THE ECOLOGY AND DISTRIBUTION OF THE
RODENTS OF NORTHERN MOHAVE
COUNTY, ARIZONA

by

Thomas Reed Darden

A Thesis Submitted to the Faculty of the
DEPARTMENT OF ZOOLOGY
In Partial Fulfillment of the Requirements
For the Degree of
MASTER OF SCIENCE
In the Graduate College
THE UNIVERSITY OF ARIZONA

1965
STATEMENT BY AUTHOR

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APPROVAL BY THESIS DIRECTOR

This thesis has been approved on the date shown below:

E. LENDELL COCKRUM
Professor of Zoology

19 July 1965
ACKNOWLEDGMENTS

I would especially like to acknowledge Dr. E. Lendell Cockrum for continued encouragement and assistance, both with the field work and the actual writing of this thesis. Thanks is also due Wade C. Sherbrooke for his assistance and companionship during the three months of field work. I wish to thank Jerry L. Osborne and Alfred L. Gardner for preparation and identification of many of the specimens. I am also indebted to my wife, Ruth, for her patient understanding and assistance during the final preparation of this manuscript. This investigation was supported in part by a grant from the Arizona Natural History Survey.
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ABSTRACT

The ecology and distribution of each rodent subspecies in northern Mohave County, with regard to Life Zone, plant associations and substrate, is the primary concern of this investigation.

Citellus leucurus escalante, Dipodomys merriami merriami, and Castor canadensis ssp. are reported from the area for the first time.

The ranges of Perognathus penicillatus sobrinus, Perognathus formosus formosus, Perognathus longimembris arizonensis, Onychomys leucogaster melanophrys, Peromyscus eremicus eremicus, and Peromyscus boylii utahensis were found to be more extensive than previously reported.

Local distribution of rodents is effected more by soil type than plant type. Also preference for a particular soil type appears to be a major factor in niche separation.

The Grand Wash Cliffs and Virgin Mountains act as an isolating barrier and have functioned as a speciating mechanism within the area.
INTRODUCTION

This thesis presents the results of a study of the geographical and ecological distribution and the taxonomic status of the rodents occurring north of the Colorado River in Mohave County, Arizona.

It is based on data obtained during eight weeks of field observations and collections made in Mohave County between July 1 and August 31 of 1964, and the subsequent examination of these and other specimens in the Mammal Collection, Department of Zoology, the University of Arizona.

John W. Powell in 1869 was the first to descend the Colorado River through the Grand Canyon (Powell, 1875). He explored much of the Strip country (a colloquial name used to describe that area of Arizona north of the Colorado River) and was responsible for the description and naming of many of the geological features in the area. Since then the geology of the region has been well studied, but biological investigations have been limited.

Studies of the mammalian fauna began with United States Biological Survey collections made by Vernon Bailey in 1889 (Bailey, 1935) and A. E. Goldman in 1922 and 1931 (Goldman, 1932). In 1933, Miss Annie M. Alexander
and Miss Louise Kellogg collected the Mohave portion of the Strip for the University of California (Benson, 1934). In 1935 Vernon Bailey wrote the *Mammals of the Grand Canyon*. This is the first and only attempt to summarize the information available concerning the distribution, taxonomy and ecology of the species occurring adjacent to and within the canyon system of Arizona. The last major collecting trip was made by personnel of the United States Biological Survey in 1936.

Cockrum (1960) reviewed the distribution and taxonomy of the mammals of Arizona. It can be surmised from this summary that the Mohave County portion of the Strip was notably lacking in recent investigations, that many forms were known only from type localities, that many disjunct distributions appeared to exist and that the actual number of collecting localities were far too few to draw meaningful conclusions concerning the mammals of the region. More recently, collectors from the Museum of Natural History at the University of Illinois have worked in the area (Hoffmeister and Nader, 1963). Their studies have aided in clearing up some of the distributional questions.
DESCRIPTION OF AREA AND PROCEDURES

The area in which this study was made lies in the extreme northwestern portion of Arizona. It is bordered on the west and north by the Arizona state line, on the east by the boundary between Mohave and Coconino counties and on the south by the Grand Canyon of the Colorado River (Fig. 1).

Geology

Physiographically the area includes parts of two provinces. The eastern portion, from the Grand Wash Cliffs to Kanab Canyon, is a division of the Colorado Plateau Province. The smaller portion, situated west of the Grand Wash Cliffs belongs to the Basin and Range Province.

The Colorado Plateau area has been described as "consisting of great rock terraces that rise one above the other as a series of broad steps leading up from the Grand Canyon to the High Plateau of Utah." (Gardner, 1941:244). Only one of the north-south series of steps falls within Arizona. This "great rock terrace" is divided by a series of faults and monoclines which tend roughly to parallel the Hurricane ledge (Fig. 1). There are two main fault scarps which are of interest to the biologist. The first, Grand Wash Cliffs, transects the area from north to south as a
series of two towering cliffs (Upper and Lower Grand Wash Cliffs) which range from 1,500 to 2,000 feet in total height (Longwell, 1928:126). This series of cliffs differs from the Hurricane Cliffs (see below) in that many canyons penetrate the walls and lead up to the Shiwwits Plateau. The second scarp, the Hurricane Cliffs (ledge) separates the Shiwwits Plateau on the west from the Uinkaret Plateau on the east. It ranges from 1,500 to 1,800 feet high in a single essentially canyonless wall stretching from the Grand Canyon north into Utah (Koons, 1945:156).

The average elevation of the Plateau portion is approximately 5,000 feet. This ranges from about 6,000 feet near the rim of the Grand Canyon to 4,000 feet along the Utah border. A notable exception is Mount Trumbull, at the south end of the Uinkaret Plateau, which attains a height of 8,028 feet (Moore, 1958:9).

The Basin and Range province comprises less than one quarter of the area west of the Grand Wash Cliffs. This province has been characterized by north-south trending fault-block mountains and ridges separated by broad alluvial valleys and basins (Gardner, 1952). In the study area, the Basin and Range province may be divided into two principle regions: the Grand Wash region and the Virgin Mountain region. The former, as the name implies, consists of a myriad of broad, rocky washes crisscrossing and being eroded through a ten to twelve mile wide valley which
terminates at Lake Mead (Longwell, 1928:109). The Virgin Mountains and their associated alluvial fans and the Virgin River valley occupy the extreme northwestern tip of Arizona. The Virgin River, which originates in Utah, cuts through the Virgin Mountains forming the Virgin River Narrows (Fig. 9). The Basin and Range province also extends into the Strip east of the Virgin Mountains and north of Segmuller and Wolf Hole Mountain in the area of St. George Utah. The relief in this province is fairly great, ranging from a high of 8,350 feet attained by Mt. Bangs in the Virgin Mountains, to a low of 1,200 feet at the surface of Lake Mead.

Volcanic activity has played an important role in the physical appearance of the area, especially in the Mt. Trumbull area. Basaltic lava flowed from Mt. Trumbull and 160 associated craters primarily during the Miocene epoch (Koons, 1945:160). These flows contributed to the formation of the Mt. Trumbull, Mt. Logan and Mt. Emma group and also to the development of the Toroweap Valley. The latter was evidently formed first by the damming of "Toroweap Canyon" by Vulcans Throne (a large volcanic cinder cone) and secondly by subsequent filling thereof with additional lava. Finally, the "Canyon" was filled with erosion products to form the present-day alluvial valley (McKee, 1938).

The Virgin Mountains, although fault-block in origin, experienced some volcanic action in the late Miocene or
early Pliocene. All of these areas are characteristically strewn with dark brown to black lava rock.

**Climate**

Sellers (1960) designates the Mohave County portion of the Strip as Northwest with regard to climate, topography and vegetation. Table 1 lists the monthly mean, mean maximum and mean minimum temperatures for the four recording stations. These data are divided according to Great Basin Desert and Mohave Desert.

The mean temperature for the Great Basin area was calculated and compared with the means for the three recording stations. Colorado City's mean most closely resembled the overall mean. This station (as the most typical) was therefore chosen for comparison with Littlefield (the only Mohave Desert station). As seen in Figure 2a, the mean temperature on the Mohave Desert averages six to twelve degrees higher throughout the year. The range of temperatures (Table 1) is very similar between the two desert regions. However, the Mohave Desert records the highest maximums whereas the Great Basin Desert records the lowest minimums.

Figure 2b compares the monthly rainfall for Tuweep (its monthly mean most closely resembles the Great Basin Desert mean as above) and Littlefield. The Great Basin's total average yearly rainfall is ten inches as compared
TABLE 1. The monthly mean, mean maximum and mean minimum temperatures for the four recording stations in the study area appear below. Fredonia is included due to its proximity to the study area (Fig. 1). Temperature records for Mt. Trumbull are not available. These data were compiled from U.S. Weather Bureau Bulletin, Climatological Data.

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Fredonia (5,000 ft.)

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Tuweep (4,775 ft.)

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Colorado City (5,010 ft.)

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Fig. 2a A graphical representation of the mean monthly temperature for Littlefield on the Mohave Desert and Colorado City on the Great Basin Desert.

Fig. 2b A graphical representation of the mean monthly precipitation of Littlefield (Mohave Desert) and Colorado City (Great Basin Desert). See text for explanation.
Mean monthly precipitation (in) temperature (°F)

- Littlefield
- Colorado City

Juweep

Tuweep

Littlefield
with the Mohave Desert total of six and one-half inches. The difference falling primarily during July and August (Table 2).

The overall pattern of rainfall, with the exception of total precipitation, is similar for both deserts. November through March represents the winter rains; April, May and June the spring dry spell; July and August, the summer rains; and September and October, the fall dry spell.

The climograph (Fig. 3) again compares the two deserts with regard to both mean precipitation and mean temperature. The only major divergence appears in the summer months. The total rainfall is less and the average temperature higher in the Mohave Desert during these months. These extreme arid conditions occur during the reproductive season of most of the area's plants and animals. These conditions contribute to the floral and faunal differences existing between the two deserts by acting as limiting factors to distribution.

**Life Zones and Associated Flora**

The life-zone system, proposed by C. Hart Merriam in 1889 and followed by many other biologists in Western North America, can easily be applied to northern Mohave County. Based on Lowe's (1963) description of the life zones in Arizona, three zones, Upper Sonoran, Lower Sonoran and Transition, may be assigned to the area.
TABLE 2. The mean monthly rainfall (in inches) data for the five recording stations discussed in the text appear below.

