

ORTHOPTERA OF THE NEVADA TEST SITE

by

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INTRODUCTION

This study is part of a larger ecological project to comparatively analyze the native animals at the Nevada Test Site. The objectives of this study were to (1) classify the species and provide taxonomic keys for their differentiation, (2) evaluate the populations, and (3) determine the seasonal and geographical distributions of native Orthoptera in areas disturbed by atomic explosions as compared to those in undisturbed areas, both contiguous and distant.

The area encompassed by the Nevada Test Site and covered by this report lies principally in the southeastern part of Nye County and approximating both Clark and Lincoln counties.

The overall study was begun in 1959 and continued into late 1963 with the periodic sampling of Orthoptera from some areas of the test site. The use of special sunken can traps instrumented the collecting of ground-inhabiting species. These traps were established in transects or quadrates according to standardized techniques. In addition, thorough collecting was done at intervals by field personnel.

The author began organized collecting at the test site as soon as the weather permitted in

the spring of 1961. Periodic trips extended through March, April, and May. Extensive collecting was done nearly every day throughout the months of June, July, and August, when these insects were most active. Periodic collecting was again resorted to through September, October, and November, until cold weather did not justify a return to the test site. Other collecting was done, as indicated, by field personnel instructed in the techniques of collecting during all months of the years that the study was in progress.

Primary emphasis was directed toward a complete systematic and ecological study of those ground-dwelling animals which may be selected as indicator animals because of their distribution and abundance in many plant communities throughout the test site.

Analysis of data was facilitated by an IBM punch card system. Field data were recorded on special forms and were transferred to IBM punch cards. The Brigham Young University Computer Research Center analyzed the project results with an IBM 650 Computer.

HISTORICAL REVIEW

The taxonomy and distribution of the American Orthoptera are actually well known in comparison with other insect orders. The Orthoptera of the Western United States, however, are still imperfectly known. The actual collecting of Nevada Orthoptera began in the early history of entomology when workers of the geological and geographical surveys entered the territory and made limited collections of the more conspicuous species. Of primary interest to these collections and the subsequent publication of the information were Cyrus Thomas and Lawrence Bruner. Although he was never in the state, Samuel H. Scudder did more for the systematic

treatment of Orthoptera than any other individual in the nineteenth century. He not only named many new species, but revised many of the recognized groups into a uniform order.

The first quarter of the present century was dominated by James A. G. Rehn and Morgan Hebard, both representing the Philadelphia Academy of Sciences. On a number of occasions they entered the state and collected intensively, particularly in the southern sections, as well as collecting extensively throughout southwestern United States. Not only did they build up a large collection of Orthoptera from the southwest, which included a number of new species

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from southern Nevada, but they have also been instrumental in doing most of the recent systematic work.

Primarily on the basis of what had already transpired, Dr. Ira La Rivers of the University of Nevada entered into a study of the Nevada Orthoptera, which resulted in "A Synopsis of Nevada Orthoptera" in which he contributed considerable original information on the ecology of the Nevada Orthoptera but little on the systematics of the group.

Contrary to the extensive work that has been done in systematics, there have been relatively few competent studies made of the ecology, the life histories and habits of North American Orthoptera. The earlier works in ecology, such as made by Vestal (1913), Hubbell (1922), Strohecker (1937), Isely (1937, 1938), and Urquhart (1941), were important and served as a basis for

the more complete works of Cantrall (1943) and Tinkham (1948). All of these important papers, however, contributed little to the knowledge of the Nevada Orthoptera because they covered areas far distant from the present study site, and very few species overlap into this area. The author is grateful to these individuals for providing a basis upon which the present study is made.

Other recent workers have attempted to study the ecology of some groups of Orthoptera by controlled laboratory experiments, but the ecological behavior of any species differs within its own range, and is far different from any so-called "controlled" laboratory situation. Nothing of a laboratory nature could be substituted for adequate field studies. The present report contains field observations and studies of all of the species here recorded.

ACKNOWLEDGMENTS

Any scientific study represents the combined efforts of many individuals and groups who have contributed to the success of the study. Appreciation is therefore extended to those individuals for the assistance rendered.

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The following personnel contributed greatly by collecting specimens, accompanying the au-

thor in the field, and contributing to the effectiveness of collecting: Clive Jorgensen, field director; D. Elmer Johnson and Merlin Killpack, consultants and specialists; Carl Ingersoll, Morris Goates, and Gerald Richards, field biologists; and especially for the long hours of collecting with and driving for the author, field biologists Willis A. Packham, Arthur Anderson, and Arnold Orton.

