

MISCELLANEOUS PUBLICATIONS
MUSEUM OF ZOOLOGY, UNIVERSITY OF MICHIGAN, NO. 51

MAMMALS OF THE LAVA FIELDS AND
ADJOINING AREAS IN VALENCIA
COUNTY, NEW MEXICO

BY
EMMET T. HOOPER

ANN ARBOR
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FREDERICK M. GAIGE
Director of the Museum of Zoology

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MAMMALS OF THE LAVA FIELDS AND ADJOINING AREAS IN VALENCIA COUNTY, NEW MEXICO

INTRODUCTION

DURING the past fifty years many authors have commented on the prevailing tendency of lava-dwelling mammals to assume a dark coloration that harmonizes with the dark substrata on which they live. Merriam (1890), Osgood (1909), Goldman (1910), Sumner (1921), Bradt (1932), Benson (1933), and Dice and Blossom (1937) are a few of the many who have called attention to this tendency. Merriam, Benson, and Dice and Blossom have pointed out that the tendency for the pelage color to resemble the color of the lava may well be an adaptation of the mammals for concealment. Such an adaptation, they suggest, possibly evolved as the result of selective predation for concealingly colored animals. Isolation of the mammals on the lava is emphasized by Benson, Dice and Blossom, and others to be of prime importance in subspeciation, particularly with respect to the rate at which the dark-colored races become differentiated.

Sumner (1921) contended that the theory of protective resemblance or concealing coloration could not well apply to the rock-restricted, light-colored *Peromyscus crinitus*, which has succeeded in maintaining itself for centuries in great abundance on an isolated lava field in California. The efficacy of selective predation in producing dark races on lava flows likewise has been denied by Buxton (1923) and McAtee (1932).

Sumner (1921) suggested that differences in conditions of climate may be responsible for the development of pale races of mammals in the desert and darker races outside of desert regions. His subsequent experiments, however, indicated that this supposition probably was erroneous (see summary of work, Sumner, 1932), at least as regards humidity as an agent responsible for the difference in coloration, and Benson (1933) showed that both light and dark races have developed under approximately identical conditions of macro-climate.

Sumner (1915 and subsequent papers: see summary, 1932) and Dice (1932) have shown that many subspecific characters are inherited and are not acquired as the result of environmental action alone in each generation.

The present report presents an analysis of the mammal fauna of a section of west-central New Mexico on and around extensive fields of blackish lava. The specimens and data forming the basis for this report are chiefly those obtained in the region during May and June, 1939, by myself and Richard H. Manville for the Museum of Zoology, University of Michigan. It was hoped that the data obtained from our studies would furnish clues to permit a better understanding of the forces directing the evolution of dark races

of mammals on lava flows. It seems clear that some directive force is present, for no instances are known of the occurrence on black lava of races of mammals with a coloration noticeably lighter than the normal coloration outside lava beds. The repeated occurrence of dark races of mammals on many lava flows in southwestern North America can hardly be explained on the basis of chance alone.

Place names and names of physiographic features mentioned herein are from maps prepared by the United States Forest Service (U. S. Dept. Agr., 1938), Darton (1928), and Ellis (1925), unless otherwise indicated. Elevations above sea level, except those for the United States weather stations and the elevation for the summit of Mount Taylor, necessarily are approximations; they are, however, probably within two hundred feet of the actual elevation above mean sea level. Capitalized color terms are from Ridgway (1912).

I am indebted to the Horace H. Rackham School of Graduate Studies of the University of Michigan for the financial aid which made this work possible. Richard H. Manville was of considerable assistance in the field collecting specimens and data essential for the present study. R. J. Shuman, William Porter, and Cecil Moore of Grants, New Mexico, kindly placed the facilities of their ranches at our disposal. Roy Ballard was of assistance in several ways. My thanks are especially due William H. Burt and others in the Museum of Zoology for reading the manuscript critically and offering helpful suggestions.

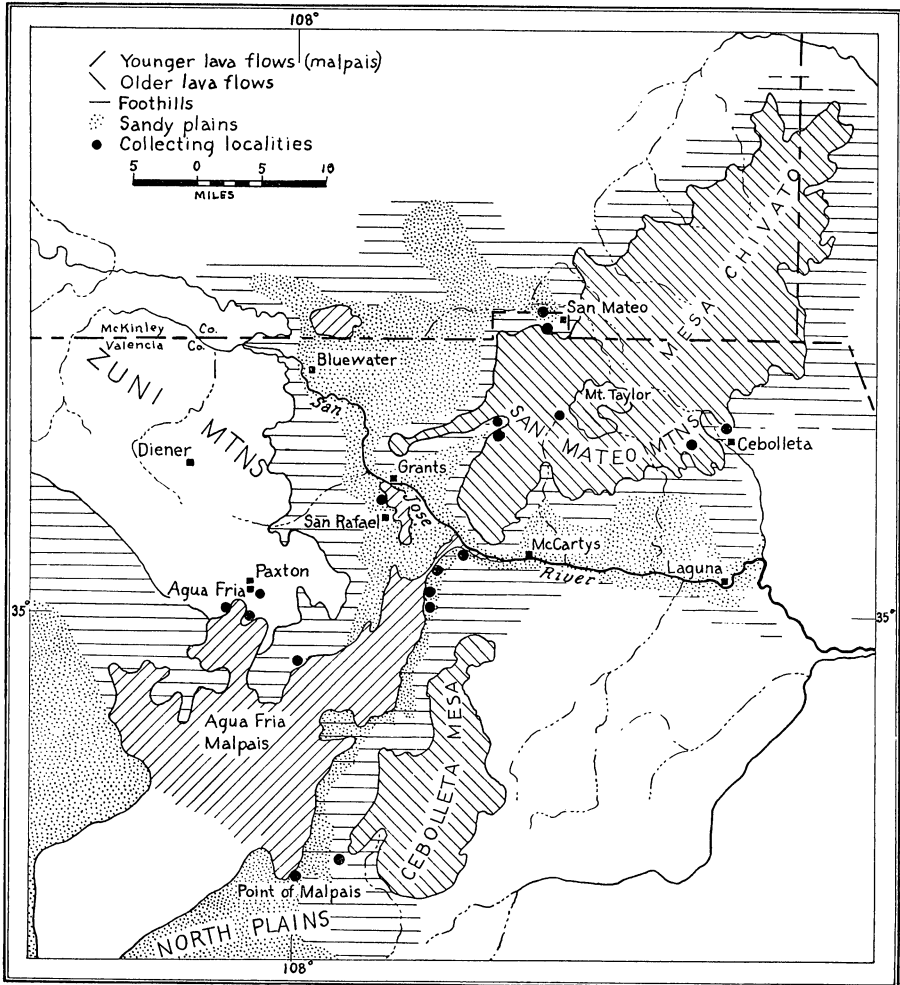
PHYSIOGRAPHY AND CLIMATE

The area herein considered is a part of the Colorado Plateau Province of the southwestern United States (Fenneman, 1931: 274, map). It embraces much of central Valencia County and southeastern McKinley County, New Mexico, centering around Grants, Valencia County, in the San Jose River Valley about seventy miles west of Albuquerque (Map 1). It includes an extreme eastern part of the Zuni Mountains, the Mount Taylor or the San Mateo Mountains (in Valencia County, not Socorro County), a southern part of Mesa Chivato, an extreme western part of Cebolleta Mesa, and, around the bases of these mountainous areas, the gently sloping highlands of the Colorado Plateau Province which drain eastwardly from the Continental Divide into the San Jose River, the Rio Puerco, and eventually into the Rio Grande. Elevations above sea level vary from 5800 feet near Laguna in the San Jose River Valley to 11,389 feet on Mount Taylor.

Mount Taylor rises from a large mesa about fifty miles long and twenty-five miles wide (Pl. I, Fig. 1), the largest and northern part of which is known as Mesa Chivato and two smaller, more southern parts as Horace Mesa and La Jara Mesa, respectively. The mean altitude of the summit of the mesa is about 8200 feet, approximately 2000 feet above the mean altitude of the surrounding desert plains and 3200 feet below the summit of Mount Taylor. The surface of the mesa is covered by a lava cap seldom less than 300 feet thick (Dutton, 1886: 164). The vegetation cover varies with the altitude and the exposure. The north-facing slopes of the mountain, from its summit down to about 8200 feet, are clothed with grass, yellow pine, Douglas fir, aspen, and oak brush. On the south-facing slopes the conifers, aspen, and oak brush are restricted to canyon sides and bottoms and are mainly between 8200 feet and 9200 feet levels; above 9200 feet the slopes are covered with low-lying vegetation—a short grass, chiefly. Small meadows of iris, dandelion, and grass are fairly common on the mountain in the more level places around springs and along stream courses. Willow, currant, and rose border many of the creek beds that remain moist throughout the year. Pinyon and sage clothe the mesa and extend down on the surrounding plains. In some deep cool canyons cut in the mesa, yellow pine occurs with willow, alder, maple, and other riparian plants. The soil in the forests above 8200 feet is predominantly loose and rich in humus. Below 8200 feet, down to the sandy plains, it is usually compact and composed of considerable gravel and rubble.

The Zuni Mountains, lying to the southwest of Mount Taylor, reach a maximum height of about 9200 feet. The vegetation on the southwestern part of the mountains, the only part of them that we saw, is approximately

the same as that on Mount Taylor for the corresponding altitude and exposure. Yellow pine and Douglas fir grow at the higher elevations and pinyon, juniper, and sage on the foothills. A conspicuous, bright, brick-red



MAP 1

MAP 1. Part of Valencia and McKinley counties, New Mexico, in which studies were conducted. Based on maps mentioned in the accompanying text and on original observations.

soil not seen elsewhere in the area occurs extensively on the southern foothills of these mountains. This soil probably was formed from the Permian "Red Beds" which are exposed there.

The desert plains surrounding the mountains, elevated mesas, and nu-

merous isolated volcanic necks are covered with lava or unconsolidated sand, silt, or clay. Typically, they support juniper, sage, and rabbit brush, and, where the soil is suitable, salt bush.

Perhaps the most conspicuous physiographic features in the area under consideration are the extensive fields of dark lava. The lava fields constitute fully one-half of the ground in the area studied. The lava composing the fields is of two general types. One type is dark gray and comparatively smooth on the surface, although sometimes it is broken into large blocks and boulders (Pl. II, Fig. 1). It is Tertiary in origin (Dutton, 1886: 177). This type supports a thicker, more continuous layer of soil and a denser cover of plants than the second type. It forms the body of Mount Taylor and is exposed further as a thick cap on Cebolleta Mesa, on the mesa surrounding Mount Taylor, and in some places south of the Zuni Mountains. The second type is reddish black, grayish black, or black and is extremely rough, jagged, deeply fissured, and little eroded (Pl. II, Fig. 2, and Pl. III). It was extruded in Quarternary time and probably mostly in Recent time, prior to the extrusion of the Recent flows in the Tularosa Basin (Robert L. Nichols, *in litt.*). The pale soil layer on it is discontinuous, shallow, and confined chiefly to leeward ledges and crevices. All of it apparently has blown on the lava from adjoining areas. This lava is almost entirely restricted to the gently sloping plains between the Zuni Mountains and Cebolleta Mesa and to the bottomlands of the San Jose River Valley. These extensive fields of black lava are known as the malpais.

The malpais is broken up into three isolated fields, one north of Bluewater, a second just south of Grants, and a third, the largest, extending from near Agua Fria southward for about twelve miles, then northeastward to the San Jose River (Map 1). Tongues of lava connect these three masses, but at the present time the tongues are almost entirely covered with soil and drifted sand. Only a few small piles of lava and numerous rough clinkers remain exposed. Studies were conducted only on the lava field near Grants and on the large field extending south from Agua Fria.

The malpais at Grants (Pl. III) is five miles long and averages about a mile wide. It has an area of five square miles and a mean elevation above sea level of approximately 6400 feet. On the north, east, south, and northwest it is bounded by gently sloping, sandy desert plains, one to five miles in width. Rocky hills adjoin it for about one-half mile along its western border. The height of the malpais above the adjoining plains averages about fifteen feet, varying from less than a foot to forty or fifty feet. Its vegetation consists chiefly of juniper, pinyon, apache plume, and sage; some sparse short grass occurs on comparatively level unbroken areas.

