Faunistic and Ecological Studies on the Orthoptera of the Big Bend Region of Trans-Pecos Texas, with Especial Reference to the Orthopteran Zones and Faunae of Midwestern North America

ERNEST R. TINKHAM

Reprinted from

THE AMERICAN MIDLAND NATURALIST
Vol. 40, No. 3, pp. 521-663, November, 1948

University Press
Notre Dame, Indiana

The American Midland Naturalist

Published Bi-Monthly by The University of Notre Dame, Notre Dame, Indiana

VOL. 40 NOVEMBER, 1948 No. 3

Faunistic and Ecological Studies on the Orthoptera of the Big Bend Region of Trans-Pecos Texas,

with Especial Reference to the Orthopteran Zones and Faunae of Midwestern North America*

Ernest R. Tinkham

Box 123, Indio, California

CONTENTS

* A contribution from the Lingnan Natural History Survey and Museum, Lingnan University, Canton, China, which under the directorship of Professor Wm. E. Hoffman, granted the writer the time to prepare the original manuscript. The manuscript was augmented by the addition of results from studies made in 1946.
revised during 1943-44 while the author served in the armed forces and in 1947 it was

Introduction

An excellent opportunity to study the orthopteran life of the Big Bend Region of southwestern or Trans-Pecos Texas presented itself when the writer was stationed at the Pink Bollworm Laboratory in the Rio Grande Valley at Presidio, Texas, during 1928 to 1930. During these two years all available spare time was devoted to the study of this region. Not only did the Big Bend Region prove to be a virgin field for the entomologist, but consequent studies have shown that its geographical location and orographic diversity have produced an exceedingly rich fauna and flora.

Prior to 1928 little study had been made of this region. The Davis Mountains and to a lesser extent the Chisos had been visited by various collectors and expeditions in the past, but the writer knows of no expedition or collector of any kind that had collected in the Chinati Mountains which served as his principal hunting grounds from September, 1928 to July, 1930, and again in 1931. Additional collections were made in the Marfa region, in 1940 and on the north side of the Davis Range in 1940 and 1943. Resuming his desert studies, in October of 1946, three weeks of collecting were conducted in the Chinatis and Chisos and other mountainous areas.

Presidio County with Brewster County on the east and Jeff Davis County on the north form the little-known Big Bend Region of Trans-Pecos Texas. The eastern apex of Brewster County on the Rio Grande is approximately 102° and the western tip of Presidio and Jeff Davis counties is about 105° West Longitude. The southern end of Brewster County on the Rio Grande, south of the Chisos, is about 29° and the northern apex of Jeff Davis County, north of the Davis Range is 31° North Latitude. Thus this area is of considerable size and roughly estimated contains 11,832 square miles or 7,573,760 acres, an area larger than such states as Massachusetts, Maryland or New Hampshire. In fact Brewster and Presidio are two of the largest counties to be found anywhere and each in size surpasses some of the smaller states of the Union. One can put in a full day of good travelling and yet remain within the boundaries of Presidio and Brewster counties. For instance the shortest route to the Chisos Mountains or to Castalon below Terlingua, from Presidio *via* Marfa, Alpine or Marathon is well over two hundred miles and much of that distance is over dirt or gravelly roads.

Possibly few regions can boast an area more diverse than these three counties. Not only do they portray interesting topographical and orographic features, but within the hundred miles from the Davis Mountains to the Rio Grande at Presidio, the floral aspect is one of extreme contrast. In that distance one passes from the pine-topped peaks of the Davis Range down through a zone of junipers and oaks to the grasslands, across broad level grasslands to the desert mountains, the Chinatis, with pines, oaks and junipers and lechuguilla, sotol and ocotillo at lower elevation and thence across the creosote-covered mesas to the mesquite valley of the Rio Grande. Another transect running from north to south through central Brewster County would pass from the forested slopes of the Glass Mountains, across the Marathon Plains into creosote-blackbrush desert, thence to more eastern semi-desert type of vegetation represented by *Leucophyllum* and *Porlieria* just north of the San-

tiago Mountains and across the creosote mesas south of the Santiagos to the magnificent Chisos. Here one would climb almost vertically through the oak zone to Pulliam Bluff and Mt. Emory, at 7836 ft., to find forests of pines, Douglas fir, Arizona cypress and various oaks. The descent would be as precipitous from the peaks to the creosote mesas of the Rio Grande near Mariscal Mountain.

Since the proposal in 1938 and the erection in later years of the Big Bend Park formed around the magnificent Chisos Mountains in the southern end of Brewster County, the public has manifested greater interest in the Big Bend Region which truly is the "last wild Texas."

As no complete work is available on the flora or fauna of this particular region, the writer believes that he is justified in dealing more fully with the various aspects of the region than would otherwise be warranted. Furthermore, a thorough treatment of physiography, climate, and the ecological aspects of the flora of the region are essential prerequisites to a comprehensive survey of the orthopteran fauna of the Big Bend Region.

Physiography of the Region

The Big Bend Region of Trans-Pecos Texas is traversed by two parallel series of ranges representing what may be called the terminal fingers of the Rocky Mountain system. These two series of disrupted sierras appear to have their origin in the Guadalupe Mountains of south central New Mexico, for south of Guadalupe Peak, that stupendous rampart known as El Capitan, this range appears to break up into two groups, the Delawares and the Sierra Diablos. The Delawares continue southeastward through the Apaches to the Davis Mountains which occupy much of the northern portions of the Big Bend Region with lesser ranges such as the Glass, Del Norte, Santiago and Dead Horse Mountains continuing on to the southeast (see fig. 1 for location of mountain ranges, etc.). The Sierra Diablos run south through the Van Horn and Tierra Viejas, to the Chinatis and the Bofecillos of Presidio County, and on to the San Carlos Sierras of northern Chihuahua. Chinati Peak, the highest point in Presidio County, attains an elevation of 7760 feet, only slightly surpassed by Mt. Emory of the Chisos with 7836 feet elevation. The Chisos Mountains in the southern part of Brewster County and lying within the apex formed by the "Big Bend" of the Rio Grande, do not appear to belong to any system but stand out in their isolated grandeur of rugged perpendicular cliffs. For years both the Davis Range and the Chisos were claimed to have the highest peaks in Texas, but the award finally went to Guadalupe Peak with an elevation of 8751 feet. Mt. Livermore in the Davis Range, 8382 feet above sea level, is the highest point in the mountainous Big Bend Region. But for noble grandeur of mountains, the superb majesty of the Chisos, with their castled peaks, is incomparable.

The trough lying between these two systems of disrupted sierras is in Presidio and Jeff Davis counties—a level far-stretching grasslands which extends itself fingerlike into and through the valleys of the Davis Mountains. In Brewster County the trough is broader with the Marathon Plains merging on the south with desert lands.

In this entire region one is never out of sight of the Sierras, and aside from the grasslands, the physiography of the region is exceedingly rough. The basin floor is often rolling and rocky, except in the Valentine, Marfa and Marathon areas where the soil cover of the grasslands is of a rich alluvial type. The mountains of the Big Bend Region are exceedingly rugged (with the possible exception of the Davis Range) with cliffs, steep slopes strewn with boulders and talus, rocky ridges and prominences, buttes, volcanic peaks and rock-walled pinnacles cut everywhere by innumerable gorges and valleys of all dimensions; for the greatest of all dynamic forces, water in the form of the

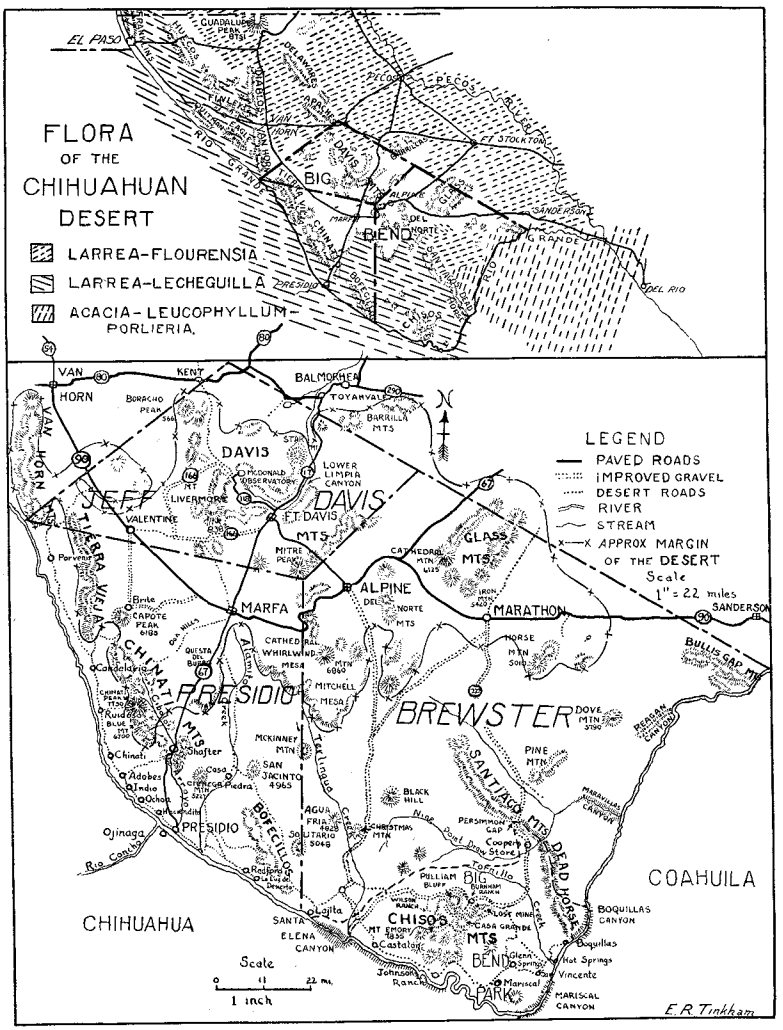


Fig. 1.—Trans-Pecos Texas showing the Big Bend Region (upper) and map of the Big Bend Region (lower).

torrential arroyos, has been working unchecked throughout the ages, mitigated only by the scarcity of water itself. In fact the desert regions of the Southwest present a tremendous area of soil erosion, abetted by the over-grazed lands of ranchers who make little effort to check the destruction.

Climate of the Region

The climate of the Big Bend Region is arid to semi-arid in type and shows considerable variability according to location and altitude. The Davis Mountains receive the greatest annual precipitation, totaling about seventeen inches, while the Rio Grande Valley from Presidio to Castalon gets the scantiest amounts, averaging about eight inches.

There is a great irregularity in the storms which come from all directions but in general these follow along the mountain systems, such as the Chinati and the Davis ranges. At Presidio from November, 1929 to June, 1930, only traces of rain fell, totaling 0.97 inches for eight months, while the Chinatis received at least four or five inches. On one occasion, the 8th of June, 1930, the writer was in one of these torrential showers which proved to be a veritable cloudburst, and yet despite its severity, one could step from wet to dry soil where the storm crossed one of the mountain tops.

An indication of the greater frequency of storms in the Chinati and Davis Mountain regions, north of the Valley, is evidenced by the frequency of the arroyos rolling down their torrents to the Rio Grande. The Cibolo Arroyo draining the northern slopes of the Chinatis and passing through the mining town of Shafter, often rolls its waters past Presidio, sometimes doing considerable damage to the west end of that town, while Presidio and the Valley receive not a trace of rain. Similarly the Alamito, six miles downstream from Presidio and draining the Marfa Plains and part of the southern slopes of the Davis Range, often comes down like a mighty Amazon when the Cibolo is dry, thus proving the greater prevalency of rains in the Davis Mountain region.

These arroyos, like the impounded waters of a reservoir when a dam gives way, carry everything before them. That these are not idle words is well proven in the floods of September and October, 1932, and again in September, 1936, when on account of the severe storms in the western Sierra Madres of Chihuahua, Mexico, the Rio Concho, with its confluence with the Rio Grande at Ojinaga just above Presidio, came down with such floods and violence that it inundated the entire valley. Damage to the cotton crop, destroyed buildings and bridges and other property amounting to hundreds of thousands of dollars.

The greater part of the annual rainfall coming as it usually does in the late summer months (Fig. 2) though sometimes earlier in June or May, brings the plant life into resurrection and makes the Marfa-Davis Mountain region a veritable paradise of green pastures.

The Marfa and Ft. Davis regions, which range in elevation from 4800 to 5200 feet or more, have much cooler summers and more severe winters than the Rio Grande Valley. One can always notice the changing temperature upon leaving the Chinatis above Shafter, at about 5000 feet elevation, and gradually dropping across the creosote mesa to Presidio at about 2700 feet elevation.

If it is winter, the additional warmth will be welcome, but if it is summer the change is one of stifling heat.

The twenty-second of December, 1929, brought the coldest weather experienced in decades (Fig. 2). The Valley recorded a minimum of 9° F. while the Marfa reports were considerably lower. Snow remained on the ground at Presidio for over a day, a very unusual occurrence, and on the 30th the writer found snow in the shade of cliffs in the Bofecillo Mountains, 30 miles east of Presidio. This extreme low temperature killed the flowering stalks of *Yucca Torreyi* that were commencing to bloom on the desert at this time, although normally they did not bud until March.

Usually, however, as in the winter of 1928-29, when only five mornings registered temperatures as low as 22° F., the minimum usually occurred at dawn. The diurnal fluctuation in the Valley is great, many days showing a range of 40 or 50 degrees or more, so that by 5:00 P.M. the maximum temperature may be 75° F., or 53° above the minimum as in one recorded case. When the sun goes down, the temperature rapidly drops, especially in winter. This is due to the sparse desert vegetation and the nature of the desert floor which is covered by a layer of gravel or cobblestones and forms what is called the "desert pavement." As soon as the sun has set, the heat in the desert pavement rapidly dissipates into the clear dry atmosphere and the temperature drops rapidly to reach the minimum at dawn.

The maximum temperatures at Presidio occurred on June 25 of 1929 and 1930, with 113° and 110° F., respectively. A second hot spell occurs usually in early September, when a temperature of 105° is not uncommon, often ranging to 109°. July and August temperatures are somewhat mitigated by the occasional summer showers.

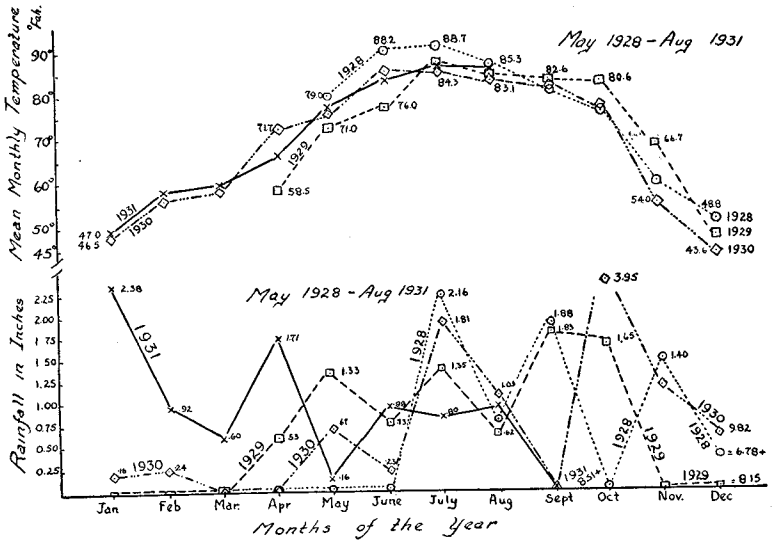


Fig. 2.—Mean monthly temperatures and rainfall at Presidio, Texas, from April, 1938 to September, 1931.

The mean annual humidity is very low and during the year the daily minimum occurs around 4.00 P.M.; the maximum at dawn. During the hot dry spells of summer it is a common occurrence for the hygroscope to register below ten and sometimes zero humidity. Only during the rainy spells, which seldom last for more than three days in the fall, and in late October to December at dawn when very heavy dews drench everything like a shower, does the humidity ever attain maximums of 90 and above.

Air movement is slight with only gentle breezes blowing during the greater part of the year. The period from October to February and sometimes March is usually calm and beautiful with clear skies and balmy days with a violet haze veiling the distant Sierras and making these months one long glorified Indian Summer. In late February and early March sandstorms commence and sometimes continue as late as June, but normally end in April. These are often of great violence and at Presidio almost always come from a northeast direction.

The number of clear days during the year at Presidio total about 325, and a completely cloudy spell of several days duration is a rare occasion.

The effect of showers is seldom noticeable after a few hours on account of the dry air, sparse vegetation, bright sunlight and the barren desert pavement which has a very high run-off rate especially after heavy and sudden showers. The sunlight is intense and this region is indeed a land of sunshine and health-giving atmosphere.

Factors Affecting Vegetation and Animal Life

Over most of the Big Bend Region the vegetation has in recent decades been greatly changed almost wholly due to the overgrazing practices of man. Only in the more inaccessible and rugged mountainous regions does the vegetation retain any of its original aspects. The herds of goats that range over the foothills of the Chinatis prevent the attainment of the natural growth of the vegetation by their close and continued browsing, and in pastured areas their effects are much more intensified and destructive. The effect of continued browsing by goats in the desert foothills, such as those of the Chinatis, is not always apparent at first sight. One is prone to consider the vegetation of these foothills as short and sparse and natural for such areas but this is far from the facts. Continual browsing has been largely responsible for the erosion of the thin soil cover coating the limestone rocks. Naturally this erosion and continued browsing of new growth plays an important rôle in reducing the insect, bird, reptilian and mammalian life in these areas. The scarcity of butterflies, grasshoppers and other forms of insect and animal life is largely attributable to the work of the goats and sheep in desert areas. Let me illustrate. One of my favorite collecting spots was a small desert valley in the Chinati foothills, between two limestone hills, two and one-half miles south by the old road from the mining town of Shafter, Texas. In this valley I collected many rare and interesting forms during the period 1928-1931. When I again visited this valley in October, 1946, after return to civilian life, I found that the right-hand hill (looking south) had been fenced for some years. The change was remarkable. The vegetation was much denser and taller than that just across

the road on the unprotected hillside. The skeleton weed (*Euphorbia antisyphilitica*) formed the finest colonies I have ever seen (Fig. 12) and the many other desert plants were in the same improved condition. The rare acridids *Zapata brevipennis* and *Netrosoma nigropleura* (not taken previously in this valley) were not uncommon and indicated how important a rôle plant protection plays in restoring animal life. Not only is the fauna favorably influenced and increased by plant protection but the denser and more luxuriant growth reduces the forces of erosion and actually aids in the restoration of the soil cover. What has been said concerning insect life is equally applicable to bird, reptile and mammalian life, for with greater plant protection and abundance of plant and animal food all forms of life will ultimately be favored.

What has been said concerning the effects of goats browsing on desert vegetation is equally applicable and even more so to cattle overgrazing of the grasslands and marginal grasslands merging with the desert. This is the direct result of the stupid and blind folly of the greedy ranchers. Cottle (1931) has shown that snakeweed (*Gutierrezia*) is the principal invader and its presence not only indicates overgrazing practices of ranchers from Texas to Arizona, but snakeweed invasion presents a blacker picture, namely that of destroyed grasslands, ruined ranches and erosion that increases yearly to the ultimate destruction of all our valuable lands in the southwestern United States. Nor have the ranchers tried to check the forces of erosion, caused by their greedy overgrazing practices, with the reduction of herd sizes and dams to control runoff, but appear to be the most indolent of men permitting gullies to expand to large arroyos and washes under their very eyes without lifting a finger to stem the tide.

These considerations should be of vital interest to every wide-awake American citizen and it is time, long past time, that our people and government did something to check the ever-increasing waste of our natural resources.

Flora of the Big Bend Region

FLORAL ZONES AND SUBDIVISIONS

As yet no comprehensive work has been attempted on the flora of the Big Bend and large areas remain unknown and will probably remain as such on account of the inaccessible nature of these remote areas. Cottle's work (1931) on certain grassland areas of the Big Bend Region is undoubtedly the most notable of the earlier attempts to study the vegetation of this region. Since the completion of the writers first manuscript in 1934, the establishment, in 1938, of the Big Bend Park in the southern end of Brewster County around the nucleus of the magnificent Chisos Mountains, has stimulated interest in this splendid area. The formation of this park has eliminated the ranchers and perhaps in time the vegetation may regain much of its former aspect within the park boundaries. Studies are in progress by the botanists at Sul Ross State Teachers College at Alpine. Dr. L. C. Hinckley's work (1944) on the Mt. Livermore area of the Davis Mountains is a worthy achievement and that botanist is now (1946) engaged in the study of the flora of the Chinati Mountains. Because of our incomplete and inadequate knowledge of the Big Bend Region the following discussion will be somewhat detailed.

The flora of the Big Bend Region may be divided into the following groups and subgroups:

A. Lower Sonoran Zone represented by various types of desert flora.

a. Rio Grande Valley chiefly of mesquite.

b. Desert Mesa of various types depending on location. In Presidio County chiefly of creosote, ocotillo and yucca and ranging from the edge of the Valley at 2700 feet to the base of the Chinati foothills around 4200 feet. In southern Brewster County, south and east of the Chisos, the mesa is dominated by creosote and large clumps of *Opuntia Engelmanni* and *O. rufida* with some *ocotillo* and *Leucophyllum*. In central Brewster County the mesa has co-dominant stands of creosote and blackbrush (*Flourensia*) over wide areas and these range across the north end of the Big Bend, north of the Davis Mountains. Other mesa areas just north of the Santiago Mountains possess a vegetation typical of the Eagle Pass region and characterized by *Porlieria, Leucophyllum* and long-bladed *Yucca*.

c. Mexican Lower Sonoran flora characterized by lechuguilla, ocotillo, sotol, huisache, guayule and many other plants in the Chinati foothills from 4200 to 4800 feet elevation.

B. Upper Sonoran Zone represented by grasslands, oaks and junipers.

a. Grasslands of the Marfa-Alpine-Marathon Plains merging with desert vegetation on the south and east (Brewster County), and extending into the valleys of the Davis and Glass Mountains on the north where a savannah-type of oaks, junipers and grasses clothe the lower mountain slopes.

b. Mexican Upper Sonoran flora represents a type found from 4800 to 5500 feet in the Chinati Mountains and perhaps at a similar elevation in the Chisos.

C. Transition Zone represented by pines, Douglas fir, cypress and certain oaks.

a. The northern slopes of Mt. Livermore in the Davis Mountains above 7500 feet or more; the northern slopes of Blue Mountain and Chinati Peak in the Chinatis, and certain high valleys and peaks in the Chisos forested with western yellow pine, Arizona cypress, Douglas fir, Chisos red oak and big-toothed maple.

It must be understood that these zones and their subdivisions are not sharply demarcated one from the other but almost imperceptibly merge or grade into each other. The areas of intergradation or transition from one zone or subzone to another is usually termed an *ecotone*. However each zone is distinct in itself and it is only the *ecotonic* area that exhibits a composite nature, a blending of two zones or subzones lying side by side. In mountainous areas these ecotones may be passed through by climbing several hundreds of feet up a mountain slope, and one zone may be observed to come down into another on a steep northern slope and the reverse occurs on southern exposures, but on flat ground ecotones may occupy a great many miles. A more detailed account of the flora of these zones now follows.

FLORISTIC ECOLOGY

A. LOWER SONORAN ZONE

a. *Rio Grande Valley Flora.*—The Rio Grande Valley lies between the mesa escarpments on either side of the river so that it varies in width from the actual confines of the river where the banks are steep (as below the mouth of the Alamito, six miles below Presidio) to a valley from one to several miles in width.

The soil of the valley floor is a heavy clay, called "adobe" which is light

to dark reddish-brown in color, very sticky when wet and fissured with cracks when dry. Where alluvial fans are formed by the numerous arroyos crossing the valley floor, the soil may vary from adobe to sandy or gravelly depending upon the type of terrain traversed by the arroyos and their size. These alluvial fans develop a flora peculiar to themselves on account of their soil structure and subsoil water supply.

The dominant plant of the valley floor, wherever adobe soil prevails, is the velvet mesquite, *Prosopis juliflora* var. *velutina,* which forms impenetrable thickets everywhere but which at present has been largely cleared to make way for the cotton fields. Associated with mesquite is the blue thorn, *Condalia lyciodes*. On the adobe flats intersected by small arroyos, mesquite and catclaw, *Acacia Greggii,* with its fragrant yellow catkins are found along the arroyos. All-thorn, *Koeberlinia spinosa,* is often found growing in large adobe mounds, the results of aeolian soil deposits. Along the sandy border of the Rio Grande and in damp sandy places, dense thickets of the Mexican jara, *Baccharis glutinosa,* abound. These flowering plants, willow-like in habit, are members of the Carduaceae and form the principal food for the colonies of Mexican beaver, *Castor canadensis mexicanus,* established in some of the ox-bow ponds of the Valley. Along the banks of former stream beds, cottonwoods, *Populus Fremontii* var. *Wislizeni,* and black willow, *Salix nigra* are found. Cattails, *Typha latifolia,* and reeds, *Juncus Torreyi,* find livelihood in these ox-bow ponds. Occasionally large groves of cottonwoods occupy river flats where the subsoil water supply meets their requirements. Mistletoe, *Phoradendron flavescens,* is a common parasite of cottonwoods in the Valley.

At certain places as at Indio and Ruidoso, respectively 16 and 42 miles upriver from Presidio, Tornillo or screw bean mesquite, *Prosopis pubescens,* is dominant where the soil is impregnated with alkali and in such places and elsewhere Bermuda grass, *Cynodon dactylon,* is common.

In the spring of the year and during the rainy season in late summer and fall, the adobe and arroyo flats are often ablaze with the yellow blooms of the woolly stemmed composite *Baileya multiradiata,* one of the characteristic flowers of the region. Jimson weed, *Datura meteloides* (with large white, morning glory-like flowers and long horned pods that Indians use in basket making), milkweed, *Asclepias* spp., and a loco weed (with large bladder-like pods) as well as other plants grow scattered over the Valley floor.

Near Ochoa, 12 miles upriver from Presidio, four-wing saltbush, *Atriplex canescens,* grows on alkali flats, often associated with the brittle joint cactus or tasajillo, *Opuntia leptocaulis*. These clumps afford splendid protection for the grasshopper, *Aeoloplus elegans,* which evades capture by jumping down into the midst of the spines. A yellow lily with rancid bulb buried deeply in the soil is found occasionally on these flats.

Near the edge of the mesa, creosote bush, *Larrea divaricata,* and ocotillo, *Fouquieria splendens,* are usually found growing on soil typical of the mesa.