The author is further indebted to Dr. Ashley B. Gurney of the U. S. National Museum for verifying and classifying certain species of Orthoptera; and Dr. Arthur C. Cole, project consultant and specialist, for the determination of several species of ants.

Appreciation is extended to those other individuals who contributed in any way to the completion of the present research.

METHODS OF STUDY

When the author began an on-site investigation of the Orthoptera of the Nevada Test Site in 1961, certain quadrat and transect studies had already been established. A reconnaissance of the test site was made to determine the most ideal habitats for Orthoptera and to check additional areas that might be sampled. Special sunken can traps (Allred, *et al.*, 1963) were established at regular intervals around the periphery of quadrates and along line transects.

The cans were emptied regularly three times per week in all areas, and the invertebrates collected were placed in 70% alcohol. Major sampling areas were run continuously over a one-year period so that a total seasonal sampling could be achieved. All the Orthoptera thus collected have been submitted to the author for study and identification.

Special berlese and host-plant studies were undertaken periodically and systematically, but

the Orthoptera collected were of minor significance to the overall study.

Several of the field biologists carried collecting nets and kept accurate information on the specimens captured.

To effect a systematic study, the author visited current study plots on every trip to the test site during the spring and autumn, and during the summer visited study plots at least twice a week, generally three times a week. Because of the many miles between some study plots this systematic collecting occupied at least half the time; the remainder of the time was spent in collecting from special areas, in between or adjacent to the study plots, and in night observations and collecting. Because of the extensive area, some study plots were visited only once by the author during the entire season.

The collecting method most generally employed, in addition to the special can traps, was use of a sweeping net on shrubbery and other vegetation, and an aerial net to capture the great majority of specimens, as most of the orthopteran inhabitants of the southwest deserts are strong fliers. A great deal of difficulty was encountered in sweeping desert plants because of their spinose nature. When these plants were sampled, an observation was first undertaken. The entire shrub or plant was carefully examined and notes taken on any orthopteran present. Periodically an entire shrub was torn apart to reveal the presence of specimens. Many insects not visible because of their concealing coloration and patterns were thus captured.

During the hot summer months many of the desert shrubs lose their leaves. The most thorough, accurate, and speedy collection from these shrubs was by trampling. Each shrub was trampled systematically, spirally from the outside to the inside. It is believed that very few orthopterans escaped when such methods were employed. An aerial net was used to capture those specimens trying to escape.

Many of the data recorded are sight records. If all the observed specimens had been captured there would have been insufficient time to examine all the areas.

No special sweeping data were maintained with reference to length of stroke, distance from the ground, speed, etc. Most species of the desert are so different that sweeping methods must be adjusted to the habits of the various forms to achieve maximum effectiveness.

The height at which some species occur on vegetation is variable according to atmospheric conditions. During the hottest hours of the summer day many species are found characteris-

tically at the tips of branches of shrubs, others near the ground in the shade, and some on the ground underneath the vegetation. Very few specimens can be found on the ground in full sun during the hot summer hours.

Desert vegetation is typically that of scattered plants, and it is possible to check an area in a short time by rapid walking between plants to observe or capture the strong flyers, and by systematic visual or mechanical examination of the plants.

Night collecting was chiefly visual with flashlights or lanterns and the use of aerial nets to capture specimens. No systematic night light collecting was maintained, although some sampling was done with black (ultra violet) light.

Baits of rolled oats and/or molasses in can traps or scattered upon the ground were tried in some areas. No special advantage could be determined, however, inasmuch as the cans frequently contained mice and other rodents or other predaceous animals. As a matter of fact, as evidenced by parts of bodies, many ground-dwelling specimens captured in the traps were consumed by these animals, notably grasshopper mice (*Onychomys*) and less frequently by shrews (*Sorex*). Wherever these rodents occurred in the cans, few or no arthropods were present. Some lizards and predaceous arthropods, especially tenebrionid beetles and scorpions, were responsible for the destruction of large numbers of specimens.

Notes were made, wherever possible, on the songs of the various species, both by day and night, though this is a minor contribution of the overall study because of the seemingly inactive nature of so many of the desert species and the absence from the test site of many stridulating nocturnal forms.

More than 8,000 specimens, both nymphs and adults, were collected and preserved in the course of the investigation. As noted earlier, specimens collected from the can traps were placed directly into separate vials of 70% alcohol. Some of the specimens of the most common species were captured, examined, and later released in the same area.

FREQUENCY AND ABUNDANCE

No statistical frequency and abundance (i.e., numbers of specimens per sweep) was attempted because of the general scarcity of orthopteran forms at the test site. Some visual observations on abundance were made.