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Fig. 3 Temperature-precipitation climograph comparing Tuweep from the Great Basin Desert and Littlefield in the Mohave Desert. Only the summer months (June, July, August and September) show extreme divergence.
The Lower Sonoran Zone occurs west of the Grand Wash Cliffs and within the Basin and Range Province. It lies below an elevation of between 3,800 feet and 4,200 feet depending upon slope exposure. This area is considered to be part of the Mohave Desert (Lowe, 1963:36), the major portion of which lies in California.

The flora of the Mohave Desert, as all other North American deserts, is predominantly shrubby in form. Shreve (1942:221) described the Mohave Desert in California as exhibiting a "poor display of life forms, simple composition of most of its communities, and strong control of the distribution of its vegetation by the texture and salt content of the soil".

The dominant plant association of the Grand Wash is creosote bush (Larrea divaricata) and bur sage (Franseria dumosa). This association (Fig. 9) is more common in gravelly (as opposed to sandy) well drained soils where the salt content is low (Hardy, 1945:86).

The Joshua tree (Yucca brevifolia) association type (Fig. 8) exhibits the greatest variety of plant species. It is restricted to alluvial fans of the Virgin Mountains and is found in gravelly, well-drained soils. Associated plants include Franseria dumosa, Ephedra nevadensis, Larrea divaricata, bladder sage (Salazaria mexicana), Yucca baccata, Yucca mohavensis, and Opuntia sp.

The blackbush (Coleogyne ramosissima) association
type forms a transition community between the creosote (Larrea) and sage brush (Artemisia) associations. It exists in coarse soils of low salt content between 3,700 and 4,000 feet (Shreve, 1942). Snakeweed (Gutierrezia lucida), Yucca baccata and Y. mohavensis are the most commonly associated plants.

The saltbush or shadscale (Atriplex confertifolia) association type forms on flat areas which are high in salt content. This type is more typical of the Great Basin Desert but occurs in the Lower Grand Wash and St. George areas.

In northern Mohave County, the Riparian community association is present only in the Lower Sonoran Life Zone. This association is found primarily along the banks of the Virgin River and Beaver Dam Wash. The cottonwood (Populus fremonti) and the desert willow (Chilopsis linearis) form the broad leaf canopy with tamarisk (Tamarix gallica) and arrow weed (Pluchea sericea) forming part of the dominant understory. Tassi and Pakoon Springs also support Riparian associations in the Grand Wash area.

The Upper Sonoran Life Zone encompasses approximately three-fourths of northern Mohave County. The two dominant vegetation associations present are the Great Basin (Desert) scrub and the juniper-pinyon woodland (Lowe, 1963).

The Great Basin Desert is the highest of the North American deserts occurring almost entirely above 4,000 feet. Its physical appearance is similar to that of the Mohave
Desert. Its life form is low shrub with almost a complete lack of trees, pure stands of vegetation are commonplace, and plant distribution is influenced by the salinity of the soil.

The most characteristic and abundant plant is basin sagebrush (*Artemisia tridentata*) which occurs on the loose packed low-alkaline soils (Hardy, 1945:89). Its elevational range extends from 4,000 feet to 6,300 feet, and is found commonly associated with juniper-pinyon and ponderosa pine. In the Great Basin, however, it usually occurs in pure stands with only a few associated grasses present.

Shadscale (*Atriplex confertifolia*) forms another association type (Fig. 4). This plant is characteristic of very saline, hard packed soils. Its elevational range is more restricted than sage brush and occurs in either pure stands or associated with burro brush (*Hymenoclea salsola*), greasewood (*Sarcobatus vermiculatus*) and/or snake weed (*Gutierrezia sarothrae*).

Black bush (*Coleogyne ramosissima*) although occurring in what is here considered to be the Mohave Desert, occurs in greater abundance on the Colorado Plateau at lower elevations. It appears as either pure stands or associated with Navajo ephedra (*Ephedra viridis*) and banana yucca (*Yucca baccata*).

Sand sage (*Artemisia filifolia*) replaces basin sage in the sandy areas. Few species of cactus occur in this
desert. The two most common types are prickly pear (*Opuntia erinacea*) and Whipple cholla (*Opuntia whipplei*).

The juniper-pinyon woodland is not a part of the Great Basin Desert but is considered as part of the Lower Sonoran Life Zone (Lowe, 1963). It ranges in elevation from 5,200 feet to approximately 7,000 feet. The two dominant forms are Utah juniper (*Juniperus osteosperma*) and single leaf pinyon (*Pinus monophylla*). At the lower elevations, the junipers are the most common of the two and quite often occur in pure stands. At higher elevations, the pinyons predominate and also occur in pure stands. The lower elevational limit of the woodland is usually sharply defined as opposed to the upper limit.

Along with many varieties of grasses (e.g. blue gramma, black gramma, June grass, side oats gramma) the most commonly associated plant is sage brush (*A. tridentata*) (Fig. 5). Other plants which occur are scarcely abundant and scattered. The most common of these include, banana yucca (*Yucca baccata*), Navajo ephedra (*E. viridis*), cliff-rose (*Cowania mexicana*), scrub oak (*Quercus turbinella*) and beaver tail cactus (*Opuntia basilaria*).

The Transition Life Zone or ponderosa pine forest is poorly represented in northern Mohave County. The largest stand is located on the southern tip of the Shivwits Plateau with isolated stands on Mt. Trumbull and the Virgin Mountains.
On the south slope of Mt. Trumbull (Fig. 7), the ponderosa pine (*Pinus ponderosa*) occur with pinyon pine and sagebrush at an elevation of 6,300 feet (Nixon Spring). At about 7,000 feet ponderosa dominate, sagebrush and pinyons disappear, manzanita (*Arctostaphylos sp.*) and Gambel oak (*Quercus gambelii*) appear. Above 7,500 feet ponderosa pine exists in an essentially pure stand with various grasses forming the main understory.

**Materials and Methods**

Field work was begun on July 1, 1964 and continued until August 31, 1964. Traps were set every night unless weather or travel conditions prohibited. Between 100 and 125 Museum Specials were set nightly in addition to rat and gopher traps when applicable. Rat traps were set during the day when diurnal rodent activity was evidenced. Trap lines were usually of the line transect type, one trap per station set three to five paces apart. This method was utilized in order to cover as many different soil conditions and plant associations as possible. All of the snap type traps were baited with peanut butter and commercial "chicken scratch" which was sprinkled on and around the treadle. This method of baiting seemed to yield a greater variety of species than peanut butter and rolled oats alone which was used during June of 1964 in the Coconino county portion of the Strip.
Fig. 4 A pure stand of shadscale (*Atroplex confertifolia*) near junction of Arizona Highway 89 and Mt. Trumbull Road. Photo by W. Sherbrooke, July 1964.

Fig. 5 A view of upper Toroweap Valley with Kanab Plateau in the background. Sagebrush (*Artemisia tridentata*) and Utah juniper (*Juniperus osteosperma*) are in the foreground. Photo by W. Sherbrooke, July 1964.
Fig. 6 Vicinity of Toroweap Point with the southern half of Mt. Trumbull range in the background. Snake weed (Gutierrezia sarothrae), yucca (Yucca baccata), hedgehog cactus (Echinocereus sp.), prickly pear (Opuntia sp.) and Utah juniper comprise the visible vegetation. Photo by W. Sherbrooke, July 1964.

Fig. 7 View from Mt. Trumbull toward Pine Mountains in the background. Clearing in right center is Nixon Spring. Pinyons, junipers and ponderosa pine all occur at this local. Photo by W. Sherbrooke, November 1964.
Fig. 8 A view of Grand Wash north of Pakoon Springs Ranch. The Virgin Mountains appear in the extreme background. Bur sage (*Franseria dumosa*), bladder sage (*Salazaria mexicana*), Joshua tree (*Yucca brevifolia*) and *Opuntia* sp. make up the visible vegetation. Photo by W. Sherbrooke, August, 1964.

Fig. 9 A view of the creosote bush (*Larrea divaricata*) - bur sage (*Franseria dumosa*) community north of Littlefield. The Virgin Mountains are in the background. The canyon in the center background is the Virgin River Narrows. Photo by T. Darden, August 1964.
The areas sampled were dictated by road conditions. All of the roads except U.S. Highway 91 through Littlefield are gravel. There are many primitive "jeep" type trails in the area which could not be traveled in our vehicle. Figure 1 shows only those roads utilized for collecting purposes.

Since the area to be covered was large and time limited, a "one night stand" collecting method was utilized. This meant trapping in an area one night, preparing the specimens in the same area the following day, and moving on to a different area that same evening. This method was followed throughout the eight weeks with the exception of the Mt. Trumbull and Virgin Mountains areas.

All specimens collected were saved. These were either prepared as study skins and skulls, flat skins and accompanying skulls, complete skeletons or skulls only depending upon the number collected and the variety obtained. All are now catalogued in the Mammal Collection, Department of Zoology, the University of Arizona.

Cheek pouches were examined and their contents saved in hopes of a food habit study. The number of pouches containing plant material other than bait were so few that a meaningful study was not possible.

A collection of the dominant plants of each area was made. Elevations were recorded by a pocket altimeter or obtained from United States Geological Survey topographic maps. In addition, soil types, plant associations, slope
exposure and drainage and weather conditions were noted.

Table 3 and Figure 1 give the localities from which specimens were collected. For a listing of the localities trapped previous to 1964 and reported in the literature, refer to Cockrum (1960) and Hoffmeister and Nader (1963).

To insure continuity in the checklist section, each subspecies is treated in the following manner:

1. The accepted scientific name appears first followed by the name of the author. The trinomial, with few exceptions agrees with the names presented in Cockrum (1960).

2. The common or vernacular name here applies only at the species level and is meant to include all of the subspecies.

3. The abbreviated synonomy first includes the original description plus the type locality. The second citation is to the first usage of the name combination employed in this paper.

4. The distribution here refers to the geological range within the study area only.

5. The Taxonomy section is included only when subspecific designation is in question. Comparison with surrounding subspecies is made with reference to color and cranial characteristics. Capitalized colors are from Ridgway (1912).

