs and adults of this grasshopper. It fed only slightly on four of the other grass species in the area.

Neither the nymphs nor the adults were ever observed feeding on dry materials on the ground.

Instar	Food
	Family: Gramineae
5th, A	1. Needle-and-Thread, Stipa comata Trin. & Rupr. a. Green leaves
5th, A	2. Sand Dropseed, Sporobolus cryptandrus (Torr.) A. Gray a. Green leaves
3rd through A	3. Bluestem, Agropyron smithii Rydb. a. Green leaves
5th	4. Side-oats Grama, Bouteloua curtipendula (Michx.) Torr. a. Green leaf
2nd through A	5. Blue Grama, Bouteloua gracilis (HBK) Lag. a. Green leaves

Cordillacris crenulata (Bruner):

Only an occasional Cordillacris crenulate (Bruner) was seen in the area of study in 1949 and 1950. This grasshopper was found only on or near blue grama, Bouteloua gracilis (HBK) Lag.

Very few observations of the feeding habits of C. crenulata nymphs and adults were made. Blue grama was the only plant upon which this species was seen feeding.

OEDIPODINAE

Encoptolophus costalis (Scudder):

Encoptolophus costalis (Scudder) appeared in very small numbers and only on the clay soil-bluestem flats of the study area in 1949 and 1950.

Criddle (1933) lists E. costalis among the grass-feeding grasshopper species which fed on several species of grass.

Very few observations of the activities of E. costalis were made in 1949 and 1950. The nymphs and adults of this species were only seen eating bluestem. It remained on the clay soil-bluestem flats after the grasses became very dry and ate dry bluestem stubble.

Instar	Food
	1. Bluestem, Agropyron smithii Rydb.
3rd though A	a. Green leaves
A	b. Dry leaves
A	c. Green stubble
A	d. Dry stubble

Hippiscus rugosus (Scudder):

Hippiscus rugosus (Scudder) was found in low numbers on the gravelly south and west slopes of the study area. The 1949 hatching date of this species was not recorded; however, in 1950, the approximate hatching date was June 21, and the first adult H. rugosus was found August 4.

H. rugosus is a grass-feeding species which was observed eating several species of grass. The younger nymphs confined their feeding

mainly to blue grama. As they developed other grasses were included in their diet.

H. rugosus nymphs and adults were never observed eating plant debris. The late nymphs and adults of this species, however, often cut off dry upright grass stems. Occasionally an adult would also cut off a green grass stem.

Instar	Food
A	Soil
A	Grasshopper Exuviae
	1. Mat Muhly, *Muhlenbergia richardsonis* Merr.
A	a. Green head
	2. Junegrass, *Koeleria cristata* (L.) Pers.
4th	a. Green leaves
	3. Downy Chess Brome, *Bromus tectorum* L.
5th, A	a. Dry stems
	4. Needle-and-Thread, *Stipa comata* Trin. & Rupr.
2nd, 3rd, A	a. Green leaves
A	b. Green stem
	5. Green Needlegrass, *Stipa viridula* Trin.
4th, A	a. Green leaves
	6. Red Three-awn, *Aristida longiseta* Steud.
A	a. Green leaves
	7. Bluestem, *Agropyron smithii* Rydb.
5th	a. Green leaf
A	b. Green stubble
	8. Bluebunch Wheatgrass, Agropyron spicatum (Pursh) Scribn. & Smith
4th, A	a. Green leaves
A	b. Green stems
	9. Tumblegrass, *Schedonnardus paniculatus* (Nutt.) Trel.
A	a. Green leaf

	10.	Side-oats Grama, Bouteloua curtipendula (Michx.) Torr.
4th through A		a. Green leaves
A		b. Green stem
	11.	Blue Grama, Bouteloua gracilis (HBK) Lag.
1st through A		a. Green leaves
	12.	Little Bluestem, Andropogon scoparius Michx.
2nd, 3rd, A		a. Green leaves

Arphia pseudonietana (Thomas):

Small numbers of Arphia pseudonietana (Thomas) were found throughout the area of study in 1949 and 1950.

Nymphs were confined mainly to the clay soil-bluestem flats. The adults, however, were dispersed throughout the area of study.

It is listed by Criddle (1933) among the mixed-feeding grasshoppers which ate mostly grass. Isely (1944) also lists it as a mixed-feeding species on the basis of mandibular morphology.

During the two years observations were made, A. pseudonietana nymphs and adults were observed feeding on several grass species but were never seen eating forbs.

A. pseudonietana nymphs were rarely seen on the ground and were never observed feeding on plant debris. The nymphs remained on grass plants for long periods of time and seemed to eat great quantities of green vegetation.

In contrast to the nymphs, the adults spent very little time on plants. They were easily frightened and constantly moved about. Their movement was characterized by flying followed by rapid crawling on the ground. Because of their constant movement, the adults apparently ate

very little; their feeding being confined to a few bites of either dry material on the ground or green vegetation. A. pseudonietana adults showed some preference for junegrass although it was observed feeding on several of the grass species growing in the area.

Instar	Food
A	Plant debris
A	Soil
	Family: Gramineae
	1. Mat Muhly, Muhlenbergia richardsonis Merr.
A	a. Green leaves
	2. Downy Chess Brom, Bromus tectorum L.
2nd, 3rd	a. Leaves
	3. Green Needlegrass, Stipa viridula Trin.
5th, A	a. Green leaves
	4. Needle-and-Thread, Stipa comata Trin. & Rupr.
5th, A	a. Green leaves
	5. Junegrass, Koeleria cristata (L.) Pers.
A	a. Green leaves
	6. Bluestem, Agropyron smithii Rydb.
2nd through A	a. Green leaves
A	b. Dry leaf
A	c. Dry stubble
	7. Blue Grama, Bouteloua gracilis (HBK) Lag.
2nd through A	a. Green leaves
	8. Side-oats Grama, Bouteloua curtipendula (Michx.) Torr.
4th, 5th	a. Green leaves
	Family: Cyperaceae
	1. Threadleaf Sedge, Carex filifolia Nutt.
A	a. Green stem

Hadrotettix trifasciatus (Say):

Hadrotettix trifasciatus (Say) was found in limited numbers throughout the area of study in 1949 and 1950. Among the first species to hatch in the spring, H. trifasciatus appeared to be one of the slowest grasshoppers in developing. The 1949 hatching date was not recorded; however, the hatching date in 1950 was May 22. Although Amphitornus coloradus (Thomas.) also hatched on this date, H. trifasciatus did not reach the adult stage until July 17, nine days after the first adult A. coloradus was noted.

H. trifasciatus has been listed by Criddle (1933) among the grasshopper species feeding on broad-leaved plants. Isely (1938), from feeding tests under cage conditions, listed two forbs as host plants of this species.

Field observations of the nymphal and adult feeding habits of this slow moving grasshopper show that it confines its feeding to forbs and dry materials found on the ground.

Isely (1946), in studying the differential feeding of various grasshoppers under cage conditions, states that: "although H. trifasciatus was the largest of the five acridian species here studied, the amount of green leaves consumed was less than that eaten by any of the other four species." It also seems to eat very little green vegetation under field conditions. Most of the time was spent crawling on the ground. Occasionally it stopped to eat dry material found on the ground but only on rare occasions crawled upon green vegetation to feed. The green forbs eaten were usually short and easily reached from the ground.

H. trifasciatus was the most cannibalistic of the grasshoppers found in the area. In addition to eating large numbers of dead grasshoppers it was noted on several occasions eating grasshoppers which were still alive but sluggish in their behavior. On one occasion an adult crawled upon a plant and pulled an adult *Melanoplus bivittatus* (Say) to the ground and started to eat it. The *M. bivittatus* adult crawled back on the plant but was immediately pulled back to the ground. This action was repeated several times before the adult *M. bivittatus* was finally killed and eaten.

Instar	Food
1st through A	Plant debris
1st through A	Dry cow manure
A	Live grasshopper
A	Dead grasshopper
3rd through A	Soil
	Family: Gramineae
	1. Bluestem, *Agropyron smithii* Rydb.
A	a. Short green stubble
	2. False Buffalo Grass, *Munroa squarrosa* (Nutt.) Forr.
A	a. Leaves
	Family: Solanaceae
	1. Cutleaf Nightshade, *Solanum triflorum* Nutt.
A	a. Green leaves
A	b. Green stem

Family: Portulacaceae

1. Common Purslane, Portulaca oleracea L.
   - A — a. Dry leaves
   - A — b. Root

Family: Liliaceae

1. Meadow Deathcamus, Zygadenus venenosus S. Wats.
   - 4th, 5th — a. Green leaves
   - 4th, 5th — b. Green stem

Family: Onagraceae

1. Scarlet Gaura, Gaura coccinea Pursh.
   - 3rd through A — a. Green leaves
   - 4th — b. Flowers

Family: Cactaceae

1. Plain Prickly Pear, Opuntia polycantha Haw.
   - 3rd through A — a. Blossoms

Family: Plantaginaceae

1. Wooly Indianwheat, Plantago purshii Roem. & Schult
   - 4th — a. Head

Family: Chenopodiaceae

1. Nuttall Monolepis, Monolepis nuttalliana (R. & S.) Engelm.
   - A — a. Green leaves

Family: Compositae

1. Meadow Salsify, Tragopogon pratensis L.
   - A — a. Green leaves
   - A — b. Green stem
   - A — c. Blossoms
2. Rush Skeltonplant, Lygodesmia juncea Don.
   - A — a. Green stem

Family: Polygonaceae

1. Prostrate Knotweed, Polygonum aviculare L.
   - A — a. Green leaves
   - A — b. Green stems

Family: Loasaceae

	1.	Tenpetal Mentzelia, Mentzelia decaptela (Pursh.) Urban & Gilg.
5th		a. Leaves
A		b. Blossoms
	2.	Mentzelia, Mentzelia oligosperma Nutt.
3rd through A		a. Leaves

Spharagemon equale (Say):

Spharagemon equale (Say) was found throughout the area of study in 1949 and 1950, but was never numerous.