It must be emphasized that the present discussion is relative to the Orthoptera of the Nevada Test Site only during the years when the

study was in progress. The same species or comparative numbers of specimens may not be present in any other year, before or after the testing program was begun. Cyclic appearance of certain species must be taken into consideration, and the same species that were numerous during the recorded period may actually be less numerous than some other species at some other time.

Nearly all grasshoppers fluctuate in numbers from year to year. One year they may be very numerous, whereas the next year few will appear. Such insects occur in small numbers for a year or two, gradually increase, and when a favorable season occurs appear in enormous numbers and may cause great damage, only to disappear again for several years.

The reason for this fluctuation is apparent. While grasshoppers are capable of increasing twenty to sixty times in one year, their enemies and diseases are capable of increasing several hundred and up to thousands of times in one season. While the grasshoppers are scarce, their parasites have a difficult time to find the hosts, and, as a result, the majority of the parasites perish. Then, as the grasshoppers increase in numbers, the few parasites left have no trouble in finding them and they, too, increase enormously. The year the grasshoppers are most numerous is often the year in which the parasites increase to such an extent that practically no grasshoppers or eggs are left to produce a brood the following year. But they are not present in sufficient numbers to cope with the swarms of grasshoppers in the year in which they are most needed.

The weather plays an important part in fluctuation of numbers. Cold, wet weather in the spring will destroy a large number of young grasshoppers. Hot, dry weather allows all eggs to hatch and the young insects to thrive. The same hot dry weather burns up the vegetation so that there is less for them to feed on. Drought and grasshoppers often go together, especially if the drought extends through several years.

In some test site areas visited regularly a large population of robber flies, bee flies, lizards and other predaceous animals were present that might have accounted for the scarcity of specimens. In the author's experience of collecting in desert environments, the specimens were far too few at the Nevada Test Site while the study was in progress.

Whenever a species was discovered in any area, as large a series as possible was collected to show variations. Too many morphologists and taxonomists fail to realize the importance of

a series and submit descriptions and drawings on only one specimen without recognizing variation within the group. Many new species have been described from unique types, and in many instances this has resulted in a long list of confusing synonyms.

STUDY OF INDIVIDUAL SPECIES

Each species represented by a series of specimens was studied for variability, and notes and measurements in millimeters were made of representative specimens of both sexes. Measurements were made with a standard micrometer in a binocular microscope. The length of the body and tegmen on large specimens was determined by metric callipers.

The most accurate species analysis should be made upon consideration of all measurements given, rather than relying on a single measurement, such as total body length, as has been used in the past. Accordingly, the following measurements were made on the series of specimens.

Length of body. The measurement was made from vertex to tip of ovipositor of female or subgenital plate of male, but excluding tegmina and wings that extend beyond the tip of the abdomen. Although this is one of the standard measurements made on Orthoptera it is variable and actually less valuable than some other measurements. The female that has been ovipositing or copulating often has the abdomen abnormally stretched; in some cases the abdomen is abnormally retracted. In the male, especially in some groups such as *Aeoloplides*, the abdomen is consistently upturned, and measurements are unreliable. In such cases the measurements are given to the most posterior part of the abdomen.

Greatest depth of body. This measurement was not used consistently. The greatest body depth in nearly all species was measured from the mesosternum to the median carina of the pronotum.

Length of pronotum. The pronotal length was taken in most cases, although it varied because of caudal prolongation. In some specimens the pronotum was noticeably aberrant, probably due to developmental injury or malformation.

Greatest breadth of pronotum. The greatest pronotal breadth occurs in most species on the disk of the metazona.

Depth of pronotum. The measurement is of importance to some groups with a high median pronotal carina, and to others with modified lateral pronotal lobes. The measurement

was from the ventral edge of the lateral lobe to the highest dorsal part, usually the median carina.

Length of tegmen. The tegminal length is considerably variable in some groups. The measurement was made of the wing in resting position from the angle of the radius, media, and costal veins in the area of the pronotum to the tip of the tegmen. In some cases where the pronotum is greatly prolonged the measurement is given as projecting beyond the pronotum. This is individually stated in the account of the species. No measurements were made on the total length of the wing, but in some species a measurement is given for wings projecting be-

yond the tegmina. In nearly all species examined the tegmina and wings are subequal in length.

Length of caudal femur. Measurements on the caudal femora have not been consistently reported, but may be important to Orthoptera systematics. This structure shows less variability than other body structures. The length was measured from the anterior development to the greatest prolongation of the genicular lobe.

Greatest breadth of caudal femur. This measurement, with the length, shows the saltatorial ability of the insect.

Other miscellaneous measurements were made according to the species and are included in the account of the individual species.