6. Habitat includes the ecology of the animal, with regard to substrate, elevation, associated vegetation and
<table>
<thead>
<tr>
<th>Number</th>
<th>Location Description</th>
<th>Elevation (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Vicinity of Pipe Springs National Monument, 5,000 ft.</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>16.1 miles South junction Arizona Highway 89 and Mt. Trumbull Road, 5,000 ft.</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Findlay Knolls, vicinity of Heaton Knolls, Antelope Valley, 5,400 ft.</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Vicinity Toroweap Point, Grand Canyon National Monument, 5,400 ft.</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Base of Vulcan’s Throne, Toroweap Valley, Grand Canyon National Monument, 4,300 ft.</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Vicinity junction of Mt. Trumbull Road and Grand Canyon National Monument Road, Toroweap Valley, 5,000 ft.</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>15.4 miles South of Colorado City - Tuweep (Toroweap) Road, 5,000 ft.</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>10.0 miles South Colorado City, via Colorado City - Tuweep (Toroweap) Road, 5,100 ft.</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>16.2 miles West junction of Colorado City - Tuweep (Toroweap) Road and Navajo Trail, via Navajo Trail, Hurricane Cliffs, 5,200 ft.</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>7.5 miles East junction of Navajo Trail and Main Street Valley Road, vicinity of Hurricane Wash, 4,400 ft.</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>2.4 miles East junction of Navajo Trail and Main Street Valley Road, via Navajo Trail, 5,200 ft.</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Nixon Spring, South slope of Mt. Trumbull, 6,200 ft.</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>West slope of Poverty Mountain via Parashont Road, 14 air miles West of Mt. Trumbull (the town), 5,800 ft.</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Vicinity of Waring (Tiger) ranch house, 18 air miles Southwest of Mt. Trumbull (the town), 5,600 ft.</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Vicinity of Mathis Pine Ranch, ca. 2.5 miles Northeast of Mt. Dellenbaugh, Shivwits Plateau, 6,100 ft.</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Ca. 5 miles East of Pigeon Spring, upper Grand Wash Cliffs, 5,400 ft.</td>
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</tr>
<tr>
<td>No.</td>
<td>Distance</td>
<td>Location</td>
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<tr>
<td>-----</td>
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</tr>
<tr>
<td>17.</td>
<td>4.3 miles</td>
<td>West junction Main Street Valley and Parashont Roads, via Parashont Road, 6 air miles Southwest Diamond Butte</td>
</tr>
<tr>
<td>18.</td>
<td>2.2 miles</td>
<td>East Nixon Spring, South slope Mt. Trumbull</td>
</tr>
<tr>
<td>19.</td>
<td>0.7 miles</td>
<td>North junction Main Street Valley Road and Virgin Mountain Road</td>
</tr>
<tr>
<td>20.</td>
<td>1.0 miles</td>
<td>South Utah-Arizona state line via Main Street Valley Road</td>
</tr>
<tr>
<td>21.</td>
<td>5.3 miles</td>
<td>South Utah-Arizona state line via Main Street Valley Road</td>
</tr>
<tr>
<td>22.</td>
<td>27.7 miles</td>
<td>South Utah-Arizona state line via Main Street Valley Road</td>
</tr>
<tr>
<td>23.</td>
<td>8.2 miles</td>
<td>West junction Main Street Valley Road, South slope Wolf Hole Mountain</td>
</tr>
<tr>
<td>24.</td>
<td>12.4 miles</td>
<td>South Utah-Arizona State line</td>
</tr>
<tr>
<td>25.</td>
<td>5.5 miles</td>
<td>South junction Lime Kiln and Pakoon Springs Road, East slope Virgin Mountains, ca.</td>
</tr>
<tr>
<td>26.</td>
<td>Vicinity</td>
<td>B.L.M. Fire Lookout, Pakoon Springs Road</td>
</tr>
<tr>
<td>27.</td>
<td>Pakoon Springs Ranch, Grand Wash</td>
<td>2,400 ft</td>
</tr>
<tr>
<td>28.</td>
<td>Tassi Ranch, Grand Wash Area</td>
<td>ca. 1,700 ft</td>
</tr>
<tr>
<td>29.</td>
<td>Vicinity</td>
<td>Beaver Dam Lodge, Littlefield</td>
</tr>
<tr>
<td>30.</td>
<td>Beaver Dam Wash</td>
<td>4 miles Northwest Littlefield</td>
</tr>
<tr>
<td>31.</td>
<td>Vicinity</td>
<td>Big Bend Wash, 4 miles South Littlefield turnoff via old U.S. Hwy. 91</td>
</tr>
<tr>
<td>32.</td>
<td>1 1/2 miles</td>
<td>South old U.S. Hwy. 91 via Virgin River Ford Road, ca. 6 miles Southwest Littlefield</td>
</tr>
<tr>
<td>33.</td>
<td>Virgin River Sand Flats, vicinity of Dam</td>
<td>2 1/2 miles East of Nevada - Arizona state line</td>
</tr>
<tr>
<td>34.</td>
<td>Elbow Canyon Pass, West slope of Virgin Mountains</td>
<td>ca. 5,200 ft</td>
</tr>
</tbody>
</table>
relative abundance.

7. Remarks includes those species which were found most commonly associated with the species discussed. In addition food habits, behavior, nesting sights and reproductive information are discussed where data permits.

8. The Specimens examined section contains first the total number personally examined. Next, the exact localities and the number of specimens from each is listed.

9. The tables of cranial measurements (Appendix A) incorporate measurements taken by the author of a representative sample of each species. Only when subspecific designation is in question is the entire sample measured. The measurements are made as defined by Cockrum (1955) and taken from a dial caliper to the nearest 0.1 mm.
SPECIES ACCOUNTS

Eutamias dorsalis utahensis Merriam
Cliff Chipmunk


Distribution.- E. dorsalis occurs throughout the Upper Sonoran and Transition Life Zones. Specimens were collected from 4,000 ft. (Pigeon Springs) and 7,300 ft. (Mt. Trumbull).

Habitat.- This species is well named as no chipmunk was sighted more than a few yards from either rock out­crops or actual cliffs. They were most abundant in the juniper-pinyon belt, but were seen lower in scrub oak and sage brush associations and higher in the ponderosa - Gambel oak complex.

Remarks.- Citellus variegatus, Peromyscus maniculatus, Peromyscus crinitus, Peromyscus truei and Peromyscus boylii were the the most commonly associated forms.

One specimen was obtained at the entrance to its nest located beneath a juniper tree. The area surrounding the base of the tree was littered with juniper berries and the animal's cheek pouches were also packed with them. Another chipmunk was shot while climbing in a scrub oak tree.
This animal's cheek pouches contained three acorns. The largest population of this form was found at Toroweap Point where both scrub oak and juniper trees exist together.

None of the specimens examined were reproductively active.


*Citellus leucurus escalante* Hansen

**Antelope Ground Squirrel**


**Distribution.** This ground squirrel inhabits the area within the Lower Sonoran and Upper Sonoran Life Zones, although it is uncommon in the higher portion of the juniper-pinyon belt.

**Taxonomy.** Specimens from northern Mohave County have previously been referred to *C. l. leucurus* (Hall and Kelson, 1959). Comparison of the specimens on hand from the study area, with a series of *C. l. leucurus* from Clark County, Nevada and a series of *C. l. cinnamoneus* from House Rock Valley and Wupatki National Monument (Coconino County, Arizona), indicates assignment of the Mohave County specimens to the subspecies *C. l. escalante*. 
Although specimens of *C. l. escalante* are not available, the overall color of the Mohave County specimens agrees with the original description. Furthermore, these specimens differ from *C. l. cinnamoneus* and *C. l. leucurus* exactly as stated by Hansen (1955:275). Those specimens from Toroweap Valley are slightly darker due to the dark basaltic lava in the area.

Skull measurements of the Mohave County specimens do not adhere as closely with *C. l. escalante* as do the color characteristics. They do, however, more closely resemble this subspecies than either of the two others considered.

The range of *C. l. escalante* within the Strip cannot be stated for certain. Specimens from the eastern edge of Mohave County approach *C. l. cinnamoneus* in color and most likely represent intergrades. The specimens from Grand Wash in no way resemble the color of the series of *C. l. leucurus* from Clark County. In addition, the Grand Wash series are all larger, with regard to skull measurements, when compared to the Clark County sample. Hall (1946;315), however, reports *C. l. leucurus* from Mesquite, Nevada (ca. one mile west of the Arizona-Nevada state line). Indeed more specimens are necessary from the Grand Wash and extreme southern Nevada before the relationship of these two subspecies can be adequately determined.

**Habitat.**—This species, in contrast to the other two
sciurid rodents present in the area, may be described as a flat lands dweller. These animals were as common in a pure stand of creosote bush as in a complex Joshua tree community. If a rock outcrop or rocky wash was near, it seemed to be utilized, but this appears not to be a necessary or constant factor. Antelope ground squirrels were observed or collected from all dominant plant associations up to and including the lower portion of the juniper-pinyon belt at 4,600 ft.

Remarks.—On three occasions, in early August, a pair of these animals were seen together. Twice they were climbing about in a creosote bush. This gregarious nature has been reported by Bradley (1965) in Clark County, Nevada. One lactating female and one scrotal male were collected in mid July.

Specimens examined, 10. Base of Vulcan's Throne, 2; Ranger Station (Tuweep), Grand Can. Nat. Mon., 1; Vic. Toroweap Point, 2; 5.3 miles S. Utah-Ariz. state line, 1; 5.5 miles S. jct. Lime Kiln and Pakoon Spgs. Ranch Rd., 2; Little Beaver Ranch, Littlefield, 2.

**Citellus variegatus utah** (Merriam)

Rock Squirrel


Distribution.— No rock squirrels were collected although many were observed. These locations were as follows: Pipe Springs National Monument; Toroweap Point; 12 miles West of Nixon Spring; Upper Pigeon Canyon; Elbow Canyon Pass (Virgin Mtns.). These observations, in addition to locations given in the literature (Cockrum, 1960 and Durrant, 1954), indicate that this species exists throughout the area with the exception of the lowest areas of the Mohave Desert.

Habitat.— With one exception, all of the animals observed were among rocky situations. Large boulders and cliff faces were easily maneuvered by these shy, quick squirrels. Scrub oak groves seemed to be a favorite feeding ground at the Pigeon Canyon and Toroweap Point locations.