Where large sandy arroyos cross the valley floor as a few miles northeast of Presidio, huisache, *Acacia Farnesiana,* and desert willow, *Chilopsis linearis,* of the family Bignoniaceae and narrow-leaved yucca or soapweed, *Yucca elata,*

are found. The desert willow with its lovely lavender-spotted white flowers, resembling large snap-dragons, line the gravelly borders of the arroyos. In large communities of *Yucca elata* growing in this vicinity, the brightly colored Scott oriole is found weaving its nest in the pendant leaves. Areas similar to these occur at Chinati, 39 miles upriver, with bluewood, *Condalia obovata,* creosote, ocotillo and *Baileya multiradiata* and other plants growing in rich profusion. Near Candelaria, 65 miles upriver from Presidio, certain sandy arroyos are dominated by *Yucca elata.*

In the wet arroyo as at the mouth of the Alamito, the Texas blue bonnet, *Lupinus texensis,* is often found blooming profusely in the early spring.

The plant life of the Rio Grande Valley in Brewster County is closely similar to that already described for Presidio County.

b. *The Desert Mesa Flora.*—The desert mesa commences as a low escarpment paralleling the Valley proper, at about 2700 feet elevation, at from one to several miles from the river. It gradually rises in elevation towards the base of the Chinati Mountains, some twenty miles north of Presidio, where it merges with the mountain slopes at 4200 to 4500 feet. Everywhere the gravelly "desert pavement" covers the adobe or gravelly subsoil and gives the mesa its characteristic appearance. Arroyos constantly intersect the mesa forming many stony-sided valleys of variable size.

The desert mesa is dominated by creosote with a general admixture of ocotillo and spanish dagger, *Yucca Torreyi,* which may in favorable habitats form dominant communities. Cane cactus, *Opuntia imbricata,* often forms societies and is certain to have an associated population of cactus wrens with them. Prickly pear, *Opuntia Engelmanni,* and the pin-cushiony masses of the strawberry pitahaya, *Opuntia stramineus,* with deep purple blossoms are found; the latter most common on the gravelly sides of the arroyo valleys and on knolls and hillsides. This pitahaya is diligently searched for in June, for its pink edible fruit with numerous tiny black imbedded seeds has a delicious strawberry flavor, so that the name "desert strawberry" is quite appropriate.

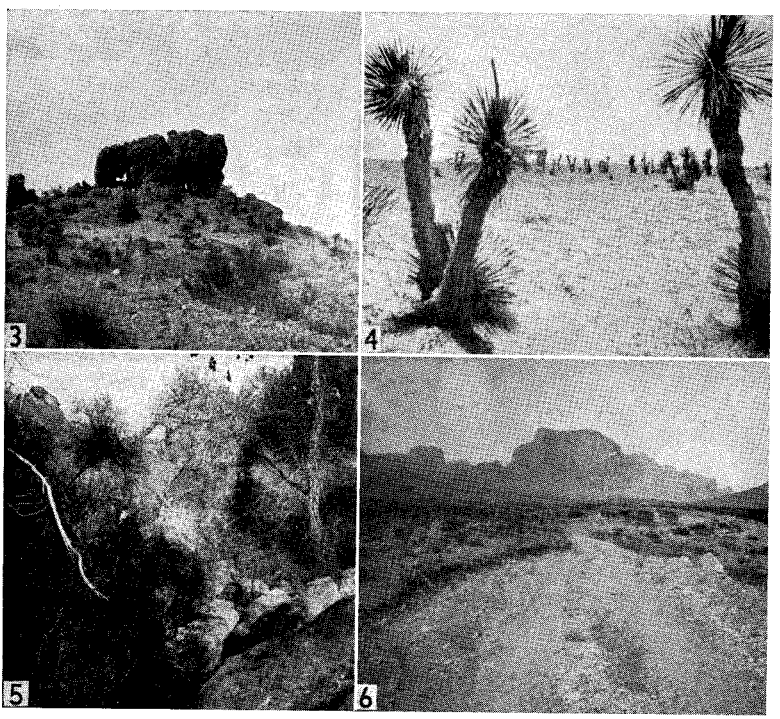
Here also are found other species of cacti such as the devil's pin cushion, *Mamillaria robustispina,* devil's head or bisnagre, *Echinocactus horizonthalonius,* with large deep pink flowers, rainbow cactus, *Echinocereus dasycanthus,* with huge orange-yellow blossoms that open fullest the second day, and the fish-hook cactus, *Neomamillaria microcarpa,* with its small coral-red fruits. Other rarer cacti include *Opuntia Grahami* of spiny prostrate form and with bright lemon-yellow flowers.

The rare and lovely night-blooming cereus, *Peniocereus Greggii,* with large fragrant flowers lasting only a night is found rarely in arroyo valleys. Its root is a huge tuber, about the size of a large turnip, in which it stores its food.

Candelilla or waxplant, *Euphorbia antisyphilitica,* occurs most commonly on limestone outcrops on hillsides and on the edge of the gravelly mesa where sangre de draco, or blood-of-the-dragon, *Jatropha spathulata,* is commonly found. The arroyo valleys have an admixture of such plants as mesquite, Spanish dagger, huisache, catclaw, bluewood or abrojo, *Condalia obovata,* and *Lycium Berlandieri,* with desert willow and yellow-trumpet flower, *Tecoma stans,* along

the stream margins. Often in the shelter of the creosote bushes, blossoming in the rainy season is the delicate blue-flowered *Commelina crispa*. Grasses are practically absent from the mesa. If the rains come in late summer or fall, as they are supposed to do, certain flowers such as *Baileya multiradiata, Cassia bauhinoides* and *Zinnia pumila* decorate the desert mesa with bright yellow and white flowers.

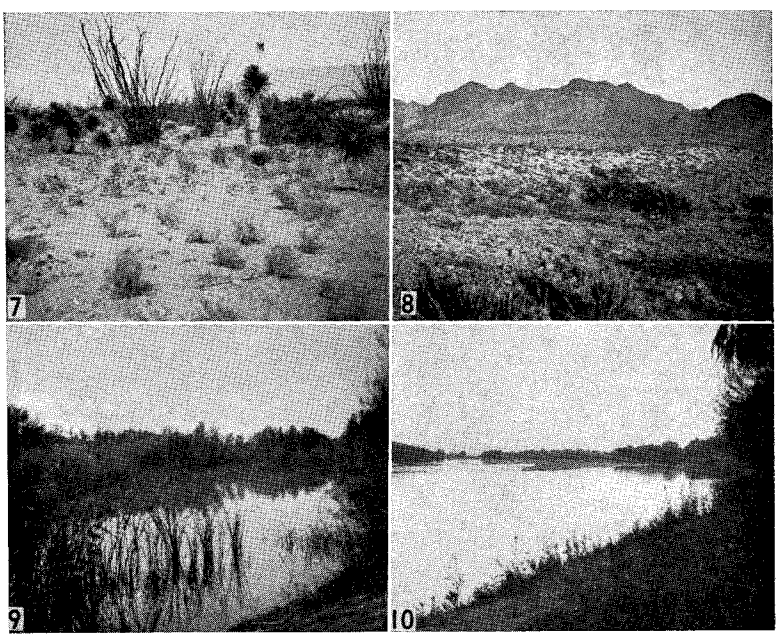
The mesa continues down the river to Lajita where the Santa Helena Canyon commences to cut its way through a tremendous rock escarpment. Southeast of Terlingua this mighty canyon, the "Grand Canyon of the Rio Grande" has its abrupt mouth for after cutting through solid rock to a depth of 2600 feet with sheer perpendicular walls, the river makes a sharp right-angled turn and follows at the base of this rock escarpment for many miles. Thus in Brewster County there is only one mesa and that on the American side of the river. In the Castalon area, the mesa is closely similar to that described above the canyon from Lajita to Candelaria, but southeast of the



Figs. 3-6. Vegetation types of the Big Bend Region.—3. Desert vegetation at Elephant Rock on north side of Chinati Mountains, six miles north of Shafter, Texas; 4. Marfa grasslands with scattered clumps of *Yucca elata;* 5. Heavily wooded canyon in the Bofecillos about 30 miles east of Presidio, Texas; 6. Wadi Burnham ranch house at north base of Chisos Mountains; Pulliam Bluff in center background, table top of Casa Grande in left background.

Chisos on the road to the Hot Springs and Boquillas the mesa assumes a different aspect. Here creosote, ocotillo, lechuguilla and numerous large clumps of cacti, *Opuntia rufida* and *O. Engelmanni*, occur with blood-of-the-dragon, and occasional plants of silver-leaf, *Leucophyllum frutescens,* which is the host plant of the grasshopper *Phaulotettix eurycercus* in this region. Travelling north along this road towards Marathon we find a new species of *Leucophylum, violaceum* described by Pennell in 1941, dominant a few miles south of the Boquillas-Chisos road junction.

The mesas surrounding the north base of the Chisos are dominated by creosote, lechuguilla, mesquite, ocotillo, *Opuntia leptocaulis, O. Engelmanni* and *O. macrocentra* and the dwarf yucca, *Yucca baccata,* and other plants. Some miles to the north the gravelly mesa is replaced by adobe soil and from here north for 20 miles to the south base of the Santiago Mountains and west of the Dead Horse Mountains, the mesa is almost a pure stand of creosote. Mesquite occurs in the washes and on bare adobe flats, in the fall, the rank-smelling, dwarf *Dyssodia polychaeta* makes golden carpets of flowers in the setting sun.



Figs. 7-10. Vegetation types of the Big Bend Region.—7. Desert vegetation of Rio Grande Valley near Chinati, looking northwest to Chinati Mountains. Ocotillo and *Y. elata* in background with the yellow composite *Baileya multiradiata* abundant in foreground; 8. Looking northeast across the creosote mesa to a portion of the Chinati Mountains just east of Shafter; Lechuguilla in left foreground; 9. Oxbow pond in the Rio Grande Valley at Presidio; 10. View of the Rio Grande at Presidio, Texas, taken from toll bridge.

On the mesa north of the Santiago Mountains after passing through Persimmon Gap, an intrusion of semi-desert vegetation, typical of the Del Rio-Eagle Pass region, is found. This mesa is characterized by creosote, the dark green clumps of goat-bean, *Porlieria angustifolia,* and *Leucophyllum frutescens* which on the 22nd of October, 1946, were mounds of large lavender-scented flowers and this species undoubtedly ranks as the most beautiful of the plants of the Chihuahuan Desert. Here also grew in profusion other plants; such as blood-of-the-dragon, strawberry pitahaya, tasajillo, honey mesquite, *Prosopis juliflora* var. *glandulosa,* blackbrush, *Yucca Treculiana* with long narrow bluish green blades, and others. Several miles north of Persimmon Gap the vegetation commences to change very gradually towards the creosote-blackbrush type of desert with other members such as the black-stemmed *Acacia constricta vernicosa,* mariola or *Parthenium incanum, Yucca Torreyi,* and *Mimosa biuncifera.* From 30 to 10 miles south of Marathon the dominant plants are creosote and blackbrush, *Flourensia cernua,* with some ocotillo and lechuguilla on knolls and with white-brush and abrojo in the washes. On a rocky ridge near a roadside spring, 12 miles south of Marathon many species of ferns were found in the rock crevices; such as *Pellaea cordata, P. atropurpurea* and *Pellaea* spp. and various species of *Notholaena* and *Cheilanthes.*

From this region the co-dominant stands of creosote and blackbrush extend north to the Carlsbad Caverns and from the Pecos River west to the Sierra Diablos and bordering the Davis Mountains on the north. Intrusions of this vegetational type break through the low hills at the west end of the Davis Range south into the western end of Presidio County west of Valentine. From the Sierra Diablos and Guadalupe Peak the creosote-blackbrush desert extends westward through southwestern New Mexico, at Hachita and Animas, and curves around the north base of the Chiricahuas to the San Pedro Valley and the Pierce region of southeastern Arizona. This type of desert characterized by *Larrea-Flourensia* may be recognized as the Pecos subregion of the Great Chihuahuan Desert. The Rio Grande type typified by lechuguilla-sotol vegetation extends northwestward up the Rio Grande to Sierra Blanca and the Franklin and Hueco Mountains and southeastward into Coahuila, Mexico. The lechuguilla-sotol type may be called the Coahuila subregion of the Great Chihuahuan Desert leaving the third type, the Salado subregion extending south from Carneros Pass, southwest of Saltillo, Coahuila, to Matehuala, San Luis Potosi.

c. *Mexican Lower Sonoran Flora.*—The lower levels of the Chinati Mountains are characterized by a flora here designated as the Mexican Lower Sonoran flora because its flora and associated fauna as well, is derived entirely from Mexico. Consequently many species of plants and animals find their northern limits of distribution on the North American continent in the Chinati Mountains.

The dominant plants of this floristic zone are sotol, *Dasylirion leiophyllum,* huisache or *Acacia Farnesiana* and lechuguilla, *Agave lecheguilla,* the latter dominating the limestone ledges of the foothills. The larvae of the giant skipper (*Megathymus mariae*) burrow in their roots and the pocket gophers

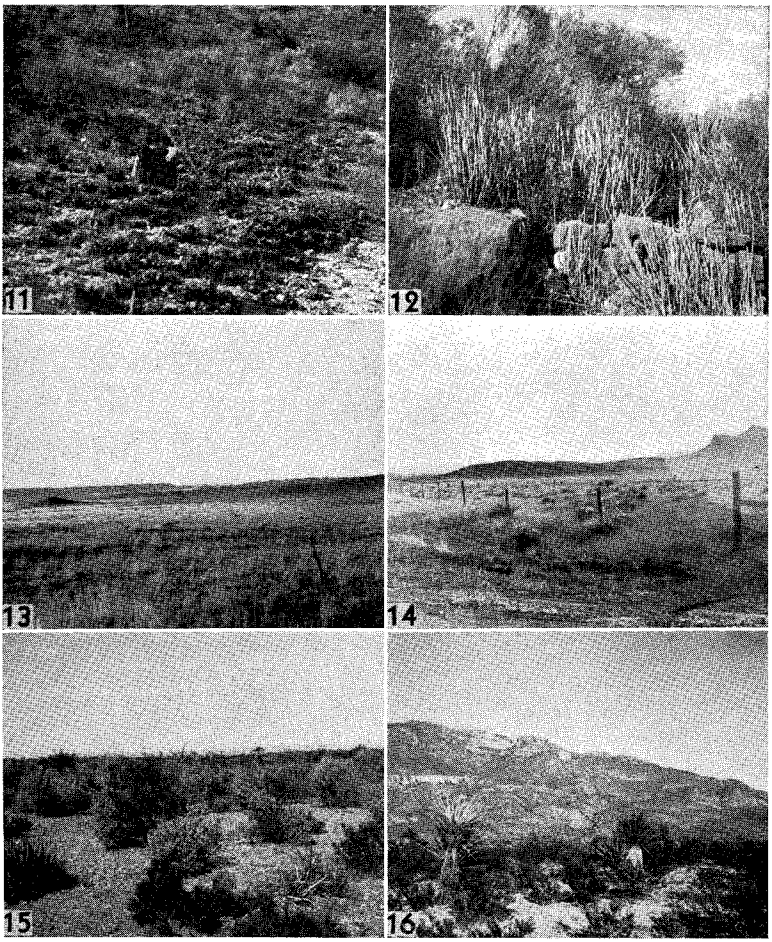
gnaw out the hearts of the plants so that there are always many dead and dying lechuguilla to be seen. On the gentle gravelly slopes at the base of the limestone hills, colonies of creosote, mariola or *Parthenium incanum,* and *Leucophyllum misum* occur with scattered plants among them of *Heliotropium angustifolium, Mortonia scabrella,* and *Buddleia marrubiifolia* with bright orange-red flowered and creased leathery leaves. The Mexican rubber plant called guayule, *Parthenium argentatum,* grows sparingly on the hill tops and its sap is quite sticky, drying into fine rubbery fibers. Spanish dagger and ocotillo are scattered here and there and with the other plants such as lechuguilla, sotol and huisache present a picture typical of this flora. Clumps of skeleton weed, *Euphorbia antisyphilitica,* are found on certain limestone ledges and these are favored habitats for the rare acridids *Zapata brevipennis* and *Netrosoma nigropleura* known only from this area.

In the shelter of rocks and in rock clefts and at the base of boulders where the soil moisture content is higher, a considerable variety of plants and flowers find a livelihood. Here are found yellow-trumpet flower, Mexican walnut, *Juglans ruprestis,* trifoliate barberry, *Berberis trifoliata, Linum Berlandiera* a flax, and *Hibiscus denudatus* and *H. Coulteri* with lavender and pale yellow flowers respectively. In the shade of large rocks and cliffs, the interesting *Forestiera angustifolia* with narrow linear leaves coming out in whorls from knotty stubs and closely resembling *Larix* in habit, is found growing with ferns such as *Notholaena sinuata* and *Cheilanthes tomentosa* and others.

Indian paint brush, *Castilleja latebracteata* described by Pennell in 1941, *Dalea formosa* the feather dalea with purple flowers, and *Psilocalyx Greggii* and various cacti such as the rare peyote, *Lophophora Williamsii,* living rock cactus, *Ariocarpus fissurata,* and others are found growing on the hilltops. On certain slopes, the resurrection plant, *Selaginella lepidophylla,* forms beautiful terraces, row upon row, which retain rain water and prevent runoff and erosion (Fig. 11).

In the valleys and along the arroyo beds grow a profusion of plants and flowers such as mesquite, catclaw, huisache, bluewood, and whitebrush, *Lippia ligustrina* with its tiny, white, honey-scented flowers. Climbing flowers are represented by *Janusia gracilis* and *Eupatorium Greggii* with its lavender tasseled blooms. *Baileya multiradiata* is also common in such locations. The foul wild gourd, *Curcurbita foetidissima,* is observed creeping across the sands of the arroyos on its long runners. In one particular valley, about two miles south of Shafter, a few plants of the blackbrush, *Flourensia cernua,* are found growing; the only ones known in the southern part of Presidio County. Despite the few plants its associated grasshopper, *Goniatron planum,* exists with them. Two other colonies are known to the writer, one 10 miles north of Marfa on the Ft. Davis road, and the other one mile north of Bunton Flat and about 29 miles north of Presidio. In Brewster County and north of the Davis Mountains blackbrush is co-dominant with creosote over great areas of the northern portion of the Chihuahuan Desert.

Grasses, which are rare in the Chinati foothill regions, include such species as *Muhlenbergia monticola, Bouteloua trifida* and *Triodia mutica.* At higher



Figs. 11-16. Vegetation types of the Big Bend Region.—11. Terracing effect and erosion control achieved by the resurrection plant, *Selaginella lepidophylla*, in the Chinati Mountains about two miles south of Shafter; 12. Fine stand of the skeleton weed, *Euphorbia antisyphilitica*, and favorite habitat of the grasshoppers *Zapata brevipennis* and *Netrosoma nigropleura* (Chinati Mts.); 13. Alpine grasslands looking north from a point a few miles east of Alpine, Texas, early January. A herd of 34 prong-horned antelopes are grazing in center of picture (Alpine-Marathon Grasslands); 14. Marathon plains looking south from a point ten miles northwest of Marathon, Texas, early January. Clumps of sacahuiste *Nolina texana* dot the center of the picture (Alpine-Marathon Grasslands); 15. Desert vegetation one mile north of Persimmon Gap on north side of Santiago Mountains showing *Leucophyllum frutescens* in heavy bloom (center) with *Porlieria angustifolia*, the dark plant (center foreground). Blood-of-the-dragon seen just above right corner, lechuguilla in left corner and stalk in right center; left of center are several stalks of *Yucca Treculeana;* 16. West base of the Dead Horse Mountains east of Cooper's Store with creosote in foreground and the Giant Dagger *Yucca carnerosana* center and right center and *Y. Treculeana* in the left corner.

elevations in the Chinatis, species of *Panicum, Setaria* and *Cyperus* in moist places, are found. These grasses have been identified by Dr. L. C. Hinckley of Sul Ross State Teachers College, Alpine, Texas, and Dr. Robert Darrow of the University of Arizona.

In other locations in the Chinati foothills many additional plants are to be found including such as *Bouvardia ternifolia, Cyphomeris gypsophiloides,* the purple-black pea, *Physalis atropurpurea,* and such rarities as *Acacia Schottii* and *Pentstemon Jamesi,* one of the few pentstemons growing in a desert environment.

Where water occurs in the larger arroyos such as the Cibolo at Shafter, cottonwoods and Mexican jara are found along their banks.

The remote and little accessible Bofecillo Mountains lying north of Redford and east of Presidio some twenty miles, are lower than the Chinatis but on account of the character of its limestone rocks and cliffs with grottoed caves and deep-walled recesses, the region assumes a different and varied aspect and provides shelter for a great variety of plants. Dense thickets of trees and shrubs, such as bluewood, cottonwood and mesquite, occur along the main water course, entangled with wild grape and creepers. In one rock-walled recess Texas ash, *Fraxinus texensis,* with other interesting plans was discovered. The plateau-like peaks and the rough mountain slopes are dominated mainly by ocotillo, sotol, lechuguilla and Spanish dagger, and in appearance are quite similar to the Chinati foothills and undoubtedly represent the Mexican Lower Sonoran flora.

B. UPPER SONORAN ZONE

a. *Grasslands.*—North of the Chinatis at from 5000 to 5500 feet elevation a series of hills such as the Cuesta del Burro and the Frenchman Hills slope off to the north in rolling fashion to finally level out on the Valentine-Marfa Plain.

This grassland represents the Upper Sonoran Zone and is dominated by various species of gramma grasses such as *Bouteloua gracilis, B. hirsuta, B. triopoda* and *B. curtipendula,* which are of chief ecological importance. Others occur, such as chino grass, *B. breviseta* and *B. chondrosiodes,* as well as *Aristida pansa, Muhlenbergia* spp., and *Chloris virgata* which is usually common along road margins. Scattered over this grassland, especially in the Marfa area, are clumps of low bushes of *Microrhamnus ericoides, Rhus trilobata, Clematis Drummondi* and *Lycium pallidum.* Dense communities of narrow-leaved yucca, like dwarfed forests, slope gently off to the south from areas east of Marfa, to finally merge into the desert flora coming up the Alamito (Fig. 7). North of Marfa considerable all thorn *Koeberlinia spinosa* grows. Other plants include *Adolphia infestans,* a tall *Eriogonum,* the pestiferous snake weed *Gutierrezia Sarothrae, Buddleia scordioides* and *Michaerantherea tannasetifolia.*

Further south on the Marfa-Presidio road, where the country becomes hillier and rockier, the floral aspects change from one dominated by grasslands to one occupied by sacahuiste and sparse tall grass. Finally on nearing the Chinatis, sotols appear, often forming dense communities on certain knolls,

with Spanish dagger, ocotillo, lechuguilla and other plants present that are typical of the Mexican Lower Sonoran Zone. At Bunton Flat, some 40 miles south of Marfa and just north of the popular landmark called "Elephant Rock" (Fig. 3), a community of tobosa grass, *Hilaria mutica,* occurs, with a blackbrush colony one mile north of Bunton Flat.

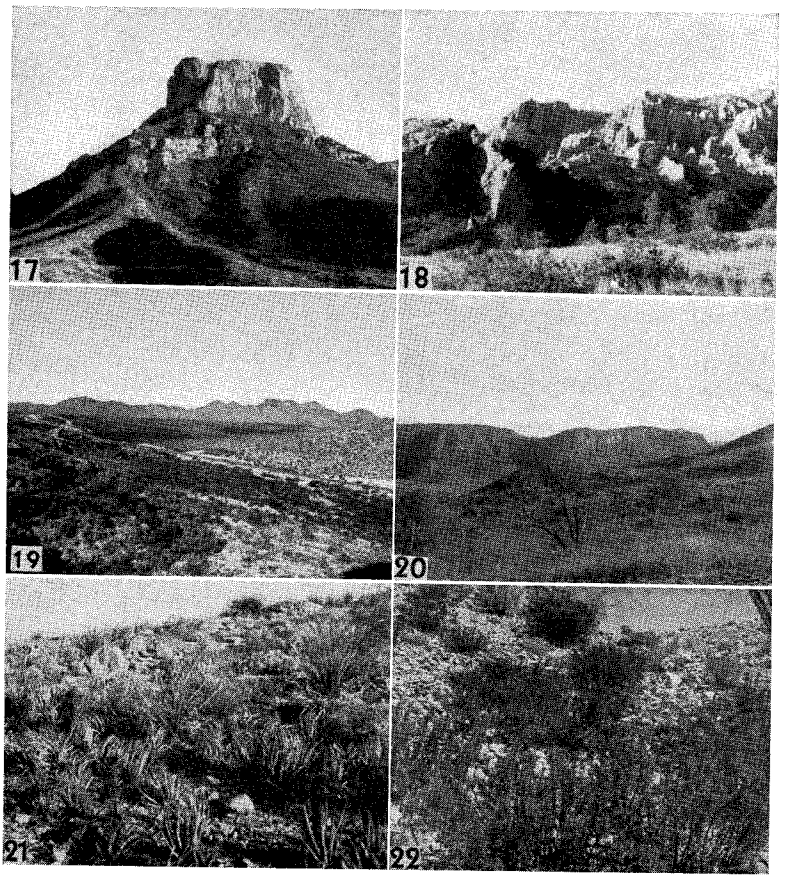
On their northern extremity, these grasslands ramify through the southern valleys of the Davis Mountains, forming excellent grazing range. Fine groves of live oaks, *Quercus Emoryi,* are located on the alluvial fans at the mouths of canyons and valleys while on the mountain slopes gray oak, *Quercus grisea,* Mexican walnut, *Juglans ruprestis,* merge with one-seeded juniper, *Juniperus monosperma.* Other trees, such as Osage orange, *Toxylon pomiferum,* with a great variety of grasses and other plants occur. Cottonwoods grow along the water courses, such as Limpia Canyon, where on south-facing slopes century plants or mescals, *Agave Wislizeni,* are seen growing. This plant is common further north around the Carlsbad Caverns and Pine Springs and their presence in Limpis Canyon indicates the infiltration of desert plants into the northern portions of the Davis Range.

The northern margins of the Davis Mountains show definitely a closer proximity to desert conditions than does the southern edge, which is grasslands. The northern border supports such common grasses as *Bouteloua gracilis, B. barbatus, B. curtipendula, Andropogon furcatus, Aristida ternipes* var. *minor;* flowers such as *Gymnolomia, Microsiphonia microsiphon, Amorpha fruiticosa* and *Tidestromia* and shrubs such as *Parthenium incanum, Lippia Wrightii, Rhus chloriophylla* and others. Scattered junipers, sotol and yucca are also seen on hillsides at the northern extremity of the Davis Mountains east of Kent.