The largest field of Recent black lava, referred to below as the Agua Fria malpais, is an irregular mass thirty miles long and one-fourth of a mile

to ten miles wide. Its area totals approximately two hundred square miles. The height of the malpais above the adjoining plains ranges from less than one foot to fifty or sixty feet. Its elevation above sea level decreases gradually from 7800 feet near Agua Fria and Flagpole Crater, one of the vents from which the lava issued, to 6100 feet near McCartys in the San Jose River Valley. Above approximately 7300 feet, yellow pine is the most abundant tree on the malpais (Pl. II, Fig. 2). At consecutively lower elevations yellow pine is replaced by pinyon and apache plume and finally by juniper and sage. The malpais is bounded on the south and north by sandy desert plains several miles wide and on the west and east by cliffs and mountains interspersed with local sandy flats a few hundred feet to more than one-half mile in width.

TABLE I
METEOROLOGICAL DATA

Compiled from the United States Weather Bureau's climatic summary for northwestern New Mexico (Linney, 1933). The subscript with each figure indicates the number of years for which records were kept.

	Laguna 5840 feet	San Fidel 6100 feet	San Rafael 6509 feet	Blue- water 6732 feet	Diener 9000 feet
Average annual precipitation (inches)	11.43 ₂₁	9.92 ₁₁	14.31 ₁₂	9.86 ₂₅	25.04 ₇
Average annual snowfall (inches)	20.6 ₁₇	14.5 ₁₁	26.5 ₁₁	18.0 ₂₂	.....
Average number of days with pre- cipitation	35 ₁₇	47 ₁₁	56 ₁₁	44 ₂₂	.....
Temperature (degrees Fahrenheit)					
Average annual	53.0 ₁₆	50.4 ₁₀	51.2 ₁₁	47.6 ₂₂	.....
Average annual maximum	68.5 ₁₆	66.3 ₁₀	67.9 ₁₁	66.1 ₂₂	.....
Average annual minimum	37.0 ₁₆	34.4 ₁₀	34.4 ₁₁	29.2 ₂₂	.....
Maximum	103 ₁₆	100 ₁₀	109 ₁₁	105 ₂₂	.....
Minimum	-20 ₁₆	-11 ₁₀	-16 ₁₁	-23 ₂₂	.....
Prevailing wind direction	W ₁₆	W ₁₀	SW ₁₁	W ₂₂	.....
Average date of last killing frost in spring	Apr. 27 ₁₆	.....	.....	May 28 ₂₁	.....
Average date of first killing frost in autumn	Oct. 14 ₁₆	.....	.....	Sept. 23 ₂₁	.....
Average length of growing season (days)	170 ₁₆	.....	.....	118 ₂₁	.....

Meteorological measurements are available from four stations in the vicinity of the lava beds (Table I). Although the data are incomplete, they are sufficient to show the climatic conditions in some areas and to permit one to reconstruct approximately the conditions prevailing over the remaining areas under consideration.

The particular climatic conditions to be found at a locality are closely correlated with the altitude of that locality. At the higher elevations, for example above 9000 feet on Mount Taylor and 8500 feet in the Zuni Mountains, the winters are long and severe and the summers short and cool.

The average annual rainfall at elevations over 9000 feet on Mount Taylor and 8500 feet in the Zuni Mountains probably exceeds twenty-five inches, the average annual snowfall is well over fifty inches, and the mean annual temperature is doubtless less than forty degrees Fahrenheit. At lower elevations the annual extremes of temperature are greater—higher in the summer and lower in the winter—and the annual precipitation is less; the summers are hot and moderately dry and the winters cool and wet. The conditions at the extremes of altitude, Mount Taylor and Laguna, represent the extremes of climate. The conditions to be found at other localities in the area are within these extremes. The exact conditions depend closely on the altitude of the locality.

The measurements made at San Fidel indicate the conditions of our several collecting localities on the northeastern part of the Agua Fria malpais. The measurements for San Rafael indicate the conditions over the Grants malpais, except that the average annual precipitation probably averages three or four inches more because San Rafael, unlike the malpais at Grants, is situated at the eastern edge of the comparatively heavy precipitation belt which covers much of the Zuni Mountains. The climate over the southwestern, higher part of the Agua Fria malpais, as in the yellow pine belt near Flagpole Crater and on Porter's Ranch, is cooler and more humid than that of the northwestern, lower part. The amount of precipitation is probably about twenty inches, slightly less than that at Diener, and the average annual temperature near forty-five degrees Fahrenheit. At North Plains, at Point of Malpais, and at Shuman's Ranch, on the southeast side of the Agua Fria malpais, conditions are similar to those at Flagpole Crater and Porter's Ranch, but the amount of precipitation is probably less. Those at our collecting stations near San Mateo and Cebolleta are probably closely similar to the ones indicated for Bluewater.

COLLECTING STATIONS

Near Flagpole Crater, seventeen miles southwest of Grants.—From May 3 to 6 we collected on the Agua Fria malpais near the Ice Caves Resort at the base of Flagpole Crater, at an elevation of 7800 feet. Yellow pine and pinyon are the dominant trees; Douglas fir and juniper are less abundant. Yellow pine, pinyon, and juniper grow both on the malpais and on the adjoining sedimentary soils. A small fraction of the lava exposed is of an old flow, probably of Miocene age (Dutton, 1886: 177). It is dark gray and, in many places, is covered with soil or overgrown with lichen. Most of the remainder is black and probably Recent in origin.

North side Flagpole Crater, nineteen miles southwest of Grants.—A specimen of a pocket gopher was collected on May 5 on a flat at the northwestern base of Flagpole Crater, at an elevation of 7800 feet. The flat is covered with rabbit brush, sage, and dry grass and is surrounded by pinyon and yellow pines.

Agua Fria, fifteen miles southwest of Grants.—Specimens were obtained at an elevation of 7600 feet on the alluvial flats adjoining Agua Fria Creek, one mile south of Paxton. The soil there is sandy and reddish brown when wet, and light tan when dry and baked by the sun. Rabbit brush, sage, and salt bush are characteristic of the flat. Approximately thirty acres of the richer soil nearest the creek were under cultivation during the period we collected there, May 4 to 6.

Porter's Ranch, eight miles southeast of Paxton.—From May 25 to 31 we collected in township eight north, range eleven west, and section ten, on property owned by William Porter; the elevation at Porter's house is 7400 feet. The terrain is mountainous; hills several hundred feet in height alternate with narrow canyons or small valleys. The hills and canyon walls characteristically support a thick layer of bright brick-red soil and are covered with stands of pinyon and juniper. The malpais is irregular in relief, undulated, with crests up to fifty feet above the surrounding troughs. A small fraction of the lava is weathered considerably and coated with lichen (Pl. II, Fig. 1), just as at Flagpole Crater; it is likely of Miocene age. The amount of soil on the weathered lava is greater than that on the more broken, unweathered Recent lava at lower elevations to the north; it is, however, restricted to occasional crevices and gentle, slightly fissured slopes. Yellow pine is the most abundant tree on the malpais; dense stands of yellow pines over two feet in diameter are common, often completely shading the substrata (Pl. II, Fig. 2). A few pinyons and occasional junipers grow in the more open places between the stands. Yellow pine appears to be dominant on the malpais and pinyon on the adjoining sedimentary soils; the edaphic separation of the two species is distinct. A few aspens were seen in a protected situation near the malpais.

Two features, in particular, of Porter's ranch influence the abundance of mammal life in the vicinity, namely, (1) an open tank continually supplied with water, and (2) extensive, cultivated fields, both immediately adjoining the malpais. The water tank serves as a water supply for many mammal kinds, bats in particular. Ten bats, of four species, were obtained there in one evening. The cultivated fields are attractive to rabbits, pocket gophers, and other rodents.

One and one-half miles south of Grants.—From May 22 to 25 we collected on the lava field near Grants about halfway between Grants and San Rafael, at an elevation of 6400 feet. The small lava field there is extremely rough, broken, and black or reddish black. Soil is limited to crevices or to flats where it has been allowed to accumulate. Vegetation on the lava is sparse; it consists chiefly of juniper, apache plume, ball cactus, and short grass. Sage and juniper are characteristic of the surrounding desert plains and slopes.

Zuni Canyon.—Traps were set on May 23 and 24 in Zuni Canyon between three and five miles west-southwest of Grants at elevations between 6700 and 7100 feet. For a distance of six miles the walls of Zuni Canyon rise precipitously two hundred feet or more above the talus slopes on the borders of the canyon floor. Pinyon and juniper are the most abundant trees. Protected ledges and shelves support some cliff rose and grass. Sage is common on the floor and sides of the canyon.

Eight miles southeast of Grants.—From May 7 to 10 we collected three miles south of the San Jose River and highway U.S. 66 on the narrow, northern arm of the Agua Fria malpais, at an elevation of 6400 feet. In coloration and ruggedness the malpais there resembles the malpais near Grants. The amount of soil drifted in from the adjoining desert is greater, however, and the vegetation is correspondingly more abundant. The malpais is elevated little more than twenty-five or thirty feet above the adjoining desert plains; peripherally, it merges gradually into the plains. About one-fourth mile east of the malpais, light sandstone cliffs arise approximately 300 feet above the plain. Juniper, pinyon, and sage are characteristic of the area. Juniper and sage are more abundant on the plain and malpais and pinyon along the cliff. Cane cactus and rabbit brush also are common on the sandy desert plain and apache plume is common on the malpais.

Nine miles south-southeast of Grants.—From May 17 to 20 we collected at an altitude of about 6500 feet at this station. The habitats, physiography, soils, and flora there are similar to those at the above-mentioned station. The malpais, however, immediately adjoins light sandstone cliffs.

Eleven miles south-southeast of Grants.—A few specimens were collected on May 18 and 19 on a ranch about two miles south of the previously men-

tioned station and immediately adjoining the Agua Fria malpais. The native flora is similar to that eight miles southeast of Grants.

Point of Malpais.—Point of Malpais, as located on the United States Forest Service map (1938), lies in township six north, range eleven west, and section two. It marks the junction of the southernmost part of the Agua Fria malpais with a broad flat valley known as North Plains. The elevation there is approximately 7100 feet. The malpais is not so rugged and badly broken as at the other collecting stations. Vegetation on it is sparse, consisting of a few dwarfed junipers, an occasional pinyon, and apache plume. The soil on North Plains, near Point of Malpais, includes sandy loam, dune sand, and hard-packed clay. Sage is dominant on the sandy soils and rabbit brush and salt bush on the clay. The hills surrounding the plains are covered with dense stands of pinyon. We collected at Point of Malpais from May 11 to 15.

Shuman's Ranch.—On May 15 and 16 we collected on J. L. Shuman's Ranch, township six north, range ten west, and section thirty. This ranch is about three miles east and a mile north of Point of Malpais and 400 feet higher in elevation. The soil is loose and sandy. Pinyon is abundant, occurring in dense stands, but there are a few junipers on the warmer more open slopes and occasional yellow pines in the protected canyons. Sage grows on the more open flats and on dry hillsides.

Four miles west of McCartys.—Two days, May 20 and 21, were spent collecting at an elevation of 6100 feet in the San Jose River Valley about four miles west of McCartys, at the western boundary of the Acoma Indian Reservation. At this locality the narrow arm of the Agua Fria malpais that extends eastward down the valley is partially covered with drifting sand from the adjoining sandy flood plain of the San Jose River. Pinyon, juniper, and sage are common on the valley floor and on the bordering hills. Several springs arise just within the Reservation boundary. Although the water from the springs is partly impounded by elevated areas to form ponds and marshes, most of it drains into a canal to maintain a flow of about twenty-five cubic feet per second. Dense growths of cattails cover many of the marshes. Adjoining meadows are sparsely covered with a short wiry grass.