In the area west of Nixon Spring, the Bureau of Land Management has chained down the juniper-pinyon-sage brush habitat. These fallen trees evidently provide the necessary cover for the rock squirrel. Three squirrels were observed in the area and two of these were chased into their burrows which were located underneath fallen juniper trees. No "suitable" rocky habitat was located near this chained area.

Remarks.— Eutamias dorsalis was collected and observed from many of the same areas that C. variegatus inhabits.
Thomomys bottae virgineus (Goldman)

Valley Pocket Gopher


Distribution. - This subspecies inhabits the lower desert portion of the study area west of the Grand Wash Cliffs. No gopher activity was observed in the Virgin Mountains.

Habitat. - Populations of this form occur along the Virgin River and Beaverdam Creek sandflats, and in the area of the many springs throughout Grand Wash. The only other gopher activity noticed was along the road cuts which crisscross the desert floor. Cultivated fields along the Virgin River supported the largest populations.

Remarks. - The owner of the Little Beaver Ranch (near Littlefield) claimed to have removed over 1,700 gophers from his 65 acre alfalfa plot in three years. The burrows in this area were all over twelve inches deep. The soil here was dry and hard packed. Those burrows along the Virgin River were usually four to six inches deep, but the soil was quite soft and sandy.

One lactating female was collected on August 10. A juvenal female only 146 mm. in total length (adults averaged 197 mm. total length) was taken from this same burrow the following day.
Specimens examined, 6. Pakoon Springs Ranch, 3; Little Beaver Ranch, ca. 2 mi. NW Littlefield, 2; Vic. Beaver Dam Lodge, 1.

_Thomomys bottae trumbullensis_ Hall and Davis

_Valley Pocket Gopher_


Distribution.—This form occurs throughout the Great Basin Desert region and up into the juniper-pinyon forest east of the Grand Wash Cliffs. This distribution is based on Cockrum (1960) since specimens from near the type locality were the only ones examined. One juvenile specimen from Fredonia, Coconino County, approaches the color of _T. b. absonus_ (Durrant, 1952:225).

Habitat.—Gopher diggings were most often seen where the soil was soft and deep, the grass or shrub cover good and the terrain level. The largest population (Nixon Spring) inhabited an open field with sage brush and some grass, and adjacent to a large pond.

Remarks.—Only three specimens of this subspecies were collected. This makes further comment on their natural history and taxonomy impossible. None of the specimens examined were reproductively active.
Specimens examined, 2. Nixon Spring, Mt. Trumbull,

Perognathus longimembrus virginis Huey

Little Pocket Mouse


Distribution.—This subspecies occurs throughout the western portion of the area in the Lower and Upper Sonoran Zones, excluding the juniper-pinyon forest. The eastern range of this subspecies and the area of intergradation with P. l. arizonensis is unknown. Specimens are on hand from the entire Great Basin Desert, however, all but one of those from the eastern portion of Mohave County are juvenals.

Taxonomy.—Durrant (1952:239) has indicated that specimens from the eastern portion of the Beaver Dam Mtns. (near topotypes) differ from those on the west slope by overall size. This same difference exists further south between specimens from either side of the Grand Wash Cliffs. The Mohave Desert specimens can be distinguished from the Great Basin forms (east of the Cliffs) by: All external measurements larger; occipito-nasal length less; nasals less; width of interparietal larger; upper alveolar length larger. In addition, the lower premolar of the "Mohave
Desert forms is larger than the last molar in all cases. Those animals from the Great Basin area have premolars equal to or smaller than the last molar. The large premolar is listed as a key characteristic of *P. l. virginis* by Durrant (1952:239).

Durrant further states that *P. l. arizonensis* can be distinguished from *P. l. virginis* by: "Total length less; hind foot smaller; occipito-nasal length less; nasals longer; mastoids larger". The occipito-nasal length of the Great Basin specimens is the only measurement which doesn't agree with these above characteristics.

These aforementioned comparisons indicate possible referral of the Great Basin forms to the subspecies *arizonensis*. However, since sufficient comparative material was lacking, and adult specimens from the eastern portion of the area were also lacking, definite assignment should not be made at this time.

**Habitat.**—This species is found only within the Lower Sonoran and desert scrub portions of the Upper Sonoran Life Zones. It occurs on both sandy and hard packed soil, but never in rocky situations. It appears to avoid valley floors, and is most common on the gently sloping bajadas.

The little pocket mouse was collected in every major plant community, but was most commonly taken in association with ephedra, snake weed and sand sage in the Upper
Upper Sonoran; and ephedra, cholla, black bush and Joshua
tree in the Lower Sonoran Zone.

Remarks.— *Peromyscus maniculatus*, *P. eremicus*,
*Dipodomys ordii*, *D. merriami*, *D. microps*, *Onychomys leu-
cogaster*, *O. torridus*, *Reithrodontomys megalotis* were all
collected in association with this form.

One lactating female was obtained July 17, two scro-
tal males were obtained August 3. Five juvenals with de-
ciduous premolars were caught in mid-July.

Specimens examined, 30. 5.5 mi. S. jct Lime Kiln
Pass and Pakoon Spgs Rd., 7; Vic. P.L.M. Fire Lookout,
Grand Wash, 2; Vic. Pipe Spgs. Nat. Mon., 3; 15.4 miles
S. Colo. City, 2; 20.4 mi. S. Colo. City, 2; 7.5 mi. E.
Main St. Valley Rd., via Navajo Trail, 5; 16.1 mi. S. jct.
Ariz. Hwy. 389 and Mt. Trumbull Rd., 2; 5.3 mi. S. Utah-
Ariz. state line, 6; 1.0 mi. S. Utah-Ariz. state line, 1;
Toroweap Valley, 1.

*Perognathus parvus trumbullensis* Benson

Great Basin Pocket Mouse

from Mt. Trumbull, 6,250 ft., Mohave County, Arizona.

Distribution.— This pocket mouse occurs within the
Upper Sonoran Life Zone, from just below and throughout the
juniper-pinyon belt. It has been reported from the
ponderosa pine forest slopes of Mt. Dellenbaugh (Hoffmeister and Nader, 1963).

Habitat.—Hall (1946) reports a wide variety of habitats for this species, and adds that it is most often associated with sage brush. Hayward and Killpack (1958) report that *P. parvus* are most common between 4,500 ft. and 6,500 ft. in association with sage brush and rocky, often steep talus slopes. They also report uncommon occurrences in open sandy flats with black brush and joint fir (*Ephedra*) being the dominant vegetation.

Of the four specimens examined, one is from a rock outcrop in the juniper-pinyon forest (Pipe Springs) and the other three from a flat gravel valley just below the juniper-pinyon belt with *Ephedra*, *Cholla sp.*, snake weed and grasses (*June grass, Russian thistle and gramma*) dominating. Sage brush was not present at either of these locations.

Remarks.—*Peromyscus maniculatus*, *P. truei*, *P. eremicus*, *Neotoma lepida*, *Reithrodontomys megalotis* and *Peromyscus formosus* were all collected from the same areas.

The type locality was trapped repeatedly in hopes of obtaining a series of topotypes. Benson (1937) failed to describe the vegetation in the original manuscript. At present the dominant plants on Mt. Trumbull are juniper, pinyon, ponderosa and sage brush, with an obvious lack of any type of grass. This lack is in part due to overgrazing
and may account for the lack of specimens from the area. Population fluctuations, however, due occur within this species (Hayward and Killpack, 1958) and may be the cause of the scarcity of specimens throughout the Strip.

None of the specimens examined were reproductively active.


*Perognathus formosus formosus* Merriam

Long-tailed Pocket Mouse


Distribution.—This subspecies occurs throughout Main Street Valley and east across the Hurricane Cliffs, possibly as far as Kanab Wash. This distribution, at the present time, excludes Toroweap Valley (see below).

Taxonomy.—Those specimens east of the Grand Wash Cliffs and west of the Hurricane Cliffs are easily referable to *P. f. formosus*. Six adult specimens from east of the Hurricane Cliffs differ from the above series by: total length and tail length less, and occipito-nasal length less. Color difference, if any, was indistinguishable. At the present time it is felt best to refer these
to *P. f. formosus* as sufficient specimens of *P. f. dom-

isaxensis* were not available for comparison.

For comparison with *P. f. melanocaudus* see the account of that subspecies.

Habitat. - This subspecies was found in rocky, sloping situations throughout its range. They were caught most often at the base of rock ledges and never was a speci-

men taken from the level valley floor. The most common associated plants include: ephedra, yucca, black bush, creosote, snake weed and occasionally juniper trees.

Remarks. - *Peromyscus boylii, P. crinitus, P. maniculatus, Neotoma lepida, Dipodomys merriami* were the most commonly associated species.

One scrotal male was collected on July 22.

Specimens examined, 26. Findlay Knolls, Antelope Valley, 2; 10 mi. S. Colo. City, 5; Hurricane Cliffs via Navajo Trail, 5; 7.5 mi. E. Main St. Valley via Navajo Trail, 1; 6 mi. S.W. Diamond Butte, 1; 27.7 mi. S. Utah-
Ariz. state line, 2; 2.4 mi. E. Main St. Valley via Navajo Trail, 2; 1.0 mi. S. Utah-Ariz. state line, 7; 5.3 mi. S. Utah-Ariz. state line, 1.

*Perognathus formosus melanocaudus* Cockrum

Long-tailed Pocket Mouse

*Perognathus formosus melanocaudus* Cockrum, Jour.
Distribution.—This subspecies, as referred to here, is restricted to Toroweap Valley.

Taxonomy.—Toroweap Valley supports a melanistic population of *P. formosus*. The darkest animals inhabit Vulcan's Throne (a large black volcanic cone) and are nearly black. Those from the surrounding area grade from dark gray to a Wood Brown color. Eleven topotypes were compared with *P. f. formosus* specimens and found to differ by: total length less, hind foot less, occipito-nasal length less, depth of bulla less. The degree of interorbital constriction, auditory and brain case inflation, distinguishing characteristics (Cockrum, 1956) were not consistent.

It is felt that *P. f. melanocaudus* should be retained until the distributional gaps are filled and the possibility of clinal variation considered.