East of the Davis Range at Paisano, where the mountains form isolated cone-shaped peaks clothed with oaks and junipers, the vegetation continues as grasslands through to Alpine and Marathon. East of there, acacias and other shurbs begin coming in until the grasslands have been practically replaced by desert shrubs. These have already been described for the mesa flora of Brewster County. Scattered junipers occur on the hillsides near Sanderson. Six miles east of Sanderson the elevation suddenly drops off into the Pecos Valley where the chief desert shrubs are creosote and blackbrush. Thus we observe that the grasslands of the Big Bend Region are ringed by desert on all sides.

East of Sanderson at about 15 miles west of Langtry, elements of the Tamaulipan Semi-desert Bushland begin to appear in such dominant shrubs as *Acacia Berlandieri, Prosopis juliflora* var. *glandulosa, Leucophyllum misum, Cercidium macrum, Porlieria angustifolia* and others. As already noted elements of this flora are found on the north side of the Santiago Mountains and as we progress eastward it becomes more and more prominent. It is this flora that brings into eastern Brewster County and the Chisos Mountains a number of faunal elements which are not found in the Chinati Mountains. These include cockroaches, stick insects, mantids, certain grasshoppers and katydids as well as cicadas and other forms of animal life. On the other hand the Chinatis have many Mexican forms not found in the Chisos.

b. *Mexican Upper Sonoran Flora.*—Elevations in the Chinati Mountains roughly between 4700 and 5500 feet represent an ecotone between the Mexican Lower Sonoran flora with its desert shrubs, and the grasslands above 5500 feet elevation. This zone is called the Mexican Upper Sonoran flora and con-



Figs. 17-22. Vegetation types of the Big Bend Region.—17. View of Casa Grande from the Chisos Basin, late afternoon. Slopes covered principally with oaks (Chisos Mts.); 18. Craggy south slopes of Pulliam Bluff as seen from the Chisos Basin. Late afternoon sun is shining through "the Window" to reveal the rocky ridges in shadowy relief (Chisos Mts.); 19. View of valley two miles south of Shafter; vegetation of lechuguilla, sotol, huisache, skeleton weed and many other plants on limestone hillsides with mesquite, creosote, bluewood, whitebrush and a little blackbrush in the valley; peaks east of Shafter in the background; 20. Lower Limpia Canyon about six miles northeast of Ft. Davis (Davis Mts.); 21. Dense stands of lechuguilla, *Agave lecheguilla*, on limestone slopes about two miles south of Shafter, Texas (Chinati Mts.). Upper left is *Acacia Farnesiana* and sotol center and to right; 22. Edge of the first mesa about one mile north of Presidio, Texas, covered with numerous clumps of the "blood-of-the-dragon" *Jatropha spathulata*. Ocotillo in upper right corner.

tains a number of species of plants and animals found nowhere else in the United States east of south central Arizona.

On the rocky slopes of the lower plateau-like hills in the Chinatis tall grasses, such as *Stipa leucotricha, Andropogon, Aristida, Muhlenbergia* spp. and *Bouteloua* spp., abound. The dwarf round-flowered catclaw, *Acacia Roemeriana* with pink tassel-like flowers, is the dominant shrub with the grasses at elevations up to 5000 feet, and on the slopes *Nolina texana,* sotol and *Acacia Roemeriana* occur. In places, communities of sotol and very tall grasses flourish on the mountain sides at 5000 to 5500 feet. On the broad plateaus at 5500 feet or more gramma grass with narrow-leaved yucca are dominant.

In the shade of cliffs in the higher valleys at 5000 to 5500 feet a great variety of flowers and shrubs are found blooming in late summer visited by the large black and yellow bumblebees, *Bremus sonorus.* This greater wealth of flowers is due to the greater moisture supply, lower temperatures and decreased aridity, and is indicative of the Mexican Upper Sonoran flora. Limits cannot be set, however, for the higher the altitude above 5000 feet the more strongly the floral aspects become typical Upper Sonoran (grasslands). On the steep north slopes of Blue Mountain, second highest peak in the Chinatis and 6700 feet in elevation and ranging from the flat plateau top down to about 5500 feet, an oak zone of *Quercus virginiana* exists, as in the Davis Range, with some hackberry, *Celtis pallida,* and Mexican walnut at the lower reaches. This is typical Upper Sonoran and in this oak zone were found several orthopterans not previously taken in the Chinatis, the same species as inhabit the oak zone of the Davis Mountains. The narrow table-topped peak of Blue Mountain (6700 feet) was dominated by one-seeded juniper and the grasshopper fauna here was typical of similar elevations in the Davis Mountains 100 miles to the north.

C. TRANSITION ZONE

The flora of the Transition Zone is found only on the highest peaks of the Big Bend Region. It is probably present on the north slopes of Chinati Peak but apparently no studies, by anyone, have been made on that inaccessible section of the Chinatis.

On the northern slopes of Mt. Livermore of the Davis Range, and highest peak in the Big Bend, the Transition Zone is represented by western yellow pine, *Pinus ponderosa,* and *Pinus flexilis;* the oaks *Quercus Gambelii* and *Q. hypoleucoides;* and quaking aspen, *Populus tremuloides,* which are the principal trees of this zone.

The commonest shrubs are mountain snowberry, *Symphoricarpos oreophilus,* bush rock spirea, *Holodiscus Wrightii,* Arizona sage, *Salvia arizonica,* wild geranium, *Geranium atropurpureum,* sagebrush, *Artemisia dracunculoides* and *A. mexicana,* golden aster, *Chrysopsis hispida* and *Eupatorium Fendleri.* Cacti are represented by *Opuntia strigil* and *O. chlorantha.*

Grasses are many including *Koeleria cristata, Bromus ciliatus* and *B. carinatus, Muhlenbergia montanus, Agropyron arizonicum, Stipa tenuissima,* and the gramma grasses, *Bouteloua gracilis* and *B. hirsuta.*

The higher peaks of the Chisos represent the Transition Zone, and these are interesting in that different peaks have different members of this flora. Mt. Emory, the highest peak, has the only aspens found in the range and Arizona cypress, *Cupressus arizonica,* and Douglas fir, *Pseudotsuga taxifolia,* are found at Boot Springs near its northern base. A few Douglas fir also grow on the higher slopes of Casa Grande. Western yellow pine grows only in Pine Canyon, a large canyon between Lost Mines and Crown peaks. Pulliam Bluff has the only growth of Bray's chestnut oak, *Quercus Muhlenbergii Brayi.* The bigtoothed maple, *Acer grandidentatum,* and the Chisos red oak, *Quercus Gravesii,* are more generally distributed on the various high peaks of the Chisos. The above mentioned trees typify the Transition Zone in the Chisos Mountains.

Fauna of the Big Bend Region

THE ORIGIN AND ADAPTATIONS OF DESERT ORTHOPTERA

Of the various orders of insects, the Orthoptera are more graminiphagous than any other group. Especially in northern latitudes orthopteran life is solely dependent upon the grasses for sustenance. Food here is usually plentiful.

On the desert, however, where grasses are scarce we find that many species have assumed an arboreal or thamnophilous (bush-loving) habit and become restricted to a particular host plant. This is a forced modification due to the nature of the environment. Search of food probably first induced grasshoppers to become shrub feeders, and as they grew in harmony with their new surroundings the different species eventually completed their life cycle on the plants themselves. This is true of many species of the Lower Sonoran Orthoptera which are dominantly of Mexican origin.

In addition to the sparsity of the flora of the desert, the bareness of the desert pavement and the intensity of the sunlight produce temperatures that would be fatal to most organisms. Hence the desert Orthoptera, especially the grasshoppers or the Acrididae, were forced to the scant shade of the plants themselves or what was preferable, to evade the high temperatures of the soil and the air contiguous to it, by climbing or jumping or flying into the bushes. In fact many species of winged grasshoppers such as *Trimerotropis* spp., *Tytthotyle maculata* and *Derotmema delicatula,* etc., remain on the soil of the desert until the maximum temperatures force them to seek the protection of the foliage. Usually this is not a case of hiding in the foliage as much as resting on the leaf exposed to the rays of the sun.

In the Imperial Valley many winged acridids that remain on the soil when temperatures are suitable, cannot be forced to fly from the bushes to the ground during the intense heat of midday when shade temperature run 120 degrees Fahrenheit and soil temperatures reach 150 degrees, but fly directly from bush to bush when disturbed.

The extensive sand areas of the Imperial Valley representing a tropical or xerothermic Colorado Desert have developed certain grasshoppers adapted to living on its burning sands. These acridids include the rare and unique *Spani-*

acris (*Ramona*) *deserticola, Coniana snowi* and *Xeracris minimus. Spaniacris* has long slender legs to raise its body off the sands and the long caudal tibiae are inbent apically to give the creature purchasing power when it takes to flight from the sand. *Coniana* is squat and short-legged yet is able to exist here where the only plant is the low cespitose *Coldenia Palmeri* which would not raise their bodies half an inch off of the sand.

Other species such as *Cibolacris parviceps, Tytthotyle maculata, Lactista oslari, Trimerotropis pallidipennis, Trepidulus rosaceus* have a wider distribution upon the deserts of southeastern California and Arizona where they inhabit volcanic desert pavement and gravelly arroyos, while in similar habitats in southwestern Texas we find such saxicolous species as *Trimerotropis texana, Heliastus benjamini, Phrynotettix robustus* and *tschivavensis* and *Anconia hebardi.*

Thamnophilous species such as *Aeoloplus elegans* and *Camplyacantha olivacea vivax* seek shelter when danger threatens, by jumping down into the bushes they are on, where the brittle joint cactus *Opuntia leptocaulis* often affords the desired protection.

Others such as *Ligurotettix coquilletti* of the Sonoran Desert play hide and seek on the bare stems of creosote and *Franseria dumosa* and are almost impossible to capture without the use of forceps. So also does *Goniatron planum* of the Chihuahuan Desert on its host plant *Flourensis cernua.* Likewise the wingless *Clematodes larreae* on its host plant, the creosote bush, escapes detection by its deceptive habits.

Thus the desert acridids due to their more precarious and diversified habits, show more interesting adaptations to their environments than do the grassland grasshoppers.

These adaptations are not only physical but morphological as well, and many strange modifications occur, the most striking examples being the fat ponderous "toadhoppers" of the genus *Phrynotettix* which have brachypterous or rudimentary wing pads and broad squattish bodies. In fact many acridids throughout the desert regions of the world have developed into this broad and squat form. Others such as *Spaniacris* have developed long slender legs to raise their bodies off the sand. Still others have become greatly slenderized to resemble the stems of desert grass. Thus *Prorocorypha snowi,* the "Matchstick Grasshopper," is exceedingly long and slender so that when it rests on a grass stem with its long ensiform antennae aligned forward, it takes a sharp eye to spot it. Almost as remarkable is the very rare *Achurum sumichrasti* of southwestern Texas and species of *Eremiacris* such as *virgata, perpallida* and *acris* exhibit similar form and habit.

Protective coloration is exhibited in most orthoptera, with striking exceptions in the nigger grasshopper, *Boopedon nubilum,* the rainbow grasshopper, *Dactylotum variegatum,* and the large and showy black and yellow horse lubber, *Taeniopoda eques,* although in the latter case these colors may be warning.

Striking examples in the opposite extremes are exemplified in certain saxic-

olous and thamnophilous species. The very rare *Anconia hebardi* and the commoner *Cibolacris parviceps, Helastus benjamini* and *Trimerotropis texana* blend perfectly with the rocks and gravel of the arroyo beds that constitute their home. *Coniana snowi* is finely speckled like the sands of Imperial Valley and *Spaniacris deserticola, Tytthotyle maculata, Lactista oslari, Arphia aberrans* and many other species show as remarkable a protective coloration.

Of thamnophilous species, those orthopterans dwelling in creosote bush, the dominant plant of the desert, exhibit a strange coloration. *Bootettix argentatus* and *punctatus* and the katydids *Anoplodusa arizonensis, Insara covilleae, Rehnia cerberus* and *victoriae* are all foliage green with nacreous markings, the latter markings probably representing the sun glistening on the shining sticky leaves of the creosote. Others such as *Clematodes, Goniatron* and *Ligurotettix* are grayish colored to resemble the stems of desert plants such as creosote, *Flourensia* and *Franseria* which they inhabit respectively.

Many desert species such as *Netrosoma nigropleura* and *Zapata brevipennis* and species of *Philocleon* and *Phaedrotettix* escape from their enemies by their remarkable jumping powers. Others like *Phaulotettix eurycercus* feign death and drop into the centers of spiny sotol bushes, with which they are associated, and thus are safe. *Oedomerus corallipes* crawls down under the rocks on mountain slopes to elude its enemies.

Host plant relationships also have been especially developed. Despite the sticky and pungent leaves of the creosote, this plant which appears to be decidedly unpalpable to many species has yet developed a considerable array of orthopterans restricted to it. In addition to *Bootettix, Insara, Anoplodusa* and *Rehnia* mentioned above, species of *Dichopetala, Eremopedes* and the stick insect *Diapheromera* are restricted to it. Other desert species are found on *Flourensia, Franseria, Gutierrezia, Baccharis* and *Artemesia.*

This in brief outlines some of the interesting adaptations of desert orthopterans to their habitats.

INSECT DISTRIBUTION AND ABUNDANCE ZONES: ENDOGENES AND ECTOGENES

Every species has its range of *optimum abundance* where the combined factors of climate (temperature, rainfall and humidity), food and edaphic features are most favorable to its existence. Rare species only exist because those specimens taken are usually far from the optimum zone of their distribution, and are rare because conditions are so drastic or unfavorable, or in other words the environmental resistance or pressure is so great that few survive. In the optimum zone the species encounters the least environmental resistance. Outside this zone, if it be defined by study, one will find a zone or area of *lesser abundance* where the species will always be found but in small numbers. This zone grades off imperceptibly on its outer periphery to an area of *rarer occurrence* where the factors of climate and food are so adverse that only a few individuals of a species survive to propagate the race. In the area of rarer

occurrence should climatic conditions become more drastic, i.e. swing further away from the optimum requirements of the species, it will disappear; if cyclic climatic fluctuations move towards more favorable conditions or towards the optimum, the species will increase in numbers but never to the point of being common unless the change is great.

This last zone might be considered as a zone of tension for every species of animal or plant, by its life activities, is striving to increase or extend the boundaries of its distribution. This is an inherent characteristic of the species; a time-space attribute for the propagation of the race. When for a series of years conditions do become more favorable or in other words the factors keeping the species in check are lowered in the environment, the species extends itself over a greater area. The reverse occurs when the conditions in the habitat become unfavorable and the resistance is high; the species is decimated in numbers.

But in the center of its distribution, the optimum of the species, where it has evolved through the ages and becomes attuned to the existing conditions, the species is always present in greatest numbers. The writer has formed the term *endogene* to indicate a species found in its optimum zone, or in other words that region in which it is particularly indigenous. Similarly by the term *ectogene* the writer refers to a species outside its optimum zone, where it is more or less rare and can be considered as living in an environment that is none too mild in character, and in which it finds a difficult livelihood.

ORTHOPTERAN ZOOGEOGRAPHY

With such a diversity and abundance of orthopteran life to contend with as is represented in the Big Region of Trans-Pecos Texas, it is imperative that a thorough knowledge of the region be had. For this reason we have already dealt with the flora of this region, which was divided floristically, by the nature of the physiography of the region and its associated plant formations, and faunistically by the character of the orthopteran fauna associated with the flora, into a series of two or possibly three faunal zones and each with several subzones or faunae.

Despite this statement the writer realizes how difficult it is to interpret faunal zones and faunae, especially when the region being dealt with lies in the midst of a vast uncharted area.

This study has shown, for instance, that due to the geographic location of the area, its physiographic diversity, its constantly changing floristic features as well as a considerable range in altitude from the Rio Grande Valley (2600 ft.) to the highest peaks (8300 ft.), the area has proved to be the meeting place of many faunae.

Our problem is to break up this mass of species into its component elements, and in doing this it will be essential to study the known distribution of each orthopteran species and to determine from the records and the writer's own observations not only here but throughout the various deserts of North America, whether the species is an endogene or ectogene in the floristic habitat in which it is found.

The known distribution of each orthopteran species has been plotted on prepared maps of North America and from this study the various species have been seriated into groups or faunae.

It does not necessarily follow that two species sharing the same habitat belong to the same group. One may be an endogene, the other an ectogene in this habitat, and consequently cannot be classed together. Plotting their respective distributions in this case will show that their geographic ranges do not coincide.

Hence if we make a transect of the region from the Rio Grande at Presidio to the highest peak, Mt. Livermore to the Davis Range, 100 miles away to the north, and make this transect an altitudinal one; by adding symbols to represent the dominant flora of each area, we can roughly define the floral zones of the Big Bend. Then by listing the endogenes of each floral zone, a faunistic-floristic transect of the region under consideration is obtained (Fig. 23). An analysis of this transect and all the component elements making up the whole, constitutes the scope of this paper.

It must be remembered that each fauna overlaps on its margins with adjacent faunae forming an area of intermingling commonly called an ecotone. The members of a fauna are usually endogenes but the members of an ecotone are usually ectogenes, as change in altitude, and climate, the presence of new plants replacing the old, change the features of the habitat and bring environmental pressure to bear on certain species thus reducing their numbers.

FAUNAL ZONES AND THEIR SUBDIVISIONS OR FAUNAE

A. The Lower Sonoran Faunal Zone is represented by the following subdivisions which are not all natural divisions:
   a. Rio Grande Valley possessing a variable and unnatural fauna due to changes wrought by agriculture.
   b. Desert Mesa comprising the typical fauna of vast stretches of the desert and this fauna is chiefly indigenous to the Chihuahuan Desert, and is called the Chihuahuan Lower Sonoran fauna.
   c. Mexican Lower Sonoran fauna is identified by a floral and faunal zone ranging approximately from 4200 to 4800 feet, that can also be called the lower desert mountain zone and is chiefly characterized by the plants, sotol, lechuguilla and ocotillo, and by limestone.

B. The Upper Sonoran Faunal Zone is divisible into four main components or faunae:
   a. Southern Short Grasslands fauna developed on the more arid short grasslands of the Western Plains. This fauna extends from southeastern Alberta, eastern Montana and North Dakota, southwest of the Missouri, south to the Panhandle and central Texas and east of the Rockies to southwestern South Dakota, western Nebraska and Kansas and western Oklahoma. In the Southwest this fauna follows the grasslands south through New Mexico to southeastern Arizona and southeastward to the Big Bend Region.
   b. Southwestern Grasslands fauna represents a fauna of the southwest ranging from southeastern Arizona to Trans-Pecos Teras, south to Chihuahua and Durango and northeast throughout New Mexico to eastern Colorado and southwestern Kansas.
   c. Mexican Upper Sonoran fauna is widespread over the Mexican Plateau finding its northern limits of distribution in southcentral Arizona mainly from the Babo-

quivari, Tumacacori and Huachuca Mountains, with elements in the Ajos, Santa Catalinas and Chiricahuas. In Trans-Pecos Texas, the fauna reappears only in the Chinatis and perhaps in the Chisos. Recent botanical explorations by Johnson and Mueller (1940-41) in northern Coahuila and Chihuahua indicate this isolated Texas unit is most probably connected with the main fauna in the Sierra Madres Occidentale *via* the mountainous masses of central Coahuila and southern Chihuahua. It does not appear to be connected with the Sierra Madres Orientale.

d. Chihuahuan Upper Sonoran fauna represents a small fauna of the Upper Sonoran Zone which is restricted to Trans-Pecos Texas and northeastern Mexico.

C. The Transition Faunal Zone appears to have two components.

a. Northern Short Grasslands fauna composed of a series of species inhabiting the northern plains of the southern portions of the Canadian prairie provinces and in the United States occupying that area extending east of the Rockies to the western edge of Minnesota, most of South Dakota and Nebraska, western half of Kansas, and ranging throughout northern New Mexico to the grasslands of the Mogollon Plateau of Arizona and the higher grasslands of the Big Bend Region.

b. Southwestern Mountain Transition fauna is composed of a group of species indigenous to the Oak and juniper zones of the southwest ranging from the higher elevations of the Chisos, Davis and Chinati Mountains to the eastern half of Arizona and north to southern Colorado.

FAUNISTIC ECOLOGY OF THE BIG BEND REGION

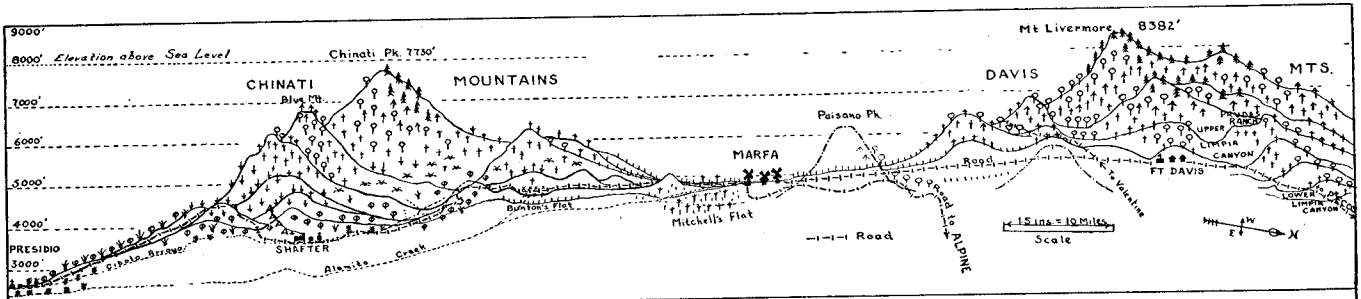
A. LOWER SONORAN FAUNAL ZONE.

a. *Rio Grande Valley.*—This fauna shows great irregularity due no doubt to the agricultural practices carried on in the Valley. These have produced verdant fields of cotton and alfalfa and other crops and with irrigation mitigating the effects of the climate, has thus given variety to its fauna.

Thus the cotton fields are conducive to the development of many species such as the bird-winged locust, *Schistocerca vaga, S. americana, Melanoplus bowditchii propinguus,* the tree cricket, *Oecanthus californicus,* and the katydids *Scudderia furcata furcifera* and *Insara elegans.*

On patches of sand in the cotton fields and elsewhere *Trimerotropis citrina* is common with an occasional *Spharagemon collare cristatum* found. The latter species is not to be confused with *Spharagemon bolli inornatum* which is found under oaks in the mountains.

Along grass covered irrigation ditches where Bermuda grass is dominant, *Platylactista aztecus* and *Encoptolophus subgracilis* occur and in more damp locations *Syrbula fuscovittata* and *Orphulella pelidna deserta* are sometimes found, while *Conocephalus strictus* was taken rarely in the tall grass bordering a small slough. *Derotmema haydenii mesembrinum* was found on certain mesquite-covered adobe flats and *Trimerotropis p. pallidipennis* was abundant everywhere. The rare *Anconia hebardi* was found on bare adobe flats and adjacent arroyo beds in the valley upriver from Presidio near Indio. Other species were taken such as the mantids *Stagmomantis californicus* and *Litaneutria minor* and the cockroaches *Arenivaga erratica* and *Eremoblatta subdiaphana,* the two latter mainly at lights. A unique specimen of *Dissosteira*



DOMINANT PLANTS CHARACTERIZING THE VARIOUS FAUNAE

1a. # Mesquite, 1b. + Creosote ¥ Ocotillo, 1c. † Sotol-Lechuguilla; 2a. † Tall grasses, 2b. ⁂ Sacahuiste † Narrow-Leaved Yucca × Tobosa Grass † Tall Grass, 2c. ||| Short Grass; 3a. ||, †, ¶ Oak 3b. † Juniper # Pine

AUSTRAL FAUNAL REGION

1. LOWER SONORAN ZONE

Lower Sonoran Fauna 1abc		Mexican L. 1c, Sonoran Fauna	Chihuahuan L. 1b Sonoran Fauna
P. desertae	Oecanthus sp.	E subdiaphana	D. corillea
S. californica	H boreale	A. piperatus	D torquata
S. limbata	M lineatus	Z. brevipennis	D v eucnemis
P. m mexicanus	M. rhombifolium	C larreae	B argentatus
E. subgracilis	M. aridus	T. eques	P maculipennis
S. c. cristatum	N. c mormonius	C c fortior	G planum
P. aztecus	A. erratica		D. h mesembrinus
M. terricolor			T texana
T. strenua	Lower & Upper S. Fauna		A hebardi
T. latifasciata	P americanica	Austroriparian = Humid L. Sonoran	P robustus
C p. aridus	B germanica	T citrina	P eurycercus
S. v vaga	P stramineus	S americana	C. o. vivax
M herbaceus?	P a. aztecus	A. huasteca	A elegans
M. f elongatus	M texana	M. lineatus	D. brevihastata
M. b. propinquus	P t pusilla	M denticrus	P. nigrovittata
I. e. elegans	A aberrans		N nigropleura
N. trops	T p pallidipennis		P eurycercus
C. fuliginosus	M d. nigricans	Eremoblatta n sp.	R. cerberus
N. c neomexicanus	S f furcifera	C. variegatus	P tinkhami
Q. californicus	S. Supellectilium	E. covilleae	E. scudderi

2. UPPER SONORAN ZONE

Mexican U. 2a. Sonoran Fauna	Chihuahuan U. Sonoran Fauna	SW. Grasslands Fauna 2b.c.	S. Short Grasslands Fauna 2c.	Upper 2abc. Sonoran Fauna
A grata	P d palmeri	Y solitaria	L minor	P coloradus
A sumichrasti	A. m cryptodomus	O scudderi	C o occipitalis	D femoratus
A mysteca	M eumera	A variegatus	C c crenulata	M neomexicanus
R v viatoria	P excelsus	S fuscovittata	B. nubilum	L Wheeleri
H benjamini	C rehni	O imperfecta	D femoratum	S shoshone
A insolita	C. polingi	E variabilis	D longipennis	D variegatum
	A. arachnopyga	H rufa	B. magna	C. stricticus
	A. semialata	A p crassa	M lahinus	M d. nigricans
	A. g. cerciata	X. c. pantherinus	M o occidentalis	H. rugosus
	T tschivavensis	T formosus	O p. deserta	M f elongatus
Tamaulipan Semi-Desert Bushland	D. oreoeca	T k fuscifrons	C pallidus	
R. victoriae	C carlsbadensis	R capito		Upper Sonoran Humid
A tonkawa	S. chimatiensis n sp	M p corrugatum		S admirabilis?
P nigrovittata		T laticincta		M glaucipes
		T melanoptera		P bruneri
		T magnifica		C c comprehendens
		E virgata	Unknown	Nr crepitans
		H v viridis	C coniceudus	O. c concinnum
	M. arizonae	M desultorius		
	M. regalis	M. thomasi		

3. TRANSITION ZONE

N. Short 2c, 3a, Grasslands F.	Southwestern Mtn. Fauna 3b
A coloradus	L cyaneus
P 4-maculatus	S b inornatum
P d deorum	T aspera
P d delicatula	T cyanipennis
A elliotti	C utahensis
D carolina	M. aridus
T pistrinaria	C. isletae
H trifasciata	P tschivavensis
S lineata	
M gladstoni	
M f r femur-rubr?	
M m mexicanus?	
P nebrascensis	
C f fasciatus	
C pallidus	
L + U Sonoran + Transitional	
G assimilis	

Fig. 23.—A faunistic-floristic transect of Presidio and Jeff Davis counties.

carolina was taken in the Valley but to venture a guess how this transitional species came to be in the Valley would be hazardous.

b. *Desert Mesa.*—The Chihuahuan Desert fauna of the desert mesa has its most interesting Orthoptera in its thamnophilous members mainly dwelling in the creosote bush. The creosote grasshopper, *Bootettix argentatus,* is found everywhere on the creosote bush which characterizes the Chihuahuan Desert. Other inhabitants are the large stick-insect, *Diapheromera covilleae,* the tiny Mogoplistine cricket, *Cycloptilum comprehendens fortior,* and the newly described katydid, *Eremopedes covilleae,* discovered by the writer. Other katydids such as *Eremopedes scudderi, Rehnia cerberus* and the pretty *Dichopetala oreoeca* feed on creosote as well as other plants. A much larger decticid fauna is found on the creosote bush on the Sonoran Desert.