Canyon Lobo Ranger Station.—June 6 and 7 we collected in the vicinity of Canyon Lobo Ranger Station at an elevation of 7500 feet. The ranger station is situated beside a small permanent creek near the head of Lobo Canyon, a broad canyon extending from the base of Mount Taylor northwardly between Horace and La Jara mesas. The topography is rough, and the hills and mesas are steep-sided. The soil is exceedingly rocky and hard-packed on all slopes and crests of hills; on flats it is sandy loam or sandy clay, and usually hard-packed and mixed with rubble. Pinyon, the most

abundant tree in the area, is in pure stands on the tops and sides of the mesas adjoining the canyon; it is mixed with juniper in more open situations on the canyon floor, and with yellow pine on steep, north-facing slopes and in other protected places. Sage is common in most situations, but is less abundant on cooler, north-facing slopes. Rabbit brush is abundant on moist sandy clay soils. Along the rocky creek bed, thickets of willow and wild rose grow between yellow pine, oak, juniper, and pinyon.

Horace Mesa.—On June 8 three specimens were collected at an elevation of 8000 feet on Horace Mesa about one and one-half miles south of Canyon Lobo Ranger Station. The soil layer on the mesa is thin and is composed of an appreciable amount of dark gray basaltic rubble. Pinyon, in pure dense stands, is the dominant plant species; sage grows in open places between the pinyon forests.

Mirabal Spring, Mount Taylor.—From May 31 to June 6 we collected in the vicinity of Mirabal Spring on the western slope of Mount Taylor, about two miles west-southwest of the summit of the mountain, at an elevation of about 9000 feet. Most of the water from Mirabal Spring seeps into the ground to maintain a small, marshy, grass-covered meadow spread out down-slope from the spring (Pl. I, Fig. 2). The soil is blackish, sandy, and rich in humus on the gentler slopes and on meadows; on steeper slopes it is more compact and rocky and paler. Yellow pine is a characteristic tree of the area; individual trees three feet in diameter are common. Between the stands of yellow pine are thickets of oak brush and dense groves of aspen. Dandelion and grass cover the meadow; iris is fairly common in moist, shaded areas.

Ranchos Vallejos.—A specimen was collected on June 5 at Ranchos Vallejos (or Ranchos Viejos) Spring. This spring is among yellow pines and aspens a mile southeast of Mirabal Spring at an elevation of 8600 feet.

Six miles northeast of the summit of Mount Taylor.—From June 15 to 17 we collected near the Fernandez Company Summer Camp on the northeast side of Mount Taylor at an elevation of 8900 feet. This camp is situated in a narrow canyon near the junction of Mesa Chivato with the bases of the steeper slopes of Mount Taylor. Thickets of willow, currant, or aspen grow on alluvial flats on the floor of the canyon. The more exposed slopes and floor of the canyon, except along the stream, are covered with a superstructure of yellow pine, and an understory of oak brush and currant. There are stands of Douglas fir on cooler, more protected slopes. Outcrops of basaltic rock shaded by dense growths of currant, oak brush, and aspen provide excellent chipmunk habitat. The soil is rocky and hard, except on the more gentle slopes in forests and on alluvial flats on the floor of the canyon.

One and one-half miles southwest of San Mateo.—From June 9 to 14 we

collected at an elevation of about 7200 feet near the mouth of a canyon one and one-half miles southwest of San Mateo. A stream, fed by several springs arising along its course, flows down the canyon throughout the year. Near the mouth of the canyon the water is impounded in one of several open earthen tanks to be used as a water supply for cattle or for irrigation of near-by alfalfa fields. In the upper, narrower reaches of the canyon yellow pine is found on the floor and pinyon on the more exposed rocky slopes. At the mouth of the canyon, yellow pine is replaced along the stream by willow, cottonwood, and rose, and by juniper and sage on the slopes. On the desert plain that extends outward from the mouth of the canyon, sage, salt bush, and rabbit brush are abundant.

One and one-half miles west of San Mateo.—On the night of June 11, traps were set among sage, salt bush, and rabbit brush on the desert plain one and one-half miles west of San Mateo, along the road extending between San Mateo and Grants, at an altitude of 6700 feet. The soil is a hard-packed clay; sandy soil is restricted chiefly to hummocks at the bases of the shrubby vegetation.

Four miles west-southwest of Cebolleta.—From June 17 to 21 we collected on Mesa Chivato at an elevation of about 7800 feet, four miles west-southwest of Cebolleta. The soil layer over the underlying dark gray basaltic rock that caps the mesa is thin and contains considerable rubble. Pinyon is the most abundant tree and sage the most abundant shrub. There are a few junipers and yellow pines; most of the latter have been removed for timber or have been cut and left where they fell. Exposed ledges of basaltic rock are numerous. Two such outcrops near camp bordered a spring-fed, marshy, grass-covered meadow about three acres in extent. In the lee of the higher outcrop and adjoining the meadow were dense growths of currant, sage, and oak brush and a few large oaks, yellow pines, and pinyons. On the opposite side of the meadow at the lower, more exposed outcrop the vegetation was less dense and was composed of cottonwood, pinyon, and yellow pine.

One mile north of Cebolleta.—From June 21 to 24 we collected at the eastern base of Mesa Chivato in Cebolleta Creek Canyon, a mile north of the town of Cebolleta (or Seboyeta) at an altitude of approximately 6700 feet. Cebolleta Creek usually flows throughout the year and supports a dense stand of riparian vegetation, including willow, cottonwood, alder, and maple. At our camp, cliffs of tan sandstone rose precipitously a hundred feet or more above the narrow canyon bottom. Juniper, pinyon, and sage are characteristic plants of the canyon walls and dry canyon floor. At the mouth of the canyon the sandy soil is cultivated.

One and one-half miles east of Cebolleta.—On June 25 Manville trapped a few specimens among sage and cane cactus on the plains one and one-half miles east of Cebolleta, at an elevation of 6600 feet.

PLANTS MENTIONED IN THE ACCOUNTS

Alder	<i>Alnus tenuifolia</i>
Apache plume	<i>Fallugia paradoxa</i>
Aspen	<i>Populus tremuloides</i>
Ball cactus	<i>Echinocereus Engelmannii</i>
Cane castus	<i>Opuntia arborescens</i>
Cattail	<i>Typha latifolia</i>
Cliff rose	<i>Cowania mexicana</i>
Cottonwood	<i>Populus wislizenii</i>
Currant	<i>Ribes inebrians</i> (?)
Dandelion	<i>Taraxacum officinale</i> (?)
Douglas fir	<i>Pseudotsuga taxifolia</i>
Iris	<i>Iris missouriensis</i> (?)
Juniper	<i>Juniperus monosperma</i>
Maple	<i>Acer glabrum</i>
Oak brush	<i>Quercus gambellii</i>
Oak	<i>Quercus</i> sp.
Pinyon	<i>Pinus edulis</i>
Rabbit brush	<i>Chrysothamnus</i> sp.
Rose	<i>Rosa</i> sp.
Sage	<i>Artemisia tridentata</i>
Salt bush	<i>Atriplex</i> sp.
Willow	<i>Salix</i> sp.
Yellow pine	<i>Pinus ponderosa</i>

GENERAL ACCOUNTS

Sorex.—No specimens of shrews have been taken in the region. Bailey (1931: 373) suggested that the shrews of the Zuni Mountains and Mount Taylor are of the race *Sorex vagrans monticola* Merriam. He reported a shrew "seen at the edge of a creek on Mount Taylor."

Myotis volans interior Miller.—Two specimens of this species of bat were collected: one at the open water tank near the malpais among yellow pine and pinyon on Porter's Ranch; the second among willows, yellow pines, and pinyons, along the creek at Canyon Lobo Ranger Station.

The method of collecting bats employed at Porter's tank was both effective and ludicrous. Armed with a piece of chicken wire about three feet wide and four feet long, Manville seated himself on one corner of the tank while I, similarly equipped with wire, stationed myself at an adjoining corner, about eight feet away. When a bat dipped down toward the water (four feet below the upper edge of the tank) one or both of us struck at the animal with the wire. Ten specimens were obtained within half an hour one evening and, in all, seventeen bats of five species were secured by this method at Porter's tank.

Myotis subulatus melanorhinus Merriam.—In areas where pinyon was the commonest tree this was the most abundant species of bat. A total of fifteen was collected: ten at the water tank on Porter's Ranch; three over the creek near Canyon Lobo Ranger Station; one among oak, pinyon, and juniper near one of the water storage ponds one and one-half miles southwest of San Mateo, and another at the same locality but among willows and yellow pines over a dry creek bed.

Myotis evotis chrysonotus Allen.—Three specimens were taken at the water tank on Porter's Ranch, and one was shot among yellow pines and willows along the creek bed one and one-half miles southwest of San Mateo.

Myotis thysanodes thysanodes Miller.—A fringed bat was shot over a willow thicket along the creek at Canyon Lobo Ranger Station. Another was collected at the water tank on Porter's Ranch.

Lasionycteris noctivagans Le Conte.—Five specimens of this species were collected: two at Porter's water tank in pinyon and yellow pine country; one at the water tank on a sage-covered flat eleven miles south-southeast of Grants; and two in yellow pine and aspen forests six miles northeast of the summit of Mount Taylor. At the last locality this was the first bat species active in the evening. *Eptesicus* and a smaller-sized species, presumably *Myotis*, appeared soon after the *Lasionycteris*.

Eptesicus fuscus pallidus Young.—Three specimens of *Eptesicus* were shot at a water tank on North Plains near pinyon forests at Point of Malpais, one at the water tank on Porter's Ranch, and one in a yellow pine

and aspen forest on mountainous slopes six miles northeast of the summit of Mount Taylor.

Lasiurus cinereus Beauvois.—The single specimen of this species obtained was found dead. It hung by its tail and interfemoral membrane on a strand of barbed-wire fence over the creek near Canyon Lobo Ranger Station. The bat apparently had been using the narrow creek canyon as a flyway when it became pinioned on the wire. Bailey (1931: 382) recorded finding a bat of this species caught by a wing on a barb of a barbed-wire fence in Moreno Valley, northern New Mexico.

Ursus americanus.—A trapper for the United States Biological Survey, Roy Ballard, reported black bear in the Zuni Mountains and in other rugged mountainous areas in the state. In the spring months of 1939 a rancher in the Zuni Mountains complained of recent depredations on his cattle by a bear. Bailey (1931: 350) considered the black bears of New Mexico to be of the geographic race *amblyceps* Baird.

Ursus perturbans Merriam.—The type specimen of this species of grizzly, the range of which Bailey (1931: 364) ascribed to the region between the San Mateo and Datil mountains, was collected in 1916 on Mount Taylor. Grizzlies were then rare in the region; they are most likely extinct there now. I found no reliable recent reports of their presence.

Procyon lotor.—Roy Ballard informed us that he had taken raccoon in his traps along water courses running down from Mount Taylor. Bailey (1931: 348) reported them "common along practically every permanent stream in New Mexico up to the lower border of the Canadian Zone." He referred specimens from New Mexico to the subspecies *mexicanus* Baird.

Bassariscus astutus.—Local residents reported that ring-tailed cats are taken occasionally, but are by no means common. A trapper working mainly in pinyon forests on the east side of the malpais near Point of Malpais said he had taken several. William Porter, Jr., told me that he had taken one among pinyon and yellow pine on his father's ranch near the western edge of the malpais, eight miles southeast of Paxton. Bailey (1931: 346) recorded the race *flavus* Rhoads in western New Mexico.

Mustela frenata neomexicana Barber and Cockerell.—Roy Ballard informed me that he had taken several weasels in the vicinity of the lava beds during 1939. Hall (1936: 101, 108) indicated the probable occurrence of the subspecies *neomexicana* in the region.

Mustela nigripes Audubon and Bachman.—Bailey (1931: 326) recorded this species from the vicinity of San Mateo and Bluewater. Aldous (1940: 23) collected a ferret at Agua Fria, but few ferrets remain in the region now. The extensive predator control probably keeps the population down to a bare minimum.

Mephitis mephitis estor Merriam.—A single skull of this species of skunk

was found among pinyons and yellow pines on Porter's Ranch. Evidence that skunks were about was brought to us on the wind at our camps among aspens and yellow pines at Mirabal Spring, about 9000 feet on Mount Taylor, and among pinyons on a boulder-strewn hillside one and one-half miles southwest of San Mateo.