DESCRIPTION OF THE AREA

LOCATION

The Nevada Test Site is located in Nye County, Nevada, contiguous to both Lincoln and Clark counties. It is approximately 65 miles northwest of Las Vegas, Clark County, Nevada, just off U. S. Highway 95. The test site encompasses some 1000 square miles, being an area approximately 40 miles from north to south by approximately 25 miles from east to west. The present study is limited by these boundaries. Most of the collecting was restricted to areas immediately surrounding the numerous access roads within the area.

PHYSIOGRAPHY

The obvious features of the Nevada Test Site are the two playa lakes, Frenchman and Yucca, and the very gradual sloping flats surrounding these areas. Scattered throughout and actually isolating these areas is a series of mountains, especially prominent to the northwest. The land is typically desert and very arid, having a total precipitation of approximately five inches per year, this occurring largely in July and December, with the most arid months being October and May. The soil is very poor and highly alkaline, especially around the playas where there is an associated, hazardous desert pavement, the small pebbles scattered over the surface of the earth. Immediately below the surface is a very dusty, powdery soil. These areas extend to the bajadas and the mostly barren foothills and higher elevations, variously covered with pinyon and juniper.

The only permanent water is restricted to few areas. Cane Springs, west of Frenchman

Playa, has a small empounded water area of approximately two hundred square feet. The water at Tippihah Spring, northwest of Yucca Playa, is restricted to the inside of a tunnel, but provides water for some animals that venture into the shaded interior. White Rock Valley, north of Tippihah Spring, has a tiny amount of water from one spring. In addition there are some few areas to the northwest with minute amounts of permanent water, and a few wells have been built for industrial purposes. Such an environment is not conducive to some orthopterans, but is more typical of the habitat of the strong flying grasshoppers.

VEGETATION

Much of the Nevada Test Site is typical of the Lower Sonoran Life Zone. The southern part is typically Mohave Desert with its *Larrea-Franseria* vegetation. More typical Upper Sonoran conditions are found in the northern section and around the bajadas adjacent to the northern limits of the Mohave Desert. The third faunal zone represented at the test site is the Transitional of higher elevations. Some higher valleys are typical of the Great Basin Desert with its associated *Artemisia*.

Immediately surrounding the completely barren Frenchman Playa of compacted silts and clays is a fringe area of *Lycium pallidum*, the dominant plant, with some *Grayia spinosa*, *Lycium andersonii*, *Dalea polyadenia*, *Eurotia lanata*, and other plants. This fringe area of *Lycium* is bordered by a much larger, very extensive area of almost pure *Larrea divaricata* with its associated *Franseria dumosa*, *Hymeno-*

clea fasciculata, *Grayia spinosa*, *Lycium andersonii*, *Ephedra nevadensis*, and *Dalea polyadenia*. The *Larrea-Franseria* vegetation is continuous upon the bajadas to the very steep and sharp hills and ridges with their scattered grasses and other vegetational types.

Separating Frenchman and Yucca playas is a series of hills and ridges with some growths of *Coleogyne ramosissima* and *Yucca brevifolia*. Immediately to the north of Yucca Playa is an association of *Atriplex confertifolia* and *Kochia americana*, with some *Eurotia lanata* and *Artemisia spinescens*, designated as *Atriplex-Kochia*. The next belt of vegetation, very extensive to the north and east, less extensive to the west and represented by a small fringe to the south between the playa and the steep hills, is a belt of *Grayia-Lycium*. The two dominant species, *Grayia spinosa* and *Lycium andersonii*, are associated with some *Eurotia lanata*, *Atriplex canescens*, *Oryzopsis hymenoides*, *Artemisia spinescens*, *Stipa speciosa*, and other plants variously scattered throughout the entire belt. Through the *Grayia-Lycium*, at various ground zero locations where atomic detonations have occurred, are extensive areas of *Salsola kali*, the first plant to appear in a new succession.

To the northwest and northeast of the *Grayia-Lycium* belt is a well-developed community of *Coleogyne*, which is the dominant flora surrounding Yucca Flat and extending to the various mountain ranges. The flora of the canyon approaches to the higher mesas to the north and west is transitional. Oak, *Quercus gambelli*, and bitterbrush, *Purshia glandulosa*, are common, along with *Chrysothamnus viscidiflorus*, *Eriogonum fasciculatum*, and other plants. The long valley approaches to the mesas are covered with *Artemisia tridentata*, with its associated grasses, particularly *Oryzopsis hymenoides*, replacing the more typical *Coleogyne*.

Some small stationary sand dunes with a mixed vegetation of *Purshia glandulosa* and many ephemerals and other annuals along with herbaceous and woody plants are found in the vicinity of the mesas.