Habitat.—This subspecies, as are the other two within the area, inhabits rocky situations. The steep, lava strewn slope of Vulcan's Throne, talus fans and rock outcrops within the Valley all support populations. Black bush, ephedra, shake weed and burroweed were the common dominant plants. This form was never taken within the juniper-pinyon forest.

Remarks.—*Peromyscus boylii, P. crinitus, Neotoma lepida* and *Dipodomys merriami* were trapped within the same
area. One lactating female was collected July 15. Three
juvenals were also taken the same day.

Specimens examined, 17. Base of Vulcans Throne,

*Perognathus formosus mohavensis* Huey

Long-tailed Pocket Mouse

from Bonanza King Mine, Providence Mountains, San Bern­
ardino County, Calif.

Distribution.— *P. f. mohavensis* inhabits the area
west of the Grand Wash Cliffs and defined as Mohave Desert.

Taxonomy.— Specimens of *P. f. mohavensis* can be
distinguished from a series of *P. f. formosus* from one
mile south of the Utah-Arizona state line by: lighter color,
total length less, tail length less, occipito-nasal and
nasal length less, and interparietal bone wider.

Habitat.— Rocky situations with black bush, ephedra,
cholla and creosote bush were the preferred habitat of this
subspecies.

Remarks.— *Peromyscus eremicus*, *Peromyscus crinitus*,
*Neotoma lepida* and *Perognathus penicillatus* were the only
other species associated with *P. f. mohavensis*.

Three *Perognathus penicillatus* sobrinus were col­
lected in the same general area as *P. f. mohavensis*. All
three were identified as being *P. f. mohavensis*, and without the skull are almost indistinguishable from the latter.

None of the specimens examined showed signs of reproductive activity.

Specimens examined, 13. Tassi Ranch, Grand Wash, 7; Big Bend Wash, 4 mi. S. Littlefield, 2; Beaver Dam, 1; Pakoon Springs Ranch, 1; Vic. P.L.M. Fire Lookout, Grand Wash, 2.

**Perognathus penicillatus sobrinus** Goldman

Desert Pocket Mouse


**Distribution.**—Hardy (1949) regarded the type locality as Mohave County, Arizona. The existence of this subspecies in Arizona was confirmed by Hoffmeister and Nader (1963), when they reported a series from Beaver (Dam) Lodge, Mohave County. One specimen from the same general location was also obtained during the course of the present study. In addition, three specimens were collected from Tassi Ranch which is two miles north of Lake Mead. The distribution,
therefore, appears restricted to the Virgin River and Colorado River-Lake Mead regions in Arizona.

Habitat.—The habitat along the Virgin River is of the Riparian type. The soil is soft and sandy, but seldom loose and wind-blown. Cottonwood, desert willow, tamarisk, mesquite and arrow weed are the typical plants. The Tassi Ranch location is essentially identical except for a less sandy soil and the lack of arrow weed. The three specimens from this location were taken near a ground seepage in a thick clump of tamarisk.

Remarks.—Dipodomys merriami, Peromyscus eremicus, P. maniculatus (one specimen) and Perognathus formosus were the only species obtained from these same areas. Of the four specimens examined (all taken during August) none showed signs of reproductive activity.

Specimens examined, 4. Tassi Ranch, 4; Virgin River Sand Flats, 2½ mi. E. Arizona-Nevada state line.

**Dipodomys ordii cupidineus** Goldman

Ord Kangaroo Rat


Distribution.—*D. ordii cupidineus* inhabits the Great Basin Desert area east of the Grand Wash Cliffs and
and Virgin Mountains. It does penetrate the juniper-pinyon belt along the canyon rim but is uncommon there. This species has been reported from Nixon Spring (Cockrum, 1960), but no evidence of kangaroo rats above 5,600 ft. was encountered during the present study.

Habitat.- This species prefers soft level soils. They are common along roadways, hummocks and the sides of washes. North of Pipe Springs, a specimen was collected well within the juniper-pinyon forest, but its burrow was located in a sand wash. Ten miles south of Colorado City, in an area of hard packed overgrazed soil, scattered strips of sandy soil supported the only burrows of _D. ordii_.

There appears to be no restriction on population distribution corresponding to vegetational distribution. Pure stands of sage brush maintained the smallest populations, undoubtedly due to the coarse soil associated with this plant type.

Remarks.- _Peromyscus maniculatus, Onychomys leucogaster, Peromyscus longimembris_ and _Reithrodontomys megalotis_ all inhabit the same areas.

Between July 8 and July 17, three scrotal males and one lactating female were collected. One female with an enlarged vulva was obtained on July 26, and another female with two embryos (9mm.) was taken on August 5.

**Dipodomys microps celsus** Goldman

Chisel-toothed Kangaroo Rat


**Distribution.**— Populations of the chisel-toothed K-rat appear to be scattered across the north-central section of the study area. No evidence of *D. microps* was found east of the Hurricane Cliffs, although Goldman (1924) reported one specimen from Kanab Wash. Signs were noted in Main Street Valley as far south as Diamond Butte. No evidence was seen west of Wolf Hole or Diamond Butte. Elevation ranged from 3,100 ft. to 5,200 ft.

**Habitat.**— *D. microps* were collected in areas of compact rocky soil, usually of a gently sloping nature. At the Hurricane Cliffs sight, the burrows were common in the black bush and ephedra areas and absent from the flat portion.
which supported a thick cover of grass and snake weed. Along Hurricane Valley (7.5 miles east of Main Street Valley), the only vegetation present was ephedra and a thick grass under cover. The third location (5.3 miles south of the Utah-Ariz. state line) represented an ecotone between the Upper Sonoran and Lower Sonoran Life Zones, and both creosote bush and black bush were abundant.

Remarks.- *Peromyscus maniculatus*, *Peromyscus crinitus*, *Perognathus formosus*, *Perognathus longimembrus*, *Dipodomys merriami* and *Reithrodonotomys megalotis* were the only associated forms.

The burrows of *D. microps* are distinct from any of the other *Dipodomys* in the area. There are many scattered entrances and no appreciable dirt mound. One typical burrow system contained twenty-one "entrances" in an area approximately eight by ten feet. There was no supporting vegetation and the whole complex of holes were dug straight down and then within a foot angled off. They don't appear to take advantage of vertical slopes or the base of shrubs to begin their burrows.

No specimens showed signs of reproductive activity. Specimens examined, 4. 7.5 mi. E. Main St. Valley via Navajo Trail, 1; 5.3 mi. S. Utah-Ariz. state line, 1; Navajo Trail Rd. and Hurricane Cliffs. 2.
**Dipodomys merriami merriami** Mearns

Merriam Kangaroo Rat


**Distribution.**- Occurs in the extreme far western portion of the area in the Mohave Desert.

**Habitat.**- This animal was collected throughout the lower portions of the Mohave Desert. They seem to prefer level terrain, but inhabit soils ranging from rocky, hard packed to sandy river bottoms. They were the most abundant rodent in the creosote bush-bur sage association. The largest series was taken from a Joshua tree, sand sage, cholla association.

**Remarks.**- *Peromyscus eremicus*, *Perognathus longimembrus*, *Onychomys torridus* and *Perognathus penicillatus* were the only other rodents collected in association with this species.

Scrotal males were collected throughout the month of August. Pregnant females were collected August 9 (2 embryos:15 mm. long) and August 19 (7 embryos:11 mm. long).

Specimens examined, 27. Virgin River Sand Flats, 5 mi. So. Littlefield, 5; 2mi. N.-l mi. E. of Littlefield, 1; Vic. Beaver Dam Lodge, 2; Virgin River, 2½ mi. E. Nev.-Ariz. state line, 6; Beaver Dam Wash, 4 mi. N. Littlefield, 1; 5.5 mi. S. jct. Lime Kiln and Pakoon Spgs. Rd., 7; Pakoon Springs Ranch, 4; Tassi Ranch, 1.
**Dipodomys merriami vulcani** Benson

Merriam Kangaroo Rat


**Distribution.**—This subspecies appears to have a disjunct distribution. It has only been taken from Toroweap Valley and the region north of Wolf Hole along the Utah-Arizona state line.

**Taxonomy.**—Those topotypes and near topotypes on hand agree with the original description (Benson, 1943). The dorsal dark coloration distinguishes them from **D. m. merriami**. In addition the overall smaller size, wider supraoccipital bone and narrower width across the paroccipital processes serve to distinguish this population from **D. m. merriami**.

Those specimens from near Wolf Hole, however, lack the dorsal coloration characteristic of this subspecies. Furthermore, the difference in width of the supraoccipital bone is not obvious. The remaining features seen to be consistent between the two populations.

These animals near St. George represent intergrades between **D. m. merriami** (Hardy, 1945). If indeed the distribution is disjunct, the fate of the northern members of the subspecies is tenuous. There is, however still sufficient difference between this population and **D. m.**
merriami to refer them to *D. m. vulcani*.

Habitat.- This subspecies, in Toroweap Valley, inhabits the talus slopes and extremely rocky situations along the lava flows. Here black bush, burroweed, and snake weed comprise the dominant plant cover. In the northern section of the distribution, this subspecies inhabits a more "typical" area. Specimens most commonly occurred on level slightly rocky terrain in association with creosote bush, bur sage, ephedra and black bush.

Remarks.- *Peromyscus formosus*, *Peromyscus maniculatus*, *P. boylei*, *P. crinitus*, *Dipodomys ordii*, *D. microps* and *Perognathus longimembris* were most commonly associated with this subspecies.

Two lactating females and one scrotal male were collected in mid August.

Specimens examined, 14. 8.1 mi. E. Nixon Spring, 7; 3.5 mi. S. Tuweep Ranger Station, Toroweap Valley, 1; 2.6 mi. S. Tuweep Ranger Station, Toroweap Valley, 1; 1.0 mi. S. Utah-Ariz. state line, 2; 12.4 mi. S. Utah-Ariz. state line, 1; Mt. Trumbull and Grand Can. Nat. Mon. Rd. jct., Toroweap Valley, 1; 5.3 miles S. Utah-Ariz. state line, 1.

*Dipodomys deserti deserti* Stephens

Desert Kangaroo Rat

Distribution.—This species is found only on the floor of the Mohave Desert. Suitable habitat was encountered only in the Pakoon Springs Ranch and Virgin River areas.