Conepatus mesoleucus mearnsi Merriam.—A desiccated carcass of a hog-nosed skunk was found in a crevasse between two masses of lava near the edge of the malpais on Porter's Ranch at an elevation above sea level of about 7400 feet. The dominant trees in the area are yellow pines and pinyons. The species is rarely found in association with yellow pines.

The specimen is tentatively referred to the subspecies *mearnsi* rather than *venaticus* Goldman, although the skull is broader than some skulls of *venaticus* from the vicinity of Tucson, Arizona.

Taxidea taxus berlandieri Baird.—Badger diggings were seen at each collecting locality where the soil was sandy and sage abundant. On June 11, a lactating female was trapped by Roy Ballard on a shady plain ten miles north of San Mateo. Ballard told us that he caught badgers regularly in his coyote sets. Unlike most other mammal kinds trapped, they were usually dead when found, even though caught for only a few hours.

Urocyon cinereoargenteus scottii Mearns.—A large, adult male, gray fox was killed about seven o'clock one morning about one-fourth mile within the lava field near Grants. The animal was traveling out toward the center of the malpais and may have been returning to the shelter of a cave from a night's foraging on the sandy juniper-studded flats bordering the malpais. Porter gave us a skull of a gray fox trapped the preceding winter near the malpais on his ranch.

Canis latrans estor Merriam.—Although their howling was heard but twice during our two months' stay in what should be their metropolis, coyotes apparently are not rare in the area—in spite of the large numbers of them killed each year in predator campaigns. They range over the entire area where we collected and probably enter all terrestrial habitats. It is probable that the coyote and the gray fox, to a great extent, rely on caves and crevasses in the malpais for refuge and nesting sites. Both species probably forage almost entirely outside the malpais. Seven specimens were collected at Porter's Ranch, in the vicinity of San Mateo, and at Shuman's Ranch. The specimens are tentatively referred to the race *estor*.

Canis lupus.—Wolves formerly occurred in the vicinity of the lava beds, but are now rare there or completely extirpated. Goldman (1937: 40) recorded the race *youngi* Goldman (1937)¹ from northwestern New Mexico.

Felis concolor.—Although I have no definite record of them, mountain lions probably occur in the Zuni and San Mateo mountains. Bailey (1931:

¹ Citation given for those subspecies described since Miller (1924).

285-86) indicated that the lions in the region are of the race *hippolestes* Merriam.

Lynx rufus.—Bobcats are common in the region. The numerous caves and ledges in the malpais and in the broken mountainous country adjoining it offer den sites for a large population of cats and other large predators. Almost every trapper reported that he took one or more bobcats each winter. Trappers for the Biological Survey in the region take them regularly whenever they trap in suitable situations. We collected skeletons of two bobcats trapped by Shuman on his ranch. I saw a large female that Roy Ballard had taken in his trap line in pinyon forests northwest of Mount Taylor. Bobcat droppings were seen on a rocky ledge in Zuni Canyon.

Citellus variegatus grammurus Say.—The rock squirrel inhabits rocky situations from the juniper and sage belts to areas where yellow pine and aspen predominate. It is, however, most common at the lower elevations. Edaphic factors apparently are more effective than are conditions of climate in defining its occurrence. The species was found living only in rocky situations where there were large boulders, rock outcrops, cut banks, or cliffs. Squirrels, or their signs, were seen at every collecting locality where such rocky situations were present. At an elevation of 9000 feet on Mount Taylor, at Mirabal Spring, a squirrel was shot among boulders at an outcrop surrounded by oak brush, yellow pine, and aspen. In Zuni Canyon two were shot near boulders at the base of the cliffs bounding the canyon. Near Cebolleta the species was found inhabiting a boulder-strewn hillside and cut-banks along a creek. At (1) Point of Malpais, at (2) the locality eight miles southeast of Paxton, and (3) at the localities eight miles southeast, eleven miles south-southeast, and one and one-half miles south of Grants, rock squirrel droppings were abundant in caves and on ledges in the malpais, but few squirrels were seen and only three collected. They were so wary that seldom could we get within shotgun range before they had disappeared in crevices in the lava.

A female taken on May 28 on Porter's Ranch contained four embryos. Another female collected on June 7 at Canyon Lobo Ranger Station was lactating.

The three specimens at hand from the malpais are no darker than the four specimens taken at light-colored sandstone cliffs near the malpais. Nor are these seven squirrels any darker than other specimens of *Citellus v. grammurus* from localities in New Mexico and Arizona where there are no extensive areas of blackish rock.

The rock squirrels on the malpais, particularly those on the Agua Fria malpais, are by no means completely isolated from other habitats suitable for squirrel existence. Apparently the interchange of squirrels between the areas of light and dark substrata is sufficient to prohibit the fixation of a dark coloration in the lava-dwelling populations alone.

Citellus spilosoma cryptospilotus Merriam.—Howell (1938: 130) recorded a spotted ground squirrel from Thoreau, about fifteen miles northwest of Bluewater, as of the race *cryptospilotus*. The species probably also occurs in the San Jose River Valley.

Cynomys gunnisoni zuniensis Hollister.—Prairie dogs are common on the plains around the lava beds and Mount Taylor. They avoid areas densely covered with plant growth and occupy instead open fields supporting a sparse growth of rabbit brush, salt bush, and short grass. One colony was seen on a sage-studded flat surrounded by pinyons at an elevation of 8000 feet on Horace Mesa. Two specimens were taken at Point of Malpais and three at Agua Fria. Those collected at Point of Malpais, on May 13, contained three and four embryos, respectively.

Eutamias quadrivittatus quadrivittatus Say.—Two species of chipmunk, *quadrivittatus* and *dorsalis*, are present in the vicinity of the lava beds, but the two are rarely found at the same locality. *Eutamias quadrivittatus* occurs with yellow pine, Douglas fir, and aspen on the upper slopes of the higher mountains. *Eutamias dorsalis* is abundant at lower elevations, where pinyon, in particular, and juniper are common. In places where warm situations, as sunny, protected canyons, extend as tongues up into cooler elevations the two species are found together. Both were seen in the oak brush and yellow pines surrounding the meadow at Mirabal Spring, about 9000 feet on Mount Taylor. They frequented fallen yellow pines and rock outcrops partly obscured by thickets of oak brush or aspen. The cheek pouches of one specimen collected at Mirabal Spring were filled with dandelion seeds. Eleven *quadrivittatus* chipmunks were collected at Mirabal Spring, and twenty-three were secured near logs and among rock outcrops in yellow pine and Douglas fir forests six miles northeast of the summit of Mount Taylor.

The breeding season for chipmunks was at its peak on Mount Taylor during the period June 1 to 16. Most of the chipmunks seen at Mirabal Spring were in pairs; each of the several pairs collected consisted of a male and a female. Of the seventeen females obtained eleven were suckling young and four were pregnant. Number of embryos recorded are two, three, four, and four; the approximate average length in millimeters of each group of embryos per female is thirty, twenty, twenty-six, and twenty-eight, respectively.

We saw no chipmunks of the species *quadrivittatus* on the malpais, even in the vicinity of Flagpole Crater or Porter's Ranch, where yellow pines were common. Only the species *dorsalis* was taken there. Howell (1929: 83) recorded *quadrivittatus* from Copperton and the Zuni Mountains, both of which are not over five miles from the malpais, but are several hundred feet higher in elevation.

Eutamias dorsalis dorsalis Baird.—Wherever we found pinyon and

rocky situations this species of chipmunk was present. It was less abundant in areas where juniper was present, and rare in yellow pine forests. Cliffs, canyon walls, and other rocky situations which offer shelter are of prime importance in defining the occurrence of the species. Without exception, all individuals of this species seen were within easy reach of rocky strongholds. In all, twenty-three were secured. Four of these were taken, with eleven specimens of *E. q. quadrivittatus*, near rocky outcrops surrounded by yellow pine, aspen, and oak brush at Mirabal Spring, about 9000 feet on Mount Taylor. Two were collected along a creek canyon among pinyons and a few yellow pines at Canyon Lobo Ranger Station. Two were shot on the malpais near stands of yellow pine and pinyon on Porter's Ranch. The remaining fifteen were all collected in rocky situations among pinyon and juniper at Shuman's Ranch, eight miles southeast of Grants, nine miles south-southeast of Grants, four miles west of McCartys, four miles west-southwest of Cebolleta, and one mile north of Cebolleta.

There are fewer individuals on the malpais than in other rocky situations. Their scarcity on the lava is probably primarily attributable to a lack there of a food supply adequate for supporting a large population throughout the year. It certainly is not due to a scarcity of resting and nesting places, for crevasses, ledges, and holes of many different sizes are present in abundance on the lava.

These chipmunks are not easily visible on lava. Their dark gray blends well with the color of the substratum, and only when they move or are silhouetted against the sky can they be seen readily. In some specimens the paler bands of the hairs are worn off and only the blackish-plumbeous basal portions of the hairs remain to make the coloration of the animal blackish and similar to that of the malpais. All specimens collected were molting.

I have records of only four lactating females and no records of pregnant females. The breeding season was further advanced in this species of chipmunk, at least in those individuals taken in the lower altitudes.

Sciurus fremonti.—Bailey (1931: 76) mentioned a specimen of chickaree (of the subspecies *mogollonensis* Mearns) taken in 1873 at El Morro. He also stated that these squirrels are "common in the Mount Taylor . . . Mountains." They are now rare there. During our two months in the field, of which a month was spent in habitat suitable for a few chickarees, we saw or heard none. Local residents reported that only occasionally was one seen. Their scarcity is probably attributable to the continuing destruction of habitat suitable to them. The yellow pine forests are fast becoming graveyards of fallen trees and dead spars as the result of extensive lumbering operations in the area.

Sciurus aberti mimus Merriam.—Abert or "tassel-eared" squirrels occur in the yellow pine forests in the Zuni Mountains and adjoining highlands,

including the malpais, on Cebolleta Mesa, and in the higher parts of the San Mateo Mountains. Litter made by them, of scales and cores of cones and debarked twigs of yellow pines, was common at Flagpole Crater, Porter's Ranch, Mirabal Spring, Ranchos Vallejos, and six miles northeast of Mount Taylor.

Two specimens were collected, one at Ranchos Vallejos and the other six miles northeast of the summit of Mount Taylor. Both were molting and were in poor pelage. The specimen from Ranchos Vallejos contained two embryos, each 40 mm. long.

The specimens are referred to the subspecies *mimus*, rather than *chuscensis* Goldman (1931), on a geographic basis only. The characters differentiating *mimus* and *chuscensis*, mainly ones of coloration, are greatly obscured through wear and molt in the two specimens.

Thomomys bottae paguatae Hooper (1940).—Twelve pocket gophers of the light-colored geographic race *paguatae* were collected in the vicinity of Cebolleta on the flood plain of Cebolleta Creek, a tributary of the Paguate River. The soil there is a light tan, sandy clay alluvium that becomes hard-packed when dry. Gophers were collected only in areas on the flood plain that were, or had been, under cultivation. Three females taken were lactating.

A discussion of the characteristics and relationships of the pocket gophers in the region is given elsewhere (Hooper, 1940).

Thomomys bottae planorum Hooper (1940).—Twenty-six specimens of *planorum* were collected in situations as follows: in light brown, sandy-clay alluvium in an alfalfa field surrounded by sage, rabbit brush, and juniper, one and one-half miles southwest of San Mateo; in hard-packed sandy soil among sage and juniper on a flat near the malpais, nine miles south-southeast of Grants; in a plowed field near the malpais eleven miles south-southeast of Grants; among pinyon and sage in hard-packed sandy soil containing a large amount of black basaltic rubble, on Horace Mesa. Two females were lactating.

Thomomys bottae collis Hooper (1940).—*T. b. collis* apparently replaces *T. b. planorum* at higher elevations on the east side of the lava beds. Ten specimens were collected in light reddish brown sandy soil in a plowed field surrounded by pinyon on Shuman's Ranch, and among sage in light tan, driftable, sandy soil on North Plains near Point of Malpais.

The pelage coloration of *collis* matches well the color of the soil in which it occurs. This is also true of the other races of gophers in the region.