Pinus edulis and *Juniperus osteosperma* are found on the higher mesas. Scattered among the pinyon-juniper are groups of *Purshia glandulosa*, *Quercus gambelli*, *Artemisia tridentata*, and other shrubs.

Jackass Flats, in the southwest corner of the test site, consists of *Larrea-Franseria*. The approach to this large area consists of mixed vegetation typical of the bajada.

These biotic communities, shown by the

inserted map, have been detailed by Allred, Beck, and Jorgensen (1963).

REGULAR COLLECTING AREAS

The following collecting areas were visited regularly twice to three times per week during the months of June, July, and August, and twice a month during March, April, May, September, October, and November, as outlined in the "Methods of Study" above. The type of collecting was modified to suit each particular area according to the vegetation present.

Area 1. (Yucca Flat, northwest of Yucca Playa) Some of the most intensive collecting was done in Study 1B, a radiating transect of eight lines running symmetrically from ground zero, the point directly under the point of detonation. The lines were marked 1BA, 1BB, 1BC, etc., through 1BH. Thirty stations were located along lines B, D, F, and H, each station being 264 feet apart. A total of 24 can traps were open continuously from March 9 to September 28, 1961; and from October 9, 1961, to February 15, 1962; and April 3 to May 18, 1962. These same stations were open for three days in the first and third week of each month.

All plants from ground zero to a radius of approximately one mile have been visibly affected by the explosions, the damage being less severe progressing from ground zero to the ends of each transect. In the immediate area where the plants were completely destroyed there has been an early plant succession of Russian thistle, *Salsola kali*. Near the maximum radius of total plant destruction a ground cover of a white composite, *Chaenactis* sp., is evident, especially during the spring. From this point outward the normal perennial vegetation is making a come-back. At the extreme periphery of this star transect there has been no visible damage, at least to the smaller perennial plants.

In addition to the regular collecting from the can traps, a concerted effort was made to collect along the 1BF transect, this transect having been chosen as typical of the area. The collecting time spent in the 1B area varied from one to several hours, and from time to time occupied different hours of the day and night.

The only orthopterans collected in the first fifteen stations from ground zero outward in the belt of *Salsola* were an occasional *Xanthippus corallipes* early in the spring, and *Trimerotropis pallidipennis* and *T. strenua* during much of the summer. The ground-inhabiting *Acheta assimilis*, three species of *Ceuthophilus*, and *Stenopelmatus fuscus* were collected in can traps.

Study 1F was established as a quadrat in a *Salsola* habitat near ground zero. Collecting cans were arranged 75 feet apart according to Diagram 1. This same plan was carried throughout the major quadrat studies.

See Table 1 for a complete summary of specimens collected in Study 1F and the *Salsola* belt of Study 1B.

Most of the collecting in Study 1B was done around stations 19 through 23, a variable belt of *Salsola*, *Oryzopsis hymenoides*, *Hymenoclea fasciculata*, *Stipa speciosa*, *Chrysothamnus viscidiflorus*, *Ephedra nevadensis*, and *Lycium andersonii*. Beyond station 23 were various con-

centrations of *Haplopappus cooperi*, *Grayia spinosa*, *Eurotia lanata*, and near the end of the transect, *Artemisia tridentata*, *Coleogyne ramossissima*, *Hymenoclea fasciculata*, and *Artemisia spinescens*.

Study 1G, though primarily set up as a reptile study through *Grayia-Lycium*, consisted of a quadrat of one hundred can traps marked from one through ten and from A through J, each set at a distance of 35 feet. Although these regularly produced large numbers of ground-dwelling Orthoptera, the specimens were only occasionally preserved. The area was regularly swept for Orthoptera and produced a variety of species from time to time.

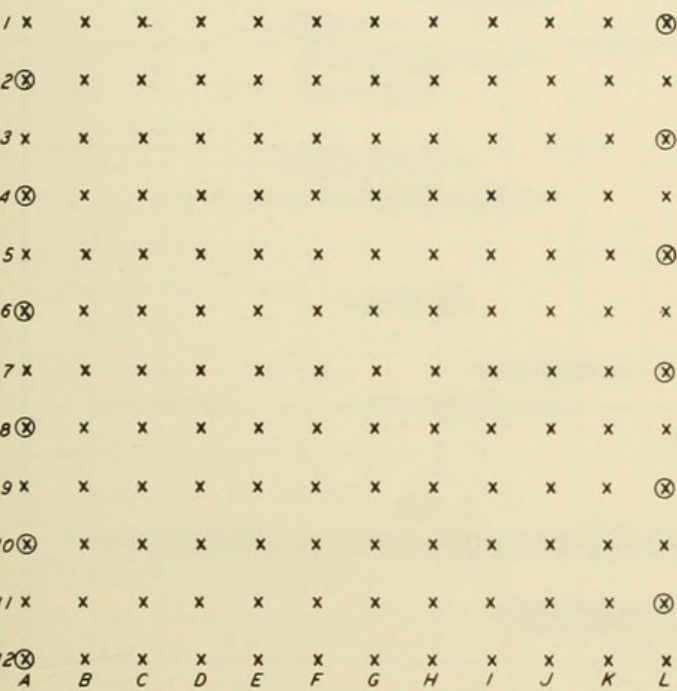


Diagram 1. Typical quadrat showing position of can traps(o).