Habitat.—This species is strictly a Lower Sonoran inhabitant of drifting "sand dune" like terrain. Only two specimens were obtained, both from the same area. This was a small isolated dune approximately three miles long and one mile wide. The dominant plants were scattered; they consisted of creosote, bur sage and slight grass cover.

Remarks.—No other rodent was trapped in this area, although numerous tracks of a small rodent of unknown type were numerous. As pointed out by Hill (1965) these tracks could have been made by any of the rodents which normally inhabit the surrounding area.

Neither of the specimens obtained (one male and one female) showed signs of reproductive activity.

Specimens examined, 2. 1.5 mi. S. old U.S. Hwy. 91 via Elbow Canyon (Virgin River Ford) Rd.

Castor canadensis repentinus Goldman (?)
Beaver

Castor canadensis repentinus Goldman, Jour. Mamm., vol. 13, p. 266, August 9, 1932, type from Bright Angel Creek, 4,000 ft., Grand Canyon of the Colorado River, Coconino County, Arizona.
Remarks.- At the confluence of the Beaver Dam Creek and the Virgin River, a large number of beaver have been sighted by residents. Shortly before the author arrived in the area, Beaver Dam Wash flooded and drove both the domestic animals and the beaver from the region. Many cuttings and scattered remains of dams and lodges were still visible, but no beaver were seen.

The beaver is still active along the Colorado River (Angel Creek, Grand Canyon National Park). It is likely to assume that the beaver migrated up the Virgin River to the lush Riparian Community at Beaver Dam. However the possibility of introduction, causes the subspecific designation to remain questionable.

**Reithrodontomys megalomelas megalomelas** (Baird)

*Western Harvest Mouse*


**Distribution.** The harvest mouse occurs throughout the area in both desert regions. Specimens have been reported from 1,600 ft. to 6,200 ft. in elevation (Cockrum, 1960).

**Habitat.** This species is most abundant in grassy areas near water. The largest sample is from Pipe Springs
National Monument. Here they were second in abundance only
to Peromyscus maniculatus. The dominant vegetation consisted
of grasses (June grass, Distichilis sp.), rabbit bush
(Chrysothamnus sp.), sand sage and burroweed. Single speci-
mens were taken from arid surroundings, but in all cases
the area supported a good grass cover, and the soil was
rocky but level.

Remarks.—Peromyscus maniculatus, Onychomys leuco-
gaster, Perognathus longimembris and Dipodomys ordii were
the most abundant associated forms.

On two occasions, June 6 and July 29, R. megalotis
was trapped before dusk, long before any other rodent ac-
tivity was observed.

Between July 6 and July 11, four scrotal males,
three lactating females and one female with three embryos
(13 mm.) were collected.

Specimens examined.—16. Pipe Spgs. Nat. Mon., 7;
16.1 mi. S. jct Ariz. Hwy 389 and Mt. Trumbull Rd., 1;
Findlay Knolls, Antelope Valley, 2; Base of Vulcan's Throne,
1; Hurricane Cliffs and Navajo Trail Rd., 1; 6 mi. S.W.
Diamond Butte, 1; 2 mi. N.E. Cane Beds, 2; Beaver Dam, 1.

**Peromyscus crinitus stephensi** Mearns

*Canyon Mouse*

19, p. 721, July 30, 1897, type from lowest water on
wagon road in canyon, east base of Coast Range, near Mexican boundary, Imperial County, California.


Distribution. - *P. c. stephensi* most likely occurs throughout the study area, although no specimens have been reported east of the Mt. Trumbull area. Specimens have been taken from 1,700 ft. (present study) up to 6,000 ft. (Cockrum, 1960), however they seem to be most abundant within the Upper and Lower Sonoran Life Zones.

Habitat. - This species is restricted almost entirely to canyons, cliff faces and talus slopes. This close association led Egoscue (1964:388) to state, "Plants, per se, have little effect on the presence or absence of canyon mice".

Remarks. - *Perognathus formosus*, *Peromyscus truei*, *Neotoma lepida*, *Citellus variegatus* and *Eutamias dorsalis* were the most common residents within this restricted niche.

Two scrotal males were taken on August 10 and 20. Juvenals were collected throughout July and August.

Specimens examined, 16. Findlay Knolls, Antelope Valley, 3; 2.6 mi. S. Tuweep ranger Station, 1; Hurricane Cliffs and Navajo Trail, 2; 2.4 mi. E. Main St. Valley via Navajo Trail, 3; 27.7 mi. S. Utah-Ariz. state line, 2; Pakoon Springs Ranch, 1; Tassi Ranch, 2; P.L.M. Fire Lookout, 1; Vic. Big Bend Wash, 4 mi. S. Littlefield, 1.
**Peromyscus eremicus eremicus** (Baird)

Cactus Mouse


**Distribution.**—The cactus mouse occurs across the western portion of the region, beyond Mt. Trumbull. Specimens are on hand from 1,700 ft. (Tassl Ranch) to 6,250 ft. (Nixon Springs).

**Habitat.**—Cactus mice are most common in the Lower and Upper Sonoran Life Zones, only two, however, were recorded from the juniper-pinyon belt and above. Within its range, it is most commonly associated with alluvial soil and is rare in rocky situations and talus fans.

Specimens were obtained from all major plant associations, with the exception of pure stands of sage brush and saltbush. This fact accounting for the lack of specimens from Antelope Valley.

**Remarks.**—Those rodents caught in association with _P. eremicus_ include: _Dipodomys merriami_, _Perognathus longimembris_, _Onychomys torridus_, _Peromyscus maniculatus_ and _Perognathus penicillatus_.

Three lactating females were caught on July 16 (1) and August 13 (2). Five scrotal males were trapped July 16.
(1), July 22 (2), August 13 (1) and August 9 (1). Two juvenals were collected in July and during the latter part of August. These data indicate at least two reproductive cycles per season.

Specimens examined, 25. 1 mi. W. Tuweep Ranger Station, Grand Can. Nat. Mon., 1; Vulcan’s Throne, Grand Can. Nat. Mon., 2; 20.4 mi. S. Colo, City, 1; 6 mi. S.W. Diamond Butte, 2; 2.4 mi. E. Main Street Valley via Navajo Trail, 1; Tassi Ranch, Grand Wash, 4; Beaver Dam, 4; Nixon Springs, 1; Virgin River at Elbow Canyon Road, 2; Vic. B.L.M. Fire Lookout, 4; Pakoon Springs Ranch, 1; 5.5 mi. S. jct. Lime Kiln and Pakoon Springs Rd., 1; Vic. Big Bend Wash, 4 mi. S. Littlefield, 1.

Peromyscus maniculatus sonoriensis (LeConte)

Deer Mouse


Peromyscus maniculatus sonoriensis, Osgood, N. Amer. Fauna, no. 28, p. 39, April 17, 1909.

Distribution.—The deer mouse inhabits the entire study area in great abundance with the exception of the most arid portions of the Lower Sonoran Life Zone. Here P. maniculatus is primarily restricted to Riparian Communities.
Taxonomy.—"Typical" *P. m. sonoriensis* and *P. m. rufinus* were compared with the series from northern Mohave County. None of the specimens, even those from above 6,000 ft., are as dark as *P. m. rufinus*; yet very few are as light as *P. m. sonoriensis*. Neither skull measurements nor color show gradation corresponding to an increase in elevation. The light and dark phases are present; the majority belong to the dark phase however. The lack of extensive montane areas in this primarily desert zone, and a closer adherence to the color and skull measurements (Durrant, 1952) of *P. m. sonoriensis* support referral of these specimens to this subspecies.

Habitat.—This was the most abundant rodent in the study area. It was found more in open terrain than in association with dense plant cover, rock slopes or outcrops. Deer mice were the most common form in pure stands of both sage brush and salt bush. An increased variety of rodent species led to a decrease in the number of *P. maniculatus* collected, and a corresponding change in habitat. For example, at Toroweap Point, where all five species of *Peromyscus* occupied the same general area, only two deer mice were collected.

Remarks.—Due to the wide variety of habitats which this species occupies, it was collected in association with every other form except *Dipodomys deserti*. 
Scrotal males were noted throughout July. Lactating females were obtained on July 7, 8 and 25; pregnant females on July 13 (5 embryos; 20mm. long) and August 5 (4 embryos; 8mm long). A juvenile male was collected near Littlefield on November 27.

Specimens examined, 99. 2 mi. N.E. Cane Beds, 2; 2.5 mi. S.E. Moccasin, 2; Pipe Spgs. Nat. Mon., 26; 10 mi. S. Colo. City, 3; Vic. jct. Mt. Trumbull Rd. and Grand Can. Nat. Mon. Rd., 6; Nixon Springs, Mt. Trumbull, 1; 3.5 mi. S. Tuweep Ranger Station, 1; 2.5 mi. S. Tuweep Ranger Station, 2; Base of Vulcan's Throne, 3; Vic. Toroweap Point, 3; 8 mi. E. Nixon Spring, Mt. Trumbull, 7; 2.4 mi. E. Main St. Valley via Navajo Trail, 2; 12.4 mi. S. Utah-Ariz. State line, 2; 27.7 mi. S. Utah-Ariz. state line, 1; Navajo Trail and Hurricane Cliffs, 3; 16.1 mi. S. jct Ariz. Hwy. 389 and Mt. Trumbull Rd., 7; Findlay Knolls, Antelope Valley, 7; 6 mi. S.W. Diamond Butte, 4; 5 mi. S.W. Diamond Butte, 3; West base of Poverty Mtn., 2; Upper Pigeon Canyon, Grand Wash Cliffs, 2; Virgin River and Elbow Canyon Rd., 1; Vic. Wolf Hole, 2; 18 mi. S.W. town of Mt. Trumbull, 5; 2.5 mi. N.E. Mt. Dellenbaugh, 4.

**Peromyscus boylii utahensis** Durrant

Brush Mouse

Distribution.—The brush mouse was encountered across the entire portion of northern Mohave County within the Upper Sonoran Life Zone.

Habitat.—This subspecies was collected from a rocky, sloping substrate in all cases. It occurred most commonly within the juniper-pinyon forest. At Toroweap Point, where the largest series was obtained, the dominant plants included: junipers, scrub oak, banana yucca and snake weed. The mice were trapped at the base of the many sandstone ledges. A large series of this form was taken from the Virgin Mountains (Elbow Canyon) during November, 1964. This location is within the juniper-pinyon belt and a Riparian Community (scrub oak and poplar). P. boylli was the only rodent collected at this time of year. The majority of the mice were captured near two abandoned buildings.