The 1949 hatching date was not recorded. The observed hatching date in 1950 was June 21, and the first adult of this species was found July 20.

Criddle (1933) placed S. equale among the species feeding on broad leaved plants. He stated further: "The insect is a trifle specialized in its food proclivities, partaking very sparingly of grasses but showing a marked preference for the Cruciferae." On the basis of mandibular morphology, Isely (1944) has also placed S. equale among the forb-feeding grasshoppers. Treherne and Buckell (1924), on the other hand, reported that it caused considerable damage to bunch grass.

In 1949 and 1950 S. equale was observed feeding on both the grasses and forbs found in the area of study. There was no indication of preference for either.

Adults were often seen congregated in small groups in vegetation-free areas. When frightened, they flew away but within a short time reassembled.

Instar	Food
3rd through A	Plant debris
A	Dry cow manure
A	Dead grasshoppers
A	Soil
	Family: Gramineae
	1. Mat Muhly, Muhlenbergia richardsonis Merr.
A	a. Green heads
	2. Junegrass, Koeleria cristata (L.) Pers.
A	a. Dry leaf
	3. Green Needlegrass, Stipa viridula Trin.
3rd through A	a. Green leaves
A	b. Green stubble
	4. Needle-and-Thread, Stipa comata Trin. & Rupr.
3rd through A	a. Green leaves
A	b. Dry stem
	5. Bluestem, Agropyron smithii Rydb.
1st through A	a. Green leaves
A	b. Dry leaves
A	c. Green stubble
A	d. Dry stubble
	6. Blue Grama, Bouteloua gracilis (HBK) Lag.
A	a. Green head
	Family: Cyperaceae
	1. Threadleaf Sedge, Carex filifolia Nutt.
A	a. Green stem
A	b. Dry stem
	Family: Liliaceae
	1. Small Soapweed, Yucca glauca Nutt.
A	a. Green leaves

Family: Solanaceae

4th through A	1.	Cutleaf Nightshade, *Solanum triflorum* Nutt.
	a.	Green leaves

Family: Onagraceae

A	1.	Scarlet Gaura, *Gaura coccinea* Pursh
	a.	Green leaf

Family: Compositae

A	1.	Fringed Sagebrush, *Artemisia frigida* Willd.
	a.	Dry stem
A	2.	Dotted Gayfeather, *Liatris punctata* Hook.
	a.	Green leaf

Family: Leguminosae

A	1.	Slimflower Scurfpea, *Psoralea tenuiflora* Pursh
	a.	Green leaf
A	2.	Purple Prairieclover, *Petalostemon purpureus* (Vent.) Rydb.
	a.	Green leaf

Spharagemon collare (Scudder):

Few Spharagemon collare (Scudder) were found in the study area in 1949, and none were found in 1950.

The 1949 hatching date was not recorded but it appeared later than *Spharagemon equale* (Say).

Criddle (1933) listed *S. collare* among the mixed-feeding grasshopper species which eats mostly grass. The few observations of the feeding of *S. collare* in 1949 seem to bear out Criddle's statement.

Instar	Food
4th through A	Plant debris

Family: Gramineae

	1.	Bluestem, Agropyron smithii Rydb.
4th through A	a.	Green leaves
4th through A	b.	Dry leaves

Family: Polygonaceae

	1.	Prostrate Knotweed, Polygonum aviculare L.
A	a.	Leaves

Trimerotropis campestris McNeil:

Only an occasional Trimerotropis campestris McNeil was found in the area of study during the two years observations were made.

The 1949 hatching date was not recorded. The first hatch of T. campestris in 1950 was approximately July 21.

Criddle (1933) placed T. campestris among mixed-feeding grasshopper species.

It was very difficult to make observations of the activities of T. campestris because of the superficial resemblance between this grasshopper and Spharagemon equale (Say). Close observations indicated, however, that T. campestris is a mixed-feeding species.

Instar	Food
4th through A	Plant debris
A	Dead grasshoppers

Family: Gramineae

	1.	Green Needlegrass, Stipa viridula Trin.
A	a.	Green leaves
	2.	Japanese Chess, Bromus japonicus Thunb.
4th	a.	Green leaves

	3.	Bluestem, Agropyron smithii Rydb.
4th through A		a. Green leaves
	4.	Blue Grama, Bouteloua gracilis (HBK) Lag.
A		a. Green leaves
		Family: Solanaceae
	1.	Cutleaf Nightshade, Solanum triflorum Nutt.
4th through A		a. Leaves
		Family: Leguminosae
	1.	Slimflower Scurfpea, Psoralea tenuiflora Pursh
4th through A		a. Green leaves
		Family: Loasaceae
	1.	Tenpetal Mentzelia, Mentzelia decaptela (Pursh) Urban & Gilg.
A		a. Leaves

Trimerotropis bruneri McNeill:

Trimerotropis bruneri McNeill appeared in the area of study in 1949 and 1950 in very low numbers.

The 1949 hatching date was not recorded. The first hatch noted in 1950 was July 14.

No observations of the feeding habits of T. bruneri were made in 1949. Scanty observations in 1950, however, indicate that the adult of this grasshopper is a forb-feeder.

Instar	Food
A	Plant debris
	Family: Polemoniaceae
	1. Hoods Phlox, Phlox hoodii Rich.
A	a. leaves

Family: Loasaceae

1. Tenpetal Mentzelia, Mentzelia decaptela (Purch) Urban & Gilg.

A	a. Leaves
A	b. Blossoms

Derotmema haydenii haydenii (Thomas):

A few Derotmema haydenii haydenii (Thomas) were found in two old prairie dog towns found in the area of study.

The 1949 hatching date was not recorded. In 1950 the first hatch was approximately July 1, and the first adult was found July 31.

Nymphs and adults were found most commonly on common purslane and to a lesser extent on prostrate knotweed. Both of these plants were found growing around old prairie dog holes.

Dry materials on the ground were not eaten until the common purslane and prostrate knotweed had become very dry. At this time D. haydenii adults were also observed feeding occasionally on short dry stubble of bluestem and, after a late summer rain August 18, 1949. on the new green growth of bluestem.

Instar	Food
A	Plant debris
A	Cow manure

Family: Gramineae

1. Bluestem, Agropyron smithii Rydb.

A	a. New green growth
A	b. Dry stubble

Family: Malvaceae

1. Scarlet Globemallow, Sphaeralcea coccinea (Pursh) Rydb.
A a. Leaves

Family: Portulacaceae

1. Common Purslane, Portulaca oleracea L.
1st through A a. Green leaves

Family: Plygonaceae

1. Prostrate Knotweed, Polygonum aviculare L.
4th through A a. Green leaves

Metator pardalinus (Saussure):

No record of the hatching date of Metator pardalinus (Saus.) was kept in 1949. The hatching date in 1950 was approximately May 19. The first adult found in 1950 was July 6.

M. pardalinus was found during both summers of observation mainly on the clay soil-bluestem flats. The population of this species was not more than one per square yard in 1949. In 1950, however, populations in the same area were as high as ten per square yard.

The 1949 observations of the activities of M. pardalinus were necessarily few because of the low population. As a nymph it was observed feeding mainly on green grass although some dry material on the ground was also eaten. After it became adult, very little feeding of any kind was noted; then only on green grass. The adults were easily frightened and seemed to either crawl or fly constantly.

The 1950 observations of the activities of M. pardalinus were considerably more numerous in accord with the increase in numbers of this species. The nymphs were again noted feeding on the green leaves

of grass plants. Dry material found on the ground was eaten in greater quantity than in previous year.

Adults observed in 1950, in contrast to those observed in 1949, consumed large quantities of green grass and dry materials found on the ground. The method of feeding on green grass by the adults was unique in that, rather than crawling upon the grass plant to feed, this grasshopper crawled up and cut off a green leaf or a portion of it and returned to the ground to eat it. Food eaten on the ground was usually held between the two front legs and eaten fron one end rather than from a side. The adults also included large amounts of fine sand and clay soil in their diet.

M. pardalinus is quite definitely a grass-feeding species. Although it was noted feeding on several grass species, bluestem was the preferred food-plant. This in in line with the findings of Criddle (1933).

The nymphs and particularly the adults are gregarious. The older nymphs were found in small groups. The adults, however, were often congregated in great numbers on the claysoil-bluestem flats.

The movements of the groups during the 1950 observations were confined within the boundaries of the claysoil-bluestem flats. Adults, in contrast to those observed in 1949, flew infrequently and movement was mainly confined to crawling on the ground.

Instar	Food
3rd through A	Plant debris
4th through A	Dry cow manure

4th through A	Soil

Family: Gramineae

	1. Junegrass, Koeleria cristata (L.) Pers.
4th	a. Green leaves
	2. Green Needlegrass, Stipa viridula Trin.
A	a. Green leaves
	3. Bluestem, Agropyron smithii Rydb.
2nd through A	a. Green leaves
5th, A	b. Drying leaves
A	c. Green stem
A	d. Dry stem
A	e. Green base of dry stem
A	f. Green stubble
	4. Bluebunch Wheatgrass, Agropyron spicatum (Pursh) Scribn. & Smith
5th	a. Green leaf
	5. Sand Dropseed, Sporobolus cryptandrus (Torr.) A. Gray
A	a. Green leaves
	6. Blue Grama, Bouteloua gracilis (HBK) Lag.
4th through A	a. Green leaves

Trachyrhachis kiowa kiowa (Thomas):

Small numbers of Trachyrhachis kiowa kiowa (Thomas) were found in 1949 and 1950. This species was found usually in blue grama areas but also on the clay soil-bluestem flats.

As Criddle (1933) stated, T. kiowa is a grass-feeding species. Blue grama was quite definitely the preferred food-plant of the older nymphs and adults. Bluestem was also eaten frequently but the other grasses in the area were either ignored or eaten sparingly by this species.

The nymphs were never observed eating dry material found on the ground and the adults fed infrequently on plant debris.