Thomomys fulvus morulus Hooper (1940).—Twenty specimens of the dark, reddish brown *Thomomys fulvus morulus* were taken on Porter's Ranch on the western side of the Agua Fria malpais among pinyon and sage in bright, brick-red sandy soil; among yellow pine, pinyon, and sage

in dark sandy loam in a plowed field along Agua Fria Creek, at Agua Fria; among sage in light brown sandy soil on a flat on the northwest side of Flagpole Crater.

At lower elevations *Thomomys fulvus* is replaced by *Thomomys bottae*. It apparently is not present in the yellow pine forests on Mount Taylor. Only specimens of a third species, *Thomomys talpoides*, were taken there.

Thomomys talpoides taylori Hooper (1940).—Twenty-six specimens of the dark-colored race *Thomomys talpoides taylori* were taken only above 8900 feet in the rich blackish soil of the meadows and gentle slopes among yellow pine, Douglas fir, aspen, and oak brush at Mirabal Spring and six miles northeast of the summit of Mount Taylor. One female contained four embryos, each 30 mm. long (June 5), and a second female was lactating (June 2).

Perognathus flavus flavus Baird.—The species *flavus* is the only species of pocket mouse we collected. Specimens were obtained on sage-studded flats and plains, where the soil was sandy and driftable: four miles west of McCartys, eight miles southeast of Grants, nine miles south-southeast of Grants, and one and one-half miles east of Cebolleta. One specimen was taken on a grassy ledge in Zuni Canyon; however, it was within two hundred feet of sandy cut banks.

A specimen from four miles west of McCartys contained three embryos (May 20); a female from nine miles south-southeast of Grants contained two embryos (May 19). A female from one and one-half miles east of Cebolleta was lactating (June 24). Two individuals taken at the station eight miles southeast of Grants were nursing young (May 8); the cheek pouches of one of these contained sage leaves, soil, a wad of hair, and a few small bones.

These specimens are larger and have a longer, narrower skull than specimens of *flavus* from Presidio County, Texas, and a longer, narrower rostrum than examples of *flavus* from the Huachuca Mountains, Arizona. In coloration, the specimens are between *flavus* from Otero County, New Mexico, and *hopiensis* Goldman (1932*b*) from the Painted Desert, Arizona.

Perognathus apache.—Specimens of the apache pocket mouse (subspecies *apache* Merriam) are recorded by Bailey (1931: 278) from near Laguna and Fort Wingate. The species likely also occurs in the immediate vicinity of the lava beds.

Dipodomys spectabilis.—Bailey (1931: 260) stated that characteristic signs of banner-tail kangaroo rats were observed near Laguna, Cubero, and in a valley fifteen miles southwest of Acoma—all localities near the lava beds. He recorded specimens (of the subspecies *baileyi* Goldman) from Juan Tafoya at the eastern base of Mesa Chivato, about ten miles northeast of Cebolleta.

Dipodomys ordii ordii Woodhouse.—The only kangaroo rats collected were of the species *ordii*. Extensive kangaroo rat habitat was present only in the valley of the San Jose River, on North Plains and on the plains east of Bluewater. Elsewhere, except for small local areas, as along roadways and at the bases of shrubs where sand had accumulated, either the soil was too rocky and compact to be tunneled easily by the rats or other conditions of environment were not suitable for them. All specimens obtained were collected in sandy soil and among sage, juniper, or pinyon at the following localities: four miles west of McCartys, eight miles southeast and nine miles south-southeast of Grants, Shuman's Ranch, and one and one-half miles west of San Mateo. The specimen from Shuman's Ranch was taken at the edge of a plowed field which was surrounded completely by a forest of pinyon.

All mature females collected were either pregnant or were lactating. A female taken at the station eight miles southeast of Grants contained five embryos (May 8).

The specimens are tentatively referred to the subspecies *ordii*. They are noticeably more buffy than specimens of *ordii* from Lincoln and Otero counties, New Mexico.

Castor canadensis.—Bailey (1931: 211) stated that beaver (of the subspecies *frondator* Mearns) were common in the headwaters of the Zuni River in the "early days." I have no record of beaver in the immediate vicinity of the lava beds.

Onychomys leucogaster melanophrys Merriam.—Eight specimens of grasshopper mouse were collected: two at the base of a juniper on a sandy flat eight miles southeast of Grants; three near pinyon, sage, and rabbit brush on sandy soil on the edge of North Plains near Point of Malpais; three at the base of sage and rabbit brush on hard-packed, sandy clay soil one and one-half miles west of San Mateo. Four of the eight mice are in the bluish juvenile pelage, two of these were taken on May 14 and two on June 12.

The specimens approach *Onychomys leucogaster ruidosae* Stone and Rehn, known to me by specimens from southeastern Arizona and southern New Mexico, in the shape of the skull; it is narrower throughout than in *melanophrys* from Winslow, Arizona.

Reithrodontomys megalotis aztecus Allen.—Harvest mice are rare in the region. Only two specimens were collected. One was taken on a rocky ledge sparsely covered with short grass and studded with juniper, pinyon, and cliff rose in Zuni Canyon. The other was trapped about fifty yards from a grass-lined irrigation ditch on hard rocky ground on an open north-facing hillside, one and one-half miles southwest of San Mateo; rocks offered the only cover on the hillside, exclusive of scattered junipers and pinyons.

The rarity of harvest mice in the region is probably due, in large part, to the scarcity of habitat suitable for them. For the most part, grass, weeds, and other low-lying vegetation that might serve as cover for harvest mice is sparse and is kept grazed almost to the ground by domestic stock.

Peromyscus maniculatus rufinus Merriam.—Specimens of the species *Peromyscus maniculatus* were taken at each locality where mouse or rat traps were set. The species is represented by more individuals, however, in situations where the rock-inhabiting species of *Peromyscus*, namely, *truei*, *nasutus*, and *boylei*, occur rarely or are entirely absent. Thus, these mice were taken in greatest numbers in the fairly open forests of yellow pine, aspen, and oak brush on Mount Taylor and among sage on sandy desert flats. Some individuals of the species *maniculatus* were taken several hundred feet within the malpais; however, more frequently the species was collected near the edge of the malpais, where it joins the desert plains.

I have records of eight lactating and three pregnant females; the pregnant females contained four, five, and six embryos, respectively.

In all, ninety-four specimens were collected. In the characters of coloration, which differentiate *rufinus* from *blandus* Osgood, these specimens are nearer *rufinus*, but definitely grade toward *blandus*. They resemble *blandus* particularly in the pinkish buff pelage, which is lighter and less pinkish than in *rufinus*. The gray pelage, however, is darker than in *blandus* and lacks the pinkish tint characteristic of that race. I can see no characters which will separate malpais-taken specimens from specimens taken outside the malpais, nor do I find constant differences between the specimens from 9000 feet on Mount Taylor and those from an elevation of around 6300 feet on the surrounding desert.

Peromyscus boylei rowleyi Allen.—Mice of the species *Peromyscus boylei* were comparatively rare in the region. Only ten of the one hundred and thirteen specimens of the species *P. boylei*, *P. truei*, and *P. nasutus* collected are of the species *boylei*. All were taken only where *P. nasutus* or *P. truei* occurred, never where both were absent. No more than one specimen was taken at a locality, except in Zuni Canyon and four miles west-southwest of Cebolleta, where two and four, respectively, were secured. Localities and situations of occurrence are as follows: in Zuni Canyon, on a rocky bench among scattered juniper, pinyon, and cliff rose; near Flagpole Crater, on the edge of the malpais among yellow pine and pinyon; eight miles southeast of Grants, on the malpais near apache plume and juniper; at Point of Malpais, on the malpais near pinyon; one and one-half miles southwest of San Mateo, on a north-facing rocky slope sparsely covered with juniper, pinyon, and sage; four miles west-southwest of Cebolleta, at the shaded base of a cliff among oak, yellow pine, currant, and sage. Rocky situations are essential to *boylei* as they are to *truei* and *nasutus*.

A female collected on June 10 one and one-half miles southwest of San Mateo was lactating. One taken on June 20 four miles west-southwest of Cebolleta contained three embryos, each 25 mm. long.

None of the three specimens collected on the malpais is darker than the specimens taken on lighter-colored substrata.

Peromyscus truei truei Shufeldt.—Mice of the species *Peromyscus truei* were taken in rocky situations among juniper and pinyon at the following localities: Canyon Lobo Ranger Station, four miles west of McCartys, eight miles southeast of Grants, Shuman's Ranch, one and one-half miles southwest of San Mateo, and four miles west-southwest of Cebolleta. The species was taken most frequently in warm situations, reached by the rays of the sun for much of the day, as on south-facing slopes or canyon walls where juniper was common. It was trapped at light sandstone cliffs, dark weathered Tertiary lava, and on black Recent malpais. It was taken in greatest numbers outside the malpais.

I have records of three lactating females and three pregnant females; each pregnant female contained four embryos.

The ecologic niches occupied by *Peromyscus truei*, *P. nasutus*, and *P. boylii* are not sharply distinct from each other in northwestern New Mexico. The three species were repeatedly taken in the same trap line set in relatively uniform habitat. All three species apparently require rocky areas or cliffs and are associated with pinyon and juniper. Apparently, both *P. nasutus* and *P. boylii* are tolerant of a wider range of environmental conditions, however, as indicated by the occurrence of the species in more varied situations and within wider limits of altitude than *P. truei*. Both *nasutus* and *boylii* were collected among yellow pines near Flagpole Crater, whereas *truei* was not. At lower elevations, in the juniper belt, *truei* was taken, but commonly only outside the malpais. Only four of the thirty-three specimens of *truei* collected were taken on the malpais, whereas forty-eight of the seventy specimens of *nasutus* were collected there.

The specimens taken on the malpais are no darker than, or otherwise appreciably different from, specimens collected on near-by light-colored sandstone cliffs. Neither does the series of thirty-three specimens collected in this region differ from other series of *P. t. truei* taken from areas in New Mexico and Arizona where there are no extensive areas of dark rocks.

Peromyscus nasutus nasutus Allen.—The species *Peromyscus nasutus*, like *P. boylii* and *P. truei*, is closely confined to rocky situations in the pinyon and juniper belts, occurring only locally at higher elevations among yellow pine and not at all out on the open desert or plains. Among boulders, at cliffs, and particularly on the malpais, it was the most abundant rodent. Specimens were collected in Zuni Canyon, one mile north of Cebolleta, eight miles southwest of Grants, nine miles south-southwest of

Grants, one and one-half miles south of Grants, at Flagpole Crater, and at Porter's Ranch.

All specimens are adults, and all were in process of molting when taken. Most of the females were pregnant or were lactating. The number of embryos per pregnant female varied from three to five and averaged four.

In all, seventy specimens of *nasutus* were obtained, forty-eight from the malpais and dark lava and twenty-two from lighter substrata. The specimens from the malpais at Flagpole Crater and at Porter's Ranch average slightly darker than the remainder of the specimens. There is no consistent difference in coloration, however, between the specimens from the malpais and those from lighter substrata. Many specimens from the malpais are as pale as those from outside the lava.

The extremes of dark coloration and extensive pigmentation are to be seen, however, in the forty-eight specimens from the malpais. Twenty-four (34 per cent) of the seventy specimens obtained show distinct, cinnamon pectoral areas. Twenty-two of the twenty-four (92 per cent) were taken on the malpais and two of the twenty-four (8 per cent) at a sandstone cliff. Thus, 46 per cent (22/48) of all *nasutus* taken on the malpais have cinnamon pectoral areas, and only 9 per cent (2/22) of those from light-colored substrata show those areas. The darkest specimen collected was taken on lava, too, not on a lighter substratum. This specimen (U. M. M. Z. No. 82210) from the lava field at Grants, is easily as dark and as extensively pigmented as specimens of *griseus* Benson (1932) from the lava fields in the Tularosa Basin. In mass, the entire upper surface of the head and body is Dark Mouse Gray. The terminal black bands are wide and subapical light bands narrow and containing comparatively little cinnamon pigment. The basal three-fourths of the head and body hairs are Blackish Plumbeous. The hairs of the entire ventral surface are tipped with Vinaceous-Cinnamon except in a small area around the anus; there the hairs are tipped with white. The hairs of the toes and of a small spot at each heel are white; the remainder of the hairs of the feet are dusky. The tail is brown above and white ventrally.