Goniatron planum and *Camplyacantha olivacea vivax* are found on *Flourensia,* the blackbrush, the latter common only in Brewster County. The beautiful spiny-legged *Rehnia cerberus* is found chiefly in mesquite. *Aeoloplus elegans* was found on Four-wing Saltbush, *Atriplex canescens,* its host plant.

Trimerotropis pallidipennis is ubiquitous everywhere on the mesa and the arroyo grasshopper, *Cibolacris parviceps,* prefers the arroyo beds crossing the mesa.

Of truly saxicolous species, those restricted to gravel and sand, the following are noteworthy: *Anconia hebardi, Trimerotropic texana* and *Cibolacris parviceps.* Rarely is the Texas toadhopper, *Phrynotettix robustus,* taken on gravelly ridges on the desert mesa.

Mestobregma terricolor is a rare terricolous species limited to certain adobe hill regions north of Presidio.

Graminiphilous species are rare, if not absent, for practically no grass is to be found on the desert mesa.

c. *The Mexican Lower Sonoran Fauna* is represented by an altitudinal zone ranging from approximately 4200 to 4800 feet in the Chinatis. It is one of the richest and most interesting of the faunae of the entire region and the Southwest. Possibly few mountainous regions of the Southwest would eclipse in interest, variety and abundance, this fauna found in the Chinati Mountains.

This fauna is predominantly Mexican in origin for being situated in the Lower Sonoran Zone, the Chinatis represent the northernmost extension of many Mexican species, while the Davis Mountains show strongest affinities with a more northern fauna. The Chisos range not only contains many of the Chinati species but by their proximity to the Pecos Valley and the Tamaulipan Semi-desert Bushland coming up the coast of the Gulf of Mexico, a strong influx of species from the east is also indicated.

The most characteristic endogenes of this Mexican fauna are the following species: *Zapata brevipennis, Pedioscirtetes maculipennis, Acantherus piperatus, Trimeotropis pistrinaria* (optimum phase), *Clematodes larreae, Netrosoma nigropleura, Phaulotettix eurycercus, Philocleon nigrovittata,* the katydid, *Pediodectes tinkhami,* discovered in 1929, and the small cricket *Haplosphyrum boreale.*

The short gramma grass cover on gravelly spots, which are sometimes found, usually support such species as *Phrynotettix robustus, Dactylotum variegatum* and *P. maculipennis.*

On the hillsides with sparse coverage of *Nolina texana* and *Acacia Roemeriana,* the rare *Zapata brevipennis* occurs and the even rarer *Netrosoma nigropleura.* The females of this latter genus are at least twice the size of the tiny males and have the curious habit of dropping their hind legs when held. The minute males have unusual saltatorial propensities.

The rare *Phaulotettix eurycercus* is sometimes found in the clumps of sotol. *Phaedrotettix dumicola palmeri* and *Agroecotettix modestus* are sometimes taken but they are endogenes of the Mexican Upper Sonoran fauna. On certain hilltops where the soil seems more damp probably due to the presence of the Resurrection plant and its terracing effect, *Trimerotropis pistrinaria* is found. They were found at no other locality than at (1) a valley about two and one half miles south of Shafter. These specimens of optimum size are about twice the size of northern specimens from Montana and Alberta and may represent a southern race. Here also is found *P. maculipennis* while *Mermiria texana* occurs abundantly and ranging upwards through the Mexican Upper Sonoran Zone. *Schistocerca vaga* is more often seen than taken because of its swift sustained flight. Rarer species that are occasionally taken mainly in clumps of desert vegetation include: *Acantherus piperatus, Clematodes larreae* and the infrequent *Pediodectes tinkhami. Rehnia cerberus* is found in mesquite, *Dichopetala oreoeca* on certain vegetation and *Melanoplus aridus* on *Dahlia Parryi.*

Sometimes interesting ectogenes are discovered. On one occasion I took a specimen of *Aulocara elliotti* on a desert hilltop at (1) and sixty miles south of the grasslands on which it is occasionally found. It was rescued from the beak of a large asilid fly. Such records prove the saying that each species is forever striving to extend its range or "striving for its place in the sun." Indeed such species as *T. pistrinaria, P. maculipennis, M. texana, A. piperatus* and *M. aridus* are strange associates. A specimen of *Brachystola magna* also taken here was an interesting ectogene.

Of saxicolous species *Cibolacris parviceps* and *T. texana* (rarely) were found in the gravel beds of Cibolo Arroyo, near Shafter. An interesting ectogene here was *Heliatus benjamini,* a single specimen was the only one found south of the Davis Mountains.

Semi-saxicolous species include the toadhopper *P. robustus, T. p. pallidipennis* and *Platylactista aztecus,* although the latter favors the presence of a little grass.

At higher elevations in tall grass *Syrbula fuscovittata, Opeia imperfecta, Eritettis variabilis* and *Psoloessa texana pusilla* were taken.

In the mountain valleys at about 4500 feet elevation, the beautiful and large *Taeniopoda eques,* shining black in color with bright yellow trimmings and rose-red wings, is found on its host plant, *Trixis californicus,* a small yellow-flowered composite. At this elevation many members of the Upper Sonoran Faunal Zone begin to appear.

B. UPPER SONORAN FAUNAL ZONE

a. *The Mexican Upper Sonoran Fauna* is restricted to a narrow zone of tall grass of steep north slopes at about 5500 feet elevation and is quite limited in nature. East of Arizona, this fauna is known at present only from the Chinati Mountains and efforts to find it in the Chisos failed in October, 1946. Only four members of this fauna are at present known in Texas, namely, *Achurum sumichrasti, Amblytropidea mysteca, Rhammatocerus viatoria viatoria* and *Amblycorypha insolita. Arenivaga grata* probably belongs to this fauna too as Hebard (1943) has just recorded the first Texas specimens from the scrub oak zone in the Chisos. Further search in the Chisos may reveal other members of this fauna present.

The Upper Sonoran Zone, however, attains its greatest development on the grasslands which represent two or possibly three faunae, namely, the Southwestern Grasslands fauna and the Southern Short Grasslands fauna and possibly a third designated here as the Chihuahuan Upper Sonoran fauna.

b. *Southwestern Grasslands Fauna.*—Typical members of this fauna include the following: *Arphia crassa, Xanthippus corallipes pantherinus, Leprus wheeleri* and *L. cyaneus, Trimerotropis melanoptera, T. magnifica, Heliaula rufa, Melanoplus lakinus, M. desultorius, M. regalis, M. arizonae,* and *M. thomasi. Acrolophitus variegatus* is found on stony soil with poor grass cover. *Derotmema h. mesembrinum* occurs on grass covered patches of adobe soil, and in tall grass on hillsides *Mestobregma plattei corrugata* is found. The katydid, *Scudderia furcata furcifera,* is a common member of this fauna. Other species include *Eritettix variabilis,* atypical *Psoloessa texana pusilla,* the handsome *Dissosteira longipennis* and the remarkable *Tropidolophus formosus* with high, serrate-edged pronotal crest, green coloration and orange wings, *Rehnita capito,* and *Hesperotettix v. viridis.*

c. *Southern Short Grasslands Fauna* includes: *Cordillacris o. occipitalis, C. crenulata, Boopedon nubilum, Drepanopterna femoratum, Trimerotropis laticincta, Melanoplus occidentalis, M. differentialis nigricans,* the mantid, *Litaneutria minor,* the lubber, *Brachystola magna,* and the bird-wing locust, *Schistocerca lineata.*

d. *Chihuahuan Upper Sonoran Fauna.*—A few species appear to be restricted to the Upper Sonoran Region of Trans-Pecos Texas and are here designated as Chihuahuan Upper Sonoran. No representatives of this fauna occur in Arizona and hence this fauna is distinct from the Mexican Upper Sonoran fauna. *Melanoplus eumera* and the stick insect *Diapheromera torquata* appear to belong to this fauna. *Ceuthophilus rehni* may also represent this fauna, as well as *C. carlsbadensis,* and *C. polingi.*

Two species *Heliastus benjamini* and *Phrynotettix tschivavensis,* a toad-hopper, do not appear to fall readily in any of the faunae already discussed, although both appear to be endogenes of the Upper Sonoran Region.

C. TRANSITION FAUNAL ZONE (approximately above 6500 feet on northern exposures and 7000 feet on southern exposures)

a. *Northern Short Grasslands Fauna.*—The distribution of members of this fauna are more extensive than those of the Southern Short Grasslands fauna whose composite range extends no further north than the Milk River Valley of extreme southeastern Alberta. On the other hand the composite range of members of the Northern Short Grasslands fauna extends well into the southern portions of the three Canadian prairie provinces of Alberta, Saskatchewan and Manitoba. Members of this fauna consequently appear to have a greater flexibility in life requirements than members of the Southern Short Grasslands fauna and the Southwestern Grasslands fauna for such species as *Hadrotettix trifasciatus* and *Aulocara elliotti* are found in the same habitat as the members of the two last mentioned faunae. In fact one specimen of *A. elliotti* was taken in typical desert habitat of the Lower Sonoran.

Members of this fauna are: *Hadrotettix trifasciatus, Aulocara elliotti, Melanoplus gladstoni, Ageneotettix deorum, Photaliotes nebrascensis, Psoloessa delicatula* and *Philbostroma quadrimaculata.* These are mainly found in grasslands in the Davis Range.

b. *Southwestern Mountain Transition Fauna.*—A fauna peculiar to itself and developed only in the Transition Zone of the mountains of the southwest is here designated as the Southwestern Mountain Transition fauna.

It is represented typically by such species as *Trimerotropis cyaneipennis, Spharagemon bolli inornatum, Trachyrhachis aspera, Ceuthophilus utahensis C. isletae* and *Mermiria neomexicana.* Other species found associated with these are: *Pediodectes bruneri, Schistocerca lineata, Conocephalus strictus* and *Hippiscus rugosus,* an oak-sylvan species in the Davis Range but inhabiting tall grasses in the Chinatis. These four latter species are not true members of this fauna.

The stick insect, *Diapheromera femorata,* probably belongs to this fauna although widespread over the eastern United States at present. Hebard (1943, p. 305) believes that this is an ancient species of this region having spread to its present range in more recent times.

Notes on Collecting Localities

The major portion of the collecting was confined to the Chinati Mountains within a six mile radius of the mining town of Shafter during the years 1928 to 1931. Collections were also made in the Marfa region and the Davis Mountains during this period and also in 1940. Collections were made on the northern slopes of the Chisos in July, 1930, and other additional collections have been in the Davis, Chinati, Dead Horse and Chisos Mountains in October, 1946, when the writer resumed desert studies after return to civilian life.

Reference to the first six numbers as localities in the Chinati Mountains will be found in the text. The remaining numbers are for listing only.

1. A valley 2½ miles south of Shafter on the Shafter-Presidio road. Elevation about 4200 to 4500 feet. Typically Lower Sonoran. Collections were made here on: Sept. 30, Oct. 28, Nov. 8, 1928; July 8, Aug. 4, Sept. 29, Oct. 12, Oct. 19, 1929; March 28, June 15, June 22, June 29, 1930, night of Sept. 22 and Sept. 23, 1931, Oct. 16-19, 1946.

2. Shafter mountain about 1½ miles north of Shafter on the old Shafter-Marfa road. Elevation 5100 to 5500 feet. Sept. 30, 1928.

3. A valley about 5 miles WNW, of Shafter at about 5000 feet and intervening territory collected on: Sept. 9, Sept. 16, Sept. 23, 1929; May 4, June 6, and July 8, 1930, Oct. 19, 1946.

4. The steep north declivity of a plateau cut by a narrow ravine at about 5500 feet elevation 5 miles WNW, of Shafter. Mexican Upper Sonoran fauna discovered here and thoroughly collected on May 4, June 6, and July 8, 1930, Oct. 19, 1946.

5. Elephant Rock, 28 miles north of Presidio on Presidio-Marfa road, collected on Sept. 3, 1928; Sept. 29, 1929 and June 22, 1930.

6. Bunton Flat just north of Elephant Rock. Brief collecting here in Tobosa grass on June 29, 1930, Oct. 20, 1946.

7. Blue Mountain trip from Bunton's Ranch House on Sept. 27, 1931. Intensive collecting during entire day from Cibolo Arroyo at 4200 feet to top of Blue Mountain 5 miles away at 6700 feet altitude.

8. Dawson's ranch and vicinity, 8 miles southeast of Shafter on July 8, 1929.

9. A grassy gulch collected on June 22, 1930 about 36 miles north of Presidio on Marfa road.

10. Bofecillo Mountains, 20 miles east of Presidio on July 4, 1929.

11. Grasslands at 5500 feet elevation at head of Pinto Canyon, in northwestern portions of Chinatis on June 8, 1930.

12. Marfa, Texas, collections on 4-5 Oct. 1929 and June 22, 1930.

13. About 8 miles south of Marfa, collected June 22 and 29, 1930.

14. About 6 miles east of Marfa on poor stony soil with sparse grass cover, collected on June 22, 1930 and Aug. 13, 1940. *Acrolophitus variegatus* taken here in 1930.

15. About 6-10 miles west of Marfa, collected Aug. 13, 1940 and Oct. 30, 1946.

16. Paisano Pass region, elev. 5200 feet or more, half way between Marfa and Alpine. Collected Oct. 8, 1928, June 23 and 29, 1929 and June 22 and 29, 1930; also Oct. 29, 1946.

17. Near south base of Davis Mts., northwest of Marfa. Collections made with Mr. F. F. Bibby on Oct. 22, 1928. Also Sept. 28, 1931.

18. Lower Limpia Canyon, McCutcheon's Ranch, Oct. 5, 1929, Oct. 12, 1946.

19. Upper Limpia Canyon near Prude's Ranch, Oct. 6, 1929, Oct. 13, 1946.

20. Pine covered mountain slopes about 3 miles NNE, of Mt. Livermore on the Perkin's ranch near present McDonald Observatory. Oct. 6, 1929. Elevation about 6500 feet or more.

21. An intensive day's collecting by the writer and his brother on the south slopes of Mt. Livermore on the Cox's Ranch from elevations of 6000 to 8000 feet, Sept. 29, 1931.

22. North side of Davis Range, 8 miles east of Kent, Sept. 14, 1940.

23. North slopes of Davis Range, 6 miles SW, of Toyahvale, collected on Sept. 13-14, 1940.

24. West base of Mt. Emory, Chisos Mts., near Wilson's Ranch, July 17, 1930.

25. Wadi Burnham's Ranch House, now Government Springs, north side of Lost Mines Peak, Chisos Mts., July 16, 18, 1930, Oct. 28, 1946.

26. Desert 20 miles north of Chisos on Marathon Road, July 18, 1930. Type locality of *Eremopedes covilleae* Hebard. Also Oct. 23, 1946.

27. 17 miles east of Marathon, collected on Aug. 14, 1940.

28. 5 miles east of Sanderson, collected on Aug. 14, 1940.

29. 8 miles east of Van Horn, collected Oct. 23, 1943.

30. Mouth of Lower Limpia Canyon, 20 miles SW, of Balmorrhea, 12 Oct. 1946.

31. 10 miles north of Marfa in community of *Flourensia cernua*, collected Oct. 13, 1946.

32. 1 mile north of Bunton Flat in *Flourensia* community, collected Oct. 21, 1946.

33. 3 miles east of Alpine on small rocky knoll covered with *Acacia greggii*, collected 22 and 29 Oct. 1946.

34. 20 miles south of Marathon in tall grass around a roadside spring, Oct. 22, 1946.

35. Persimmon Gap region, 44 miles south of Marathon in the Santiago Mts., collected Oct. 22, 23, 1946.

36. Cooper's Store, 45 miles south of Marathon on north edge of Big Bend Park, collected Oct. 23, 28, 29, 1946.

37. Dead Horse Mts., several miles east of Cooper's Store, collected Oct. 24, 1946.

38. Green Gulch, 3 miles south of Gov't Springs, Chisos Mts., collected Oct. 25, 1946.

39. Pass at top of Green Gulch en route to Chisos Basin, collected Oct. 25, 1946.

40. South Base of Pulliam Bluff, Chisos Basin, collected Oct. 26, 1946. Elevation ranging from 6000 to 7000 feet.

41. Chisos Basin, collected Oct. 27, 1946.

42. Hillside, 5 miles south of Chisos-Boquillas road junction, Oct. 28, 1946.

43. Creosote-leucophyllum mesa, 5 miles north of Hot Springs, Oct. 28, 1946.

44. 10 miles west of Valentine, collected Oct. 30, 1946.

ACKNOWLEDGMENTS

To the late and lamented Mr. Morgan Hebard, dean of American orthopterists and for many years associated with the Academy of Natural Sciences of Philadelphia, the writer owes a great debt of gratitude, not only for his prompt and courtecus determinations of Orthoptera collected in the Big Bend Region, but also for his kind assistance which enabled the author to make two extensive expeditions throughout the Southwest in 1930 and 1931. This expedition work in New Mexico, Arizona, Utah, Nevada and California gave the writer an invaluable comprehension of the orthopteran fauna of the great Southwest and this knowledge augmented by two full years of collecting in Trans-Pecos Texas and exploratory work with Dr. Forrest Shreve on the deserts of northeastern Mexico, in 1940 and further studies in the fall of 1946, has been indispensable in the preparation of this study on the flora and orthopteran fauna of the Big Bend Region of Trans-Pecos Texas.

Thanks are also due Mr. James A. G. Rehn, Curator of Orthoptera at the Academy of Natural Sciences of Philadelphia and for many years intimately associated in work with Mr. Morgan Hebard, for his kind determination of certain groups of material. The writer also wishes to thank Dr. A. B. Gurney for the identification of certain specimens.

The writer wishes to express thanks to Mr. F. F. Bibby, formerly of the Texas State Division of Entomology for great stimulation given during the early phases of this work. Gratitude is also expressed to Dr. V. L. Cory for the identification of certain plants of the region and to Dr. F. L. Thomas, Chief, Texas State Division of Entomology for his continued interest in this work. To my former Boy Scouts, who have aided in the capture of many rarities, many thanks are tendered.

Last, but not least, the writer owes a deep personal debt to Professor Wm. E. Hoffman, Director of the Lingnan Natural History Survey and Museum, Lingnan University, Canton, China, not only for giving me much valuable time to prepare this manuscript, but out of his own busy life took time to correct the original manuscript

and aided immeasurably to direct and formulate the formative years of the writer. For these gracious services the writer wishes his manuscript to be considered a Contribution from the Lingnan Natural History Survey and Museum.

Glossary of Terms

acute—sharply pointed.
annuli—small dots or rings.
antennae—paired, thread-like appendage attached near the eyes and of varying lengths.
apex—tip.
apterous—without vestige of wings.
arboreal—dwelling in trees.
arcuate—arched or bowed in outline.
arenicolous—dwelling in sandy areas.
bifurcate—forked.
brachypterous—having small or rudimentary wings unfit for flight.
cactophilous—living in clumps of cacti.
calcariae—large curved spurs situated at the internal apex of the hind tibiae.
campestrian—dwelling in grasses or meadows.
carina—a keel or ridge usually on the pronotum.
carinate—provided with a carina or carinae.
caudal—referring to posterior part of the body.
cercus—one of a paired appendage usually of small size found on the genitalia of Orthoptera and usually situated just below the supra-anal plate.
cespitose—low creeping habit of certain plants.
concolorous—of the same general color.
crenulate—of wavy outline.
cristate—raised into a crest.
cursorial—legs adapted for running.
deserticolous—dwelling in the desert.
deserto-campestrian—living in a desert type of sparse grasses.
detritus—living in or under vegetational debris collected around plants on the edges of washes or arroyos.
dimorphic—having two forms.
domiciliary—living in houses.
ectogene—a species found outside its zone of optimum abundance.
ecotone—an area where two vegetational types merge together.
edaphic—referring to soil or type of soil.
endogene—a species found within its zone of optimum abundance.
ensiform—sword-shaped; referring to the form of the antennae.
fastigium—that pointed or rounded portion of the vertex projecting in front of the eyes of orthopterans.
fauna—a group of animal species having the same general life habits, dwelling in the same general area under the same climatic conditions, and possessing the same general geographic distribution.
fasciae—transverse bands crossing the wings or legs.
filiform—thread-like or of equal diameter, referring to antennae.
foveolae—a pit or shallow depression on the fastigium of grasshoppers and usually referred to as the lateral foveolae of the fastigium or vertex.
frontal costa—a prominent vertical ridge in grasshoppers running from the fastigium down between the bases of the antennae to the lower portions of the face.
genitalia—the mating organs.
habitat—the place inhabited by an insect or the type of locality where a species is captured.
macropterous—large-winged, usually referred to brachypterous species.
megacephalic—big-headed or head larger than normal.
metazona—posterior portion of the pronotum behind the median sulcus.
nacreous—mother-of-pearl coloration.

Nearctic—pertaining to the fauna of temperate and arctic North America.
oedipodine—a member of the Oedipodinae or band-winged grasshoppers.
ovate—oval or somewhat circular in outline.
pronotum—the collar-like structure behind the head of orthopterans.
prozona—the anterior portion of the pronotum in front of the median sulcus.
prosternal spine—a cone or heavy spine situated between the forelegs of certain groups of grasshoppers.
raptorial—legs adapted for grasping prey.
retrorse—bent backwards, referring to the prosternal spine.
rugose—with raised ridges or wrinkled.
saltatorial—referring to legs adapted for jumping.
saxi-arenicolous—rocky and sandy areas of arroyos.
saxi-campestrian—inhabiting gravelly grass areas.
saxicolous—dwelling in gravelly or stony areas or habitats.
sellate—saddle-shaped, referring to the pronotum.
serrate—like the teeth on a saw in general appearance.
spiracle—a breathing pore through which air enters or leaves the body of insects by means of the tracheae or air-tubes.
stridulation—the sound produced by certain orthopterans to attract the opposite sex of the species.
subgenital—the plate underlying the genitalia.
sulcate—grooved.
sulcus—a groove or crease.
supra-anal—the triangularly-shaped plate lying above the genitalia.
sylvan—a species living on the leafy floor of a forest.
tarsus—the foot or jointed appendage attached to the apex of the tibia and bearing claws or ungues and pad or pulvillus at its end.
tectate—roof-like.
tegmina—the narrow thickened first pair of wings that protect the flying wings in Orthoptera (singular-tegmen).
terricolous—dwelling on bare earthen areas.
thamnophilous—dwelling in shrubs or bushes.
troglodytic—dwelling in caves or burrows of rodents.
truncate—cut off squarely or obliquely at the tip.
vertex—top of the head between the eyes.

Detailed Faunistic and Ecological Studies on the Big Bend Orthoptera

KEY TO THE FAMILIES OF ORTHOPTERA OF TRANS-PECOS TEXAS

1. Hind legs constructed for jumping ..... **Saltatorial Orthoptera** 2
   Hind legs constructed for running or walking ..... **Cursorial Orthoptera** 6
2. Completely apterous, body humped—Camel crickets ..... GRYLLACRIDIDAE
   Winged, although tegmina and wings often abbreviate 3
3. Tarsi three-segmented 4
   Tarsi four-segmented, antennae longer than the body ..... TETTIGONIIDAE
4. Pronotum extending to the apex of the abdomen ..... TETRIGIDAE
   Pronotum normal, not extending to apex 5
5. Antennae shorter than the body—Grasshoppers ..... ACRIDIDAE
   Antennae longer than the body—Crickets ..... GRYLLULIDAE
6. Body ovalish in outline, depressed, pronotum shield-like and covering the head; wings present in males, often absent in females; legs compressed and spiny; cerci jointed; rapidly running insects—Cockroaches ..... BLATTIDAE
   Body elongate, head free; pronotum narrow and elongated; legs slender; walking

insects 7
7. Forelegs raptorial, fitted for grasping; cerci jointed ..... MANTEIDAE
Forelegs simple, cerci without joints, Stick insects ..... PHASMIDAE

The BLATTIDAE

Despite their very great antiquity which dates back to Devonian times, the Blattidae or cockroaches appear be be quite capable of taking care of themselves for many domiciliary species have spread all over the civilized world. A study of the distribution of such species as *Blatta orientalis*, the Oriental roach, would reveal much concerning the fascinating old trade routes of the world. The desert inhabiting species of the subfamily Polyphaginae are interesting creatures but the domiciliary ones are rather disgusting at best.

KEY TO THE MALES OF TRANS-PECOS BLATTIDAE

1. Size large, dark brown in color ..... *Periplaneta americana*
Size medium to small 2
2. Size medium, usually pale gray in coloration, female wingless 3
Size small, usually tan in coloration, females winged 4
3. Body and wings soft gray; tegmina pale, minutely dappled with dark gray along certain veins ..... *Arenivaga erratica*
Body and wings pale brownish gray, tegmina almost transparent ..... *Eremoblatta subdiaphana*
Size larger, almost one inch long; body reddish brown, pronotum dark with pale anterior margin ..... *Arenivaga grata*
4. Uniformly tan in coloration ..... *Parcoblatta desertae*
Two black bands longitudinally on pronotum ..... *Blatella germanica*
Pronotum dark in center with transparent margin; tegmina with pale cross-streak in basal third ..... *Supella supellectilium*

BLATTINAE

BLATTELLA GERMANICA (Linnaeus)

The German cockroach is a cosmopolitan species that is a pest in the Valley.

PARCOBLATTA DESERTAE Rehn and Hebard

Presidio, 5, V, 30, 1 ♂ (taken from Pink Bollworm hibernation tray).