Instar	Food
A	Plant debris
	Family: Gramineae
	1. Junegrass, Koeleria cristata (L.) Pers.
A	a. Green leaf
	2. Red Three-awn, Aristida longiseta Steud.
A	a. Green leaf
	3. Bluestem, Agropyron smithii Rydb.
3rd through A	a. Green leaves
A	b. Dry stubble
	4. Blue Grama, Bouteloua gracilis (HBK) Lag.
3rd through A	a. Green leaves
	5. False Buffalo Grass, Munroa squarrosa (Nutt.)Torr.
A	a. Green leaves
	Family: Cyperaceae
	1. Threadleaf Sedge, Carex filifolia Nutt.
A	a. Drying stem

CYRTACANTHACRINAE

Schistocerca lineata (Scudder):

Schistocerca lineata (Scudder) was found infrequently in the study area in 1949 and 1950. It was confined to the deep gullies and ravines in which shrubs were growing.

S. lineata was reported by Criddle (1932 and 1933) to be definitely associated with American licorice and to have eaten species of the genera Astragalus, Lathyrus, and Vicia.

During the two years of observation, it was most commonly found on or near wild rosebush and to a lesser extent on or near American licorice. Adults were also observed feeding very sparingly on stiff goldenrod and coralberry.

Ball (1936) reports that S. lineata nymphs were found in abundance feeding on the crowns of side-oats grama, Bouteloua curtipendula (Michx.) Torr..

In the area of study in 1949 and 1950, nether S. lineata nymphs nor adults were observed feeding on any of the grass species present.

The nymphs and adults were seldom seen on the ground and were never observed feeding on dry materials on the ground. Both the nymphs and adults remained high on shrubs when at rest.

Instar	Food
	Family: Caprifoliaceae
	1. Indiancurrant Coralberry, Symphoricarpos orbiculatus Moench.
A	a. Green leaf

Family: Rosaceae

	1.	Wild Rosebush, Rosa sp.
3rd through A	a.	Green leaves

Family: Compositae

	1.	Stiff Goldenrod, Solidago rigida L.
A	a.	Green leaf

Family: Leguminosae

	1.	American licorice, Glycyrrhiza lepidota Pursh
4th through A	a.	Green leaves

Hesperotettix viridis viridis (Thomas):

The 1949 hatching date in the study area for Hesperotettix viridis viridis (Thomas) was not recorded. The date of the first hatch of this species in 1950 was June 14 and the first adults were noted August 1.

Food preference tests by Isely (1938 and 1946) show that, of the food-plants tests, H. viridis preferred broomweed, Amphiachyris dracunculoides (D.C.) Nutt., and gum weed, Grindelia sp.. Ball (1936) reports that in Arizona H. viridis feeds primarily on broom snakeweed, Gutierrezia sarothrae (Pursh) B. & R., secondly on burrow weed, Aplopappus sp., and thirdly on rabbitbrush, Chrysothamnus sp..

In the area in which observations were made during 1949 and 1950, H. viridis was closely associated with broom snakeweed as a nymph and as an adult. In ravines where broom snakeweed was not found, it was closely associated with stiff goldenrod.

H. viridis was never seen feeding on dry materials on the ground or on any of the various grasses found in the area. In addition to

broom snakeweed and stiff goldenrod, only rubber rabbitbrush and curlycup gumweed were selected as food-plants from the many forbs in the area.

The nymphs and adults spent very little time on the ground. As an early numph, much of the time on plants was spent in feeding. As it developed less time was spent in feeding until, as an adult, very little feeding took place. The adults moved very little and spent long periods of time in one place on the plants.

Instar	Food
	Family: Compositae
1st through A	1. Broom Snakeweed, Gutierrezia sarothrae (Pursh) B. & R. a. Green leaves
A	2. Curlycup Gumweed, Grindelia squarrosa (Pursh) Dunal a. Green leaves
3rd through A A	3. Stiff Goldenrod, Solidago rigida L. a. Green leaves b. Blossoms
A A	4. Rubber Rabbitbrush, Chrysothamnus nauseosus (Pall.) Brit. a. Leaves b. Blossoms

Hypochlora alba (Dodge):

Few Hypochlora alba (Dodge) were found in the study area in 1949 and 1950.

Hebard (1928) states that H. alba is found only on or near silver sagebrush, Artemisia cana Pursh., but, in accordance with the findings of Criddle (1933), Isely (1938) and White and Rock (1945), it was found to be definitely associated with white sagebrush, Artemisia ludoviciana Nutt..

White sagebrush was the preferred food-plant for both the nymphs and adults. Silver sagebrush was also eaten, but to a lesser degree. H. alba was observed feeding sparingly on fringed sagebrush, Artemisia frigida Willd., but was never observed eating big sagebrush, Artemisia tridentata Nutt., which is common in the area.

Instar	Food
	Family: Compositae
	1. Fringed Sagebrush, Artemisia frigida Willd.
4th through A	a. Leaves
	2. Silver Sagebrush, Artemisia cana Pursh
4th through A	a. Leaves
	3. White Sagebrush, Artemisia ludoviciana Nutt.
1st through A	a. Leaves
A	b. Blossoms

Aeoloplus turnbulli turnbulli (Thomas):

The population of Aeoloplus turnbulli turnbulli (Thomas) was low in the study area during the two years range grasshopper observations were made. The hatching date of this species was not recorded. In 1950, the first adult was found July 8.

A. turnbulli has been listed by both Criddle (1933) and White and Rock (1945) as a forb-feeding species which feeds largely on Atriplex and its allies.

In the area of study A. turnbulli was most numerous on black greasewood. In addition to feeding on black greasewood, it also fed on other Chenopodiaceae found in the area. None of the grasses in the area were eaten.

Instar	Food
A	Soil
	Family: Chenopodiaceae
	1. Common Winterfat, Eurotia lanata (Pursh) Moq.
3rd through A	a. Leaves
	2. Tumbling Russian Thistle, Salsola kali L.
4th, A	a. Stems
	3. Seepweed, Suaeda erecta (Wats.) A. Nels.
A	a. Leaves
	4. Atriplex, Atriplex argentea Nutt.
4th, A	a. Leaves
	5. Shadscale Saltbush, Atriplex confertifolia (Torr.) Wats.
3rd through A	a. Leaves
A	b. Flower buds
	6. Black Greasewood, Sarcobatus vermiculatus (Hook.) Torr.
3rd through A	a. Leaves

Phoetaliotes nebrascensis (Thomas):

Phoetaliotes nebrascensis (Thomas) was found chiefly on the clay soil-bluestem flats during the two years of grasshopper observations.

The observed hatching date of this species in 1949 was June 8, and the hatching date in 1950 was June 12. Most adults were brachypterous and only two macropterous individuals were found during the two-year period.

P. nebrascensis was listed by Criddle (1933) as eating mostly grass. Isely (1944) lists P. nebrascensis among grasshoppers with mixed-feeder mandibles.

The only green vegetation upon which nymphs and adults were observed feeding in 1949 and 1950 was grass. Bluestem was definitely preferred over all other grass species eaten by this grasshopper.

The first four instars were very seldom observed feeding on dry materials found on the ground. These early nymphs appeared to spend more time on plants than any of the other grasshopper species observed. In addition to feeding, they perched on the grass plants when not feeding and remained there during times of temperature, light, or wind changes which normally kept other grasshoppers on the ground.

The older nymphs and adults were found on the ground as well as on grass plants. Only occasional feeding on dry materials was noted.

When the bluestem found on the clay soil-bluestem flats started to dry in midsummer small localized areas of the flats were found in which the bluestem was greener and more succulent. The population of P. nebrascensis was always much higher in these localized areas than elsewhere. When the localized green areas became dry, P. nebrascensis moved from the flats into the adjacent gullies where the grasses remained green. In 1949 they returned to the flats after a late summer rain produced new green growth of bluestem.

Instar	Food
A	Plant debris
3rd, 4th	Dry cow manure
A	Soil

Family: Gramineae

	1.	Canada Wildrye, Elymus canadensis L.
4th through A		a. Green leaves
	2.	Inland Giant Wildrye, Elymus cinereus Scribn. & Merr.
5th, A		a. Green leaves
	3.	Mat Muhly, Muhlenbergia richardsonis Merr.
A		a. Green head
	4.	Junegrass, Koeleria cristata (L.) Pers.
2nd through A		a. Green leaves
	5.	Downy Chess Brome, Bromus tectorum L.
2nd, 3rd		a. Green leaves
2nd, 3rd		
	6.	Japanese Chess, Bromus japonicus Thunb.
1st through 4th		a. Green leaves
	7.	Green Needlegrass, Stipa viridula Trin.
3rd through A		a. Green leaves
A		b. Green head
	8.	Needle-and-Thread, Stipa comata Trin. & Rupr.
3rd through A		a. Green leaves
	9.	Sand Dropseed, Sporobolus cryptandrus (Torr.) A. Gray
A		a. Boot
	10.	Bluestem, Agropyron smithii Rydb.
1st through A		a. Green leaves
4th, A		b. Green stubble
A		c. Dry stubble
	11.	Slender Wheatgrass, Agropyron trachycaulum (Link.) Malta.
A		a. Green leaves
	12.	Bluebunch Wheatgrass, Agropyron spicatum (Pursh) Scribn. & Smith
A		a. Green leaf
	13.	Tumblegrass, Schedonnardus paniculatus (Nutt.) Trel.
A		a. Green stem below head
A		b. Green head
	14.	Blue Grama, Bouteloua gracilis (HBK) Lag.
4th through A		a. Green leaves

	15.	Little Bluestem, Andropogon scoparius Michx.
A		a. Green leaf

Melanoplus dawsoni (Scudder):

Melanoplus dawsoni (Scudder) was found in small numbers in the area of study in 1949 and 1950. Only brachypterous individuals occurred and all were found in cool shaded areas of deep gullies.