Area 4. (Immediately to the north of Area 1 described above) Study 4A consisted of a quadrat of twelve can traps open continuously from September 22, 1960, to September 23, 1961, and from October 10-12, 1961. This is a typical *Grayia-Lycium* habitat similar to study 1B or 1G, but with larger shrubs. Desert pavement is common on the surface. A small sandy wash through most of the study is lined primarily with *Atriplex canescens*, host to a variety of Orthoptera during the hot mid-day hours. During the cooler parts of the day the insects were commonly found along the gravel in the bottom of the wash.

Specimens collected in the *Grayia-Lycium* habitat of study areas 1B, 1G, and 4A are summarized in Table 2.

Area 5. (Frenchman Flat, southwest of Frenchman Playa) This area consisted of three very extensively collected studies, two quadrates and one line transect, each established with can traps for the capture of ground-dwelling

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
ACHETA ASSIMILIS												
AEOLOPLIDES TENUIPENNIS						X						
ARENIVAGA ERRATICA								X				
CEUTHOPHILUS DESERTICOLA												
C. FOSSOR												
C. LAMELLIPES												
CIBOLACRIS PARVICEPS ARIDUS												
CORDILLACRIS OCCIPITALIS CINEREA						X						
LITANEUTRIA MINOR												
STENOPELMATUS FUSCUS								X			X	
TRIMEROTROPIS PALLIDIPENNIS												
T. STRENUA												
XANTHIPPIUS CORALLIPES CORALLIPES												

Table 1. Seasonal distribution of the Orthoptera characteristic of the *Salsola* habitat (Study 1F).

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
ACHETA ASSIMILIS												
AEOLOPLIDES MINOR												
A. TENUIPENNIS												
ANCONIA INTEGRA												
ANOPLODUSA ARIZONENSIS												
ARENIVAGA APACHA					X							
A. ERRATICA												
ATELOPLUS LUTEUS												
CAPNOBOTES FULIGINOSUS												
CEUTHOPHILUS DESERTICOLA												
C. FOSSOR												
C. LAMELLIPES												
CIBOLACRIS PARVICEPS ARIDUS												
CORDILLACRIS OCCIPITALIS CINEREA												
DEROTMEMA DELICATULUM												
EREMIACRIS PALLIDA												
EREMOBLATTA SUBDIAPHANA												
HESPEROTETTIX VIRIDIS												
LIGUROTETTIX COQUILLETII CANTATOR												
LITANEUTRIA MINOR												
MYRMECOPHILA MANNI												
OECANTHUS CALIFORNICUS												
POECILOTETTIX SANGUINEUS												
PSEUDOSERMYLE STRAMINEA												
PSOLOESSA DELICATULA DELICATULA												
STENOPELMATUS FUSCUS												
TANAOCERUS KOEBELEI KOEBELEI												
TRIMEROTROPIS ALBESCENS												
T. INCONSPICUA												
T. PALLIDIPENNIS PALLIDIPENNIS												
T. STRENUA												
XANTHIPPIUS CORALLIPES CORALLIPES												

Table 2. Seasonal distribution of the Orthoptera characteristic of the *Grayia-Lycium* habitat (Studies 1B, 1G, 4A, 5E).

arthropods. Study 5A was operated continuously from September 22, 1960, to September 22, 1961, in a *Larrea-Franseria* habitat. The vegetation consisted more specifically of *Larrea divaricata*, *Franseria dumosa*, *Hymenoclea fasciculata*, *Grayia spinosa*, *Lycium andersonii*, *Ephedra nevadensis*, and *Dalea polyadenia*. The surface was desert pavement, particularly typical of the Frenchman Flat area. A few slight depressions and washes were present in the quadrat.

Study 5CQ was situated immediately across the road and north of Study 5A, and consisted of the same type of vegetation. Both areas were usually collected together. Study 5CQ consisted of a line transect of 25 can traps set 35 feet apart. The area was originally designated for a special study, but the cans were occasionally checked for ground-dwelling Orthoptera when the area was not being utilized for its specific

purpose. These cans were open from June 24-30, 1961; from July 10 to August 4, 1961; and from August 8-20, 1961.