This very small species, represented by a single male, was described from Valverde County and recorded from Ft. Davis and the Chisos Mountains by Hebard, in 1917. The Presidio specimen appears to represent the southwestern distributional point of this species. Mr. J. H. Russell, who has been for many years stationed with the Customs Service at Presidio, has taken a few additional specimens at light.

SUPELLA SUPELLECTILIUM (Serville)

Presidio, Oct. 1946 (infesting houses).

Within the past fifteen years this small Sudanese roach has spread all over the southern portions of the United States. It was found first in Arizona, in 1933, and spread from there into California although the initial introduction was probably through New Orleans. It was definitely not present at Presidio,

Balmorrhea, Jeff Davis Co., 12, X, 46, 1 ♂. Chisos Bason, south base Pulliam Bluff, elev. 6000 ft., 25, X, 46, 1, ♀.

Synonyms: Melanoplus phoetaliotiformis Sc., *M. autumnalis, M. harrisii* Morse, *M. sanguineocephalis* (La Munyon), *M. volucris* (Dodge).

This interesting species, known as the "Red-nosed Grasshopper" has an extensive distribution over the Great Plains. Its range extends from southern Alberta to northern Texas and east of the Rockies to eastern Minnesota, western Indiana and Illinois south through central Kansas and Oklahoma to Dallas, Texas, thence through New Mexico to southeastern Arizona and the Big Bend of Texas. In Mexico it is found south to Vera Cruz and Districto Federal. Its unusual form and shape and its variability with occasional cases of macropterism, largely accounts for the many synonyms that exist today. It is an uncommon species in the Big Bend and is encountered most frequently in the higher grasslands of the Davis Range. Its distribution appears to be mainly Transition in extent.

DACTYLOTUM VARIEGATUM Scudder

Shafter Mt., near Shafter, Presidio Co., 30, IX, 28, 9 ♂♂, 3 ♀♀. Chinati Mts., 8, IX, 29, 1 ♂; 16, IX, 29, 3 ♂♂; 23, IX, 29, 2 ♂♂, 7 ♀♀; 6, VII, 30, 1 ♀. North base of Blue Mt., Chinati Mts., (7), 27, IX, 31, 2 ♂♂, 1 ♀; 6 ♂♂ (Univ. of Minn. Cln.). Marathon, Brewster Co., Texas, Aug. 26-27, 1913, 2 ♀♀ (Rehn and Hebard; 3940-4160 feet elev.). 20 miles southwest of Balmorrhea, Jeff Davis Co., 12, X, 46, 1 ♂. 10 miles north of Marfa, Presidio Co., 13, X, 46, 1 ♂. 1 mile north of Bunton Flat, 29 miles n. of Presidio, 22, X, 46, 2 ♂♂. 3 miles east of Alpine, 22. X, 46, 2 ♂♂, 1 ♀. Dead Horse Mts., Brewster Co., 24, X, 46, 1 ♂ (rare). Chisos Basin, south base Pulliam Bluff, elev. 6000 ft., 25, X, 46, 3 ♂♂, 1 ♀ (rare).

Few acridids anywhere will surpass the beauty of this species which has been called the "Rainbow Grasshopper," the "Barberpole" and the "Colonel." Only *Taeniopoda eques* (Burm.) in its striking black colors with gold braid and rose wings approaches it in coloration. *D. variegatum* is, however, more regally robed in its royal purple washed with yellow and orange red and it cannot be mistaken for any other species in the Southwest. It has a northern relative *D. pictum* which is found only on the Great Plains.

The distribution of *D. variegatum* is at present poorly defined. It ranges from the Big Bend Region to Arizona where it is found west to the Baboquivari Mts. and north to the Sierra Anchas. In Mexico it is found in northern Sonoran and south to Casa Grande in Chihuahua. In its habitat preferences *variegatum* seems to occupy the ecotonic area between the Lower and Upper Sonoran Zones as it does not occur in the oak zone itself or out on the desert proper. Hence it is not typically Lower or Upper Sonoran.

The TETTIGONIIDAE

The members of the Tettigoniidae are a composite group of orthopterans known as katydids. The Phanerotropinae and Pseudophyllinae are the green leaflike katydids in which the female ovipositor is very short and strongly recurved with its margins serrate with teeth. This ovipositor is used to lay the flat oval eggs along the margins of leaves. The Decticinae have long or gently decurved or recurved sword-like ovipositors and their tegmina are very abbre-

viated although a few genera are fully winged. The green "Cone-headed Katydids" include the Copiphorinae of large size and the Conocephalinae of small size. Both these subfamilies have long straight or gently recurved ovipositors and the eggs are laid singly in the ground. Members of the decticid genera *Anabrus* and *Peranabrus* are very destructive in the northwestern states but Trans-Pecos Texas has no injurious members.

KEY TO THE SUBFAMILIES OF THE TETTIGONIIDAE OF TRANS-PECOS TEXAS

1. First two tarsal segments without lateral grooves; male subgenital plate produced caudad 2
   First two tarsal segments with lateral grooves; male subgenital plate small 3
2. Ovipositor abruptly recurved with margins serrate or toothed; tegmina usually long and slender (although abbreviate in *Dichopetala*) and not enclosing the abdomen; male subgenital plate produced briefly caudad and often recurved ..... PHANEROTROPINAE
   Ovipositor sword-like and gently recurved; tegmina large and enclosing the entire body; male subgenital plate straight and lengthily produced caudad ..... PSEUDOPHYLLINAE
3. Pronotum small; tegmina usually long and linear; fore tibiae spineless on the upper surface 4
   Pronotum large and broad, forming a shield protecting the base of the tegmina which are usually small brachypterous trilling pads, although fully winged in *Capnobotes;* fore tibiae with a short spine or spines on the dorsal surface ..... DECTICINAE
4. Vertex produced forward into a long or rounded cone broadest at the base; fore and middle legs spined beneath; size large ..... COPIPHORINAE
   Vertex terminating in a rounded tubercle, the base narrower than the middle; fore and middle legs not spined below; size small ..... CONOCEPHALINAE

PHANEROTROPINAE

This is the largest subfamily of katydids in southwestern Texas. With the exception of *Dichopetala* all are long-winged and in form closely resembling leaves in outline. The general color is green or grayish green and the size range is from small to medium large. The ova are oval in outline and flat and laid along or in the margins of leaves.

KEY TO THE GENERA OF THE PHANEROTROPINAE OF TRANS-PECOS TEXAS

1. Species of small size and long slender legs; tegmina and wings represented by small trilling pads ..... *Dichopetala* Bruner
   Species with tegmina well developed and elongate 2
2. Size small and body slender; legs very slender and tegmina long and uniformly narrow 3
   Size large and more robust; legs not as slender and tegmina long, usually broadened in the middle and tapering to a rounded apex 4
3. Species exceptionally slender; hind legs very long, delicate and slender; tegmina usually long and slender and surpassed by the wings to a variable extent; body color usually grayish green; tegmina and wings in females often abbreviate in certain species ..... *Arethaea* Stål
   Species not as slenderly built; tegmina and wings equally as long in females as in males and far surpassing apex of the abdomen; legs not exceptionally slender; tegmina usually barred with whitish diagonal stripes on greenish background; size small ..... *Insara* Walker

4. Tegmina distinctly broadened in the middle; vertex much broader than the first antennal segment 5

Tegmina long and nearly equal in breadth throughout; vertex of about the same width as the first antennal segment ..... *Scudderia* Stål

5. Caudal femora much shorter than the length of the tegmina; female ovipositor short and abruptly turned upwards; size moderately large and form leaf-like ..... *Microcentrum* Scudder

Caudal femora about the length of the tegmina; female ovipositor long, sword-like and gently recurved; size moderately large ..... *Amblycorypha* Stål

DICHOPETALA Brunner

In 1914, Rehn and Hebard monographed this genus then describing *oreoeca* as a new species from the Big Bend Region. Fourteen species were discussed; the genus finding its optimum development in western Texas and central Mexico where many species are found. Of the Texas species only *oreoeca* Rehn and Hebard and *brevihastata* Morse are indigenous to the Big Bend Region.

The males of this interesting genus resemble more closely decticids than phanerotropids, but the females have the ovipositor sharply recurved and the margins serrate with teeth. The genera body color is shining reddish brown or greenish with a dorso-lateral stripe of white edged with orange or red running the length of the body. The legs and antennae are very long and slender.

DICHOPETALA OREOECA Rehn and Hebard

Shafter Mt. 2 miles north of Shafter, 30, IX, 28, 3 ♂♂, 2 ♀♀ (elev. c. 5200 feet). Maguire Ranch, Upper Limpia Canyon, Davis Mts., 6, X, 1929, 1 ♀ (M. Hebard; Tinkham Cln.). Wilson's Ranch, west base of Mt. Emory, Chisos Mts., 17, VII, 30, 1 ♂, 1 ♀ nymph (elev. c. 5000 feet.). Cox's Ranch, south slope of Mt. Livermore, Davis Mts., 29, IX, 31, 2 ♀♀ (*Opuntia arborescens*).

The canyon behind Pulliam Bluff, Chisos Mts., at elevations from 4600 to 5000 feet is the type locality of the male and the female type is from Moss Well in the Chisos.

Rehn and Hebard state that *oreoeca* ranges from 3900 to 6500 feet in elevation. In the Chinatis it was found from about 4200 to 5500 feet. Aside from the Chinati, Chisos and Davis Mountains it is known from Montelovez, Coahuila, Mexico. *D. oreoeca* is a member of the Chihuahuan Upper Sonoran fauna.

DICHOPETALA BREVIHASTATA Morse

30 miles north of the Chisos Mts., 18, VII, 30, 4 ♂♂, 2 ♀♀ (Hebard Cln.).

Hebard has designated the College Campus, Mesilla Park, New Mexico as the male type locality and Riley's Ranch, Mesilla Valley, Dona Ana County, New Mexico, as the allotype or female type locality. This is the widest ranging species of the genus being known from Baboquivari and Santa Catalina Mountains of southeastern Arizona east through Trans-Pecos Texas to San Patricia County, Texas and south to Jaral, in southern Coahuila, Mexico.

Brevihastata does not occur in the mountains of Trans-Pecos Texas accord-

ing to Hebard. The specimens recorded here were taken on the creosote-covered mesa of the desert thirty miles north of the Chisos Mountains. These specimens were mating in bright sunlight near noon on a hot summer day. *Brevihastata* appears to be a member of the Chihuahuan Lower Sonoran fauna.

ARETHAEA SEMIALATA Rehn and Hebard

Presidio, 30, XI, 28, 2 ♂♂. Shafter Mountain, 2 miles north of Shafter, 30, IX, 28, 2 ♂♂, 2 ♀♀ (elev. c. 5200 feet).

This species is easily recognized by its uniformly pale grayish green coloration suffused with pinkish along the sides of the abdomen. The antennae and legs are very long and slender and the tegmina narrow and long in the male but much abbreviated in the female. The song of this species is a sort of fluttering waver closely similar to the sound produced by running into the wind with a wide thin band of golf ball rubber.

Rehn and Hebard described this species in 1914 from Garden Spring and Moss Well in the Chisos. It has been found throughout the Chisos and Chinati and Davis Mountains west to the Franklin Mountains near El Paso and Mesilla Valley near the Organ Mountains in New Mexico which represent the northwestern limits of distribution. The species is unrecorded from Mexico but undoubtedly exists in northeastern Mexico. *A. semialata* appears to be a member of the Chihuahuan Upper Sonoran fauna.

ARETHAEA ARACHNOPYGA Rehn and Hebard

Rehn and Hebard described this species in 1914 from the Ord Mountains in Brewster County, Trans-Pecos Texas. Marathon in Brewster County is the type locality of this species which is known from Marathon, the Ord Mountains and Monclova, Coahuila, Mexico. No specimens of this species were taken by the writer.

A. arachnopyga appears to be a member of the Chihuahuan Upper Sonoran fauna.

§ ARETHAEA GRACILIPES CERCIATA Hebard

Shafter Mountain, 2 miles north of Shafter, Texas, 30, IX, 28, 1 ♀ (allotype; Hebard Cln.; elev. about 5200 feet).

This subspecies was described by Hebard, in 1936, in his *Revision of the Genus Arethaea.* The allotype female was taken as indicated above by the writer and the male holotype was discovered by Rehn and Hebard in the canyon behind Pulliam Bluff, Chisos Mountains on September 7, 1912, at elevations between 4600 and 5000 feet.

Cerciata is the southeastern race of *gracilipes gracilipes* which occurs in the Panhandle of Texas, western Oklahoma, southern Colorado and New Mexico. It is the rarest of the species of *Arethaea* in Trans-Pecos Texas and larger than the nominal race *gracilipes.* Both sexes have long narrow tegmina surpassed by the wings by eight to ten millimeters.

Cerciata is known only from the Chinati and Chisos Mountains and appears to be a member of the Chihuahuan Upper Sonoran fauna.

INSARA ELEGANS ELEGANS (Scudder)

Candeleria, Presidio County, 27, IX, 28, 1 ♀. Ruidoso Hot Springs, Presidio County, 17, X, 28, 1 ♂ (*Larrea divaricata*). Presidio, 28, VIII, 39, 1 ♀ (at light); 15, IX, 29, 1 ♀ (cottonfields); 18, V, 30, 1 ♀ (at light).

Hormilia is a synonym of *Insara*.

This slender species is light green (sometimes pale brown) in color with a few short diagonal lines on the tegmina. The tegmina and wings are of the same length in both sexes and the wings are of tissue paper transparency.

Elegans, the nominal race, ranges from Trans-Pecos Texas west to western Arizona where in the extreme western desert portions it is replaced by *Insara elegans conseutipes* (Scudder). *I. elegans elegans* is a member of the Lower Sonoran fauna.

SCUDDERIA FURCATA FURCIFERA Scudder

Adobes, Presidio County, 27, IX, 28, 1 ♀. Chinati Mts., (7), 27, IX, 31, 2 ♂♂, 2 ♀♀ (fairly common at elevations from 4500 to 5000 feet). Cox's Ranch, south base of Mt. Livermore, Davis Range, 29, IX, 31, 1 ♂.

Spiloeris maculatus Rehn and Cockerell, is a synonym.

This species is commoner than the records would suggest as it is fairly common in the cotton fields of the Rio Grande Valley. It was fairly common at elevations of 4500 to 5000 feet on the northern slopes of the Chinatis in late September of 1931, where it was most frequently found in clumps of Sacahuiste or Bear Grass (*Nolina*).

From southwestern Texas *Scudderia f. furcifera* ranges to the Pacific and north to Caliente, Nevada and Colorado and south in Mexico to Tamaulipas, Vera Cruz and Oaxaca. This species appears to be a member of the Lower and Upper Sonoran fauna.

AMBLYCORYPHA Stål

In this handsome genus of katydids the female is easily recognized by the long and gently recurved ovipositor which distinguishes it from the short recurved ovipositor of *Scudderia* and *Microcentrum*. Two species occur in Trans-Pecos Texas, *insolita* and *huasteca,* the former recognized by its larger size and pink spots (male) and yellow spots (female) on the green tegmina.

AMBLYCORYPHA HUASTECA (Saussure)

Indio, Presidio Co., 29, IX, 28, 1 ♂ (*Prosopis pubescens*). 9 miles west of Marathon, Brewster Co., 3 ♂♂ (males common at night singing in low bushes of *Microrhamnus*).

Scudder's *Phylloptera caudata* is a synonym.

The records appear to indicate that this species is mainly Upper Sonoran for on the Marathon grasslands it was quite common at night singing in the scattered low clumps of *Microrhamnus* bushes. The song was a peculiar ticking sound like *t-t-t-t-t-tk* repeated over and over again at spaced intervals of time. The song is quite distinct from *A. insolita* which is similar but more fluttering in note.

According to Hebard (1931a) this species finds its northernmost limit of

distribution in Marshall County of northeastern Kansas. Eastern limits of its range are eastern Kansas and Oklahoma, Dallas and Galveston, Texas, thence ranging west to Clarendon, Kertville and Uvalde, Texas. The Marathon and Indio records appear to be the first for Trans-Pecos Texas and Indio marks its southwestern limit of distribution in the United States. In Mexico it has been taken south to Tampico. *A. huasteca* is a member of the more humid section of the Lower Sonoran.

AMBLYCORYPHA INSOLITA Rehn and Hebard

Shafter Mt., 2 miles north of Shafter, Chinati Mts., 30, IX, 28, 5 ♂♂, 4 ♀♀ (singing on *Trixis californicus* in sun at about 5500 feet elev.). Chinati Mts., (3), 16, IX, 29, 1 ♂ (north base perpendicular cliff at 5400'). Cibolo Arroyo banks, 2 miles above Shafter, 16, IX, 29, 1 ♂ (Scout Lloyd Johnson; on *T. californicus*). Wilson's Ranch, west base Chisos Mts., 17, VII, 30, 1 ♀ (violet colored). 30 miles south of Marathon, Brewster Co., 18, VII, 30, 1 ♂ (Hebard Cln.). Six miles southwest Toyahvale, Davis Mts., Jeff Davis Co., 13, IX, 40, 3 ♂♂, 4 ♀♀ (night collecting on *T. californicus*). Nine miles north of Shafter, 13, X, 46, 2 ♂♂ (night collecting).

This handsome and rare species which was described in 1914, is the largest species of the genus. The principal host plant in the Chinati and Davis Mountains appears to be *Trixis californicus* although north of Shafter it was singing at night in a species of *Baccharis* growing along the edge of an arroyo. At the west base of Mt. Emory, near Wilson's Ranch, Chisos Mountains, the writer heard the males singing from plants growing on the perpendicular rock cliffs several hundreds of feet above the base. Whenever a cloud passed over the sun during the afternoon of July 17, 1930, these fluttering troubadours would burst forth in a chorus of song. On Shafter Mountain they were singing about 5 p.m. in the direct rays of the setting sun. The song of *A. insolita* is a sort of fluttering *shk-shk-shk-shk-shk* repeated at spaced intervals.

Insolita is known from the Chinati, Chisos and Davis Mountains of the Big Bend Region and from the Baboquivari, Santa Catalina and Pinal Mountains and Oak Creek Canyon in Arizona, although in that state it is very rare. *Amblycorypha insolita* is a member of the Mexican Upper Sonoran fauna whose distribution is similar to that already discussed under *Amblytropidea mysteca, Achurum sumichrasti, Rhammatocerus v. viatoria* and *Arenivaga grata.*

MICROCENTRUM RHOMBIFOLIUM (Saussure)

El Paso, Texas, 18, IX, 31, 1 ♂ (at light).

This large beautiful green species is easily recognized by the leaf-like appearance of the tegmina which are much widened in the central portions, and by the male subgenital plate being only moderately extended caudally as a flat plat. In *Scudderia* and *Amblycorypha* the subgenital plate is recurved.

This arboreal species is found throughout the Southwest wherever cottonwoods occur and it should be found dwelling in cottonwood groves along the Rio Grande near Presidio. It is also found on willows and other plants.

Microcentrum rhombifolium ranges across the southern United States north to Utah, Colorado and Kansas and south in Mexico to Sinaloa and Morelos.

PSEUDOPHYLLINAE

The Pseudophyllinae, the leaf-winged katydids, as their name indicates, have few representatives in the United States. In the tropical regions of the Old and New World there are many remarkable members of this subfamily, some of which are among the largest of orthopterans. The presence of a member of the Pseudophyllinae in the Chisos Mountains, the newly recognized genus *Paracyrtophyllus* Hebard, 1941, not only attests to the remarkable orthopteran fauna of the Big Bend Region, but further indicates considerable antiquity to that range at a time when the Southwest was humid rather than arid.

PARACYRTOPHYLLUS EXCELSUS (Rehn and Hebard)

Chisos Basin, Chisos Mts., 26, X, 46, 1 ♂ (night collecting; "quonking" in pine).

This handsome green katydid, belonging to the group Pterophyllae, was described by Rehn and Hebard, in 1914, from the Chisos Mountains. Moss Well at the foot of Pulliam Bluff at elevations of 4700 to 5000 feet is the type locality. There they found it common in the low scattered oaks (*Quercus Emoryi*) on the mountain sides.

A strong down-draft wind was blowing from the Chisos Basin to Window Rock, at nightfall of October 26, 1946, when I heard a faint sound which I thought was a wood-boring larva gnawing away close by. Taking my flashlight, I started down a steep narrow canyon in search following the sound, and to my surprise discovered that it became louder and louder. Presently when I heard the loud penetrating *quonk—quonk—quonk* my pulse quickened for I

Fig. 35.—The Chisos Quonker, *Paracyrtophyllus excellus*, in a typical pose on a branch of the gray oak, *Quercus grisea*.

realized then it was the Chisos leaf katydid which I especially desired. Creeping forward quietly I finally spotted my first *Paracyrtophyllus* "quonking" away on a limb of a pine tree and fully one hundred yards from camp. I returned to camp and later with the aid of an electric spot-light lantern held by my wife, I managed somehow to maintain a precarious balance in the top of an oak long enough to capture my prize. The photograph will explain far better than words the features of this large katydid known only from the Chisos Mts. The greatly elongated subgenital plate is observed projecting beyond the apex of the tegmina. The nights in the Chisos Basin were getting cold at this time of year and this male was undoubtedly the last of that season's population. The writer spent several hours in night collecting on October 25 but not a single katydid was heard.

Whether *P. excelsus* occurs at high elevations on Chinati Peak remains to be discovered. The species, however, undoubtedly occurs in the lofty San Carlos Sierras, some fifty miles to the south in Chihuahua.

P. excelsus appears to be a member of the Chihuahuan Upper Sonoran fauna.

COPIPHORINAE

The cone-headed katydids of the subfamily Copiphorinae are large grass-inhabiting species commonest in areas where the grass grows tall and rank. They are recognized by their large size, usually green or gray coloration and by the cone-like fastigium that projects forward from between their eyes. In the United States quite a few species are represented in the southeastern states and Florida and many handsome species flourish in subtropical and tropical regions for this subfamily is tropicopolitan.

NEOCONOCEPHALUS ROBUSTUS CREPITANS Scudder

10 miles west of Marathon, Brewster Co., 21 Oct. 1946, 1 ♂ (singing by roadside in Johnson grass; male minus hind legs when captured).

This species is slightly larger and bears a longer fastigial cone than *Neoconocephalus triops* commonly found on the Sonoran Desert in Arizona and the Southwest. Despite the handicap of the loss of both hind legs this male was endeavoring to carry on the functions of the species and its song could be heard well over a distance of 100 yards.

This is the first record of this species for Trans-Pecos Texas as previously Cisco, Texas, marked its southwestern limit of distribution. Thus the Marathon record is an extension southwestward of approximately 375 miles in the range. *N. r. crepitans* is known from Sedan and White Bear Lake, Minnesota, to Cold Springs, New Jersey and south to Hastings, Florida; its western limits being Lincoln, Nebraska; Ellis, Finney and Morton counties, Kansas; Perkins and Mt. Sheridan, Oklahoma and Clarendon and Cisco, Texas. It is an inhabitant of the Upper Sonoran (humid) Zone.

As *Neoconocephalus triops* (Linn.) has an extensive distribution in the desert regions of the Southwest and is recorded by Hebard, 1932b, from Tampico, Tamaulipas and other Mexican states, it may eventually be found in the Big Bend Region.

CONOCEPHALINAE

The Conocephalinae are quite similar in general appearance to the cone-headed katydids but are much smaller in size. They have a world-wide distribution and are chiefly represented by the genera *Orchelimum* and *Conocephalus*. There are many species found in the eastern United States but few in the arid southwest.

ORCHELIMUM CONCINNUM CONCINNUM Scudder

Mouth of Lower Limpia Canyon, 20 miles SW. of Balmorrhea, 12 Oct. 1946, 1 ♂ (singing in bright sunlight on *Baccharis glutinosa* by edge of stream). 12 miles south of Marathon, Brewster Co., 22 Oct. 1946, 1 ♂ (in very tall goldenrod growing in wet ground near a roadside spring).

The genus *Orchelimum* averages slightly larger in size than *Conocephalus* and is recognized by the upcurved instead of straight ovipositor of the female and the cylindrical prosternal spines which in *Conocephalus* are very short or wanting.

The length of the ovipositors is the only criterion available in separating the nominal race, *O. c. concinnum,* from its northern race, *O. c. delicatulum* of the Dakotas and Minnesota. The nominal race ranges from Del Dio and Dallas, Texas, east to Homestead, Florida; north to New Hampshire, southern Ontario, Menominee, Michigan, and southeastern Minnesota and west to Lincoln, Nebraska, and Saline County, Kansas. The above records are the first for the Big Bend Region and as such mark a new southwestern distributional point some 200 miles west of Del Rio, the previous record.

CONOCEPHALUS STRICTUS (Scudder)

Davis Mts., 22, X, 28, 1 ♀. Ochoa, 12 miles upstream from Presidio, 8, X, 28, 1 ♀ (tall grass by edge of pond). Cox's Ranch, south slope of Mt. Livermore, Davis Range, 29, IX, 31, 1 ♀. 6 miles NE. of Ft. Davis, Lower Limpia Canyon, 12, X, 46, 1 ♂. 2 mi. E. of Paisano Pass, Brewster Co., 29, X, 46, 1 ♂.

C. strictus is distinguished from the other Nearctic species of the genus by having the female ovipositor longer than in any other species and ranging from 19.0 to 30.0 mms. in length. The wings are abbreviate in this species.

In Trans-Pecos Texas, *C. strictus* is a rare species. In 1915, Rehn and Hebard recorded it from Marathon and Del Rio. It has a very extensive range in the United States, from southeastern Arizona to North Carolina and north to Staten Island, Pennsylvania, Illinois, southwestern Minnesota to Hot Springs, South Dakota. Its western limits are Kearney, Nebraska; Syracuse, Kansas and Cisco, Texas. It has not been reported as yet from Mexico.

C. strictus appears to be a member of the Upper Sonoran fauna. As *Conocephalus fasciatus fasciatus* has a very wide range in the United States it may possibly occur in the tall grasslands of the Transition Zone at higher elevations in the Davis Mountains.

DECTICINAE

The members of this interesting subfamily are known as shield-backed katydids because the pronotum in most genera is much enlarged and caudally

produced to protect the small tegminal pads. Several genera such as *Capnobotes* and *Anoplodusa* are fully winged and *Rehnia* and *Zycloptera* have tegmina and wings not quite extending to the apex of the abdomen. Genera with small tegminal pads include: *Eremopedes, Ateloplus, Pediodectes, Idiostatus, Idionotus, Decticita* and others. Only *Anabrus* and *Peranabrus* of the northwestern states are injurious to crops. The subfamily reaches its greatest development in the Sierra Nevada region of California where *Aglaothorax* and *Neduba* and *Acrodectes* are also found. The desert regions of Trans-Pecos has seven species, two of these were discovered by the writer and described by Mr. Morgan Hebard of Philadelphia.