Criddle (1933) lists M. dawsoni among the mixed-feeding grasshopper species which ate mostly broad-leaved plants. Nymphs and adults of this species were observed eating only forbs and shrubs in 1949 and 1950.

Instar		Food
		Family: Caprifoliaceae
	1.	Indiancurrant Coralberry, Symphoricarpos orbiculatus Moench.
A		a. Leaves
		Family: Onagraceae
	1.	Scarlet Gaura, Gaura coccinea Pursh
4th through A		a. Green leaves
		Family: Compositae
	1.	Heath Aster, Aster ericoides L.
A		a. Blossoms
	2.	Aromatic Sagebrush, Artemisia dracunculoides Pursh
5th, A		a. Green leaves
	3.	False Boneset, Kuhnia eupatorioides L.
A		a. Leaves
	4.	Meadow Salsify, Tragopogon pratensis L.
A		a. Green leaves
A		b. Dry leaves
	5.	Stiff Goldenrod, Solidago rigida L.
4th through A		a. Leaves

Family: Leguminosae

5th, A	1.	Slimflower Scurfpea, Psoralea tenuiflora Pursh a. Green leaves
A	2.	Purple Prairieclover, Petalostemon purpureus (Vent.) Rydb. a. Green leaves
5th, A	3.	Lupine, Lupinus parviflorus Nutt. a. Leaves

Family: Rosaceae

4th through A	1.	Rosebush, Rosa sp. a. Green leaves

Melanoplus mexicanus mexicanus (Saussure):

The lesser migratory grasshopper, Melanoplus mexicanus mexicanus (Saus.) was the most numerous and most commonly found grasshopper in the study area in both 1949 and 1950. It was found throughout all the vegetational types in the area. In both years, however, it was noted that the nymphal population was much greater on the clay soil-bluestem flats.

M. mexicanus was one of the first species to hatch in the spring. The first hatch observed in 1949 was April 28, and in 1950 on May 19. The first adult found in 1950 was July 11.

In 1949, feeding by the first two instars was confined mainly to dry materials found on the ground. These dry materials consisted of plant debris and dry cow manure. When small forbs such as the common dandelion and Nuttall violet were present, the nymphs were noted feeding on the blossoms but not on the green leaves. On one of the clay soil flats where bluestem was the dominant vegetation the population of the first three instars by cage count was as high as 150 per square yard.

The green vegetation in this area, however, showed very little evidence of feeding. The nymphs were seen on the grass plants for varying periods of time but only occasional feeding was noted. When feeding did occur it was usually on the dried or drying tips of the grass leaves.

When the nymphs reached the third instar and as they developed into adults more and more green grass was added to their diet. By the time the majority of M. mexicanus were adults, feeding on green vegetation had changed from grass to a large variety of forbs and shrubs found in the area. This feeding on forbs and shrubs was not confined to the adults but was also common to the late nymphs at that time.

At the time that this change in feeding was noticed the grasses in the area were becoming quite dry. M. mexicanus then moved into areas where forbs and shrubs were more numerous. These areas were not found on the clay soil-bluestem flats but in eroded areas of the sidehills and gullies; consequently, the population of this species decreased on the flats.

Following a heavy rain of 2.47 inches August 18, 1949, which induced new growth of grass many M. mexicanus returned to the flats. They preferred the new shoots of bluestem although forbs and shrubs were still eaten but not as predominantly as was previously noted.

In 1950 nymphs were again more numerous on the clay soil-bluestem flats. However, the population by cage counts was never more than fifteen per square yard.

The first two instars did not confine their feeding to dry materials as had been noted the previous year. In addition to feeding on dry

materials found on the ground, there was also considerable feeding on small forbs such as pale alyssum, Nuttall violet, common dandelion, threadleaf phacelia, Vicia spp., scurfpea, and prostrate knotweed. The nymphs were found to be more numerous in areas of these forbs.

As has been pointed out previously, the 1950 hatching date of M. mexicanus was nearly one month later than in 1949. The change in feeding habits of the first two instars in 1950 may possibly be correlated with a greater number of forbs being available as food-plants in 1950. Unfortunately no measure of the density of forbs in the area in 1949 and 1950 was made.

When the nymphs reached the third instar and as they developed into adults, the green vegetation consumed also included various grasses.

Throughout the summer, M. mexicanus could be observed in any of the vegetational types found in the area. If they were in an area where forbs and shrubs were greener than the grasses these plants constituted the main part of their diet. Where the grasses remained green, grasses were eaten as much as forbs and shrubs. Dry or drying materials continued to be eaten in considerable amounts throughout the life of this species.

Pfadt (1949c) has stated that, from cage tests under laboratory conditions, M. mexicanus differentially selects certain plants for food. From the field observations made in one area over a period of two years this conslusion can not be confirmed; rather, the conclusion from field observations by Criddle (1933) that this species "...will eat almost any plant which grows..." appears to be in line with the field observations reported here.

Under certain circumstances it appeared that some plants were eaten more than others. As has been noted previously, there were periods when forbs and shrubs seemed to be preferred and, conversely, there were periods when grasses seemed to be preferred.

It was noted that at times large numbers of M. mexicanus ate on one plant and continued to feed until very little of the plant remained. This type of feeding activity usually occurred after the plant involved had been broken or injured in some manner. Whenever a plant was pulled out of the ground and laid on the surface, this same type of response was noted.

As has been pointed out, feeding on grasses decreased as the plants became dry. The reverse situation appeared to be the case with downy chess brome which was eaten much less when green than when it was dry.

Instar	Food
1st through A	Plant debris
1st through A	Dry cow manure
3rd, 4th	Dead cicada
3rd through A	Dead grasshopper
A	Soil
A	Unidentified Crustaceous Lichen
	Family: Gramineae
	1. Japanese Chess, Bromus japonicus Thunb.
3rd through A	a. Green
3rd through A	b. Dry

	2.	Downy Chess Brome, Bromus tectorum L.
3rd through A		a. Dry leaves
3rd through A		b. Dry head
A		c. Dry stem
	3.	Sandberg Bluegrass, Poa secunda Presl.
A		a. Green leaves
	4.	Bluestem, Agropyron smithii Rydb.
1st through A		a. Green leaves
1st through A		b. Dry leaves
3rd through A		c. Green stem
A		d. Green base of dry stem
5th, A		e. Head
A		f. Green stubble
A		g. Dry stubble
	5.	Bluebunch Wheatgrass, Agropyron spicatum (Pursh) Scribn. & Smith
A		a. Green leaves
	6.	Slender Wheatgrass, Agropyron trachycaulum (Link.) Malta
A		a. Green leaves
	7.	Canada Wildrye, Elymus canadensis L.
A		a. Green leaves
	8.	Inland Giant Wildrye, Elymus cinereus Scribn. & Merr.
A		a. Green leaves
	9.	Junegrass, Koeleria cristata (L.) Pers.
A		a. Green leaves
A		b. Dry leaves
	10.	Needle-and-Thread, Stipa comata Trin. & Rupr.
4th through A		a. Green leaves
	11.	Green Needlegrass, Stipa viridula Trin.
4th through A		a. Green leaves
4th through A		b. Heads
	12.	Mat Muhly, Muhlenbergia richardsonis Merr.
A		a. Heads
	13.	Sand Dropseed, Sporobolous cryptandrus (Torr.) A. Gray
A		a. Heads
A		b. Late boot

A	14. False Buffalo Grass, Munroa squarrosa (Nutt.) Torr. a. Green leaves
A	15. Prairie Cordgrass, Spartina pectinata Link. a. Green leaves
A	16. Tumblegrass, Schedonnardus paniculatus (Nutt.) Trel. a. Dry head
A	17. Blue Grama, Bouteloua gracilis (HBK) Lag. a. Green leaves
	Family: Cyperaceae
A	1. Threadleaf Sedge, Carex filifolia Nutt. a. Drying stems.
	Family: Liliaceae
4th through A	1. Small Soapweed, Yucca glauca Nutt. a. Blossoms
A	2. Segolily Mariposa, Calchortus nuttallii T. & G. a. Dry capsule
	Family: Capparidaceae
A	1. Roughseed Clammyweed, Polanisia trachysperma T. & G. a. Dry leaf
	Family: Polemoniaceae
5th, A	1. Hoods Phlox, Phlox hoodii Rich. a. Drying leaves
3rd through A 3rd through A	2. Gilia, Collomia linearis Nutt. a. Green leaves b. Green stems
	Family: Malvaceae
5th, A	1. Scarlet Globemallow, Sphaeralcea coccinea (Pursh.) Rydb. a. Green leaves
	Family: Caprifoliaceae
A	1. Indiancurrant Coralberry, Symphoricarpos orbiculatus Moench. a. Green leaves

Family: Polygalaceae

1. White Polygala, Polygala alba Nutt.
   - A — a. Leaves
   - A — b. Blossoms

Family: Solanaceae

1. Cutleaf Nightshade, Solanum triflorum Nutt.
   - 3rd through A — a. Leaves
   - 3rd through A — b. Stems

2. Ground Cherry, Physalis lanceolata Michx.
   - 3rd through A — a. Blossoms
   - 3rd through A — b. Fruit

Family: Drupaceae

1. Chokecherry, Prunus melanocarpa (A. Nels.) Rydb.
   - A — a. Green leaves

Family: Portulacaceae

1. Common Purslane, Portulaca oleracea L.
   - A — a. Leaves
   - A — b. Stem

Family: Onagraceae

1. Scarlet Gaura, Gaura coccinea Pursh
   - 4th through A — a. Green leaves
   - A — b. Blossom bud

Family: Cactaceae

1. Plains Pricklypear, Opuntia polyacantha Haw.
   - 1st, 2nd — a. Spines
   - 3rd through A — b. Blossoms
   - A — c. Green stem
   - 1st through A — d. Dry stem

Family: Plantaginaceae

1. Bottlebrush Indianwheat, Plantago aristata Michx.
   - 4th through A — a. Green leaves
   - 4th through A — b. Green head