This blackish specimen approaches the extreme of dark and extensive pigmentation toward which some of the other specimens from the lava beds may be tending in their increase of pigmentation in the pectoral region. The difference in coloration and pigmentation between this specimen and the other specimens obtained, however, is great. None of the other specimens of *nasutus* approaches it closely in coloration.

I can find no characters of the skull which will separate the specimens from the malpais from those taken on the lighter substrata, nor do I see cranial characters which will distinguish the entire series from a series of *nasutus* from El Paso County, Colorado, or from a second series of the same race from Lincoln and Otero counties, New Mexico.

Neotoma micropus canescens Allen.—A single juvenile specimen, tentatively identified as *micropus*, was collected on May 6 among apache plume, juniper, and sage at the edge of the malpais, eight miles southeast of Grants. The habitat in which the animal was taken is one not usually associated with the species, and the locality is probably the westernmost from which the species has been recorded.

Neotoma albigula albigula Hartley.—Thirty-seven white-throated wood rats, thirteen males and twenty-four females, were collected. Most were taken at their nests among pinyon and juniper in rocky situations, such as on the malpais, along the face of a cliff, in outcrops, or among large boulders, but a few were trapped at nests out on the sandy desert at the bases of cane cacti and junipers. We saw no sign of wood rats out on the sandy desert flats where cane cactus, pinyon, and juniper were absent.

Specimens were collected one and one-half miles south of Grants, eight miles southeast of Grants, nine miles south-southeast of Grants, at Shuman's Ranch, four miles west of McCartys, at Canyon Lobo Ranger Station, one and one-half miles southwest of San Mateo, four miles west-southwest of Cebolleta, and one mile north of Cebolleta. In all, ten specimens were taken on the main masses of malpais, four on small islands of lava surrounded by desert, and twenty-three in situations off the black lava masses.

I have records of five pregnant and four lactating females. Each pregnant female contained two embryos.

There is considerable variation in coloration in the specimens. The darkest, most extensively pigmented specimens are from the lava mass near Grants. The mass effect of these specimens is near Sayal Brown dorsally, Cinnamon on the sides and lateral portions of the throat, Vinaceous-Cinnamon on the belly and undersurfaces of the legs, pure white on the throat, breast, upper surfaces of the feet, undersurface of the tail, and in the inguinal region, Slate-Black on the upper surface of the tail and Neutral Gray on the face and forehead; the hind feet are lightly washed with dusky to the toes. The black terminal bands of the dorsal hairs are wide, obscuring much of the narrower, subapical bands of Pinkish Cinnamon and giving a grizzled black and cinnamon appearance to the upper surface. On the sides the black band is present on fewer hairs and finally on the sides of the belly it is entirely absent. The bases of the belly hairs are Deep Neutral Gray—as are the bases of all the other hairs of the body except those on the upper surface of the tail, the feet, chin, throat, and inguinal region—and the distal halves are rich Vinaceous-Cinnamon. Hairs having a subterminal cinnamon band are present over much of the body, but are absent on the chin, throat, upper part of the tail, surfaces of the feet, and in the inguinal region.

The palest, least extensively pigmented specimen is from nine miles

south-southeast of Grants on an arm of the Agua Fria malpais. The mass coloration of the specimen is Cinnamon-Buff dorsally, Light Pinkish Cinnamon on the cheeks and dorsal two-thirds of the sides only, white on the underparts, feet, ventral half of the tail, and ventral third of the sides, and Fuscous or Hair Brown on the dorsal half of the tail. Few dorsal hairs have the black terminal band, when compared with the number possessing the black band in the darkest specimens from the malpais at Grants; the light subapical band is, therefore, exposed more and the mass effect is considerably lighter. Hairs possessing the black bands are almost entirely restricted to the middorsal region of the body; scarcely any are present on the dorsal two-thirds of the sides and none on the lower third. The light bands of the hairs are Pinkish Buff on the dorsal surface of the body and on the cheeks and Light Pinkish Cinnamon on the rump, upper surfaces of the legs, and dorsal two-thirds of the sides. The hairs of the belly, legs, and ventral third of the sides are white for their distal half and, like the hairs of the dorsal surface, Plumbeous basally. The hairs of the feet, throat, breast, inguinal region, and undersurface of the tail are white throughout.

The coloration of the remainder of the specimens collected is between the extremes as given above. Some of the specimens are dark dorsally and white ventrally; some have pinkish cinnamon areas on the sides of the throat; some have a very dark dorsal tail stripe and yet are comparatively pale on the upper surface of the body.

The darkest, most extensively pigmented specimen is similar to specimens of *sheldoni* Goldman from the Pinacate Mountains, Arizona. It is by no means as dark or as extensively pigmented as specimens of *melas* Dice (1929) from the Tularosa Lava Beds of southern New Mexico. The palest specimen is almost as light as specimens of *mearnsi* Goldman from the Sonoran Desert of southwestern Arizona. The variation in color of the entire series collected is sufficient to bridge the gaps rather evenly from the blackish, extensively pigmented *melas*, through the dark *sheldoni* to the light, comparatively little pigmented *mearnsi*.

Of the specimens collected, the seven from the lava field at Grants are the darkest and most extensively pigmented. No specimen from there is lighter in tint, as buffy in hue, and any less extensively pigmented than the darkest, most reddish, and most extensively pigmented specimen taken elsewhere in the region. This relatively uniform dark coloration may well be correlated with a comparatively complete isolation of the rats of this lava field from the rats from other areas, including the Agua Fria malpais. The lava field at Grants is surrounded by a band of sandy desert one-half mile to five miles in width, country not well suited to *albigula* wood rats. Only at two restricted places, in length not more than one-tenth the total distance around the field, does the malpais approach to within one-half mile of rocky

juniper-studded areas where these rats might be expected to occur commonly, and where movement of individuals between the areas of light and black substrata might be fairly common.

The specimens of *albigula* from the Agua Fria malpais, which is much less isolated from neighboring habitats suitable for *albigula* wood rats, show no uniform tendency to match the color of the substratum. Individuals lighter than average *albigula*, others darker than average, occur both on the malpais and on neighboring light-colored substrata. Thirteen individuals are at hand from the vicinity of the Agua Fria malpais—taken on the lava, at a sandstone cliff no more than one-third of a mile from the malpais and at places contiguous with it, or on the desert between the malpais and the cliff. Two specimens from the sandstone cliff and one from the desert flat about fifty yards from the malpais are about as dark as the specimens from the lava field at Grants. Two other specimens, one from the malpais and the other from the sandstone cliffs, are the lightest *albigula* collected. The coloration of each of the other eight specimens falls within these two extremes. Thus, variation in coloration is apparently greater on the Agua Fria lava field than on the field near Grants. Agua Fria populations are less isolated from populations living on light-colored substrata than are the populations living on the lava field near Grants.

As a series, the thirty-seven skins collected average darker than twenty skins of *albigula* from Pima and Pinal counties, Arizona. In cranial characters also the series is distinctive; the spread of the zygomata averages greater, the nasals are shorter and broader anteriorly, and the auditory bullae are smaller than in a series of forty-seven skulls of *albigula* from Pima, Pinal, Coconino, and Cochise counties, Arizona.

Neotoma stephensi relicta Goldman (1932a).—Goldman (1910: 81) listed a specimen of wood rat, taken on the malpais near Grants, under the name *Neotoma lepida stephensi* Goldman. This specimen, he noted, is "unusually dark, even for *stephensi*." Later (1932a: 67), he recorded a specimen from Bluewater, which may be the same specimen recorded at the earlier date from Grants. The only wood rats we collected on the lava field at Grants were of the species *Neotoma albigula*. On May 20, however, we took a small juvenile *stephensi* among sage, juniper, and pinyon, and scattered malpais on the sandy bottomlands of the San Jose River, four miles west of McCartys.

The relationships of the "*lepida*," "*desertorum*," "*stephensi*," and other rats of the "*lepida* group" have been obscure for some time and are still not well understood. Goldman (1932a) considered *N. lepida* and *N. desertorum* conspecific and *N. stephensi* specifically distinct. At the same time he applied the name *N. s. relicta* to the race that was previously known as *Neotoma l. lepida*. The characters differentiating the species *stephensi*

from the species *lepida* are subtle, and the two species eventually probably will again be considered conspecific. For the present I follow the conclusions of the latest reviewer of the "*lepida* group" (Goldman, 1932a) and treat *stephensi* as a distinct species.

Neotoma mexicana fallax Merriam.—The Mexican wood rat is more closely restricted to rocks and cliffs than the white-throated wood rat and is present in greater numbers at higher altitudes, among yellow pine. It was taken at several localities among juniper and sage, but was less common there than the white-throated wood rat, and, unlike that species, was not found out on the sandy desert at the base of cane cactus or juniper. The habitat preferences of the two species were well demonstrated at rocky outcrops around a wet meadow four miles west-southwest of Cebolleta. *N. mexicana* occurred along the outcrop that was well shaded with a dense growth of oak, yellow pine, pinyon, sage, and currant. *N. albigula* inhabited a second, more exposed outcrop, poorly shaded by cottonwood, pinyon, and juniper. Specimens were collected at Flagpole Crater, at Porter's Ranch, at Zuni Canyon, eight miles southeast of Grants, nine miles south-southeast of Grants, Point of Malpais, one and one-half miles southwest of San Mateo, four miles west-southwest of Cebolleta, and one mile north of Cebolleta. Nests and other signs of wood rats, presumably of this species, were seen along a shaded rock outcrop at Mirabal Spring, about 9000 feet on Mount Taylor.

In all forty-three specimens, twenty-seven males and sixteen females, were collected; of these, thirty are from the malpais and thirteen from outside the malpais. Many of the adult females were lactating, and some were pregnant. I have but two records of pregnancy; a female taken on May 29 and another collected on June 20 each contained two embryos.

As in *albigula* the coloration of the specimens varies considerably, ranging from light buff dorsally and white ventrally to dark gray or grayish black dorsally and pinkish cinnamon ventrally. The light buff dorsal coloration is not necessarily accompanied by white ventral coloration; some specimens that are buffy dorsally have a suffusion of pinkish cinnamon over the entire ventral surface. Likewise, the dorsal gray is sometimes accompanied by white underparts. There is a gradual gradation between the extremes of coloration. If this gradation did not exist the species might well be considered dichromatic, the light specimens a buff phase and the dark specimens a gray phase.

The darkest specimen has the teeth well worn, but it is apparently partially in juvenile pelage; it was collected on the Agua Fria malpais on Porter's Ranch. It is Dusky Neutral Gray dorsally and Mouse Gray ventrally. The feet are Pale Mouse Gray. The under surface of the tail is Pallid Mouse Gray, and the upper surface near Deep Mouse Gray. The

hairs of the dorsal portion of the body are Blackish Plumbeous for about three-fourths of their length; this long basal portion subtends a narrow band of Pinkish Buff, which in turn is basal to a wider terminal band of black. On the sides of the body the black band is present on fewer hairs and ventrally it is entirely lacking, the Pinkish Buff band becoming the terminal band.

The darkest, most extensively pigmented specimen in full adult pelage is from an area one and one-half miles southwest of San Mateo where dark basaltic rocks are mixed with light sandstone boulders. It is but slightly darker and no more extensively pigmented, however, than several specimens in adult pelage from the malpais on Porter's Ranch. The mass effect of the upper surface of the body is grizzled black and Cinnamon-Buff and the under surface is Pinkish Cinnamon. The feet and lower part of the tail are white, the ankles are surrounded by a band of Light Pinkish Cinnamon, the outer surfaces of the hind legs and the tail are Fuscous, and the sides of the throat are Pinkish Buff. The terminal black bands are longer than the sub-terminal Cinnamon-Buff bands on the hairs of the dorsal surface; the remaining basal two-thirds of the hairs are Blackish Plumbeous. The hairs of the ventral surface are Blackish Plumbeous basally and Pinkish Cinnamon or white distally; the Pinkish Cinnamon is concentrated in the pectoral region and across the belly.