KEY TO THE GENERA OF THE DECTICINAE OF TRANS-PECOS TEXAS

1. Tegmina and wings not reaching the apex of the abdomen 2
   Tegmina and wings very long, exceeding the tip of the abdomen; color grayish, wings black; size large; ovipositor very long and gently decurved ..... *Capnobotes* Scudder
2. Tegmina longer than the pronotum which is green, subsellata and margined posteriorly with pearly white; body entirely foliage green; wings fan-like mottled with patches of green and black, ovipositor very long and gently decurved; all legs armed with spines ..... *Rehnia* Caudell
   Tegmina projecting for a distance shorter than the pronotum; all legs not heavily armed with spines; pronotum flat and not subsellate; ovipositor not very long and gently recurved 3
3. Posterior margin of the pronotum convexly rounded; prosternum armed with spines; size medium to large ..... *Pediodectes* Rehn and Hebard
   Posterior margin of the pronotum squarely truncate; prosternum not usually armed; size small to medium ..... *Eremopedes* Cockerell

CAPNOBOTES FULIGINOSUS (Thomas)

Paisano, Presidio Co., 23, VII, 29, 1 ♂ (in small cave). Kelligan Canyon near El Paso, 18, IX, 31, 6 ♂ ♂ (taken by night collecting). North end of Davis Range, 6 miles southwest of Toyahvale, 13, IX, 40, 1 ♂ (night collecting). 2 miles north of Pine Springs, Texas, 10, X, 46, 1 ♀ (pinyon zone).

Fuliginosus is the largest and one of the handsomest members of this subfamily. It is easily recognized by its large gray size, long tegmina and wings which are coal black. Its spiny forelegs are used to capture prey. When annoyed it raises its tegmina and wings over its back in quite a striking show apparently to warn its enemies. The song is a loud and continuous and a sort of quavering sound difficult to interpret but something like *zik-k-k-k-k-k—zik-k-k-k-k-k—zik-k-k-k-k-k* with the *ks* fluttering and undulating in tone.

The species matures in mid-June and lives until November. It is believed the eggs are laid in the fall and hatch in the early spring. About 50 eggs are laid. In Texas the host plant was *Acacia Greggii* but in Arizona Palo Verde *Cercidium aculeatum* is favored and also mesquite *Prosopis velutina.* Other host plants include *Atriplex confertifolia* and *Larrea divaricata,* the creosote plant.

Fuliginosus is commonest and of the largest size in Arizona where it is found throughout the desert mountain ranges of the southwestern half of the state. It ranges north to the Beaverdam Mt. Pass of extreme southwestern Utah

and Walker's Lake, Nevada, Lake Tahoe to Los Angeles, California. East it is found rarely to the Davis Mountains which appear to be the first records for the Big Bend Region. East of Arizona the writer has taken it as far north as Water Canyon, Magdalena Mts., New Mexico, and just north of Pine Springs on almost the New Mexico border. In 1944, Tinkham presented a complete account of this handsome species, and the enquiring student is referred to that work. *C. fuliginosus* appears to be an inhabitant of the Lower Sonoran Faunal Zone but it is also found at the lower edge of the Upper Sonoran Zone.

REHNIA CERBERUS Rehn and Hebard

Chinati Mts., (1), 27, IX, 31, 8 ♂♂, 1 ♀ (night collecting); 30, IX, 28, 1 ♀. one mile south of Shafter, Chinati Mts., 13, X, 46, 2 ♂♂ (*Acacia Greggii;* night collecting). Ruidoso Hot Springs, 42 miles up river from Presidio, Presidio Co., 14, X, 28, 1 ♂ (singing in evening before sundown; attacked the collector). Haciendita, 9 miles up river from Presidio, 14, IX, 28, 1 ♂. Presidio, 10, IX, 28, 1 ♀ nymph (in mesquite tree). Marfa, 1 ♀ (G. Gottholt). 20 miles north of Chisos Mts., Brewster Co., 18, VII, 30, 1 ♀ nymph. 1 mile north of Bunton's Flat, 29 miles north Presidio, 20, X, 46, 3 ♂♂ (singing in *Acacia* trees before sundown). 3 miles east of Alpine, 21, X, 46, 5 ♂♂, 1 ♀ (common in low *Acacia Greggii* bushes covering a small rocky knoll). Persimmon Gap, 44 miles south of Marathon, Brewster Co., 22, X, 46, 1 small ♂ (in Mexican Persimmon *Diospyros texana*). 10 miles north Government Springs (Wadi Burnham Ranchhouse), 24, X, 46, 1 ♂ seen in dense clump of *A. Greggii* at night but could not be captured. Chisos Basin, Chisos Mts., 26, X, 46, 2 ♂♂ (*A. Greggii;* elev., c. 6200 feet).

Cerberus is one of the handsomest members of this striking genus. Its coloration is deep foliage green with nacreous trimmings on the posterior margin of the pronotum and on the thoracic pleurites. When annoyed this species portrays interesting aggressive habits by producing a few sharp squeaks, spreading its beautifully mottled fan-like wings as it rears back with the spiny forelegs held outstretched above its head and its powerful mandibles wide open for action. In this combatant pose it is ready to fight all comers. In fact it will jump forward to the attack a distance of half a foot as I discovered from my very first experience with this splendid creature at the Ruidoso Hot Springs. True to its name of Cerberus, in Greek mythology Hercules' dog guarding the gates of Hades, this handsome species is most unusual for an orthopteran and it guards well its own integrity. For a full account on this strange decticid the reader is referred to the author's works of 1944.

The adults are found from July to November and the eggs (one female possessed 54) are laid in the fall and hatch in the spring so that by midsummer the nymphs are mature. Mesquite and catclaw are the favored host plants, rarely *Karwinskia Humboltiana* (in Mexico) is also eaten. The species is strongly carnivorous in captivity but in nature is undoubtedly herbivorous due to its foliage green coloration.

The song of *cerberus* is a strong *tszeee-e-e-k—tszeee-e-e-k—tszeee-e-e-k* rapidly repeated and continued indefinitely until disturbed.

Cerberus is definitely restricted to the Chihuahuan Desert of Trans-Pecos Texas and northeastern Mexico where the writer has taken it in Nuevo Leon (28 miles NW. of Monterey) and in Coahuila (42 miles NW. of Saltillo and

6 miles north of Parras). Hebard, in 1932, reported it from Jaral, Coahuila. *Cerberus* is a member of the Chihuahuan Lower Sonoran fauna.

REHNIA VICTORIAE Caudell

15 miles east of Sanderson, Texas, 14, VIII, 40, 1 ♂. Sand dunes near Monohans and Odessa, Texas, 2, X, 31, 4 ♂♂ (night collecting). Eagle Pass, Texas, 14, VIII, 40, 2 ♂♂ (night collecting). Laredo, Texas, 15, VIII, 40, 1 ♂; 10, IX, 40; 1 ♂ (night collecting).

This species differs from *cerberus* by its smaller size and less spiny legs, the short femoral spines of the legs green and not black as in *cerberus*.

The life history is probably similar to that in *cerberus* although these have not been studied. The host plants, however, differ as *R. victoriae* is indigenous to the Tamaulipan Semi-Desert Bushland fringing the Chihuahuan Desert on the east and this Bushland is characterized by such plants as *Acacia Berlandieri, Prosopis glandulosa, Karwinskia* and *Pithecolobium*. It has been taken on *Karwinskia Humboltiana, Prosopis glandulosa, Acacia Berlandieri* and blackbrush (*Flourensia cernua*). The penetration of various plants west of the Pecos River accounts for *victoriae* being found in this region. The song is a rapid, long continued *zeee-e-e-e-t—zeee-e-e-e-t—zeee-e-e-e-t.*

The species was named for Cuidad (city) Victoria, capital of Tamaulipas, Mexico. It is a member of the Lower Sonoran fauna pertaining to the Tamaulipan Semi-Desert Bushland. In the United States it ranges north to the extreme southwestern corner of Kansas (Hebard 1931).

KEY TO THE SPECIES OF PEDIODECTES OF TRANS-PECOS TEXAS

Lower part of the black face with a triangular patch of white ..... *bruneri*
Lower part of black face crossed by a broad, decurved band of white ..... *tinkhami*

§ PEDIODECTES TINKHAMI Hebard

The type male was collected by the writer at locality (1) about 2½ miles south of Shafter in the Chinati Mountains foothills on Sept. 29, 1928. The female type came from the Wadi Burnham Ranch at the north base of the Chisos Mountains in Brewster County, Texas. Paratypes were also taken at the latter locality and from the Ord Mountains by the late field naturalist Mr. O. C. Poling. A female nymph representing the first Mexican record was taken at the San Carlos Mines, 10 miles southwest of San Carlos, Chihuahua, Mexico, on July 3, 1930.

This interesting and rare species is quickly separated from all other desert decticids by the broad arcuate band of creamy white crossing the middle of the black face. The coloration is cinnamon buff mottled with clay color and microscopic streaks of tawny olive. The caudal femora are tinged with delicate green.

Little is known of the biology of *P. tinkhami* although the large nymphs present in July mature in August. The eggs are probably laid in the fall and hatch the next spring. Many adults meet accidental death by falling into pools of water in the arroyo bottoms while seeking water. I have found such speci-

mens in the Chinati and Chisos Mountains but unfit for preservation. The song of this species is not known nor is the host plant known.

Pediodectes tinkhami is a member of the Chihuahuan Lower Sonoran fauna

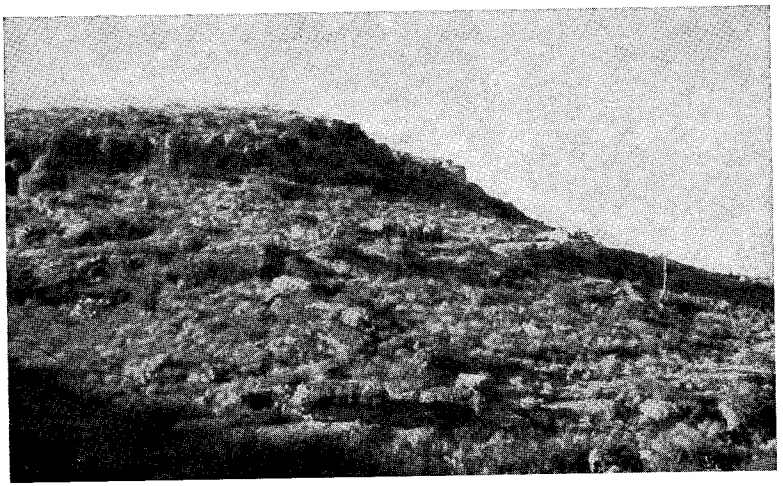


Fig. 36.—Type locality of *Pediodectes tinkhami* Hebard. The dominant plants at about 4200 ft. elevation are lechuguilla (*Agave lecheguilla*), sotol (*Dasylirion texanum*) and many other less important plants.

and is at present known only from the Chinati and Chisos Mountains of Trans-Pecos Texas and the San Carlos Sierras of northern Chihuahua, Mexico.

PEDIODECTES BRUNERI (Caudell)

Davis Mts., Prudes Ranch, elev. about 6000 feet, 6, X, 29, 1 ♂; Cox's Ranch, south slope of Mt. Livermore, Davis Mts., elev. about 7800 feet, 29, IX, 31, 5 ♂♂, 6 ♀♀ (in mountain grass). Twenty miles west of Ozona, Texas, 13, IX, 40, 2 ♀♀. Chisos Basin, Chisos Mts., Brewster Co., Tex., 26, X, 46, 1 ♀ (scrub oak and grass at 6500′ elev.)

The type locality of this species is Belfrage, Texas. It is smaller than *tinkhami* and darker colored and the two species can be easily separated according to the key. Little is known concerning the biology of *bruneri* but the eggs are probably laid in the fall and the nymphs emerge in the spring, to become adults in August or early September. The adults probably feed on grasses.

P. bruneri is known from the Davis Mountains east to the Edwards Plateau, south to Belfrage and north to Quanah, Texas. It is an inhabitant of the Upper Sonoran Faunal Zone. Its faunal affinities are not definitely known.

KEY TO THE SPECIES OF EREMOPEDES OF TRANS-PECOS TEXAS

Tegmina jet black with the veins outlined in yellow; supra-anal plate deeply grooved; subgenital plate cleft ..... *covilleae*

Tegmina not jet black but more brownish with veining not as conspicuous; supra-anal plate deeply cleft, subgenital plate entire ..... *scudderi*

EREMOPEDES SCUDDERI Cockerell

Dawson's Ranch, (8), 8, VII, 29, 1 ♀ (feeding on pollen of flower stalk of *Dasylirion texanum*). Chinati Mts., (3), 16, IX, 29, 1 ♂ (in clump of *Agave lechuguilla*). Paisano, 22, VI, 30, 1 ♂ juv. (in grass). Wadi Burnham's Ranch, north base of Chisos, 18, VII, 30, 1 ♀ (from fly trap baited with dough). Creosote mesa 20 miles north of Chisos, 18, VII, 30, 1 ♂ (swept from creosote). Kelligan Canyon near El Paso, Texas, Franklin Mts., 18, IX, 31, 3 ♂♂, 1 ♀ (night collecting; gray phase). Bunton Flat, 29 miles north of Presidio, 20, IX, 31, 1 ♂ (trilling at night on *Opuntia arborescens*). North end of Davis Mountains, 6 miles SW. of Toyahvale, 13, IX, 40, 2 ♂♂. Six miles east of Marfa, 13, VIII, 40, 2 ♀♀ (hiding in *Clematis Drummondi*). 10 mi. west of Marfa, 30, X, 46, 1 ♂.

Ateloplus macroscelus Rehn and Hebard, described from El Paso in 1909 is a synonym.

This interesting species is usually found in the green or gray color phase with the dorso-lateral lines marked with a lacery of pink and white, with yellowish margins to the pronotum. Optimum specimens from the desert regions are of large size but in northern New Mexico and northeastern Arizona, on the periphery of its range, its size is small.

The female lays about twenty-four eggs in the fall which undoubtedly hatch in the spring and become adults in July. The song is a soft low *zeeee-e—zeeee-e--zeeee-e—zeeee-e* continuous for long periods of time. The species is thamnophilous and phyllophagous on the creosote bush principally although in various parts of its range *Acacia constricta, Sarcobatus vermiculatus, Dasylirion texanum,* are the host plants. When confined specimens eat one another as is typical of this group.

E. scudderi is a member of the Chihuahuan Lower Sonoran fauna and is confined to the Chihuahuan Desert. It is found in Trans-Pecos Texas and its distribution extends up the Rio Grande Valley into northern New Mexico and southeastern Colorado and across the desert areas of the northwestern portions of New Mexico to Concho, Arizona. These specimens, however, on the periphery of its range are of dwarf size. In southern Coahuila, Mexico, in 1940, the writer found it common on the creosote bushes of the Chihuahuan Desert, where the specimens were of optimum size.

§ EREMOPEDES COVILLEAE Hebard

Hebard described this species in 1934, from several specimens taken by the writer (July 18, 1930) on creosote, twenty miles north of the Chisos Mountains. This locality, desert mesa, is the type locality and is southeast of Persimmon Gap.

My notes made at the time showed that it differed from *E. scudderi* with which it was associated on the creosote plant, by the following characteristics: posterior portions of the pronotum margined with a broad band of buff; tegmina somewhat greater in length and jet black with the network of veins in yellow; supra-anal plate deeply grooved whereas in *scudderi* it was deeply split and by the subgenital plate being split for most of its length whereas in *scudderi* it was entire.

Nothing is known about the biology of this rare species which is known only from two male adults and one or more nymphs. Efforts were made to find

it at the type locality, in October, 1946, but without results. *E. covilleae* is a member of the Lower Sonoran Chihuahuan fauna and it should be found in the desert areas of Coahuila in northeastern Mexico.

Dr. T. H. Hubbell has specimens of what may prove to be a new genus of decticids from the Big Bend Region so that the prospects of discovering new elements in this region is still not completely exhausted. However, the writer believes that the likelihood of finding new species will be much less than even some years ago. A number of new records for the Big Bend may still be found on the eastern border of Brewster County.

The GRYLLACRIDIDAE

The members of this family, first recognized as a family by Dr. H. H. Karny of Vienna, in 1926, are either winged or wingless. The very large genus *Gryllacris* which is tropical and subtropical in distribution has very long antennae and is winged. The long antennae are used in the capture of smaller insects living on the tropical verdure of leaves and upon which they exist. Many other genera of the nine subfamilies are wingless. The camel or cave crickets of the subfamily Rhaphidophorinae have been frequently classed as a subfamily of the Tettigoniidae, but rightly belong to the Gryllacrididae. The Rhaphidophorinae are very ancient in origin, having probably developed in middle Mesozoic times, and there is every indication that modern members have shown little change since the Eocene according to the authority Dr. Theodore H. Hubbell who monographed the Nearctic representatives of the genus *Ceuthophilus* in 1936, and described many new species at that time. Only the genus *Ceuthophilus* has been found in Trans-Pecos Texas. As the various members of this genus are difficult to dissociate no keys will be presented to this genus. Specimens should be sent to Dr. Hubbell at the University of Michigan for determination.

RHAPHIDOPHORINAE

CEUTHOPHILUS VARIEGATUS Scudder

Presidio, 28, VIII, 29, 1 ♂; 2, VII, 30 and 26, IX, 31, 3 ♂ ♂, 1 juv. ♂, 1 juv. ♀ (nymphs taken in showerhouse); 19, X, 46, 1 ♂. An arroyo valley 8 miles north of Presidio, 21, IX, 31, 1 ♂ (feeding on dead scorpion at night). Chinati Rancho, 22 miles up river from Presidio, 34, IX, 31, 1 ♂, 2 ♀ ♀ (in large adobe house with concrete floors).

This large and robust cave cricket is often seen at night jumping across the desert floor but it is seldom captured due to its great jumping powers which sends it off into the night quicker than the light can follow its actions.

C. variegatus is a member of the *Pallidus* group containing two other members namely *pallidus* Thomas 1872, and *isletae* Hubbell 1936, all of which are found in the Big Bend Region of Trans-Pecos Texas. It is a member of the Chihuahuan Lower Sonoran fauna and its range extends up the Rio Grande Valley from the Big Bend Region to Mesilla Park, New Mexico, and east to Uvalde County and the mouth of the Rio Grande. South in Mexico it has been recorded from Matamoros, Tamaulipas, San Lorenzo, Coahuila which is typically Chihuahuan Desert and from San Pedro (Ocampo) in Zacatecas.

CEUTHOPHILUS PALLIDUS Thomas

Hubbell reports this wide-spread species from the Ord Mountains of Brewster County. Its range is very extensive extending throughout the Great Plains region from southern Manitoba and Saskatchewan south to the Ord Mountains and east of the Rockies to central Iowa, eastern Kansas and Oklahoma and central Texas. In the Southwest its optimum zone is from 5000 to 9000 feet elevation in the mountains of New Mexico and the non-desert ranges of Arizona, where it has been found as far west as Flagstaff. *C. pallidus* appears to be a member of the Northern Short Grasslands fauna of the Transition Zone.

CEUTHOPHILUS ISLETAE Hubbell

This comparatively new species was described from seven specimens with the holotype coming from Albuquerque and the female allotype from Maxwell, Colfax County, New Mexico. One male, two females and one juvenile female were taken in 1928, by that veteran collector, the late Mr. O. C. Poling, in the foothills west of the Ord Mountains of Brewster County.

Hubbell believes this species to be an inhabitant of the grasslands on the slopes of the mountain ranges extending from the Big Bend Region into northern New Mexico. It thus would appear that *C. isletae* is probably a member of the Southwestern Mountain Transition fauna.

CEUTHOPHILUS REHNI Hubbell

Hubbell described this new species from four specimens, the types collected by Mr. O. C. Poling in the foothills west of the Ord Mountains and a female from Limpia Canyon in the Davis Mountains of Jeff Davis County, at an elevation of 500 to 5500 feet.

Hubbell believes that this species inhabits caves and talus cavities on rocky slopes and canyon sides and thinks that its distribution will eventually be found to extend in similar habitats into New Mexico. From the little known facts concerning this species, it would appear that it is best placed as a member of the Southwestern Mountain Transition fauna. In Hubbell's monograph it is a member of the *longipes* Group; *C. longipes* being known only from the depths of the Carlsbad Caverns.

CEUTHOPHILUS POLINGI Hubbell

Mouth of Upper Limpia Canyon near Ft. Davis, 13, X, 46, 1 juv. ♂ (night collecting; det. Hubbell 1948).

C. polingi is named in honor of that great field collector Mr. O. C. Poling, formerly of Ft. Davis, Texas, who died in the spring of 1929. Many of the new species of *Ceuthophilus* described from the Big Bend Region, by Hubbell, were colletced by Mr. Poling. *C. polingi* is a member of the *Silvestris* group of the genus *Ceuthophilus* which contains six species one other of which, namely *carlsbadensis,* has been found in the Big Bend.

Poling's cave cricket was described from only two males, holotype and paratype, collected at Ft. Davis, October 15-28, 1927. The Ft. Davis region abounds in oaks and rocky mountain slopes and from the meagre information

available it would appear that *polingi* is a member of the Chihuahuan Upper Sonoran fauna.

CEUTHOPHILUS CARLSBADENSIS Caudell

The types of this interesting species were described by Caudell, in 1924, from the Carlsbad Caverns. It is distinguished from *C. longipes,* known only from these caverns, by its larger size and longer legs. They are so pale in color that their stomach contents can be seen through the translucent walls of the abdomen, according to Bailey in his *Animal Life of the Carlsbad Caverns* (1928). When approached or alarmed, they made long hops, but were generaly slow and sluggish for crickets, moving slowly and touching the ground in front with the long antennae as if feeling their way. "They apparently fed on insect remains dropped by the myriads of bats in the guano-bat caves, and they in turn were preyed upon by the cave mouse *Peromyscus leucopus tornillo.*"

C. carlsbadensis has also been found in the caves of Dark Canyon, 12.5 miles southwest of the Carlsbad Caverns and the only Big Bend record is from the cave at Phantom Lake, near Ft. Davis in the Davis Mountains. Being strictly cavernicolous it is difficult to assign this species, but it is believed to be a member of the Chihuahuan Upper Sonoran fauna.

§ CEUTHOPHILUS UTAHENSIS Thomas

Cox's Ranch, south base of Mt. Livermore, Davis Mts., 39, IX, 31, 1 ♂, 1 ♀ (taken in a mole burrow under a rotting log in a clump of pine trees at about 8300 feet elevation by E. R. Tinkham).

This is the first record for Texas of this western species known from Utah and Arizona. This species is of rather small size, of a uniform buffy brown coloration and with the caudal femora often strongly bowed outwards in the male. Like many species of *Ceuthophilus* this species prefers to dwell in rodent burrows under logs in the pine forests of high mountain slopes.

There are two phases, the northern *utahensis* and the southern *uniformis.* The *uniformis* phase in its range is typical of that for members of the Southwestern Mountain Transition fauna. Its range thus extends from the Davis Mountains, where it is isolated in Texas, north to Estes Park and Ft. Collins, Colorado and throughout many of the mountain ranges of New Mexico.

CEUTHOPHILUS CONICAUDUS Hubbell

Chinati Mts., 1 mile south of Shafter, 19, X, 46, 1 ♂ (night collecting in a small arroyo; det. Hubbell 1948).

C. conicaudus is a member of the *Secretus* Group of the large diversified *Lapidicola* series which contains 22 species placed in 8 different groups. Already mentioned above is the *Pallidus* group with three species namely *variegatus, pallidus* and *isletae* and *rehni* of the *Longipes* group. The *Secretus* group contains *secretus, conicaudus* and *aztecus. Conicaudus* is very closely allied to *secretus* replacing that species in the more arid areas of Texas and Oklahoma. The types, male and female, were described from "Camp Boulder" in the Wichita Nat'l Forest, Comanche County, Oklahoma. Its range closely follows the distribution of mesquite in Texas and Oklahoma, according to

Hubbell, and has been recorded from Woods, Comanche and Harmon counties of Oklahoma south to Austin and San Antonio, Texas, thence west to Montell in Uvalde County, the Big Bend Region and the caves in Dark Canyon close to Carlsbad Caverns, New Mexico. In the Big Bend, Hubbell reports it from the cave near Phantom Lake and Ft. Davis in the Davis Mountains of Jeff Davis County and from the foothills west of the Ord Mts., Tibbett's Ranch near Alpine and from Boot and Upper Juniper Springs in the Chisos Mts. of Brewster County.

C. conicaudus is with great difficulty placed because its range appears to be rather unusual and the writer feels it is best to leave it unassigned for the present.

The GRYLLULIDAE

The crickets, represented by several genera and species in a number of subfamilies, are poorly represented in the Big Bend Region. All, with the exception of the large black field cricket, *Gryllulus assimilis,* are rather uncommon in Trans-Pecos Texas. The field cricket is ubiquitous over the entire United States and in some sections becomes an important economic species. Members of the Oecanthinae, the tree crickets, also assume economic importance in the northwestern states.

KEY TO THE SUBFAMILIES OF THE GRYLLULIDAE OF TRANS-PECOS TEXAS:

1. Hind legs armed with rows of long spines on the tibiae 2
   Hind legs without rows of long spines on the tibiae; body covered with scales; pronotum flat and very large ..... MOGOPLISTINAE
2. Head vertical, form robust, color brown or black 3
   Head horizontal, form slender and pronotum narrow, color whitish green; caudal tibiae armed with long spines interspersed with minute teeth; tree crickets ..... OECANTHINAE
3. Minute, flat, wingless crickets living as guests in nest of ants; caudal femora greatly enlarged, eyes very small; myrmecophilous or ant-loving crickets ..... MYRMECOPHILINAE
   Small to large crickets living in grass or vegetation; caudal tibiae without small teeth between the spines 4
4. Size very small with bristles covering the body and legs; tibiae armed with long movable spines; lawn crickets ..... NEMOBIINAE
   Size medium to large without bristles on body or legs; caudal tibiae with all spines immovable; field crickets ..... GRYLLULINAE

GRYLLULINAE

GRYLLULUS ASSIMILIS (Fabricius)

Presidio, common also in the Chinati Mountains.

Uvarov of the British Museum has proposed the name *Gryllulus* since *Gryllus* does not refer to this cricket. This species and its many forms ranges over the whole of the United States and Mexico. In the arid Southwest the variant *personatus* with long flying wings is the common form. The field cricket is an inhabitant of both the Lower and Upper Sonoran Zones.