Between studies 5A and 5CQ is an asphalt road. On both shoulders of the road the *Larrea* was very high, luxuriant and green. Most of the two common *Larrea*-inhabiting species, *Boottettix punctatus* and *Insara covilleae*, were collected in these dense shrubs near the road. These specimens were all very brightly colored. Beyond the shoulders of the road the shrubs were smaller, less dense, and more generally brownish in color. The specimens collected in these shrubs were fewer in number, and the same two species of grasshopper were brown rather than green.

Orthopterans collected in the *Larrea-Franseria* areas are summarized in Table 3.

Study 5E, another quadrat, was predominantly *Lycium pallidum*. Situated nearer French-

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
<i>ACHETA ASSIMILIS</i>										X		
<i>AEOLOPLIDES MINOR</i>												
<i>A. TENUIPENNIS</i>												
<i>ANCONIA INTEGRA</i>								X				
<i>ANOPLDUSA ARIZONENSIS</i>												
<i>ARENIVAGA ERRATICA</i>												
<i>ARETHAEA BREVICAUDA</i>												
<i>ATELOPLUS LUTEUS</i>												
<i>BOOTETTIX PUNCTATUS</i>												
<i>CAPNOBOTES FULIGINOSUS</i>								X				
<i>CEUTHOPHILUS DESERTICOLA</i>												
<i>CEUTHOPHILUS FOSSOR</i>												
<i>CEUTHOPHILUS LAMELLIPES</i>												
<i>CIBOLACRIS PARVICEPS ARIDUS</i>												
<i>DEROTMEMA DELICATULUM</i>												
<i>EREMIACRIS PALLIDA</i>												
<i>EREMOBLATTA SUBDIAPHANA</i>												
<i>INSARA COVILLEAE</i>												
<i>LIGUROTETTIX COQUILLETII CANTATOR</i>												
<i>LITANEUTRIA MINOR</i>												
<i>MELANOPLUS ARIDUS</i>												
<i>OECANTHUS CALIFORNICUS</i>									X			
<i>PSOLOESSA DELICATULA DELICATULA</i>												
<i>STAGMOMANTIS CALIFORNICUS</i>												
<i>TANAOCERUS KOEBELEI KOEBELEI</i>												
<i>TRIMEROTROPIS INCONSPICUA</i>												
<i>T. PALLIDIPENNIS PALLIDIPENNIS</i>												
<i>T. STRENUA</i>												
<i>TYTHOTYLE MACULATA</i>												

Table 3. Seasonal distribution of the Orthoptera characteristic of the *Larrea-Franseria* habitat (Studies 5A, 5CQ).

man Playa, the average elevation of this study was only slightly lower than studies 5A and 5CQ and was considerably more alkaline. A nearby outwash leading to Frenchman Playa was very alkaline with an abundance of *Atriplex canescens* and *A. confertifolia*. The alkali grasshopper, *Anconia integra*, was most common to this latter area. The can traps in this study were open from September 22, 1960, to September 22, 1961.

Area 6. (Yucca Flat, adjacent to the northern edge of Yucca Playa) Study 6A was a typical quadrat located in an *Atriplex-Kochia* habitat. The vegetation consisted of *A. confertifolia* and *K. americana*, with some *Eurotia lanata* and *Artemisia spinescens*. The vegetation was scattered, with large areas of alkali-encrusted surface. During most of the season the vegetation

was green only in the immediate confines of the roads and along some of the lower depressions. In other areas it was very dry and brittle. The can traps in this study area were open continuously from September 22, 1960, to September 23, 1961. Table 4 summarizes the Orthoptera collected in this *Atriplex-Kochia* habitat.

Area 10. (Bajada, north of Yucca Playa) This typical quadrat, known as study 10D, was situated in a *Coleogyne* habitat. The rolling terrain, drained by a sandy wash with numerous large rocks, sloped between the ridges and Yucca Flat. The study was situated near an extensive area of active radiation, the debris being collected in long windrows. Whether or not any of the Orthoptera collected in the area had come in direct contact with this radiation is unknown.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
ACHETA ASSIMILIS												
AEOLOPLIDES MINOR												
ANCONIA INTEGRA												
ARENIVAGA ERRATICA												
ATELOPLUS LUTEUS												
CEUTHOPHILUS DESERTICOLA												
C. FOSSOR												
C. LAMELLIPES												
DEROTMEMA DELICATULUM												
EREMOBLATTA SUBDIAPHANA							X	X				
LITANEUTRIA MINOR												
TRIMEROTROPIS BILOBATA												
T. PALLIDIPENNIS PALLIDIPENNIS												
T. SPARSA												

Table 4. Seasonal distribution of the Orthoptera characteristic of the *Atriplex-Kochia* habitat (Study 6A).