The palest specimen obtained is also from one and one-half miles southwest of San Mateo. It is, however, but slightly paler than five specimens from the malpais at Flagpole Crater and eight miles southeast of Grants. Its mass coloration is Pinkish Cinnamon dorsally and white ventrally. As compared with the darkest specimen described above, on the dorsal surface there are fewer black-tipped hairs and the subapical Cinnamon-Buff band is considerably wider; the Pinkish Cinnamon-tipped hairs of the ventral surface are restricted to a narrow band in the pectoral region.

The tendency for the rats from the malpais to be darkest and most extensively pigmented, particularly on the ventral surface of the body and on the feet, is indicated in the adult pelage, but is best seen in the juvenile pelage. Thirteen specimens in juvenile pelage are at hand, six from the malpais and seven from lighter-colored substrata. Each of those from the malpais is much darker than any one from outside the malpais. Four of them are Pinkish Cinnamon over the entire ventral surface of the body, three have an indistinctly bicolor tail, three have slightly dusky feet, and one has the tips of the toes black. In the specimens taken on the lighter substrata the Pinkish Cinnamon of the ventral surface, when present, is restricted to the pectoral region, the tail is distinctly bicolor, and the feet and toes are white.

The specimens at hand are too few to allow one to state with a fair degree of certainty that the juvenile pelage in this species has progressed further

than the adult pelage in the development of dark coloration on the malpais. The fact that the contrast between the juvenile pelages on and outside the malpais is greater than the contrast between the adult pelages on and outside the malpais suggests that the juvenile coat may be evolving dark coloration and extensive pigmentation at a rate more rapid than that for the adult pelage. That the juvenile coat in these rats may be modified without the adult coat being affected in the same way or by the same amount, and that the two pelages may be influenced by different genetic factors, is suggested by the work of Sumner (1924: 477) and Clark (1938: 3-4) on *Peromyscus*. The juvenile coats of "Hairless" and "Nude" mice are normal, but subsequent coats are considerably modified.

The hypothesis that dark coloration evolves more rapidly in the juvenile pelage than in the adult, in those lava-dwelling mammals which are tending to develop dark-colored races, fits with the theory of concealing coloration and selective predation employed by Benson (1933) to explain the development of dark races of mammals on lava fields. Selective predation, if it is active in directing the evolution of dark coloration, should have its maximum effect on the juvenile pelage. It is probably during the season of year when most individuals of the prey species are in juvenile pelages that the greatest number of individuals of that prey species is removed. The young animals are the principal breeding stock for the following year. If more concealingly colored than "normal" colored young survive the height of the predation period and live to breed the next year, the proportion of concealingly colored to "normal" young should be greater, and so on season after season.

Under this hypothesis selection for concealingly colored rats in adult pelage would be expected to proceed concurrently with selection for those in juvenile pelage; however, it probably would not effect the dark concealing coloration as rapidly. The old adult rats probably escape predators more often than do the younger, less experienced juveniles, and selection of those adults which are concealingly colored would be slower, though over a long period of time no less efficient.

Unfortunately, I have no juvenile specimens from the malpais of *Neotoma albigula* or *Peromyscus nasutus*, two other species in which there is an indication of a development of a dark race on the malpais, and thus cannot test this hypothesis in those species.

The forty-three specimens, as a series, agree in their dorsal coloration and their cranial characters with a series of *fallax* from Otero and Lincoln counties, New Mexico. They average darker dorsally than a series of twenty-one *mexicana* Baird from extreme southeastern Arizona and western Texas and a series of seven *pinetorum* Merriam from San Francisco Mountain, Arizona. Eight specimens, however, are as light or are lighter than the palest specimens of either *pinetorum* or *mexicana*. The amount of ventral pigmentation is greater in my series than in the other series of *fallax* or

in the series of *mexicana* or *pinetorum*. The diagnostic characters of *inopinatus* given by its authority, Goldman (1933: 471), do not well apply to the series.

Microtus pennsylvanicus.—Bailey (1931: 200) mentioned the presence of a colony of *Microtus pennsylvanicus modestus* Baird at San Rafael.

Microtus longicaudus.—Bailey (1931: 196) stated that he "found evident traces of this species" in the Zuni Mountains and on Mount Taylor. Apparently, he examined no specimens from those mountains.

Microtus mexicanus mogollonensis Mearns.—A single specimen of *Microtus mexicanus* was collected among currant, sage, oak brush, and yellow pines at the edge of a marshy meadow near the base of a rocky cliff four miles west-southwest of Cebolleta. This was the only specimen of meadow mouse obtained. Bailey (1931: 204) mentioned that Hollister caught two specimens of *M. mexicanus* at Agua Fria Spring and twelve specimens in a damp grassy area at an elevation of about 9000 feet on Mount Taylor. We saw no signs of them in the moist meadows on Mount Taylor. Extensive grazing by cattle has reduced meadow mouse cover and probably has diminished their populations markedly.

Ondatra zibethica.—Muskrat workings were abundant along the waterways from the springs at San Rafael and along the canal draining the springs arising on the western edge of the Acoma Indian Reservation, about four miles west of McCartys. The banks of the canals at both these situations were literally riddled with burrows made by muskrats, but few of the burrows had been used recently. Local residents assured me that muskrats had inhabited these waterways at least during the past forty years. A single skull was picked up at San Rafael.

Erethizon epixanthum couesi Mearns.—Porcupines or their workings were seen at every collecting station where there were pinyons or yellow pines. In some areas, as near Flagpole Crater, droppings and splinters from their gnawings could be found under almost every pinyon and often under yellow pine and juniper. The pinyon, however, seems to bear the brunt of their attacks in the region. Ranchers reported that in summer porcupines from adjoining forests readily enter fields planted to corn, alfalfa, and other crops. One rancher told me he killed fifty-two porcupines within a month's time in his cornfield!

Manville saw a porcupine about seven o'clock one morning at the mouth of a small cave, four miles west-southwest of San Mateo. Late that evening he found the porcupine at the same spot and apparently in the same posture. Another was seen in a cave in sandstone cliffs one mile north of Cebolleta. Specimens were collected as follows: a skeleton found in a cave on the periphery of the malpais at Point of Malpais; a large male shot at the base of a clump of apache plume on the edge of the malpais; a lactating female killed in an alfalfa field, one and one-half miles southwest of San Mateo.

The numerous caves in the malpais apparently are used extensively as refuge sites by the species.

Lepus californicus texianus Waterhouse.—Jack rabbits are common in open to semiopen areas in which sage, rabbit brush, juniper, or pinyon grows. They were not seen in rocky situations, such as outcrops, cliffs, or malpais or in the dense forests of yellow pine, Douglas fir, aspen, or oak brush. Specimens were taken at Porter's Ranch, one and one-half miles southwest of San Mateo, and two miles east of Grants along highway U. S. 66.

Sylvilagus nuttallii pinetis Allen.—Nelson (1909: 211) recorded two specimens from Copperton, near Mount Sedgwick in the Zuni Mountains. The species also probably occurs in the yellow pine and Douglas fir forests on Mount Taylor.

Sylvilagus audubonii cedrophilus Nelson.—The species *Sylvilagus audubonii* is the more common of the two species of cottontail occurring in the region. It is characteristic of the flats, slopes, and mesas studded with pinyon and juniper. We found the species to be most abundant on flats grown to short grass, rabbit brush, and sage and immediately adjoining the malpais. Such situations apparently afforded optimum conditions of food, and nesting and hiding places. Individuals were seen on the malpais, but only on the smoother not greatly elevated portions and never over two or three hundred feet within the lava field. In each instance when a rabbit was started from its foraging activities on ground near the malpais it invariably headed for a retreat in the malpais.

Specimens were collected at Porter's Ranch, eight miles southeast of Grants, Point of Malpais, and one and one-half miles southwest of San Mateo.

Odocoileus hemionus.—Local residents informed us that deer are becoming less abundant, because of the increased number of hunters and the removal of plant cover as the result of lumbering operations. Cecil Moore showed us a set of mule deer antlers found in a cave in the malpais near Flagpole Crater. We saw deer tracks on Porter's Ranch and had reports of deer on Mount Taylor. Bailey (1931: 29) listed specimens from the vicinity of the lava beds under the subspecific name *macrotis* Say.

Antilocapra americana.—Whereas pronghorns formerly ranged over most of the plains country, they now are found only in restricted areas. A resident of Grants stated that pronghorns occurred on the plains north of Mount Taylor and Mesa Chivato, introduced there a "few years" previous to 1939.

Ovis canadensis.—Bailey (1931: 21) referred the mountain sheep of the malpais and Zuni Mountains to the race *O. c. mexicana* Merriam on the basis of two heads, from the malpais, examined by him. Skulls of mountain sheep are occasionally found at the bottom of crevasses or in caves in the malpais. We heard of several and saw two found by Cecil Moore in a cave near Flagpole Crater.

DISCUSSION

It is common knowledge among mammalogists that on a lava flow a dark coloration which simulates the color of the lava appears chiefly, if not entirely, among those populations of a species of mammal which tend to be restricted to the flow. Populations of many other species of mammals not restricted tend to be unaffected. Wide-ranging kinds, such as the coyote and the common white-footed mouse, do not differentiate into dark races on lava beds because, it is commonly believed, the lava-dwelling populations are not sufficiently isolated from populations outside the lava beds, and the dark coloration is thus not permitted to become fixed in the lava-dwelling animals alone, but is scattered through the populations both on and outside the lava beds.

Eight species of mammals occur on the Grants malpais, Agua Fria malpais, and in other rocky situations, but are chiefly absent from adjoining sandy desert plains. These are: *Citellus variegatus*, *Eutamias dorsalis*, *Peromyscus boylii*, *Peromyscus truei*, *Peromyscus nasutus*, *Neotoma albigula*, *Neotoma stephensi*, and *Neotoma mexicana*. In not one of these species, except possibly *N. stephensi*, are all the individuals from the malpais darker and more extensively pigmented than the individuals outside the malpais.

In *C. variegatus*, *E. dorsalis*, *P. boylii*, and *P. truei* there is no indication of the development of dark races on the malpais; malpais-taken specimens are indistinguishable from those collected outside the malpais.

In the series of seventy specimens of *P. nasutus* obtained, of which forty-eight are from the malpais, only one individual is any darker than typical *P. n. nasutus*. This individual agrees in coloration with the darkest specimen of *P. n. griseus* at hand from the malpais in the Tularosa Basin, New Mexico.

Only one specimen of *Neotoma stephensi* from the malpais is preserved in collections, as far as I know. This specimen, Goldman said (1910: 81), "is unusually dark even for *stephensi*" [= *N. stephensi relictus*]. This single specimen affords little reason for assuming that all *stephensi* rats from the malpais are dark; more likely, that species reacts with respect to coloration much as do *Peromyscus nasutus*, *Neotoma albigula*, and *N. mexicana*, in each of which some individuals are dark and some are light.

The specimens of *Neotoma albigula* vary considerably in coloration. Thirty-seven specimens were preserved, distributed as follows: ten from the Grants and Agua Fria malpais, four on small islands of lava surrounded by sandy desert and twenty-three in situations outside the malpais. Seven of the ten specimens from the malpais are all darker than average *albigula* (the race). The coloration of the other three specimens is about average for *albigula*. Three of the total of twenty-seven specimens from outside the

malpais are darker than average *albigula*. Thus, 70 per cent of the malpais-taken specimens are darker and more extensively pigmented than the average *albigula*, but 9 per cent of the specimens from *outside* but also near the malpais are also darker than average, resembling the dark malpais specimens. Dark individuals, thus, occur predominantly on the malpais, but are not entirely restricted there, and considerable variation in coloration is found both on the malpais and on the lighter-colored rocky substrata neighboring it.