2. Wooly Indianwheat, Plantago purshii Roem. & Schult.

4th through A	a. Green leaves
4th through A	b. Green head

Family: Chenopodiaceae

1. Nuttall Monolepis, Monolepis nuttalliana (R. & S.) Engelm.

3rd through 5th	a. Green leaves
3rd through 5th	b. Green stem

2. Common Winterfat, Eurotia lanata (Pursh.) Moq.

A	a. Green leaves
A	b. Dry leaves
4th	c. Blossoms

3. Black Greasewood, Sarcobatus vermiculatus (Hook) Torr.

3rd through A	a. Bark

4. Tumbling Russian Thistle, Salsola kali L.

A	a. Blossom

5. Lambsquarters Goosefoot, Chenopodium album L.

A	a. Broken upright stem

Family: Compositae

1. Common Dandelion, Taraxacum officinale Weber

1st through A	a. Green leaves
1st through A	b. Dry leaves
1st through 3rd	c. Blossoms

2. Meadow Salsify, Tragopogon pratensis L.

4th through A	a. Green bracts
5th, A	b. Green leaves
3rd through A	c. Dry leaves
A	d. Green stem
4th through A	e. Dry stem
3rd through A	f. Blossom

3. Heath Aster, Aster ericoides L.

A	a. Blossom

4. Prickly Lettuce, Lactuca scariola L.

A	a. Green leaves
A	b. Dry leaves

	5.	Broom Snakeweed, Gutierrezia sarothrae (Pursh) B. & R.
A		a. Dry leaves
A		b. Blossom
	6.	Upright Prairieconeflower, Ratibida columnifera (Nutt.) Worton & Standl.
A		a. Green leaves
A		b. Dry leaves
5th, A		c. Flower
	7.	Fringed Sagebrush, Artemisia frigida Willd.
4th through A		a. Dry leaves
A		b. Dry stem
	8.	Aromatic Sagebrush, Artemisia dracunculoides Pursh
A		a. Blossom
	9.	Silver Sagebrush, Artemisia cana Pursh
5th through A		a. Bark
	10.	Big Sagebrush, Artemisia tridentata Nutt.
5th through A		a. Bark
	11.	Hairy Goldaster, Chrysopsis villosa Nutt.
A		a. Green leaves
	12.	Wavyleaf Thistle, Cirsium undulatum (Nutt.) Spreng.
5th through A		a. Green leaves
5th through A		b. Dry leaves
5th through A		c. Broken stems
5th through A		d. Blossoms
	13.	False Boneset, Kuhnia eupatorioides L.
A		a. Leaves
A		b. Blossoms
	14.	Western Yarrow, Achillea lanulosa Nutt.
3rd		a. Green leaves
4th, 5th		b. Blossom
	15.	Stiff Goldenrod, Solidago rigida L.
4th through A		a. Green leaves

Family: Violaceae

	1.	Nuttall Violet, Viola nuttallii Pursh
1st through 3rd		a. Green leaves
2nd through 3rd		b. Dry leaves
1st through 3rd		c. Blossoms

Family: Leguminosae

	1.	Stiffleaf Vetch, Vicia sparsifolia Nutt.
1st through 5th	a.	Green leaves
1st through A	b.	Dry leaves
	2.	Mat Vetch, Astragalus caespitosus (Nutt.) A. Gray
1st through 5th	a.	Green leaves
	3.	Slimflower Scurfpea, Psoralea tenuiflora Pursh.
A	a.	Green leaves
A	b.	Dry leaves
A	c.	Blossoms
	4.	Purple Prairieclover, Petalostemon purpureus (Vent.) Rydb.
A	a.	Green leaves
	5.	Silky Prairieclover, Petalostemon villosus Nutt.
A	a.	Green leaves
	6.	American Licorice, Glycyrrhiza lepidota Pursh
A	a.	Green leaves

Family: Brassicaceae

	1.	Pale Allyssum, Allysum alyssoides (L.) Gouan
1st through 5th	a.	Green leaves
2nd through 5th	b.	Dry leaves
3rd	c.	Stem
1st through 3rd	d.	Petiole
1st through 3rd	e.	Dry capsule

Family: Hydrophyllaceae

	1.	Threadleaf Phacelia, Phacelia linearis (Pursh.) Holz.
1st, 2nd	a.	Green leaves
3rd through A	b.	Dry leaves
3rd through A	c.	Dry stem
3rd	d.	Blossom

Family: Polygonaceae

	1.	Prostrate Knotweed, Polygonum aviculare L.
1st through A	a.	Green leaves
1st through A	b.	Green stem
A	c.	Dry stem

	1.	Biscuit Root, Lomatium montanum Coult. & Rose
3rd		a. Green leaves
		Family: Loasaceae
	1.	Tenpetal Mentzelia, Mentzelia decaptela (Pursh) Urban & Gilg.
A		a. Blossoms
	2.	Mentzelia, Mentzelia oligosperma Nutt.
A		a. Leaves
A		b. Blossoms
		Family: Campanulaceae
	1.	Harebell, Campanula rotundifolia L.
4th, 5th		a. Stem
4th		b. Drying blossom
		Family: Linaceae
	1.	Lewis Flax, Linum lewisii Pursh
A		a. Green leaves
		Family: Cruciferae
	1.	Tumbling Mustard, Sisymbrium loeslii L.
4th through A		a. Green leaves
A		b. Green silique

Melanoplus keeleri luridus (Dodge):

Melanoplus keeleri luridus (Dodge) was found in very low numbers in 1949 and 1950. It was confined to the ravines and gravelly hills where a great variety of forbs was growing.

M. luridus is listed among the mixed-feeding grasshopper species by Criddle (1933). The nymphs and adults were observed feeding only on forbs in 1949 and 1950.

Instar	Food
	Family: Onagraceae
	1. Scarlet Gaura, Gaura coccinea Pursh
A	a. Leaves
	Family: Compositae
	1. Aromatic Sagebrush, Artemisia dracunculoides Pursh
4th through A	a. Green leaves
5th, A	b. Blossom
5th	c. Bark
	2. Heath Aster, Aster ericoides L.
5th, A	a. Blossoms
	3. Wavyleaf Thistle, Cirsium undulatum (Nutt.) Spreng.
3rd, 4th	a. Green leaves
	4. False Boneset, Kuhnia eupatorioides L.
4th through A	a. Green leaves
A	b. Blossoms
	5. Dotted Gayfeather, Liatris punctata Hook.
A	a. Green leaves
A	b. Blossoms
	Family: Leguminosae
	1. Slimflower Scurfpea, Psoralea tenuiflora Pursh
5th, A	a. Green leaves
	2. Purple Prairieclover, Petalostemon purpureus (Vent.) Rydb.
4th through A	a. Green leaves
A	b. Blossoms
	3. Silverleaf Scurfpea, Psoralea argophylla Pursh.
4 through A	a. Green leaves
	Family: Linaceae
	1. Lewis Flax, Linum lewisii Pursh.
3rd, 4th	a. Green leaves

Melanoplus infantilis Scudder:

Melanoplus infantilis Scudder was found in very small numbers in 1949 and 1950 and only on the clay soil-bluestem flats.

Isely (1944), from his study on the mandibular morphology of grasshoppers, placed M. infantilis among the grass-feeding species. Criddle (1933) also lists this grasshopper as a grass-feeding species which feeds on several species of grass.

Only scanty observations on the activities of M. infantilis were possible during 1949 and 1950. Bluestem was the only green vegetation upon which the nymphs and adults were observed feeding and only the adults were seen eating plant debris found on the ground.

Instar	Food
A	Plant debris
	Family: Gramineae
	1. Bluestem, Agropyron smithii Rydb
2nd through A	a. Green leaves
A	b. Dry leaves
A	c. Dry stubble

Melanoplus bivittatus (Say):

The two-striped grasshopper, Melanoplus bivittatus (Say), was one of the first grasshoppers to hatch during the two years observations were made. The approximate hatching date in 1949 was April 28. In 1950, the first hatch of this species was May 19, and the first adult was found July 1, five days before adults of any other species were found.

M. bivittatus was never high in numbers and was confined mainly to areas in which forbs were numerous. It was especially numerous on green tumbling mustard which grew in the shallow gullies of the side hills. Adults were also found concentrated along the bank of a creek where smooth brome was the dominant vegetation.

The statement made by Criddle (1933) that M. bivittatus is a very general feeder was borne out by the field observations made in 1949 and 1950. No single food-plant was preferred and, in addition to dry materials found on the ground, both forbs and grasses were eaten.

Instar	Food
1st through A	Plant debris
A	Dead grasshoppers
	Family: Gramineae
	1. Canada Wildrye, Elymus canadensis L.
A	a. Green leaves
	2. Inland Giant Wildrye, Elymus cinereus Scribn. & Merr.
A	a. Green leaves
	3. Prairie Cordgrass, Spartina pectinata Link.
A	a. Green leaves
	4. Downy Chess Brome, Bromus tectorum L.
A	a. Green head
	5. Japanese Chess, Bromus japonicus Thunb.
4th through A	a. Green leaves
	6. Smooth Brome, Bromus inermis Leyss
3rd through A	a. Green leaves
	7. Bluestem, Agropyron smithii Rydb.
3rd through A	a. Green leaves
A	b. Green stems
A	c. Green stubble

Family: Cyperaceae

A — 1. Alkali Bulrush, Scirpus paludosus A. Nels.
a. Green stems

Family: Liliaceae

4th through A — 1. Small Soapweed, Yucca glauca Nutt.
a. Blossoms

5th — 2. Common Starlily, Leucocrinum montanum Nutt.
a. Green leaves

Family: Capparidaceae

A — 1. Roughseed Clammyweed, Polanisia trachysperma T. & G.
a. Green leaf

Family: Caprifoliaceae

A — 1. Indiancurrant Coralberry, Symphoricarpos orbiculatus Moench.
a. Green leaves

Family: Solanaceae

A — 1. Cutleaf Nightshade, Solanum triflorum Nutt.
a. Green leaves

Family: Drupaceae

4th through A — 1. Chokecherry, Prunus melanocarpa (A. Nels.) Rydb.
a. Green leaves