MIOGRYLLUS LINEATUS (Scudder)

This species from Brownsville, Texas, west to San Diego, California, undoubtedly occurs in the Big Bend Region but as yet has not been reported.

NEMOBIINAE

NEMOBIUS CAROLINUS NEOMEXICANUS Scudder

Ft. Davis, mouth of Upper Limpia Canyon, 13, X, 46, 1 ♂ (singing in crevices in bark or root of giant cottonwood at night).

This specimen was identified by Dr. A. B. Gurney of the United States National Museum. An unidentified specimen taken at Presidio lights, in late August, 1929, probably represents this same species. This species ranges west to southern California north to Littlefield, Arizona, and south into Mexico. It is an inhabitant of the Lower Sonoran Zone.

NEMOBIUS CUBENSIS MORMONIUS Scudder

This species found in bermuda grass areas in damp places from Texas to Arizona and north to Nevada, Utah and Colorado should be found eventually in the Big Bend Region, perhaps in the Rio Grande Valley.

OECANTHINAE

OECANTHUS CALIFORNICUS Saussure

Presidio, 28, IX, 29, 1 ♂.

This is the commonest species of tree cricket found in the Rio Grande Valley and at night its purled lute-like trilling comes softly and distinctly from the dense thickets bordering the cottonfields. The range of this species is from Oregon and Idaho south to Costa Rica and as far east as western Texas.

OECATHUS sp.

Ruidoso Hot Springs, 10 miles north of Ruidoso, Presidio Co., 18, IX, 28, 1 ♂ (trilling at night in *Yucca Torreyi*).

A series of this species is needed before its identity can be satisfactorily established. It may possibly represent a new species.

MOGOPLISTINAE

CYCLOPTILUM COMPREHENDENS FORTIOR Hebard

12 miles north of Presidio on the desert mesa, 30, IX, 28, 4 ♂♂, 1 ♀ (swept from *Larrea divaricata*). Chinati Mts., 4, VIII, 29, 1 ♀ (on *Larrea*).

In 1931, Hebard described *fortior* as a new subspecies and designated Ajo, Pima County, Arizona, as the type locality stating that the series from the Big Bend Region and southern Arizona average slightly larger than those elsewhere in its range.

This small, interesting cricket inhabits the desert regions from Trans-Pecos Texas to southeastern California and south into Coahuila and Sonora, Mexico. It is thamnophilous dwelling on creosote and other dominants such as *Flouren-*

sia and *Chrysothamnus* or rabbit brush. *Fortior* is a member of the Mexican Lower Sonoran fauna.

CYCLOPTILUM COMPREHENDENS COMPREHENDENS Scudder

No specimens of this, the nominal race, were taken by the writer although Hebard, 1931d, records a series from the Davis Mountains and others from east of the Pecos River.

HAPLOSPHYRUM BOREALE (Scudder)

Ruidoso Hot Springs, 16, X, 28, 1 ♂ (in detritus under drooping legume in an arroyo canyon). Chinati Mts., (1), 16-18, X, 46, 3 ♀♀ (found hiding under limestone rocks on mountain side in daytime). Chisos Basin, elev. 6000 feet, 24, X, 46, 1 ♂ (under rock).

The range of this purplish gray cricket extends from Brownsville, Texas, west through New Mexico and Arizona, where it is rare, to California. In Mexico it has been found in Lower California and on some of the islands adjacent to its coast. The writer took a female specimen on Feb. 27, 1947, under a rock on a mountain side 5 miles north of Mesquital, Baja California, N. lat. 28.5°.

Hebard states that *H. boreale* may eventually prove to be only a race or synonym of the Mexican *Haplosphyrum aztecum* (Saussure).

H. boreale is a member of the Lower Sonoran fauna.

MYRMECOPHILINAE

No members of the tiny brown ant-loving crickets were taken by the writer although they undoubtedly occur in the ant nests in the Big Bend Region.

Summary with Especial Reference to Faunal Zones and Faunae of Midwestern North America

The preceding pages have discussed the floral and faunal characteristics of the region concerned and have dealt in detail with the respective members of the orthopteran fauna found in the Big Bend Region of Trans-Pecos Texas.

The florae of the Lower and Upper Sonoran and Transition Zones have been briefly but carefully described and divided into their component parts. The Lower Sonoran Zone includes the Rio Grande Valley of mesquite, the desert mesa of creosote, ocotillo and other plants, and the flora found at elevations of from 4200 to 4800 feet in the Chinati Mountains. The Upper Sonoran Zone, as discussed, comprises various types of grasslands and their associated orthopteran faunae. The Transition Zone was seen to be composed of the oak and pine clothed mountain slopes of the Davis Range and certain high, north-facing slopes in the Chinati and the Chisos Mountains.

Approximately 2000 specimens comprise the basis of this study, and these with few exceptions were collected by the writer. One hundred fifty species representing eighty-nine genera are recorded from the Big Bend Region of Trans-Pecos Texas and an additional nine are listed as probably occurring in the area. Of those recorded one hundred thirty-six are reported from Presidio

County alone—proof of the remarkable orthopteran fauna developed in that particular county. Of the 150 species, 97 belong to the grasshoppers or Acrididae; 22 pertain to the katydids or Tettigoniidae; 8 to the camel crickets of the family Gryllacrididae; 9 to the true crickets; and the remaining 23 are divided as follows: 9 cockroaches, 5 mantids, 7 stick insects and 2 grouse locusts of the family Tetrigidae.

Of the various subfamilies of the Acrididae, the band-winged members of the Oedipodinae, represented by 33 species, indicate that this group of soil-loving grasshoppers are especially adapted to the semi-desert regions of the Southwest. The slant-faced grasshoppers of the subfamily Acridinae with 27 known species and the Cyrtacanthacrinae, the spine-breasted grasshoppers, with 30 species, reveal that these two subfamilies are also very well represented. The toad-hoppers are of especial interest since they are the only two Nearctic representatives of a large and widespread Gerontogeic subfamily, the Pamphaginae. The leaf-katydids of the Phanerotropinae are well represented with 10 species. With the discovery of two new species of shield-backed katydids, the Decticinae now with 7 species assume new interest and importance. One pseudophyllid from the Chisos has been recorded.

Two decticids, *Pediodectes tinkhami* and *Eremopedes covilleae,* and a subspecies of the leaf-katydid, *Arethaea gracilipes cerciata,* were discovered by the writer during 1928-1930 and were described by Mr. Morgan Hebard in 1934 and 1936a. A new species of bird-winged locust, *Schistocerca chinatiensis* Tinkham, was found by the writer in October, 1946 and is described in this work. In addition Dr. Theodore H. Hubbell in his monographic work in 1936, described three new camel crickets from this region; namely, *Ceuthophilus rehni, C. isletae* and *C. polingi* and recorded several additional species for the first time from this area.

Two new North American records, north of Mexico; namely *Zapata brevipennis* and *Netrosoma nigropleura* have been reported. Three species: *Amblytropidea mysteca, Rhammatocerus v. viatoria* and *Clematodes larreae* are recorded from areas east of Arizona for the first time and are also first Texas records. New Texas records include the following species: *Heliaula rufa, Trimerotropis cyaneipennis,* and *T. strenua, Heliastus benjamini, Melanoplus desultorius* and *Ceuthophilus utahensis.*

The following species, although not as yet known from the Big Bend Region, will probably be found there: *Syrbula admirabilis, Amphitornus ornatus, Melanoplus femur-rubrum femur-rubrum, M. m. mexicanus, M. herbaceus, Neoconocephalus triops, Conocephalus f. fasciatus, Miogryllus lineatus* and *Nemobius cubensis mormonius.*

A panoramic view of the Big Bend Region would exhibit by its physiographical, phytogeographical and zoogeographical features the following faunal zones of the Austral Faunal Region: the Lower Sonoran Zone occupied by the desert, the Upper Sonoran Zone comprising the semi-arid grasslands, and the Transition Zone restricted to the mountain peaks of the Davis, Chinati and Chisos ranges. This view, however, would not reveal the various faunal subdivisions or faunae of these zones. This is due to the fact that the components

of the various zones exist side by side, some finding in that particular zone the sum total of the conditions favorable for their optimum development, while others are suppressed by conditions less favorable to their growth. There is an overlapping and intermingling of species from the various zones, especially the ecotonic areas where the zones intergrade. We find that some species are non-discriminators of zones due to their tolerance to a wide range of climatic conditions, while others may be rare because they require a particularly favorable set of conditions before they can thrive. This is expressed in a number of species which have evolved and remain within a given region where they live with other species, common to several zones and widely disseminated over southwestern or western North America.

This mix-up of faunal zones is not limited to the level grasslands nor deserts but occurs also in the proximity of, and in, the mountainous regions. Here faunas are superimposed altitudinally and the boundaries of one intermingle with those of higher elevations while their lower margins merge with those from lower altitudes, whether of grassland or desert. We find that the analysis of such a conglomeration of species is not an easy matter, but one requiring much study, especially of the actual geographical distribution of each individual species.

On the semi-arid grasslands of the Southwest it is impossible to determine whether three species dwelling side by side are members of the same fauna or representative of three different faunae, each originating or having its optimum zone in a different region, such as: one from the Great Plains region, another from the Southwestern Grasslands and the third of Mexican origin. They dwell together because their habitat represents the common meeting ground of different faunae, and only an exhaustive study would reveal whether or not that particular region is part of their area of optimum distribution.

Faunal zones and faunal regions are man-made designations in which groups of animals are placed if the members have the same range of environmental requirements. These divisions therefore indicate the adaptations of a particular species or group of species to their environment. The capacity of each to meet either a narrow or broad range in climatic and food conditions determines their potentialities for reproduction and dispersal, which is of course the basis of distribution. The species by its own selection of the factors most favorable to its life processes naturally indicates the faunal region or zone or fauna to which it belongs. The arduous task is the correct interpretation by man of the natural phenomena involved. What to one worker may seem a feasible and plausible explanation may to another appear unwieldy or incorrect. It is hoped that the writer's analyses may prove correct despite the paucity of our knowledge concerning most species.

This study of the orthopteran faunal zones of the Big Bend Region of Trans-Pecos Texas has revealed the following subdivisions or faunae of the Lower and Upper and Transition Zones found in the Southwestern United States. The writer has used the term *fauna* to designate the subdivision of a zone. Naturally all members or species of a single fauna bear a closer relationship to each other than do other members of a zone or zones. However, one

must remember that the individuality of each species prevents a minute comparison of the biological and ecological characteristics of one species with another in the same fauna. In general, however, we can say that the species of a certain fauna have in common: the same general distribution, the same temperature preferences and the same general response to climatic conditions; but their choice of habitat and food plants need not necessarily be the same—they are often diverse.

The faunae of the various Zones are briefly summarized below:

AUSTRAL FAUNAL REGION

A. LOWER SONORAN ZONE

a. *Lower Sonoran Fauna.*—The range of the species of this fauna is determined by the distribution of the creosote plant (*Larrea divaricata*) which characterizes the desert regions of the Southwest. This region includes the Pecos, Otero and Rio Grande valleys of Trans-Pecos Texas and New Mexico, southwestern and western Arizona, the southwestern tip of Utah, southern Nevada and southeastern California. In Mexico it includes western Sonora, Baja California, Coahuila, Nuevo Leon and part of Zacatecas.

b. *Mexican Lower Sonoran Fauna.*—A fauna peculiar to the mountainous regions of northeastern Mexico whose northern limits of distribution are found in the southern portions of the Big Bend Region of Trans-Peocs Texas and also in south central Arizona. The range of the members of this fauna are more co-extensive than that of the following group.

c. *Chihuahuan Lower Sonoran Fauna.*—This fauna is indigenous to the Chihuahuan or eastern desert tract of North America. It is found only east of the Continental Divide and is largely restricted to Trans-Pecos Texas but its northern limits extend beyond that found in the Mexican Lower Sonoran fauna. In Mexico this fauna is found in Coahuila and western Nuevo Leon.

B. UPPER SONORAN ZONE

a. *Mexican Upper Sonoran Fauna.*—This Upper Sonoran fauna of Mexican origin is known in the United States only from the Chinati Mts. of Trans-Pecos Texas and certain mountain ranges of south central Arizona such as the Baboquivari, Tumacacori, and Santa Ritas. The altitudinal range of this fauna extends generally between 4500 and 5500 feet. This fauna ranges far south into Mexico.

b. *Chihuahuan Upper Sonoran Fauna.*—This Upper Sonoran fauna is peculiar to Trans-Pecos Texas and the northeastern Mexican states of Coahuila and western Nuevo Leon. It is found generally at altitudes ranging from 4500 to 6000 feet and its northern limits range well north of that area occupied by the Mexican Upper Sonoran fauna.

c. *Southwestern Grasslands Fauna.*—This fauna is composed of a large number of grassland species inhabiting the Southwestern Grasslands whose range extends generally from southeastern Arizona to the Big Bend Region of Trans-Pecos Texas and north over New Mexico to southeastern Colorado and southwestern Kansas and sometimes north to extreme southwestern Nebraska. In Mexico this fauna ranges south over the Highland plateau, at appropriate elevations of 5000 to 6000 feet, to Zacatecas.

d. *Southern Short Grasslands Fauna.*—This large group of species has considerably more latitude in distribution than those of the Southwestern Grasslands fauna due principally to a greater range in tolerance to the climatic conditions existing in the Southwest. Their distribution covers the general area of the Southwest occupied by the Southwestern Grasslands fauna, but on the Great Plains

their range extends north between the Rocky Mountains and the western portions of Kansas, Nebraska and South Dakota to southwestern North Dakota (west of the Missouri), the eastern portion of Montana to the Milk River Valley of extreme southeastern Alberta.

C. TRANSITION FAUNAL ZONE

a. *Northern Short Grasslands Fauna.*—Members of this fauna have a temperature preference slightly lower than those of the Southern Short Grasslands Fauna and hence in the Southwest are found at higher altitudes of 5500 to 6500 feet on the grasslands adjacent to and extending throughout the Davis Mountains and similar ranges of the Southwest. Further north the members of this fauna are common plains species extending their range to the Canadian Prairie Provinces and occupying much of the area between the Rocky Mountains and the Mississippi Valley as far south as northern Oklahoma.

b. *Southwestern Mountain Transition Fauna.*—This fauna is composed of a small group of species found at altitudes ranging from 5500 to 7500 feet elevation in the mountainous regions of Trans-Pecos Texas, New Mexico and eastern Arizona. Many species are associated with the more forested areas of that region.

The Orthoptera, especially the Acrididae or grasshoppers, are undoubtedly the finest known indicators of insect faunal regions and zones. Not only are they of relatively large size and comparatively few in number of species but they are rich in numbers of individuals of each species and further their terrestrial habits make them rather "autochthonous," that is, we can be reasonably certain, with few exceptions, that a grasshopper taken in a certain type of environment, be it mountain peak, grasslands or desert, is a product of that particular type of habitat. In other words we can be sure that the eggs of a certain acridid species were laid in that same environment in which the young hoppers developed to maturity. Furthermore, the *direct metamorphosis* of acridid from eggs to nymph which reaches maturity by a series of successive molts has many advantageous factors. It not only simplifies the matter of habitat and food (the young eat the same plants as the adults) but it also presents a simpler and more constant habitat picture than do insects such as butterflies, beetles, bees, wasps and dragonflies with their indirect metamorphoses. In addition grasshoppers are not only the product of their environment for one particular season but are time-products of their habitats for hundreds and thousands of years. Not only are they terrestrial and feed on the earth's common coverage, grasses of the plains and shrubs and grasses of the desert, but many species are brachypterous and flightless and therefore confined to a given habitat. Even the winged species are sedentary and non-migratory, with the exception of the Rocky Mountain Locust (*Melanoplus m. mexicanus*) which migrates in drought years. Incidentally, the species of locusts which possess both solitary and migratory phases number less than ten for the entire world. On the other hand it is a matter of conjecture how far a butterfly, moth, bee, wasp, beetle or dragonfly has wandered and flown before being captured. Butterflies and moths are frequently observed migrating.

Because of their terrestrial and sedentary habits, the grasshoppers are not only fine indicators of environmental conditions but their time-space distribution is an ancient and excellent one, that is, the geographic distribution of species, genera and subfamilies is a good index of the time-space factor. In

other words the geographic range of each grasshopper is an expression of a long period of time. Unfortunately man does not know how many thousands of years it has taken each species to reach the limits of its present range, but we are reasonably certain that in comparison, man's antiquity is young.

Time may show that grasshoppers may prove to be as accurate an index to faunal zones and regions as we can find among the terrestrial members of the animal kingdom. Certainly they are superior to birds with their roving habits, and they may outrank mammals, horned lizards and snails in this regard. Because they are more widespread and more common than horned lizards and

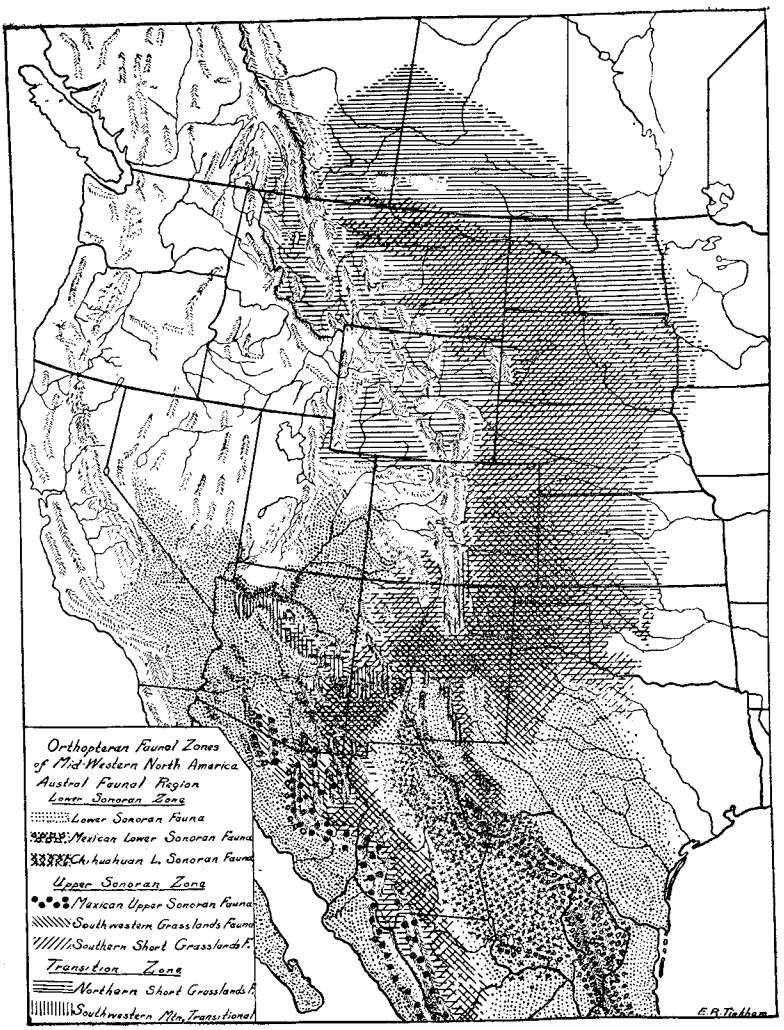


Fig. 37.—Map of the Orthopteran Faunal Zones of Midwestern North America.

snails they have certain advantages over these forms especially when considered on a world-wide basis. The comparative merits of grasshoppers *versus* mammals as faunal indicators will not be argued or discussed at this time.

From these observations the writer believes that the map of the Orthopteran Faunal Zones of Midwestern North America (Fig. 37) accurately depicts the insect faunal zones of that area since it is based on many species. Time may prove that these insect faunal zones accurately delineate those of other groups of animals and may be found more accurate than our present faunal maps (of Merriam *et al.*) which are based entirely on the normal mean temperature for the six hottest weeks of the year for southern limits and by the total quantity of heat during the period of growth and reproduction for northern limits of zonal distribution.

The accompanying map (Fig. 37) illustrates the extent of the various faunae of the Lower, Upper and Transition Zones of the Austral Faunal Region of Midwestern North America.

Below, in generic arrangement, is a list of species collected in the Big Bend Region of Trans-Pecos Texas. Several species are listed that probably in this region but which have eluded discovery to date.

Seasonal distribution, habitat and faunal designations are given for each species in as concise a manner as possible.

A Seasonal, Environmental and Faunal List of the Orthoptera of the Big Bend Region of Trans-Pecos Texas*

BLATTIDAE

BLATTINAE

Blatella germanica	annual	domiciliary	Lower & Upper Sonoran
Parcoblatta desertae	May	detritus	Lower Sonoran
Periplaneta americana	annual	domiciliary	Lower & Upper Sonoran
Supella supellectilium	annual	domiciliary	Lower & Upper Sonoran

POLYPHAGINAE

Arenivaga erratica	Aug.-Oct.	detritus	Lower Sonoran
Arenivaga grata	July-Sept.	troglodytic	Mexican U. Sonoran
Arenivaga tonkawa	Aug.-Sept.	detritus	Tamaulipan S-D. Bushland
Eremoblatta subdiaphana	May-Sept.	detritus	Lower Sonoran
Eremoblatta n. sp.	Aug.-Sept.	detritus	Chihuahuan L.S.

MANTEIDAE

AMELINAE

Litaneutria minor	July-Oct.	campestrian	S.S. Grasslands U.S.
Yersiniops solitarium	Sept.	campestrian	SW. Grasslands U.S.

OLIGONICINAE

Oligonicella scudderi	Aug.-Oct.	campestrian	SW. Grasslands U.S.

MANTEINAE

Stagmomantis californica	Aug.-Oct.	thamnophilous	Lower Sonoran
Stagmomantis limbata	Aug.-Oct.	thamnophilous	Lower Sonoran

* An asterisk indicates the first American record north of Mexico; a dagger denotes the first records east of Arizona; a double dagger indicates a first Texas record; a section mark indicates species new to science discovered by the writer.

PHASMIDAE

Parabacillus coloradus	Aug--Oct.	campestrian	Upper Sonoran

HETERONEMIAE

Diapheromera covilleae	July-Oct.	thamnophilous	Chihuahuan L.S.
Diapheromera femorata	Aug.-Oct.	arboreal	Upper Sonoran
Diapheromera velii eucnemis	July-Sept.	thamnophilous	Chihuahuan L.S.
Diapheromera torquata	July-Oct.	thamnophilous	Chihuahuan L.S.
Megaphasma denticrus	Sept.-Oct.	thamnophilous	Austroriparian
Pseudosermyle straminea	Aug.-Oct.	campestrian	L. & U.Sonoran

TETRIGIDAE

Paratettix a. aztecus	Jan., Jul.-Sept.	wet soil nr streams	L. & U. Sonoran
Paratettix m. mexicanus	Sept.-Oct.	wet soil	Lower Sonoran

ACRIDIDAE

ACRIDINAE

Achurum sumichrasti	early June	campestrian (tall)	Mexican U. Sonoran
Eremiacris virgata	Sept.-Oct.	campestrian (tall)	SW. Grasslands U. S.
Mermiria neomexicana	late July-Nov.	campestrian	L. & U.Sonoran
Mermiria texana	Sept.-Oct.	wet soil nr streams	U. pt. U. Sonoran
Bootettix argentatus	annual	thamnophilous (*Larrea*)	Chihuahuan L. S.
Pedioscirtetes maculipennis	July-Sept.	saxi-campestrian	Chihuahuan L. S.
Acrolophitus variegatus	June-Sept.	saxi-campestrian	SW. Grasslands U.S.
Syrbula fuscovittata	Aug.-Oct.	campestrian	SW. Grasslands U.S.
Syrbula admirabilis ?	Aug.-Oct.	campestrian	Upper S. (humid)
Opeia imperfecta	late June-Oct.	campestrian	SW. Grasslands U.S.
†*Amblytropidea mysteca*	May-early Jul.	campestrian (tall)	Mexican U. Sonoran
Amphitornus coloradus ?	July-Sept.	campestrian	N. Short Grlands Transit.
Eritettix variabilis	May-July	campestrian	SW. Grasslands U. S.
Phlibostroma 4-maculata	Sept.-Oct.	campestrian	N. Short Grlands Transit.
Cordillacris o. occipitalis	June-July	campestrian	S. Short Grasslands U. S.
Cordillacris c. crenulata	June-July	campestrian	S. S. Grasslands U. S.
Orphulella p. deserta	June-Aug.	campestrian	Humid U. & L. Sonoran
Acantherus piperatus	Aug.-Oct.	campestrian	Mexican L. Sonoran
Ageneotettix d. deorum	July-Oct.	campestrian	N. Short Grasslands T.
Psoloessa t. pusilla (atyp)	May-Sept.	campestrian	U. Sonoran, L. S. (pt.)
Psoloessa d. delicatula	May-June	campestrian (tall)	N. S. Grasslands & U. S.
†*Rhammatocerus v. viatoria*	Apr.-May	campestrian (tall)	Mexican U. Sonoran
Boopedon nubilum	Sept.-Oct.	campestrian	S. S. Grasslands U. S.
**Zapata brevipennis*	Sept.-Oct	deserticolous	Mexican L. Sonoran
‡*Heliaula rufa*	July-Oct.	saxi-campestrian	SW. Grasslands U. S.
Drepanopterna femoratum	July-Oct.	campestrian	S. Short Grasslands
Aulocare elliotti	June-Oct.	campestrian	N. S. Grasslands T.
Goniatron planum	July-Oct.	thamnophilous	Chihuahuan L. S.