Neotoma mexicana has a range in variation of coloration similar to that seen in *N. albigula*, except that the darker more extensively pigmented adult pelages apparently are less restricted to the malpais. Forty-three specimens were preserved, thirty from the malpais and thirteen from outside the malpais. In proportion to the number from each of these two situations there are almost as many of the dark, more extensively pigmented specimens from outside the malpais as there are from the malpais. The darkest specimen in adult pelage, which has cinnamon pigment distributed over most of the underparts, is from an area where there is no black lava, fifteen miles from the malpais. It is, however, closely similar to several others from the malpais. The palest, least pigmented specimen is from the same locality, but it, too, is but slightly paler than five specimens from the malpais. Adult pelages of *mexicana*, thus, exhibit considerable variation in coloration and in the distribution of the pigmentation of the body. The darker adult pelages fail to be restricted to the malpais.

The juvenile pelage presents a different picture. Thirteen specimens in juvenile pelage are at hand, six from the malpais and seven from neighboring lighter-colored substrata. All those from the malpais are darker than those from outside the malpais. They are similar to young individuals of *Neotoma mexicana atrata* Burt (1939) from the Tularosa Basin flows and are distinctly set apart from the lighter, less extensively pigmented specimens from areas in Valencia County a few miles outside the malpais. The number of juvenile specimens at hand is too small to warrant sweeping generalizations. The specimens indicate, however, that the juvenile pelage of *N. mexicana* has progressed further than the adult pelage in the development of dark coloration. As pointed out above in the species account of *N. mexicana*, this should be expected if a dark, concealing coloration in lava-dwelling mammals has a positive survival value under selective predation, as contended by Benson (1932) and others.

No species reaches the extremes of increased pigmentation attained by the corresponding species in the Tularosa Basin. The species *Citellus variegatus*, *Peromyscus nasutus*, *Neotoma albigula*, and *Neotoma mexicana* occur on both the Tularosa malpais and the Valencia County malpais. On the Tularosa malpais each of these species is represented by a dark race, which

is entirely restricted to the malpais; also apparently all individuals on the malpais, of each of these species, are darker than all individuals outside the malpais. The same four species occur on the Valencia County malpais, but in none has the darker coloration progressed so far, in none is it limited to the malpais, and in none is it distributed among all individuals on the malpais.

Difference in degree of isolation probably accounts for the difference in the development of dark color and the difference in the distribution of the dark animals in Valencia County and the Tularosa Basin. The four species under consideration, *C. variegatus*, *P. nasutus*, *N. albigula*, and *N. mexicana*, are all limited by habitat preference to rocky situations. Because of rock-loving habits they are closely restricted to the malpais and rocky areas outside it, and are absent, or present in but small numbers, on sandy desert or grasslands. A detailed account of the proximity and distribution of habitat suitable for these species around the Tularosa malpais is not available. Apparently the only places where rock-dwelling mammals outside the Tularosa malpais can gain access to the black Recent lava beds without crossing open sandy desert are along the western edge of the beds, near the Trans-Malpais Hills (Bradt, 1932: 326), and at the northern end, where the malpais joins an older lava flow and rocky terrain surrounding that older flow (Benson, 1932: 16). The total frontage on the Tularosa malpais, of rocky situations, which are not over one-half mile from the malpais, amounts to roughly one-thirtieth of the distance around the malpais; twenty-nine thirtieths of that malpais fronts on unhospitable sandy desert over one-half mile in width. In Valencia County, about three-fifths of the Agua Fria malpais and one-tenth of the Grants malpais fronts on habitat suitable to the rock-loving species.

Interchange of individuals on and outside the malpais should be least for the Tularosa malpais, more for Grants malpais, and greatest for the Agua Fria malpais. And, accordingly, one would expect the degrees of development of the dark coloration, the distribution of the dark-colored animals on the malpais, and the amount of restriction of the dark animals to the malpais to vary in that order, Tularosa, Grants, and Agua Fria. Actually this is just what occurs. The tendency to develop races, in which dark color is constant and restricted to the malpais, is greatest on the Tularosa beds, less on the beds at Grants, and least on the Agua Fria flow.

Of the specimens of *Peromyscus nasutus* from the black lava 46 per cent have cinnamon pigmentation in the pectoral region; only 9 per cent of the specimens from outside the malpais show those areas. Similarly, 70 per cent of the specimens of *Neotoma albigula* from the malpais are darker than average *albigula*; about 9 per cent of the specimens from outside the malpais are darker than average. In *Neotoma mexicana* the percentage of darker

adult specimens from the black lava is about equal to that of such specimens from outside the black lava fields. All juveniles, however, from the malpais and none from outside the malpais are darker than average juvenile *mexicana*. The fact that a larger proportion of dark individuals of each of these species was taken on the malpais suggests strongly that the dark coloration has a higher survival value on the black lava and that the centers of dispersal of the more intensively pigmented animals are now the fields of black lava. The darker individuals may have evolved outside the black lava flow and subsequently emigrated to the flows. But at the present time the centers of populations of dark individuals, that is the largest numbers of dark individuals, are on the black lava. The numbers of dark individuals available to move outward from the lava are greater than the numbers available to move from the lighter substrata onto the lava.

SUMMARY

Sixty kinds, species and subspecies, of mammals are recorded from the lava fields and areas adjoining those fields in Valencia and McKinley counties, New Mexico, with notes on the ecology and on the distribution, particularly with respect to the lava fields, of each of the kinds observed.

No species collected exhibits a blackish race on any of the lava fields, even on the field at Grants which is fairly well isolated from other rocky terrain. Of the eight kinds which are restricted by habitat preference to rocky situations, only the species *Peromyscus nasutus*, *Neotoma albigula*, and *Neotoma mexicana* tend toward the development of a dark race on the black lava. Some individuals of each of these species are more pigmented than average members of the respective race of each species outside the lava beds. These darker individuals occur predominantly on the black lava, but are not entirely restricted there.

The fact that fewer darker animals are present outside than on the black lava fields indicates: (1) that the darker coloration has a higher survival value on the black lava; and (2) that the present center of dispersal of the darker animals is the black lava and not the lighter substrata near the black lava.

The condition in Valencia County contrasts markedly with the condition obtaining in the Tularosa Basin, New Mexico. In the Tularosa Basin *Peromyscus nasutus*, *Neotoma albigula*, *Neotoma mexicana*, and *Citellus variegatus* are represented by blackish races closely restricted to the black lava.

The difference in subspeciation on the lava beds in the two regions is explained on the basis of degree of isolation of the beds from other rocky terrain. The beds in the Tularosa Basin are apparently much more isolated than those in Valencia County. The blackish pelage coloration has become more completely fixed in the lava-restricted populations in the Tularosa Basin than in the populations on the lava beds in Valencia County.

In comparing the rock-requiring species on the Agua Fria and Grants lava fields, one finds that those on the Grants fields have progressed further in the development of dark races. The lava fields at Grants are the more isolated.

In *Neotoma mexicana* there is an indication that dark coloration on the black lava is developing more rapidly in the juvenile pelage than in the adult pelage. This is consistent with the theory of selective predation for concealingly colored black animals on black lava.

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1938 Cibola National Forest New Mexico. U. S. Dept. Agr., Forest Serv., map.

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PLATE I

FIG. 1. View of Mount Taylor from the southwest, over sage-studded plains and large mesa surrounding the base of the mountain. Note sharp separation of the grass-covered south slopes from the coniferal forests on the north slopes. June 13, 1939.

FIG. 2. Meadow and slopes about Mirabal Spring; elevation 9000 feet on Mount Taylor. June 2, 1939.

PLATE I

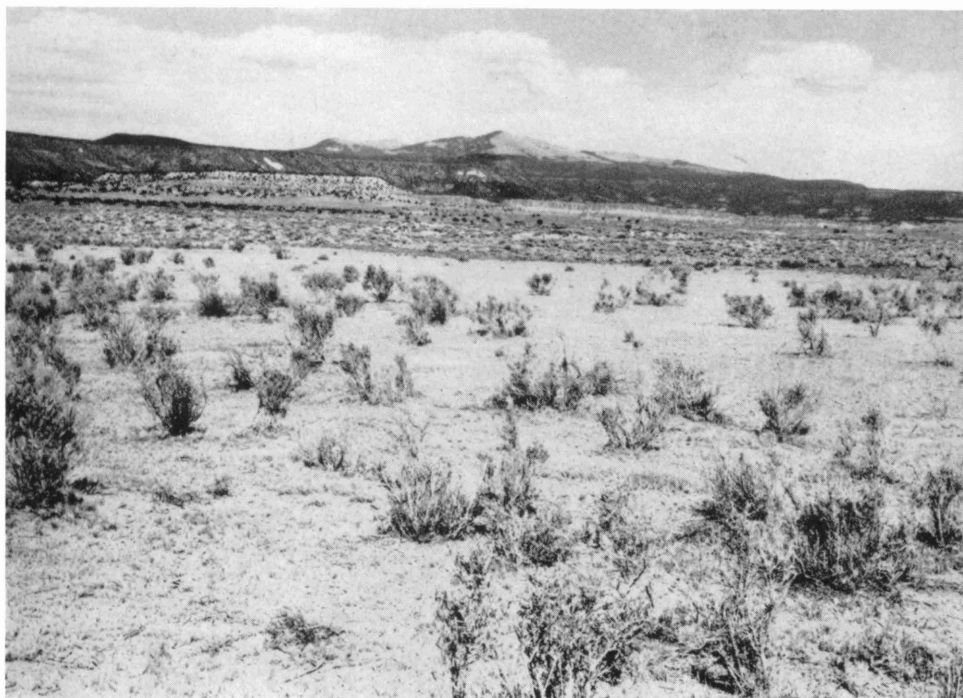


FIG. 1



FIG. 2

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PLATE II

FIG. 1. Yellow pines on an outcrop of weathered Tertiary lava on Porter's Ranch, eight miles southeast of Paxton; elevation 7400 feet. May 30, 1939.

FIG. 2. View of black Recent lava from Flagpole Crater, seventeen miles southwest of Grants, elevation 7800 feet. Yellow pines on the lava, pinyon on the adjoining, light-colored sedimentary soil. May 5, 1939.

PLATE II



FIG. 1

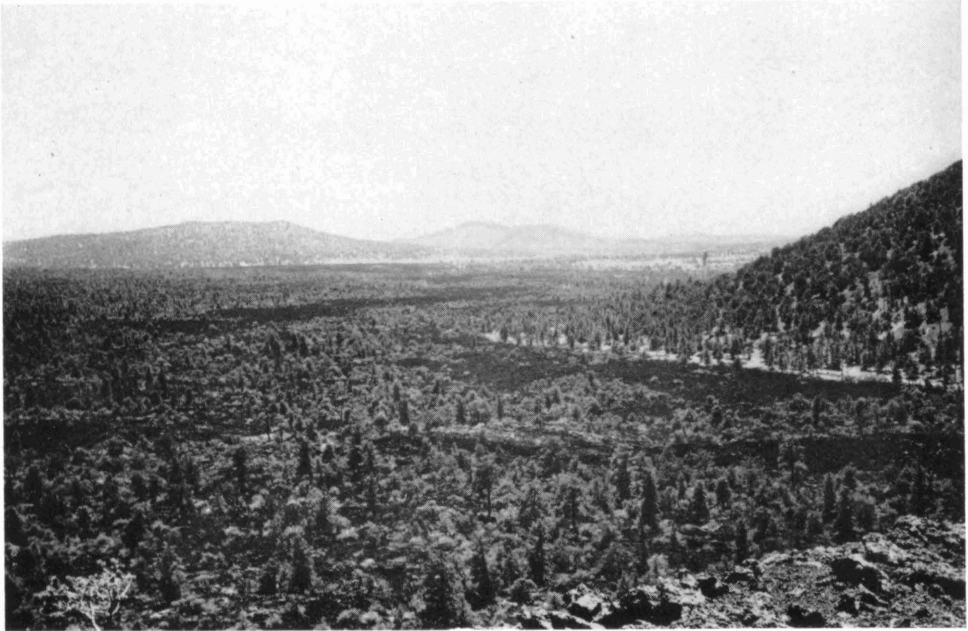


FIG. 2

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PLATE III

FIG. 1. View of black Recent lava from a light-colored, sandstone hill surrounded by the lava. One mile south of Grants; elevation 6400 feet. May 22, 1939.

FIG. 2. Close-up of Recent lava. One mile south of Grants; elevation 6400 feet. May 22, 1939.

PLATE III



FIG. 1



FIG. 2

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