Family: Plantaginaceae

A — 1. Woolly Indianwheat, Plantago Purshii Roem. & Schult.
a. Dry stem

Family: Chenopodiaceae

3rd through A — 1. Nuttall Monolepis, Monolepis nuttalliana (R. & W.) Engelm.
a. Green leaves

4th through A — 2. Common Winterfat, Eurotia lanata (Pursh.) Moq.
a. Leaves

3. Lambsquarters Goosefoot, Chenopodium album L.
A — a. Broken upright stem

4. Black Greasewood, Sarcobatus vermiculatus (Hook.) Torr.
3rd, A — a. Green leaves

5. Shadscale Saltbush, Atriplex confertifolia (Torr.) Wats.
A — a. Green leaves

6. Tumbling Russian Thistle, Salsola kali L.
A — a. Green stems

Family: Compositae

1. Common Dandelion, Taraxacum officinale Weber
1st, 2nd — a. Blossoms

2. Meadow Salsify, Tragopogon pratensis L.
5th, A — a. Green leaves
5th, A — b. Green stem
5th, A — c. Drying stem

3. Prickly Lettuce, Lactuca scariola L.
3rd through A — a. Green leaves

4. Chicory Lettuce, Lactuca pulchella (Pursh.) D. C.
A — a. Green leaves

5. Wavyleaf Thistle, Girsium undulatum (Nutt.) Spreng.
4th through A — a. Green leaves
4th — b. Blossoms

6. Stiff Goldenrod, Solidago rigida L.
A — a. Green leaves
A — b. Blossoms

Family: Leguminosae

1. Stiffleaf Vetch, Vicia sparsifolia Nutt.
1st, 2nd — a. Green leaves

2. Slimflower Scurfpea, Psoralea tenuiflora Pursh
A — a. Green leaves

Family: Loasaceae

1. Mentzelia, Mentzelia oligosperma Nutt.
A — a. Leaves

Family: Campanulaceae

	1.	Harebell, Campanula rotundifolia L.
4th	a.	Green stem

Family: Cruciferae

	1.	Tumbling Mustard, Sisymbrium loeslii L.
3rd through A	a.	Green leaves
3rd through A	b.	Green stems
A	c.	Green siliques

Melanoplus differentialis (Thomas):

Only two Melanoplus differentialis (Thomas) adults were found on the rangeland study area in 1949. None were seen in 1950.

The two adults seen in 1949 were eating slimflower scurfpea, Psoralea tenuiflora (Pursh).

Melanoplus bowditchi canus Hebard:

The sagebrush grasshopper, Melanoplus bowditchi canus Hebard, was found in small numbers in the area of study in 1949 and 1950.

White and Rock (1945) state that this species is found around or near silver sagebrush and Criddle (1933) states that M. canus is restricted in feeding to silver sagebrush.

M. Canus was observed feeding on all of the sagebrush species found in the area of study. Silver sagebrush was the preferred food-plant. White sagebrush and aromatic sagebrush were eaten very sparingly.

It was generally found on the taller plants in the area until oviposition commenced in late August. At that time it appeared that the adults were more numerous on the shorter plants.

This species was seldom seen on the ground and only occasional feeding by the older adults and nymphs on dry materials on the ground was noted.

Instar	Food
4th through A	Plant debris
A	Dry cow manure
A	Soil
	Family: Compositae
	1. Fringed Sagebrush, *Artemisia frigida* Willd.
4th through A	a. Leaves
A	b. Bark
	2. Aromatic Sagebrush, *Artemisia dracunculoides* Pursh
A	a. Blossoms
	3. Silver Sagebrush, *Artemisia cana* Pursh
2nd through A	a. Leaves
3rd through A	b. Bark
A	c. Blossoms
	4. Big Sagebrush, *Artemisia tridentata* Nutt.
2nd through A	a. Leaves
3rd through A	b. Bark
	5. White Sagebrush, *Artemisia ludoviciana* Nutt.
A	a. Leaves
A	b. Blossom

Melanoplus femur-rubrum femur-rubrum (DeGeer):

The number of *Melanoplus femur-rubrum femur-rubrum* (DeGeer) found in the study area during the two years of observation were very low. The hatching dates of this species were not recorded; however, it was one of the last grasshoppers in the area to hatch and develope.

Criddle (1933) stated that M. femur-rubrum, along with Melanoplus mexicanus (Saus.) and M. bivittatus (Say), will "eat almost any plant which grows" and has listed it among the mixed-feeding species of grasshoppers.

Due to the small numbers of this species present in the study area, only scanty observations upon its habits were possible. During both years of observation it was most numerous in areas where forbs were the dominant vegetation. The various forbs and shrubs found in these areas comprised the majority of its food. Very little feeding on grasses was noted.

M. femur-rubrum appeared to spend most of its time on plants. Only occasional feeding of this species on dry plant debris was seen.

Instar	Food
A	Plant debris
	Family: Gramineae
	1. Bluestem, Agropyron smithii Rydb.
A	a. Green stubble
A	b. Dry stubble
	2. Prairie Cordgrass, Spartina pectinata Link.
A	a. Green leaves
	Family: Capparidaceae
	1. Roughseed Clammyweed, Polanisia trachysperma T. & G.
A	a. Flower bud
	Family: Polemoniaceae
	1. Hoods Phlox, Phlox hoodii Rich.
A	a. Drying leaves

Family: Caprifoliaceae

1. Indiancurrant Coralberry, Symphoricarpos orbiculatus Moench.
3rd through A a. Leaves

Family: Solanaceae

1. Cutleaf Nightshade, Solanum triflorum Nutt.
4th through A a. Green leaves

Family: Onagraceae

1. Scarlet Gaura, Gaura coccinea Pursh
3rd through A a. Green leaves

Family: Chenopodiaceae

1. Tumbling Russian Thistle, Salsola kali L.
A a. Green leaves

Family: Compositae

1. Common Dandelion, Taraxacum officinale Weber
3rd through A a. Green leaves
3rd through A b. Dry leaves

2. Heath Aster, Aster ericoides L.
A a. Flowers

3. Hairy Goldaster, Chrysopsis villosa Nutt.
3rd through A a. Green leaves

4. Wavyleaf Thistle, Cirsium undulatum (Nutt.) Spreng.
3rd a. Green leaves

Family: Leguminosae

1. Slimflower Scurfpea, Psoralea tenuiflora Pursh
A a. Green leaves

2. American Licorice, Glycyrrhiza lepidota Pursh
5th, A a. Green leaves

3. Lupine, Lupinus parviflorus Nutt.
3rd a. Green leaf

Family: Brassicaceae

	1.	Pale Alyssum, Alyssum alyssoides (L.) Gouan
4th	a.	Blossom

Family: Cruciferae

	1.	Tumbling Mustard, Sisymbrium loeslii L.
2nd through A	a.	Green leaves
A	b.	Green silique

Melanoplus gladstoni (Scudder):

Only an occasional Melanoplus gladstoni Scudder was observed in the area of study in 1949 and 1950. Those observed were found on gently sloping gravelly areas which adjoined the clay soil-bluestem flats.

Criddle (1933) lists M. gladstoni as a grass-feeding grasshopper species. In 1949 and 1950 the few adults observed seemed to prefer bluestem, but on at least two occasions, forbs were also eaten.

Instar		Food
		Family: Gramineae
	1.	Bluestem, Agropyron smithii Rydb.
A	a.	Green leaves
A	b.	Green stubble
A	c.	Dry stubble
		Family: Compositae
	1.	Dotted Gayfeather, Liatris punctata Hook.
A	a.	Blossoms
		Family: Leguminosae
	1.	Purple Prairieclover, Petalostemon purpureus (Vent.) Rydb.
A	a.	Green leaves

Melanoplus Packardii Scudder:

The first hatch of Packard's grasshopper, Melanoplus packardii Scud., in 1949 was approximately May 1, and in 1950 the first hatch was May 22. The first adult found in 1950 was July 8.

This species was found in small numbers throughout all of the vegetational types of the study area. However, on the hills and benches of the lower elevations, where forbs were quite prevalent, the population of M. packardii was definitely higher.

Criddle (1933) listed M. packardii as a general feeder. The field observations during the two summers covered by this report indicate that this conclusion is correct in that plant debris, forbs, and grasses are eaten. During both years of study, however, it was quite evident that forbs were definitely preferred over all other green vegetation found in the area by both the nymphs and adults. The blossoms of various forbs seemed to be particularly relished.

From the large number of plants which M. packardii was observed eating, it is quite difficult to state that any one species was eaten more than the others. However, it was noted that adults could always be found on or near slimflower scurfpea plants, a plant readily eaten by this insect.

The nymphs and adults of this species also consumed large amounts of dry materials found on the ground and dry or drying vegetation.