OEDIPODINAE

Arphia crassa	Sept.-Oct.	campestrian (tall)	SW. Grasslands U. S.
Arphia aberrans	April-May	deserticolous	L. & U. Sonoran
Encoptolophus subgracilis	June-Oct.	campestrian (cul.)	L. Sonoran
Hippiscus rugosus	Sept.-Oct.	tall campestrian & oak sylvan	U. S. & Humid Carolinian
Xanthippus c. pantherinus	May-June	campestrian	SW. Grasslands U. S.
Leprus cyaneus	July-Oct.	campestrian (tall)	SW. Mtn. Transition
Leprus wheeleri	Aug.-Oct.	campestrian (tall)	Upper Sonoran
Tropidolophus formosus	Sept.-Oct.	on malvas	SW. Grasslands U. S.
Dissosteira carolina	July	terricolous (dust)	N. Short Grasslands T.
Dissosteira longipennis	July-Oct.	campestrian (tall)	S. Short Grasslands U. S.
Spharagemon b. inornatum	Sept.-Oct.	oak sylvan	SW. Mtn. Transition
Spharagemon c. cristatum	May-Oct.	arenicolous	Lower Sonoran
Platylactista aztecus	June-Oct.	des.-campestrian	Lower Sonoran
Derotmema h. mesembrinum	June-Oct.	terricolous	Chihuahuan L. S.
Trachyrhachis k. fuscifrons	Aug.-Oct.	campestrian	SW. Grasslands U. S.
Trachyrhachis aspera	Sept.-Oct.	campestrian	SW. Mtn. Transition
Rehnita capito	June-Sept.	des.-campestrian	SW. Grasslands U. S.
Mestobregma p. corrugatum	June-Sept.	campestrian	SW. Grasslands U. S.
Mestobregma terricolor	Aug.-Oct.	terricolous	Lower Sonoran

Trimerotropis texana	July-Sept.	saxi-arenicolous	Chihuahuan Lower S.
‡*Trimerotropis cyaneipennis*	Sept.-Oct.	semi-sylvan(mtn.)	SW. Mtn. Transition
Trimerotropis p. pallidipennis	annual	deserticolous	L. & U. Sonoran
Trimerotropis citrina	June-Oct.	arenicolous	Austroriparian
‡*Trimerotropis strenua*	July-Oct.	deserticolous	Lower Sonoran
Trimerotropis pistrinaria	July-Oct.	deserticolous	U.S. & N. Short Grasslds.
Trimerotropis lacticincta	July-Oct.	campestrian	SW. Grasslands U. S.
Trimerotropis latifasciata	Aug.-Oct.	deserticolous	Lower Sonoran
Trimerotropis melanoptera	Aug.-Oct.	campestrian (tall)	SW. Grasslands U. S.
Trimerotropis magnifica	July-Oct.	campestrian (tall)	SW. Grasslands U. S.
Hadrotettix trifasciatus	July-Oct.	saxi-campestrian	N. Short Grasslands
Anconia hebardi	Apr.-May	saxi-arenicolous	Chihuahuan L. S.
Cibolacris p. aridus	May-Nov.	saxicolous	Lower Sonoran
‡*Heliastus benjamini*	Sept.-Oct.	saxicolous	Mexican U. S.
		PAMPHAGINAE	
Phrynotettix robustus	May-Nov.	deserticolous	Chihuahuan L. S.
Phrynotettix tschivavensis	June-Oct.	saxi-campestrian	Chihuahuan U. S.
		ROMALEINAE	
Brachystola magna	Sept.-Nov.	campestrian	S,Short Grasslands U. S.
Taeniopoda eques	Sept.-Nov.	thamnophilous	L. Sonoran (restricted)
		CYRTACANTHACRINAE	
†*Clematodes larreae*	May-Nov.	thamnophilous	Mexican L. S.
Schistocerca v. vaga	Sept.-May	d.-thamnophilous	L. Sonoran
Schistocerca a. americana	June-Dec.	campestrian (tall)	Austroriparian
Schistocerca shoshone	Aug.-Nov.	thamnophilous	Upper Sonoran
Schistocerca lineata	Sept.-Nov.	semi-oak-sylvan	N. Short Grasslands T.
§*Schistocerca chinatiensis* n. sp.	Sept.-Nov.	thamnophilous	Chihuahuan U.S.
**Netrosoma nigropleura*	Sept.-Nov.	des.-campestrian	Chihuahuan L. S.
**Philocleon nigrovittata*	July-Nov.	des.-campestrian	Tamaulipan S-D Bushland
Phaedrotettix d. palmeri	Aug.-Oct.	campestrian	Chihuahuan U. S.
Phaulotettix eurycercus	Aug.-Nov.	thamnophilous	Chihuahuan L. S.
Agroecotettix m. crypsidomus	July-Nov.	thamnophilous	Chihuahuan U. S.
Camplycantha o. vivax	July-Nov.	thamnophilous	Chihuahuan L. S.
Aeoloplus elegans	June-Sept.	thamnophilous	Chihuahuan L. S.
Hesperotettix v. viridis	June-Oct.	thamnophilous	SW. Grasslands U. S.
Melanoplus aridus	June-Oct.	thamnophilous	L. S., U. S., Transition
‡*Melanoplus desultorius*	Aug.-Nov.	campestrian	SW. Grasslands U. S.
Melanoplus glaucipes	July-Nov.	thamnophilous	U. S. (humid)
Melanoplus thomasi	Sept.-Nov.	campestrian	SW. Grasslands U. S.
Melanoplus d. nigricans	Sept.-Nov.	forage crops	L. S., U. S. (cultivated)
Melanoplus lakinus	July-Nov.	campestrian	S. Short Grassland U. S.
Melanoplus eumera	Aug.-Nov.	campestrian (tall)	Chihuahuan U. S.
Melanoplus gladstoni	Sept.-Nov.	campestrian	N. St. Grasslands Trans.
Melanoplus arizonae	July-Nov.	campestrian	SW. Grasslands U. S.
Melanoplus regalis	July-Oct.	campestrian	SW. Grasslands U. S.
Melanoplus o. occidentalis	June-Oct.	campestrian	S. Short Grasslands U. S.
Melanoplus herbaceus?	July-Oct.	thamnophilous	Lower Sonoran
Melanoplus f. elongatus	July-Oct.	thamnophilous	Upper Sonoran?
Melanoplus b. propinquus	July-Oct.	thamnophilous	Lower Sonoran
Melanoplus f-r. femur-rubrum?	July-Dec.	campestrian	Transition
Melanoplus m. mexicanus?	July-Nov.	campestrian	Transition & Boreal
Photaliotes nebrascensis	Aug.-Nov.	campestrian	N. Short Grasslands T.
Dactylotum variegatum	July-Oct.	des.-campestrian	Upper Sonoran
		TETTIGONIIDAE	
		PHANEROTROPINAE	
Dichopetala oreoeca	Sept.-Oct.	thamnophilius	Chihuahuan U. S.
Dichopetala brevihastata	July-Oct.	thamnophilius	Chihuahuan L. S.
Arethaea semialata	Sept.-Oct.	thamnophilius	Chihuahuan U. S.
Arethaea arachnopyga	Sept.-Oct.	thamnophilius	Chihuahuan U. S.
§*Arethaea g. cerciata*	Sept.-Oct.	thamnophilius	Chihuahuan U. S.
Insara e. elegans	June-Oct.	thamnophilius	Lower Sonoran
Scudderia f. furcifera	Aug.-Nov.	thamnophilius	L. & U. Sonoran
Amblycorypha huasteca	Aug.-Oct.	thamnophilius	Lower Sonoran(humid)
Amblycoryhpa insolita	Aug.-Oct.	thamnophilius	Mexican Upper Sonoran
Microcentrum rhombifolium	Aug.-Nov.	arboreal	Lower Sonoran

	PSEUDOPHYLLINAE		
Paracyrtophyllus excelsus	July-Oct.	arboreal (oaks)	Chihuahuan U. S.
	COPIPHORINAE		
Neoconcephalus r. crepitans	Sept.-Nov.	campestrian (tall)	Upper Sonoran (humid)
Neoconocephalus triops?	Sept.-May	thamnophilous	Lower Sonoran
	CONOCEPHALINAE		
Orchelimum c. concinnum	Aug.-Nov.	thamnophilous	Upper Sonoran (humid)
Conocephalus strictus	Aug.-Oct.	campestrian (tall)	Upper Sonoran
Conocephalus f. fasciatus?	Aug.-Oct.	campestrian	Transitional
	DECTICINAE		
Capnobotes fuliginosus	July-Oct.	thamnophilous	Lower Sonoran
Rehnia cerberus	Sept.-Nov.	thamnophilous	Chihuahuan L. S.
Rehnia victoriae	Aug.-Oct.	thamnophilous	Tamaulipan S-D Bushland
§*Pediodectes tinkhami*	Aug.-Oct.	deserticolous	Chihuahuan L. S.
Pediodectes bruneri	Sept.-Nov.	campestrian (tall)	Upper Sonoran (humid)
Eremopedes scudderi	July-Nov.	thamnophilous	Chihuahuan L. S.
§*Eremopedes covilleae*	July-Oct.	thamnophilous	Chihuahuan L. S.
	GRYLLACRIDIDAE		
	RHAPHIDOPHORINAE		
Ceuthophilus variegatus	July-Oct.	deserticolous	Chihuahuan L. S.
Ceuthophilus pallidus	Aug.-Oct.	terricolous	N. Short Grasslands T.
Ceuthophilus isletae	Sept.-Oct.	troglodytic	SW. Mtn. Transition
Ceuthophilus rehni	Aug.-Oct.	troglodytic	Chihuahuan U. S.
Ceuthophilus polingi	Sept.-Oct.	troglodytic	Chihuahuan U. S.
Ceuthophilus carlsbadensis	Sept.-Jan.	cavernicolous	Chihuahuan U. S.?
§*Ceuthophilus utahensis*	Sept.-Oct.	troglodytic	SW, Mtn. Transition
Ceuthophilus conicaudus	Sept.-Oct.	troglodytic	?
	GRYLLULIDAE		
	GRYLLULINAE		
Gryllulus assimilis	July-Oct.	des.-campestrian	L. & U. S. & Trans.
Miogryllus lineatus?	Aug.-Oct.	campestrian	Lower Sonoran
	NEMOBIINAE		
Nemobius c. neomexicanus	Aug.-Oct.	campestrian	Lower and U. Sonoran
N. cubensis mormonius?	Aug.-Oct.	campestrian	Lower Sonoran
	OECANTHINAE		
Oecanthus californicus	Sept.-Oct.	thamnophilous	Lower Sonoran
Oecanthus sp.	Sept.-Oct.	thamnophilous	Lower Sonoran
	MOGOPLISTINAE		
Cycloptilum c. fortior	Aug.-Oct.	thamnophilous	Lower Sonoran
Cycloptilum c. comprehendens	Aug.-Oct.	thamnophilous	Upper Sonoran (humid)
Haplosphyrum boreale	Sept.-Nov.	troglodytic	Lower Sonoran

Conclusions

The above list of one hundred and fifty known species and of nine additional species that should be found, testify to the remarkable orthopteran fauna that has developed in the Big Bend Region of Trans-Pecos Texas. This is due to the geographical setting of the Big Bend Region which is so situated that the Davis Range with its grassy valleys on the north has much the same faunal elements as the Great Plains and the Rocky Mountain region to the north while the Chisos Mountains show a strong influx of more eastern species which reach their western limits of distribution on the eastern border of the Big Bend in eastern Brewster County and the Chisos. The Chinati Mountains in the southern part of Presidio County and at least 75 miles northwest of the Chisos, due to their different floristic features and limestone formation, possess elements of a Mexi-

can Lower Sonoran fauna not found elsewhere in the entire United States. In addition the Chinatis have representatives of a Mexican Upper Sonoran fauna found for the first time east of south-central Arizona. The result is an area exhibiting interwoven and superimposed faunae that make this Big Bend Region of Trans-Pecos Texas one of the richest and most remarkable in the United States.

This entire treatise has been graphically condensed into a faunistic-floristic transect of Presidio and Jeff Davis counties which is presented in the body of this report (Fig. 23). This transect represents a 100 mile section running from the Rio Grande Valley at Presidio, across the Chinati Mountains and the Marfa grasslands of Presidio County to the northern slopes of Mt. Livermore of the Davis Mountains in Jeff Davis County. On this transect graph the vegetational types of the Big Bend Region are roughly typified by certain designated symbols which are used to indicate the various floral types upon which the faunal zones and their component faunae are based. It was not deemed necessary to produce a similar transect crossing the Chisos Mountains northward through Brewster County.

In the summary a map of the Orthopteran faunal zones of Midwestern North America presents in a geographical plane the composite distribution of the various zones and faunae as depicted in the faunistic-floristic transect of this region.

Careful notes on the biology, habit, song, and host plant of each orthopteran species have been presented whenever possible.

A detailed study of each individual species of Orthoptera, its biology and zoogeography, has made it possible to assign most of the 150 species of Big Bend Orthoptera to the various faunae characterizing and composing the Lower and Upper Sonoran and Transition Faunal Zones of the Austral Faunal Region of Midwestern North America.

It is hoped that this contribution, the result of several years collecting and further years of study, preparation and writing, will fill a gap in our knowledge of one of the largest and most remarkable, yet little known areas, of the Southwestern desert regions.

REFERENCES

ALEXANDER, GORDON 1941—Keys for the identification of Colorado Orthoptera. Univ. of Colo. Studies, Series D, 1(3): 129-164, 4 figs.

BALL, E. D., E. R. TINKHAM, ROBERT FLOCK AND C. T. VORHIES 1942—The Grasshoppers and other Orthoptera of Arizona. Univ. of Ariz., Tech. Bull. 93: 257-373, pls. I-IV, 11 figs. (93 illus.).

BEAMER, RAYMOND 1917—The grasshoppers of Kansas: Part II. The Oedipodinae of Kansas. Bull. Univ. Kansas, Biol. Ser., 18: 51-126, illus.

BENSON, LYMAN 1941—The mesquite and screw-beans of the United States. Amer. Jour. Bot., 28: 748-754, map, 1 pl.

BIBBY, F. F. 1931—Coccoids collected on wild plants in semi-arid regions of Texas and Mexico (Homoptera). Jour. N. Y. Ent. Soc., vol. 39.

BUCKELL, E. R. 1922—British Columbia Orthoptera. Proc. Ent. Soc. Br. Col., No. 20, Syst. Ser., 12-41.

———1924—Additions and corrections to the list of British Columbia Orthoptera. Proc. Ent .Soc. Br. Col., 22: 7-12.

CARTER, W. T. AND V. L. CORY 1930-31—Soils of Trans-Pecos Texas and some of their Vegetative relations. Trans. Texas Acad. Sci., 15: 19-37.

CAUDELL, A. N. 1903—Two Orthoptera hitherto unrecorded from the United States. Proc. U. S. Nat. Mus., no. 1378, 27: 949-952.

———1904—Orthoptera from Southwestern Texas. Mus. Brookl. Inst. Arts and Sci., Bull., 1: 105-116, 6 pls.

———1907—The Decticinae of North America. Proc. U. S. Nat. Mus., no. 1530, 32: 285-410.

CORY, V. L. 1930—Contributions to the family Liliaceae. Bull. Sul Ross State Teachers College. No. 3: 32-36.

COTTLE, H. J. 1931—Studies in the Vegetation of Southwestern Texas. Ecology, 12(1): 105-156, 47 figs.

DUNCAN, CARL D. 1924—Spiracles as sound producing organs. Pan. Pac. Ent., 1: 42-42.

FLETCHER, HENRY T. 1928—Notes on the vegetation of the Green Valley region. Bull. Sul Ross State Teachers College. No. 2: 6-49.

———1930—Notes on the Ethnobotany of Bee Canyon. Ibid., No. 3: 37-44.

FOX, HENRY 1917—Field notes on Virginia Orthoptera. Proc. U. S. Nat. Mus., no. 2176, 52: 199-234.

GURNEY, A. B. 1940—A revision of the grasshoppers of the genus *Orphulella* Giglio-Tos from America north of Mexico (Orthoptera: Acrididae). Ent. Amer., 20: 85-157, illus.

HEBARD, MORGAN 1917—Notes on Mexican Melanopli (Orth.; Acrididae). Proc. Acad. Nat. Sci. Phila., 79: 251-257.

———1918—New Genera and Species of Melanopli found within the United States (Orth.; Acrididae). Trans. Amer. Ent. Soc., 44: 141-169.

———1919—New Genera and Species of Melanopli found within the United States (Orth.; Acrididae). Part II. Ibid., 45: 257-298.

———1920—Revisionary studies in the genus *Arenivaga* (Orth.; Blatt.; Polyphaginae). Ibid., 46: 197-217.

———1922a—New Genera and Species of Melanopli found within the United States (Orth.; Acrididae). Part III. Ibid., 46: 355-403.

———1922b—New Genera and Species of Melanopli found within the United States and Canada (Orth.; Acrididae). Part IV. Ibid., 48: 49-66.

———1922c—North American Acrididae (Orthoptera). Papers 1 & 2. Ibid., 48: 89-108.

———1922d—Dermaptera and Orthoptera from the state of Sinaloa, Mexico. I (Derm.; and non-Saltatorial Orth.). Ibid., 48: 157-196.

———1923—North American Acrididae (Orthoptera). 3. A study of the Ligurotettigi. Ibid., 49: 43-92, pls. 6-7.

———1924—The group Scyllinae as found in North America with records and data on its occurrence in the United States (Orth.). Ibid., 50: 157-165.

———1924b—A revision of the genus *Taenipoda* (Orth.; Acrididae; Cyrtacanthacrinae). Ibid., 50: 253-274.

———1925a—The group Taeniopodae as found in the United States (Orth.). Ibid., 51: 1-12.

———1925b—The Orthoptera of South Dakota. Proc. Acad. Nat. Sci. Phila., 77: 33-155.

———1925c—Dermaptera and Orthoptera from the state of Sinaloa, Mexico. 2. Saltatorial Orthoptera. Trans. Amer. Ent. Soc., 51: 265-310.

———1926—Key to the North American genera of the Acridinae which occur north of Mexico (Orth.; Acrididae). Ibid., 52: 47-59.

———1928—The Orthoptera of Montana. Proc. Acad. Nat. Sci. Phila., 80: 211-306.

———1929—The Orthoptera of Colorado. Ibid., 81: 303-425.

———1930—The Orthoptera of Alberta. Ibid., 82: 377-403.

———1931a—The Orthoptera of Kansas. Ibid., 83: 119-227.

———1931b—Studies in Lower California Orthoptera. Trans. Amer. Ent. Soc., 57: 113-127.

———1931c—The races of *Diapheromera veliei* (Orth.; Phasmidae; Heteronemiinae). Ent. News, 42: 65-67.

———1931d—The Mogoplistinae of the United States (Orth.; Gryllidae). Trans. Amer. Ent. Soc., 57: 135-160.

———1932a—The Orthoptera of Minnesota. Univ. Minn. Agric. Exp. Sta. Tech. Bull. 85: 1-611.

———1932b—New species and records of Mexican Orthoptera. Trans. Amer. Ent. Soc., 58: 201-371, pls. 17-22.

———1932c—Notes on Montana Orthoptera. Proc. Acad. Nat. Sci. Phila., 84: 251-257.

———1934a—The Dermaptera and Orthoptera of Illinois. Ill. State Nat. Hist. Surv. Bull., 20: 125-279, illus.

———1934b—Studies in Orthoptera which occur in North America North of the Mexican Boundary. III. Revisionary Data and new North American Decticinae. Trans. Amer. Ent. Soc., 60: 31-54, pls. 2-3.

———1935a—Orthoptera of the upper Rio Grande Valley and the adjacent mountains in northern New Mexico. Proc. Acad. Nat. Sci. Phila., 87: 45-82.

———1935b—Studies in the Orthoptera of Arizona. I. New genera, species and races. Trans. Amer. Ent. Soc., 61: 111-153, pls. 4-7.

———1935c—Studies in the Orthoptera of Arizona. II. A list of the Dermaptera and Orthoptera with new records and corrections of the literature subsequent to 1909. Ibid., 61: 269-316.

———1936a—Studies in Orthoptera which occur in North America north of the Mexican Boundary. 6. Revision of the genus *Arethaea* (Tettigoniidae: Phanerotropinae). Ibid., 62: 231-256, illus.

———1936b—The Orthoptera of North Dakota. North Dakota Agric. Exp. Sta. Tech. Bull. 284: 1-69.

———1937—Studies in Orthoptera which occur in North America north of the Mexican boundary. 9. On *Arphia conspersa*, notes and a new species of *Spharagemon*, a new genus and its races of the group Heliasti and a new generic name for the group Anconiae (Oedipodinae, Acrididae). Trans. Amer. Ent. Soc., 63: 361-379, pls. 12-13.

———1939—An ecological survey of the Orthoptera of Oklahoma. Okla. Agric. Exp. Sta. Tech. Bull. 5: 1-31.

———1941—The group Pterophyllae as found in the United States (Orthoptera: Tettigoniidae). Trans. Amer. Ent. Soc., 67: 197-319, pls. 18-19.

———1943—The Dermaptera and orthopterous families Blattidae, Mantidae and Phasmidae of Texas. Ibid., 68: 239-311, pls. 12-13.

HENDERSON, W. W. 1924—A taxonomic and ecological study of the species of the subfamily Oedipodinae (Orth.; Acrididae) found in Utah with a summary of world distribution and a list of Orthoptera recorded from the state. Utah Agric. Exp. Sta. Tech. Bull. 191, 150 pp., illus.

———1931—Crickets and Grasshoppers in Utah. Utah Agric. Exp. Sta. Cir. 96, 37 pp., illus.

HINCKLEY, L. C. 1944—The Vegetation of the Mount Livermore area in Texas. Amer. Midl. Nat. 32(1): 236-250, 5 figs.

HITCHCOCK, A. S. 1935—Manual of the Grasses of the United States. U. S. Dept. Agric. Misc. Publ. 200.

HUBBELL, T. H. 1922—The Dermaptera and Orthoptera of Berrien County, Michigan. Univ. Mich. Occas. Papers, Mus. Zool., no. 116.

———1936—A monographic revision of the genus Ceuthophilus. Univ. Fla. Publ. vol. 2, no. 1, 551 pp., illus.

HUBBELL, T. H. AND A. I. ORTENBURGER 1926—Notes on Oklahoma Orthoptera with a list of species from the state. Proc. Okla. Acad. Sci., 6: 149-183.

ISELY, F. B. 1937—Seasonal succession, soil relations, numbers, and regional distribution of northeastern Texas acridians. Ecol. Monogr. 7: 318-344.

———1938—The relations of Texas Acrididae to plants and soil. Ecol. Monogr. 8: 551-604.

MCNEILL, Jerome 1901—Revision of the Orthopterous genus *Trimerotropis*. Proc. U. S. Nat. Mus., 23: 393-450, no. 1215.

PARKER, J. R. 1930—Some effects of temperature and moisture upon *Melanoplus mexicanus* Saussure and *Camnula pellucida* Scudder (Orthoptera). Montana Agric. Exp. Sta. Bull. 223: 1-132.

REHN, JAMES, A. G. 1904a—Notes on Orthoptera from northern and central Mexico. Proc. Acad. Nat. Sci. Phila., 56: 513-549.

———1904b—Notes on Orthoptera from Arizona, New Mexico and Colorado. Ibid., 56: 562-575.

———1907—Notes on Orthoptera from southern Arizona with descriptions of new species. Ibid., 59: 24-81.

———1919—Descriptions of new and critical notes upon previously known forms of North American Oedipodinae (Orth.; Acrididae). First Paper. Trans. Amer. Ent. Soc., 45: 229-255, pl. 26, col. pl. 27.

———1942—On the locust genus *Psoloessa* (Orth.; Acrid.; Acridinae). Trans. Amer. Ent. Soc., 68: 167-237, illus.

REHN, JAMES, A. G. AND HEBARD MORGAN 1906—A contribution ot the knowledge of the Orthoptera of Montana, Yellowstone Park, Utah and Colorado. Proc. Acad. Nat. Sci. Phila., 58: 358-418.

———1908—An orthopterological reconnoissance of the southwestern United States. I. Arizona. Ibid., 60: 365-402.

———1909a—An orthopterological reconnoissance of the southwestern United States. II. New Mexico and western Texas. Ibid., 61: 111-175.

———1909b—An orthopterological reconnoissance of the southwestern United States. III. California and Nevada. Ibid., 61: 409-483.

———1912—Fixation of single type (Lectotypic) specimens of species of North Amer-

ican Orthoptera. Ibid., 64: 60-128.

———1914—A study of the species of the genus *Dichoptela* (Orth.; Tettigoniidae). Ibid., 76: 64-160.

———1920—Descriptions of New Genera and Species of North American Decticinae (Orth.; Tettigoniidae). Trans. Amer. Ent. Soc., 46: 225-265.

———1925—Distributional notes on North American Orthoptera. Fla. Ent., 41-45.

ROBERTS, H. RADCLIFFE 1941a—A comparative study of the subfamilies of the Acrididae (Orthoptera) primarily on the basis of their phallic structures. Proc. Acad. Nat. Sci. Phila., 93: 201-246, 90 figs.

———1941b—Nomenclature in the Orthoptera concerning Genotype designations. Trans. Amer. Ent. Soc., 67: 1-34.

———1942—Two subspecies of *Melanoplus differentialis* and related new species from Mexico with discussion of their variations (Orth.; Acrididae: Crytacanthacridinae). Ibid., 68: 151-166.

SCHULTZ, ELLEN D. AND ROBERT RUNYON 1930—Texas Cacti. Texas Acad. Sci., vol. 14, 181 pp., illus.

SCUDDER, SAMUEL H. 1898—Revision of the orthopteran group Melanopli (Acrididae) with special reference to North American forms. Proc. U. S. Nat. Mus., 20: 1-421, pls. 1-26. No. 1124.

SHREVE, FORREST 1939—Observations on the vegetation of Chihuahua. Modroño 5(1): 1-13. Pls. 1-3 with 6 figs.

———1942—The desert vegetation of North America. Bot. Review, 8(4): 195-246, 1 map.

SPERRY, OMER E. 1938— A check list of the Ferns, Gymnosperms, and Flowering Plants of the proposed Big Bend National Park of Texas. Bull. Sul Ross State Teachers College, 19(4): 9-98, 1 map, 1 fig.

———1941a—Additions to the check list of plants of the proposed Big Bend Park area. Ibid., 22(1): 9-16.

———1941b—Plants of Brewster County, Texas. Ibid., 22(1): 17-60, 1 fig.

TINKHAM, ERNEST R. 1934—The Dragonfly Fauna of Presidio and Jeff Davis Counties of the Big Bend Region of Trans-Pecos Texas. Can. Ent., Oct., pp. 213-218.

———1938—Western Orthoptera attracted to light. Jour. N. Y. Ent. Soc., 46: 339-353.

———1939—Five new records and notes on Canadian Acrididae from the Higdon Ranch, southeastern Alberta. Can. Ent., 71: 121-126.

———1940—Taxonomic and Biological Studies on the Cyrtacanthacrinae of South China. Ling. Sci. Jour., 19(3): 269-382. Pls. 10-16, 13 figs.

———1941—Biological and Faunistic notes on the Cicadidae of the Big Bend Region of Trans-Pecos Texas. Jour. N. Y. Ent. Soc., 49; 165-183. Pl. VI, 3 figs. Figs. 1-2.

———1942—The rediscovery of *Anoplodusa arizonensis* (Orthoptera) Bull. Chicago Acad. Sci., 6(12): 221-227, 2 figs.

———1944—Biological, Taxonomic and Faunistic studies on the Shield-back Katydids of the North American Deserts. Amer. Midl. Nat. 31(2): 257-328, 28 figs.

UVAROV, B. P. 1943—The tribe Thrinchini of the subfamily Pamphaginae, and the interrelations of the Acridid subfamilies (Orthoptera). Trans. Roy. Ent. Soc. London, 93(1): 1-72, 73 figs.

INDEX