Remarks.—Peromyscus truei, Peromyscus maniculatus, Neotoma lepida and Perognathus formosus were the most common rodents collected with P. boylli.

Of the five species of Peromyscus occurring in the area, the adults of P. boylli were by far the largest by weight, with an average of 29.4 grams.
Scrotal males were collected on July 14, 15 and 28. One lactating female was captured on August 7. In addition four juvenals with lead gray pelage were obtained in mid July. These data indicate at least two reproductive seasons per year.

Specimens examined, 26. Toroweap Point, Grand Can. Nat. Mon., 12; 2.2 mi. E. Nixon Spring, 1; Base of Vulcan's Throne, 1; Elbow Canyon, Virgin Mtns., 7; Upper Pigeon Can., Grand Wash Cliffs, 2; 12.4 mi. S. Utah-Ariz. state line, 1; 2 mi. N.E. Cane Beds, 2.

**Peromyscus truei truei** (Shufeldt)

*Pinyon Mouse*


Distribution.- _Peromyscus truei_ inhabits an area closely associated with the juniper-pinyon belt and the ecotone between this and the ponderosa pine forest. Elevation of the specimens collected range from 4,700 ft. to 7,000 ft.

Habitat.- This species appears to be restricted entirely to the juniper and/or pinyon tree association. No specimens were collected more than a few yards from one or the other of the trees. For example, 10 miles south of
Colorado City is a small knoll approximately two miles long and from 200 to 300 yards wide, which supports a sparse stand of juniper trees. The knoll is isolated by many miles of sage brush and salt bush. Three pinyon mice were collected here and nowhere else in the surrounding area.

The preferred habitat for this species appears to be quite rocky with some degree of sloping. Long (1940) prefers to call *P. truei* the "rock mouse" due to its strong preference for talus slopes and vertical cliffs.

Remarks.— *Peromyscus maniculatus*, *Neotoma lepida*, *Peromyscus boylii* and *Peromyscus crinitus* were the most commonly associated forms.

Scrotal males were caught throughout the latter half of July. On August 6, a female with four embryos (7 mm.) was collected.

Specimens examined.— 43. Nixon Springs, 5; 8 mi. E. Nixon Spring, 2; Vic. Toroweap Point, Grand Can. Nat. Mon., 4; West Base of Poverty Mtn., 3; Findlay knolls, Antelope Valley, 1; 18 mi. S.W. Town of Mt. Trumbull, 1; Vic. Pipe Springs Nat. Mon., 5; 2.5 mi N.E. Mt. Dellenbaugh, 1; West Slope Wolf Hole Mtn., 1; 2 mi. N.E. Cane Beds, 18; 5 mi. S. Moccasin, 1.
Onychomys leucogaster melanophrys Merriam

Northern Grasshopper Mouse


Distribution.—O. leucogaster occurs in the Upper Sonoran Life Zone, east of the Grand Wash Cliffs. Specimens are reported within an elevational range of 4,500 ft. to 6,500 ft. (Cockrum, 1960). This latter location is given as Nixon Spring, which is 6,250 ft. in elevation. No specimens have been recorded from the Virgin Mountains.

Habitat.—This species was nowhere abundant. The largest series was collected from the vicinity of Pipe Springs National Monument. The soil was slightly sandy and reddish in color. The dominant plants included: sand sage, burroweed, yucca and scattered juniper trees. The undercover was scattered grass clumps (Distichlis). The dominant plants of the remaining collection sites varied. The rather loose soil and grass cover (Russian thistle, June grass and gramma) remained constant. Salt bush with Russian thistle and a pure sage brush stand with a short grass undercover yielded the next two largest series.

Remarks.—Those forms occurring in common with O. leucogaster include: Dipodomys ordii, Peromyscus maniculatus, Reithrodontomys megalotis and Perognathus longimembris.
The genetics of the two color phases of this species has been studied by Emscule (1963) and shown to function as a simple Mendelian ratio. The dark phase acts as an autosomal recessive in the presence of the pale phase.

In the Pipe Springs National Monument, during two successive nights of trapping, two light phase (one male and one female) and two dark phase (one male and one female) animals were collected. The soil color was reddish-brown and closely resembled the light phase. Sixteen miles south of Arizona Highway 389 via Mt. Trumbull Road, one dark phase male and one light phase female were caught. In this area the soil color approaches the dark phase. The remaining adult skin examined was of the dark phase and was also collected on dark soil.

Sample size is small, yet the recessive dark phase exceeds the expected ratio. However, the dark colored soil, which is the most common, would favor a selective force in the recessive direction.

On July 7, 9 and 10 two lactating females and one female with three embryos (13 mm.) were collected. During this same time, four juvenals were also obtained.

Onychomys torridus longicaudus Merriam

Southern Grasshopper Mouse


Distribution.- From the specimens examined and reported in Cockrum (1960), it appears that this form is restricted to the Lower Sonoran Life Zone in the Mohave Desert portion of the study area.

Habitat.- Furt (1934) describes the preferred habitat for this species as profuse vegetation in small ravines, at or near water. Long (1940) collected grasshopper mice near the burrows of antelope ground squirrels, kangaroo rats or wood rat dens.

The single specimen collected during this study came from an area of soft almost sandy soil and a lush vegetation including: Joshua tree, yucca, snake weed, cholla and bladder sage.

Remarks.- Specimens collected at this one location include: Peroznathus lon-membrus, Peromyscus eremicus and Dipodomys merriami.

This single specimen, a female, contained three embryos (13 mm.) The date of capture was August 9. None of the other specimens examined showed reproductive activity.
Specimens examined, 3. Beaver Dam, 2; 5.5 mi. S. jct. Lime Kiln and Pakoon Springs Rd., 1.

Neotoma lepida monstrabilis Goldman

Desert Wood Rat


Distribution.—The desert wood rat occurs throughout the study area in the Lower and Upper Sonoran Life Zones. Specimens have been recorded from 1,600 ft. at Littlefield to 6,200 ft. at Nixon Spring (Oockrum, 1960).

Taxonomy.—Goldman (1932), in his original description, utilizes the Pinkish Buff upper parts as the key diagnostic feature to distinguish this subspecies from Neotoma lepida. Those specimens examined from Fredonia (Coconino Co.), Cane Beds and Antelope Valley all exhibit this characteristic. Neotoma lepida taken from lava flows are dark grayish brown with a dark golden-buff abdomen.

The degree of the Pinkish Buff coloration decreases in those specimens from west of Antelope Valley, and the overall color changes from a buff hue to a light gray. Specimens from the Mohave Desert approach a Light Grayish Olive color. Skull measurements of one adult female (UA 12996) from Pakoon Spring Ranch are all smaller than
the skull measurements from those specimens taken to the east.

As indicated by Goldman (1932), Hardy (1945) and Durrant (1952) the Grand Wash and Virgin-Beaver Dam Mountains area is a zone of intergradation between the two subspecies (monstrabilis and lenida). Since sufficient comparative material from Nevada is lacking, the specimens examined are here referred to N. I. monstrabilis. It is realized that intergradation, perhaps extending as far east as Main Street Valley exists.

Habitat.-- This species was most common in the juniper-pinyon and lower desert scrub areas in close association with rock ledges, rock outcrops, cliffs, washes and canyon walls. No nests constructed away from a rocky habitat, as is common in other species and reported for this species (Hall, 1946), were observed. Specimens were caught in all major plant communities within its range.

Remarks.-- Perognathus formosus, Peromyscus truci, Peromyscus maniculatus, Perognathus parvus and Peromyscus crinitus were most commonly caught in association with this species.

The nest building instinct exhibited by pack rats is very weak in this particular species. It may well be described as only a collecting instinct. The actual nest was usually located under a rock overhang and inaccessible.
The area in front of the entrance was littered with twigs, leaves, seeds, bones and other debris. Pinyon and juniper twigs and berries were the most common items collected. In the Lower Sonoran Zone, ephedra and cholla branches comprised the majority of the debris.

Two pregnant females were captured on July 11, one contained a single embryo (14 mm.), the other had two (26 mm.). No reproductively active males were collected.

Specimens examined, 12. 2.5 mi. S. E. Moccasin, 2; 2 mi. N. E. Cane Peds, 1; 16.1 mi. S. jct Ariz. Hwy. 389 and Mt. Trumbull Rd., 1; Findlay Knolls, Antelope Valley, 4; West Base Poverty Mtn., 1; Pakoon Spgs. Ranch, 1; Beaver Dam Wash, 4 mi. N. W. Littlefield, 1.

Erethizon dorsatum subsp.
Porcupine

Remarks.—Only one specimen was collected, but the skull was crushed before it could be measured. The porcupine was taken within the juniper-pinyon belt at the north end of Toroweap Valley.

Durrant (1952:390) assigns those specimens from Utah west of the Colorado River to the subspecies epixanthum. He adds that one specimen from Kanab, Cane County, Utah appeared to be an intergrade between E. d. couesi, which occurs in southern Nevada, and E. d. epixanthum.
Considering these facts, it is impossible to assign a subspecific rank to those porcupines occurring within the Strip without further investigation.
Hypothetical List

1. *Citellus tereticaudus tereticaudus* (Baird). Hall (1946:319) reports a specimen from Bunkerville, Clark County. This is approximately four miles west of the Arizona-Nevada state line. Although suitable habitat exists in the Littlefield area, no specimens or signs have been recorded.

2. *Dipodomys microps woodburyi* Hardy. This subspecies has been collected from the west slope of the Beaver Dam Mountains (Hardy, 1945:97) just north of the Utah-Arizona state line. This form undoubtedly occurs in the Littlefield area, although no specimens are know.

3. *Microtus montanus rivularis* Bailey. Specimens of this subspecies are know from the St. George area (Durrant, 1952:330). They occur along the Virgin River in Utah, and may well occur east of the Virgin Mountains in the short section of the Virgin River south of St. George, Utah. The Virgin River Narrows most likely restricts any movement of this form to the west.

4. *Ondatra zibethicus goldmani* Huey. This subspecies has been reported both from Utah (Durrant, 1952:360) and Nevada (Hall, 1946:568) along the Virgin River. This leaves little reason to doubt its existence in Arizona.
DISCUSSION

Species Interrelationships

In Northern Mohave County, there are many locations where two or more species of the same genus were taken from the same trap line. Whenever accurate field identification was possible, critical habitat observations were recorded. These data indicate niche separation in many cases, but still leave unanswered questions. 