Instar	Food
3rd through A	Plant debris
4th, 5th	Dry cow manure
5th	Dead cicada
5th, A	Dead grasshoppers
A	Soil

Family: Gramineae

	1. Bluestem, Agropyron smithii Rydb.
3rd through A	a. Green leaves
A	b. Dry leaves on the ground
A	c. Dry stems on the ground
	2. Needle-and-Thread, Stipa comata Trin. & Rupr.
A	a. Green leaves
A	b. Drying leaves
	3. Mat Muhly, Muhlenbergia richardsonis Merr.
A	a. Heads

Family: Liliaceae

	1. Small Soapweed, Yucca glauca Nutt.
A	a. Leaves
A	b. Blossoms
	2. Segolily Mariposa, Calochortus nuttallii T. & G.
A	a. Dry capsule

Family: Capparidaceae

	1. Roughseed Clammyweed, Polanisia trachysperma T. & G.
A	a. Dry leaves

Family: Polemoniaceae

	1. Hoods Phlox, Phlox hoodii Rich.
A	a. Dry leaves

Family: Polygalaceae

1. White Polygala, Polygala alba Nutt.

A	a. Leaves
A	b. Blossoms

Family: Solanaceae

1. Cutleaf Nightshade, Solanum triflorum Nutt.

A	a. Green leaves
A	b. Green stems

Family: Onagraceae

1. Scarlet Gaura, Gaura coccinea Pursh

4th through A	a. Green leaves
5th	b. Flower bud

Family: Cactaceae

1. Plains Pricklypear, Opuntia polycantha Haw.

3rd through A	a. Dry stem
3rd through A	b. Blossoms

Family: Chenopodiaceae

1. Nuttall Monolepis, Monolepis nuttalliana (R. & S.) Engelm.

5th	a. Green leaves

2. Common Winterfat, Eurotia lanata (Pursh) Moq.

4th	a. Green leaves

3. Tumbling Russianthistle, Salsola kali L.

A	a. Green stem

Family: Compositae

1. Common Dandelion, Taraxacum officinale Weber

3rd through A	a. Green leaves
3rd through A	b. Dry leaves

2. Meadow Salsify, Tragopogon pratensis L.

A	a. Green leaves
A	b. Dry leaves
A	c. Green stems
A	d. Blossoms

	3.	Heath Aster, Aster ericoides L.
A		a. Blossom
	4.	Wavyleaf Thistle, Circium undulatum (Nutt.) Spreng.
A		a. Green leaves
4th through A		b. Dry leaves
4th through A		c. Blossoms
	5.	False Boneset, Kuhnia eupatorioides L.
A		a. Green leaves
A		b. Blossoms
	6.	Dotted Gayfeather, Liatris punctata Hook.
A		a. Blossoms

Family: Leguminosae

	1.	Stiffleaf Vetch, Vicia sparsifolia Nutt.
3rd through A		a. Green leaves
	2.	Slimflower Scurfpea, Psoralea tenuiflora Pursh
4th through A		a. Green leaves
4th through A		b. Dry leaves
A		c. Dry stem on the ground
A		d. Blossoms
	3.	Lupine, Lupinus parviflorus Nutt.
4th through A		a. Green leaves
4th through A		b. Blossoms
4th through A		c. Seed pod
	4.	Silky Prairieclover, Petalostemon villosus Nutt.
A		a. Blossoms
	5.	Purple Prairieclover, Petalostemon purpureus (Vent.) Rydb.
A		a. Blossoms
	6.	Silverleaf Scurfpea, Psoralea argophylla Pursh
A		a. Green leaves
	7.	Common Breadroot Scurfpea, Psoralea esculenta Pursh
A		a. Green leaves

Family: Hydrophyllaceae

4th	1.	Threadleaf Phacelia, Phacelia linearis (Pursh) Holz.
4th		a. Green leaves

Family: Polygonaceae

	1.	Prostrate Knotweed, Polygonum aviculare L.
3rd through A		a. Green leaves

Family: Loasaceae

	1.	Tenpetal Mentzelia, Mentzelia decaptela (Pursh) urban & Gilg.
A		a. Green leaves
4th through A		b. Blossoms

Family: Linaceae

	1.	Lewis Flax, Linum lewisii Pursh
A		a. Seed

Family: Scrophulariaceae

	1.	Penstemon, Penstemon cristatus Pursh
A		a. Dried blossoms

PRELIMINARY GRASSHOPPER DAMAGE STUDY

That grasshoppers are in direct competition with livestock for the available food-plants on our ranges is quite evident to anyone who has observed a range infested by these insects.

Various workers have attempted to measure the amount of damage by grasshoppers to range vegetation. In every case, however, either the grasshoppers, the vegetation, or both have been subjected to cage conditions. For example, Morton (1936) and (1939) compared the dry weight of vegetation on a grasshopper infested range with the dry weight of vegetation under cages from which grasshoppers were excluded. Hinkle (1938), using "ocular" measurements entirely, compared the utilization of vegetation by grasshoppers in cages against the vegetation in cages from which grasshoppers were excluded. More recently, Pfadt (1939a) made a study in which he compared the dry weight of grasses on which known population of Aulocara elliotti had been placed.

In order to determine the feasibility of measuring grasshopper damage to range land under natural conditions, the writer, working with J. C. Wright of the Department of Botany and Bacteriology, Montana State College, carried out the following experiment in 1950 at the OW Ranch.

The area selected for study consisted of approximately 1000 acres of winter range from which all livestock were excluded during the period of study. Slightly less than one-half of the area was sprayed June 28 to eliminate the grasshoppers; the application was made by aircraft and the material used was aldrin at a dosage of 1 2/3 ounces per acre.

From the standpoint of grazing value the vegetational types of greatest importance on the OW range are those dominated by bluestem and needle-and-thread-bluestem. Comparable representative areas of each were selected in both the sprayed and the unsprayed areas.

Grasshopper populations in the study area were measured by the use of bottomless cages with screen top and sides. Each cage measured two feet long, two feet wide, and four feet high. Approximately two hours after sunset or at such time when little or no grasshopper activity was detected four cages were randomly placed in the area to be sampled. The bottom edges of each each cage were banked with dirt to prevent the movement of grasshoppers in or out of the cages. The next morning grasshoppers which had been caught by the placement of the cages the previous evening were removed from the cages through a door in one side and the number and instar of each species recorded. The cages were then removed from the area.

Snedecor's (1950) method of analysis for this cage method of determining grasshopper populations in the two vegetational types is shown in tables I and II.

The grasshopper populations in the area which was sprayed were reduced to 0.38 per square yard and remained at a low population level throughout the period of study.

The grasshopper populations in the uncontrolled vegetational types varied throughout the period of study. A summary of the populations measured by the cage method during the period of study is found in tables III, IV, and V. It will be noted that tables IV and V are both

TABLE I. ANALYSIS OF VARIANCE OF 10 SETS OF 4 CAGES PLACED ON THE UNCONTROLLED NEEDLE-AND-THREAD—BLUESTEM TYPE

(July 9, 1950 to September 8, 1950)

Source of Variation	Degrees Of Freedom	Sum of Squares	Mean Square
Date of Placement	9	15.61	1.73
Number of Cages/Date	3	1.37	0.46
Discrepance	27	12.21	0.45
Total	39	29.19	

F Value for Date of Placement $= \frac{1.73}{0.45} = 3.84$

F.01 = 3.14

F Value for Number of Cages/Date $= \frac{0.46}{0.45} = 1.02$

F.01 = 4.60

TABLE II. ANALYSIS OF VARIANCE OF 12 SETS OF 4 CAGES PLACED ON THE UNCONTROLLED BLUESTEM TYPE

(July 7, 1950 to September 8, 1950)

Source of Variation	Degrees Of Freedom	Sum of Squares	Mean Square
Date of Placement	11	20.36	1.85
Number of Cages/Date	3	0.73	0.24
Discrepance	33	17.86	0.63
Total	47	38.95	

F Value for Date of Placement $= \frac{1.85}{0.63} = 2.94$

F.01 = 2.52

F Value for Number of Cages/Date $= \frac{0.24}{0.63} = 0.38$

F.01 = 4.46

TABLE III. GRASSHOPPER POPULATIONS IN THE UNCONTROLLED NEEDLE-AND-THREAD—BLUESTEM TYPE

(10 sets of 4 cages placed between July 9, 1950 and September 8, 1950)

Grass Feeders		Mixed Feeders		Forb Feeders	
Species	Total No.	Species	Total No.	Species	Total No.
D. Femoratum	7	M. m. mexicanus	24	H. trifasciatus	3
A. deorum	17	M. bivittatus	2	M. b. canus	3
A. coloradus	20	T. campestris	1	M. k. luridus	1
O. obscura	2	M. packardii	6	H. v. viridis	3
M. m. macclungi	12	S. equale	5	M. dawsoni	1
M. infantilis	1		39		11
M. pardalinus	3				
A. pseudonietana	1				
P. nebrascensis	2				
H. rugosus	1				
P. quadrimaculatum	1				
	67				

40 cages = 17.78 square yards

Grass Feeders = $\frac{67}{17.78}$ = 3.77 per square yard

Mixed Feeders = $\frac{39}{17.78}$ = 2.19 per square yard

Forb Feeders = $\frac{11}{17.78}$ = 0.62 per square yard

TABLE IV. GRASSHOPPER POPULATIONS IN THE UNCONTROLLED BLUESTEM TYPE

-WET AREA-

(7 sets of 4 cages placed between July 7, 1950 and September 7, 1950)

Grass Feeders		Mixed Feeders		Forb Feeders	
Species	Total No.	Species	Total No.	Species	Total No.
D. femoratum	23	M. m. mexicanus	27	H. trifasciatus	1
A. deorum	14	M. bivittatus	2	A. t. turnbulli	1
M. pardalinus	12	S. equale	1		2
P. nebrascensis	10		30		
T. k. kiowa	1				
A. elliotti	3				
	63				

28 cages = 12.44 square yards

Grass Feeders = $\frac{63}{12.44}$ = 5.06 per square yard

Mixed Feeders = $\frac{30}{12.44}$ = 2.41 per square yard

Forb Feeders = $\frac{2}{12.44}$ = 0.16 per square yard

TABLE V. GRASSHOPPER POPULATIONS IN THE UNCONTROLLED BLUESTEM TYPE

-DRY AREA-

(5 sets of 4 cages placed between July 7, 1950 and September 7, 1950)

Grass Feeders		Mixed Feeders		Forb Feeders	
Species	Total No.	Species	Total No.	Species	Total No.
D. femoratum	11	M. m. mexicanus	9	0	0
A. deorum	1	T. campestris	1		
O. obscura	2	S. equale	2		
M. m. macclungi	1		12		
M. pardalinus	3				
T. k. kiowa	1				
	19				

20 cages = 8.89 square yards

Grass Feeders $= \frac{19}{8.89} = 2.14$ per square yard

Mixed Feeders $= \frac{12}{8.89} = 1.35$ per square yard

Forb Feeders $= 0 = 0$ per square yard

measures of the grasshopper populations in the bluestem vegetational type; however, one is a measure of populations in a "dry" area in which the bluestem was short and the other a measure of populations in a "wet" area in which there was an excellent growth of succulent bluestem.