No grasshopper migrations were observed at the Nevada Test Site, and direct body contact with this debris is questionable. Dates of operation of can traps were from September 22, 1960, to September 23, 1961, and from October 10-12, 1961.

Coleogyne is a poor environment for Orthoptera. Some other vegetation, typical of the bajada, was present. Table 5 summarizes the specimens collected in this *Coleogyne* environment.

Area 12. (Particularly Rainier Mesa, northwest of Yucca Flat) A typical pinyon-juniper association is found on Rainier Mesa. Two comparative studies were established. Study 12A was situated in a disturbed area near the detonation of a nuclear explosion. Most of the trees were killed off by the physical effects of the explosion. The dominant vegetation consisted of small oaks, *Quercus gambelli*, and bitterbrush, *Purshia glandulosa*. The surface rocks had been disturbed, and a series of large fissures in the ground from the rim of the mesa outward was evidence of the explosion.

The other study, 12E, was in an undisturbed pinyon-juniper area of living trees and no rock disturbance or ground fissures.

Ten cans were open in study 12A, fifteen cans in study 12E, from July 24-28, 1961, and from August 11-19, 1961. Then, ten cans were open in each study from October 19 to November 17, 1961, and from April 10-12, 1962.

The can traps in both studies were established to test the effectiveness of natural cover (flat rocks) as opposed to the artificial cover (masonite boards) generally used with the cans, or no cover; and to test the effectiveness of bait as opposed to no bait. One of the best ways to capture ground-dwelling Orthoptera, particularly camel crickets, is by the use of rolled oats or molasses. (Although no molasses was used in these areas it was tested in study 5CQ in a controlled bait experiment. The study was carried out for all animals, especially arthropods, and the data on the Orthoptera were recorded along with the other captures. The baits were changed from time to time during the course of the experiment and consisted of banana oil, stale beer and brown sugar, molasses, molasses diluted with diesel fuel, rolled oats, and meat of various kinds.) Eight of the cans were covered with flat rock covers elevated sufficiently to permit any animal to crawl under for protection; twelve of the cans were covered with the masonite boards; and five cans were left without covers. In some of the cans oatmeal was placed only in the cans, some were left without bait, and the remainder had bait scattered about the ground as well as in the can. The baiting practice was abandoned after the second visit to the areas because there was no significant difference in the results and many of the arthropod inhabitants as well as the bait had been eaten by vertebrate predators.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
ACHETA ASSIMILIS												
AEOLOPLIDES MINOR								X				
AGENEOTETTIX DEORUM DEORUM												
AMPHITORNUS COLORADUS ORNATUS												
ANOPLODUSA ARIZONENSIS							X					
ARENIVAGA ERRATICA												
CAPNOBOTES FULIGINOSUS												
CEUTHOPHILUS DESERTICOLA			X			X						
C. FOSSOR												
C. LAMELLIPES												
CIBOLACRIS PARVICEPS ARIDUS												
CORDILLACRIS OCCIPITALIS CINEREA												
DRACOTETTIX PLUTONIUS												
EREMIACRIS PALLIDA												
EREMOBLATTA SUBDIAPHANA												
HESPEROTETTIX VIRIDIS												
INSARA COVILLEAE												
I. ELEGANS MACULATUS												
LEPRUS GLAUCIPENNIS												
LIGUROTETTIX COQUILLETTI CANTATOR												
LITANEUTRIA MINOR												
MELANOPLUS ARIDUS												
M. COMPLANATIPES CANONICUS												
MORSEA CALIFORNICA PIUTE												
PARABACILLUS HESPERUS								X				
PSEUDOSERMYLE STRAMINEA						X						
PSOLOESSA DELICATULA DELICATULA												
STAGMOMANTIS CALIFORNICUS												
STENOPELMATIS FUSCUS							X		X			
TANAOCERUS KOEBELEI KOEBELEI												
TRIMEROTROPIS ALBESCENS												
T. FONTANA												
T. INCONSPICUA												
T. PALLIDIPENNIS PALLIDIPENNIS												
T. STRENUA												
TYTTHOTYLE MACULATA												
XANTHIPPIUS CORALLIPES CORALLIPES												

Table 5. Seasonal distribution of the Orthoptera characteristic of the *Coleogyne* habitat (Studies 10D, TA).



Beck, D. Elden, Allred, Doral M., and Brinton, Elias P. 1963. "Ticks of the Nevada Test Site." *Brigham Young University science bulletin* 4, 1–11.

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