*Peromyscus maniculatus* was collected from many diverse habitats. Of the four other members of this genus occurring within the area, *P. truei* was more often associated with *P. maniculatus*. When the population of *P. truei* was small, there appeared to be no difference in habitat. However, large populations of both species appear to bring about a separation. Under these circumstances, *P. maniculatus* inhabits the flat open areas sparsely covered with junipers and pinyons, while *P. truei* prefers the sloping rocky areas with good tree cover. *Peromyscus boylii* follows the same pattern as *P. truei* when associated with *P. maniculatus*.

At Toroweap Point all five species of *Peromyscus* were collected from the same area. Many of the specimens were juvenals, preventing accurate identification. However,
those data taken indicate that *P. trueli* occurred at the
top of the line on a flat area covered by juniper trees.
Both *P. crinitus* and *P. boylii* were found down the rock
wash, with no recognizable separation. *P. maniculatus*
occur in the lower sage covered flat along with an occa­sional *P. eremicus*.

Four species of *Dipodomys* occur within the area,
but only three occupy the same area. *D. merriami* and
*D. ordii* inhabit Toroweap Valley where the distinction
of their niches is classic. The latter's preference for
soft soil dominates and *D. ordii* occupies the alluvial valley
floor. *D. merriami*, which exhibits a wide habitat selection
throughout its range, here occupies the talus slopes and
lava cones along the valley sides.

*D. ordii* and *D. microps*, although their ranges
seemingly overlap, were never observed in the same area. How­ever, the difference in substrate preference between the
two (see species accounts) would no doubt serve to sep­arate them.

*D. merriami* and *D. microps* occur together in the
Wolf Hole area. The former is far more abundant, but no
apparent niche difference was noticed. *Dipodomys deserti*
is the most selective with regard to substrate and thus
avoids excess contact with *D. merriami*. That latter species
was never trapped near the wind-blown sand occupied by *D.*
deserti.
At this point, it should be mentioned that the seemingly disjunct population of *Dipodomys merriami vulcani* may be the result of competition from *D. ordii* and *D. microps*. Both of these species occur between the Wolf Hole and Mt. Trumbull populations of *D. m. vulcani*, and the combination of the two species may have acted to split the population.

The few remaining rodents occurring within the study area inhabit niches which are distinct from those of their related forms.

**Factors Influencing Rodent Distribution**

Elevational and climatological extremes are of primary importance in limiting overall distribution of terrestrial life forms. Local distribution within an essentially homogeneous environment (with regard to elevation and macroclimate) is controlled by other factors.

As pointed out by Hardy (1945:100) edaphic features are of major importance in limiting rodent distribution. This is due to the effect of soil moisture, depth, chemical composition and texture on the distribution of vegetation which is utilized by rodents for food and cover. Also, the burrowing and nest building habits of most rodents demand a soil of a particular texture and depth and/or gradient. These latter requirements appear to function as a limiting factor (to rodent distribution) more often than local plant distribution. Many workers (Grinnell 1928:433,
Dice 1931:312, Grinnell and Orr 1934:211) discount food as a critical limiting factor. They state that within the proper plant association most mammals can find a few species of plants upon which they can feed.

The direct relationship of soil to rodent distribution is clearly demonstrated in Northern Mohave County. There are, of course, species which don't strictly inhabit one soil or substrate type. These forms can, however, usually be described as favoring a general type of substrate and found not to inhabit other types. For example, Peromyscus maniculatus, although not typical of one soil type, can be described as avoiding steep rocky slopes.

Edaphic factors alone can not support or limit a population. The necessity of vegetation as food and cover can not be denied nor be considered separately. Only one species, however, within the area, Peromyscus truei, appeared to be restricted to a certain vegetation type (juniper-pinyon forest). The remainder of the species seem to inhabit a specific soil type as opposed to a specific plant association.

**Taxonomy and Speciation**

Before embarking on any discussion of speciation, the taxonomic status of the forms involved should be thoroughly understood. This is far from the case in the
study area, especially with regard to the family Heteromyidae.

The status of *Dipodomys merriani merriami* and *D. m. vulcani* appears valid. The St. George, Utah area is obviously one of intergradation (Hardy 1945, Durrant, 1952). It should be mentioned, that up until 1965 the races on either side of the Beaver Dam-Virgin Mountain chain and the Grand Wash Cliffs were in close contact only at the northern end of the Beaver Dam Mountains in Utah. Now, however, a four-lane highway has been constructed at the Virgin River level through the Virgin Mountains. The road cut will provide adequate habitat for many of those forms which before had been unable to migrate across the mountains. The results of any migration will make the status of those races on either side, which is tenuous at this point, even more so in the future.

The range of *Perognathus longimembris arizonensis* is still in doubt. It is felt, however, that additional study will extend its range throughout the Great Basin portion of Mohave County. *P. l. virginiis* extends throughout the Mohave Desert area and those specimens from north of Wolf Hole most likely represent intergrades between the two subspecies.

The *Perognathus formosus* group presents more taxonomic problems than any other. *P. f. mohavensis* is distinguishable from other forms within the area. The
interrelationships of *P. f. formosus*, *P. f. melanocaudus* and *P. f. domisaxensis* remain in doubt. The existence of *P. f. formosus* is not questioned, but its range and intergradation with *P. f. domisaxensis* in still unknown. If further study verifies the stated range of *P. f. formosus*, and fill the distributional gaps between this race and *P. f. melanocaudus*, the two subspecies should undoubtedly be synonymized. For, it is felt that a subspecies based on a probable one gene difference (color) is not a valid criterion for separation. It is regrettable that sufficient comparative material was not available to allow more positive statements.

The effect of the Grand Canyon as an isolating barrier has been discussed by Goldman (1937), Grinnell (1914) and Kelson (1951). This barrier is effective not only at the subspecific level but also at the specific level. *Perognathus parvus*, *Perognathus formosus* and *Dipodomys microps* are found only in the Strip portion of Arizona and only west of the Colorado River throughout their entire range.

Within the study area there appears to be only one factor operating as a speciating mechanism, the Grand Wash Cliffs. These Cliffs along with the Virgin and Beaver Dam Mountains constitute a continuous barrier stretching from the edge of the Grand Canyon into southwestern Utah. The most important aspect of this barrier is not
its impenetrability, but the fact that it separates the Great Basin Desert from the Mohave Desert.

At the species level, the barrier separates those forms which are endemic to the two areas. *Dipodomys deserti deserti*, *Onychomys torridus longicaudus*, *Perognathus penicillatus sobrinus* remain west of the Cliffs. *Perognathus parvus trumbullensis*, *Dipodomys ordi cupidineus*, *Onychomys leucosaster melanophrys* are restricted to the Great Basin area.

Hardy (1945) has discussed the effects of the Beaver Dam Mountains on speciation at the subspecies level. He points out that intergradation occurs at the north end of the Beaver Dam Mountains, and it is felt that the occurrence of this phenomenon decreases as you move south. In the area of the Grand Canyon, the Cliffs are almost vertical with approximately a 2,000 ft. throw. This essentially prevents intergradation of most all but the rock dwelling forms. The following subspecies occur only west of the Cliffs: *Thomomys bottae virgineus*, *Perognathus longimembris virginius*, *Perognathus formosus mohavensis*, *Dipodomys merriami merriami* and *Dipodomys microps woodburyi* (nor yet recorded from Arizona). The related subspecies which occur east of the Cliffs include: *T. b. trumbullensis*, *P. l. arizonensis*, *P. f. formosus*, *D. m. vulcani* and *D. m. celsus*. 
CONCLUSIONS

1. *Citrillus leucurus* escalante, *Dipodomys merriami* merriami and *Castor canadensis* ssp. have been found for the first time to inhabit Northern Mohave County, Arizona.

2. The ranges of *Perognathus penicillatus* sobrinus, *Perognathus formosus* formosus, *Perognathus longimembris arizonensis* (?ssp.), *Onychomys leucogaster* melanophys, *Peromyscus eremicus eremicus* and *Peromyscus boylii utahensis* were found to be more extensive within the study area than previously reported.

3. Field observations indicate that niche separation among sympatric species is based mainly on substrate preference.

4. The preference by rodents for a certain soil type as opposed to a particular plant association acts as the most important factor in limiting local rodent distribution.

5. The taxonomic relationship of *Perognathus formosus melanocaudus* and *Perognathus formosus formosus* is obscure. Additional study is needed to clarify their status.

6. The Grand Wash Cliffs and Virgin Mountains act both as ecological and geological barriers. The Grand Wash Cliffs not only present a formidable geological structure, but effectively separate two major deserts.
APPENDIX A

Tables of Measurements
<p>| Sex | Catalog number or number of individuals averaged | total length | tail | hind foot | ear | occipitofrontal length | length of nasals | zygomatic breadth | mastoid breadth | interorbital breadth | posterior breadth | Alveolar length of upper row of ( \text{?} ) |
|-----|------------------------------------------------|--------------|------|-----------|----|------------------------|-----------------|-----------------|-----------------|------------------|-----------------|-----------------|------------------|
| M   | 11859                                          | 210          | 92   | 27        | 23 | 35.6                   | 11.1            | 19.0            | 16.0            | 7.8              | 11.7            | 5.1             |
|     |                                                |              |      |           |    |                        |                 |                 |                 |                  |                 |                 |
|     | <strong>Eutamias dorsalis utahensis</strong>                |              |      |           |    |                        |                 |                 |                 |                  |                 |                 |
|     | 6 av....                                       | 212          | 62.3 | 35.7      | 10.7| 38.5                   | 11.2            | 21.7            | 18.7            | 9.4              | 14.2            | 6.5             |
|     | Max....                                        | 230          | 67.0 | 38.0      | 11.0| 40.0                   | 12.2            | 22.6            | 20.0            | 9.6              | 14.8            | 7.3             |
|     | Min....                                        | 195          | 55.0 | 33.0      | 10.0| 37.1                   | 10.0            | 20.2            | 17.8            | 9.2              | 14.0            | 5.7             |
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LITERATURE CITED


1 piece in pocket
1 inch = approximately 8 miles