The grasses in plots four feet square were clipped to ground level in the two vegetational types of the sprayed and unsprayed areas. The first plots were clipped during the period July 6-14, one week after the spraying operation. Two successive clippings at one month intervals were made in the same area as the first clippings were made.

The plots were laid out at ten-foot intervals along a 100-foot line for the first clipping and subsequent clip plots were located adjacent to those clipped the first time. Eighty-seven plots were clipped in the sprayed area and 114 plots were clipped in the unsprayed area.

The clipped grasses were air-dried and a summary of the total weights expressed in pounds per acre is given in tables VI and VII.

The increase in weight of the grasses in the sprayed area can be attributed to continued growth during the period between the first and third clippings. The loss in weight in the unsprayed area can be attributed to grasshopper damage.

The maximum damage measured assumes that the grasses in the unsprayed area continued to grow in the same amount as those in the sprayed area. The maximum damage in the needle-and-thread—bluestem type amounts to 298.5 pounds per acre air dry weight or 53.5% of the total yield. The maximum damage in the "dry" bluestem type amounts to

TABLE VI. A COMPARISON OF WEIGHTS OF GRASS CLIPPINGS AND GRASSHOPPER POPULATIONS IN TWO SPRAYED AND UNSPRAYED VEGETATIONAL TYPES

	Average Number Grasshoppers Per Square Yard	Weight of Grass Clippings Expressed In Pounds Per Acre Air Dry Weight			
		First Clip	Second Clip	Third Clip	Increase or Decrease
A. Sprayed Area					
1. Bluestem Type	<1	439.8	540.7	508.3	+68.5
2. Needle-and-Thread—Bluestem Type	<1	571.8	750.8	696.2	+124.4
B. Unsprayed Area					
1. Bluestem Type (Wet Area)		719.3	502.74	343.32	-375.98
(a) Grass Feeders	5.06				
(b) Mixed Feeders	2.41				
(c) Forb Feeders	0.16				
2. Needle-and-Thread—Bluestem Type		433.40	381.50	259.30	-174.10
(a) Grass Feeders	3.77				
(b) Mixed Feeders	2.19				
(c) Forb Feeders	0.62				

TABLE VII. A COMPARISON OF WEIGHTS OF GRASS CLIPPINGS AND GRASSHOPPER POPULATIONS IN TWO SPRAYED AND UNSPRAYED VEGETATIONAL TYPES

	Average Number Grasshoppers Per Square Yard	Weight of grass Clippings Expressed In Pounds Per Acre Air Dry Weight			
		First Clip	Second Clip	Third Clip	Increase or Decrease
A. Sprayed Area					
1. Bluestem Type	<1	439.8	540.7	508.3	+68.5
2. Needle-and-Thread—Bluestem Type	<1	571.8	750.8	696.2	+124.4
B. Unsprayed Area					
1. Bluestem Type (Dry Area)		327.24	171.90	124.36	-202.88
(a) Grass Feeders	2.14				
(b) Mixed Feeders	1.35				
(c) Forb Feeders	0				
2. Needle-and-Thread—Bluestem Type		433.40	381.50	259.30	-174.10
(a) Grass Feeders	3.77				
(b) Mixed Feeders	2.19				
(c) Forb Feeders	0.62				

271.38 pounds per acre as against 444.48 pounds per acre in the "wet" bluestem type. However, on a percentage basis this amounts to 68.6% of the total yield in the "dry" bluestem type and 56.4% of the total yield in the "wet" bluestem type.

The minimum damage measured assumes that the grasses in the unsprayed area did not continue to grow after the first clipping. Such an assumption does not seem very plausible. However, even when such an assumption is made, the data show that the damage by grasshoppers is high. The minimum damage in pounds per acre air dry weight in each type is the loss in weight recorded in tables VI and VII. In percentages of the total yield in each type this amounts to 40.2% for the needle-and-thread—bluestem type, and 52.3% for the "wet" bluestem type.

DISCUSSION

This study was conducted primarily as an effort to obtain some fundamental information regarding the biology of range grasshoppers. It was confined to observations of these insects in their natural environment rather than under the artificial conditions of laboratory or cage studies.

In the laboratory it is not possible to duplicate the numerous natural factors which may influence grasshopper behavior. It is felt, therefore, that laboratory studies are of importance mainly in their indications of activities which may be occurring in nature.

In laboratory feeding experiments plants are grown and handled under artificial conditions and plant tissues are often injured. The effect of injured tissue upon the feeding habits of some grasshoppers has been noted in field observations. An observation commonly reported by farmers and entomologists working on grasshopper research and control is that plants which have been injured in cultivation are eaten more readily by grasshoppers than are uninjured plants. These observers have noted that some grasshoppers, namely *Melanoplus bivittatus*, *Melanoplus mexicanus mexicanus*, *Melanoplus differentialis*, and *Melanoplus packardii*, will congregate on one plant, particularly an injured plant, to feed. This writer noticed that after western tickweed, *Lappula redowskii*, was passed through the hand but apparently uninjured, an adult *M. mexicanus* immediately crawled upon it and started to feed. Feeding by this species on western tickweed was noted at no other time.

The field observations show that grasshopper distribution in the rangeland study areas was not random and as Isely (1944) has stated: "The availability of specific host plants---looms large as one of the environmental factors in evaluating conditions which will help explain the local and regional distribution of grasshoppers."

It was found that a majority of the grasshopper species present did not display the omnivorous habits popularly assigned to all grasshoppers. They may be placed in three general categories: those which feed only on grass, those which feed only on broad-leaved plants, i.e., forbs and/or shrubs, and those which are mixed feeders feeding on both grasses and broad-leaved plants.

In addition, several species appeared to be highly selective in their food-plant preference. Among the grass-feeding species found to be selective are: Opeia obscura, Phlibostroma quadrimaculatum, Trachyrhachis kiowa kiowa, and Cordillacris crenulata which fed mainly on blue grama, Bouteloua gracilis. Amphitornus coloradus preferred needle-and-thread, Stipa comata. Others such as Phoetaliotes nebrascensis, Melanoplus infantilis, Ageneotettix deorum, Drepanopterna femoratum, Aulocara elliotti, and Metator pardalinus were found in greater numbers where bluestem, Agropyron smithii, was the dominant vegetation. Mermiria maculipennis macclungi and Hippiscus rugosus were most numerous in the south and east-slope bunch-grass areas.

Selectivity by some of the species which fed only on broad-leaved plants was also apparent. Acrolophitus hirtipes fed on members of the plant family Boraginaceae. Schistocerca lineata fed mainly on wild

rosebush, Rosa sp., and American licorice, Glycyrrhiza lepidota. Hypochlora alba and Melanoplus bowditchi canus confined their feeding to members of the plant genus Artemisia with H. alba being confined mainly to white sagebrush, Artemisia ludoviciana. Hesperotettix viridis viridis was found chiefly on broom snakeweed, Gutierrezia sarothrae, and stiff goldenrod, Solidago rigida. Aeoloplus turnbulli turnbulli ate only members of the family Chenopodiaceae. Derotmema haydenii haydenii was generally found on forbs in old prairie dog towns.

Among the mixed-feeding species are three of the most commonly found grasshoppers in Montana: Melanoplus mexicanus mexicanus, Melanoplus bivittatus and Melanoplus packardii. However, even here there was an indication, at least with M. mexicanus, that food-plant preference may change as environmental conditions change.

The study of the feeding habits of various grasshopper species may be used to explain the varied results obtained in control operations. Some species, in particular those which feed on blue grama, confine their feeding activity to plants and do not feed on materials found on the ground at any time. Phoetaliotes nebrascensis remained upon plants as nymphs and would probably not be controlled by baits until they became adult. In contrast, a species such as Arphia pseudonietana which was observed feeding very little as an adult, could only be controlled as a nymph. Hadrotettix trifasciatus could be controlled quite readily by baits since it feeds mainly on dry materials found on the ground. However, because of this feeding preference, there would be little point in expending money, time, and effort in its control.

Local movements by various grasshopper species were also observed. The species found in greatest numbers hatched on the clay soil-bluestem flats of the study area. As the vegetation on the flats became quite dry, several of the species moved out. Ageneotettix deorum moved to the side hills and Melanoplus mexicanus mexicanus moved to any area where the vegetation, particularly the broad-leaved plants, remained green. Phoetaliotes nebrascensis congregated in localized areas which remained green and finally became most numerous in the deep gullies and old stream beds where succulent stands of grasses remained. After a late summer rain which brought forth new growth of the grasses, there was a return by all of these species to the clay soil-bluestem flats. Some species much as Aulocara elliotti, Drepanopterna femoratum, and Metator pardalinus, remained on the clay soil-bluestem flats throughout the season.

At least two species, Drepanopterna femoratum and Metator pardalinus, displayed a tendency to congregate in bands of varying size as adults.

The preliminary work on grasshopper damage has shown that it is possible to measure damage to rangeland grasses without resorting to cage experiments. It has also shown that rangeland grasshoppers are in direct competition with livestock for available food-plants and must be taken into consideration in good range management practices.

SUMMARY

The field observations of thirty-eight species of rangeland grasshoppers found in one area of southeastern Big Horn County, Montana, show that:

1. In general, rangeland grasshopper distribution is not random but is dependent upon the type of vegetation present.

2. In general, rangeland grasshoppers are not omnivorous but are selective in a food-plant preference.

3. Rangeland grasshopper species may differ widely in feeding habits.

4. Feeding habits of rangeland grasshoppers may change as the grasshoppers develop or may vary with changes in environmental conditions.

5. Local movements of some but not all rangeland grasshoppers take place with changes in environmental conditions.

6. Rangeland grasshopper damage is measureable without resorting to cage experiments.

7. Rangeland grasshoppers are in direct competition with livestock for the available food-plants.

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