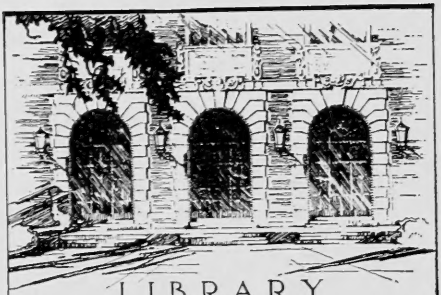

A Taxonomic and Evolutionary Study of the Piñon Mouse, *Peromyscus truei*

DONALD F. HOFFMEISTER

THE UNIVERSITY OF ILLINOIS
Museum of Natural History

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Introduction

A study of the variation among numerous populations of any one animal should reveal something of the possible processes of evolution involved in the steps, however minute, toward differentiation. The study should indicate whether or not the accumulation of morphological differences results in the formation of new units — subspecies or species — from similar, pre-existing units. In mammals, some, if not all, morphological differences between populations, as between individuals, are known to be hereditary. An opportunity to study this variation in the small piñon mouse, *Peromyscus truei*, was made possible by the availability of samples, each of one or more individuals, representing several hundred populations.

Piñon mice may be regarded as nearly average representatives of the genus *Peromyscus*. They are "average" in most morphological features and in geographic occurrence, but are specialized in the development of larger than average — indeed, nearly the largest — ears and auditory bullae. *Peromyscus truei* occurs from central Oregon and southern Wyoming southward to the tip of Lower California and along the tableland of Mexico to northern Oaxaca. Throughout much of this range, the mice occur only in association with piñons, or junipers where these trees replace the piñon, and where the piñon-juniper grows among rocks. This close ecological association has resulted in the common name piñon mice.

The species *Peromyscus truei* probably had a center of dispersion or origin in southwestern United States, and particularly in the Colorado plateau area. Three species closely related to *Peromyscus truei* may have differentiated from this parental stock.

This study attempts to analyze the variation within populations and among populations. The only previous study of variation (geographic) in the piñon mice was that by Wilfred Osgood in 1909, and he had fewer than half the specimens now available for such a study.

Acknowledgments

Many persons have aided with advice, suggestions, loans of specimens, photographs, and in many other ways. Especial thanks go to Dr. E. Raymond Hall for his assistance in this study and guidance in my doctoral work. Dr. Alden H. Miller kindly placed at my disposal the facilities of the California Museum of Vertebrate Zoology and extended many other courtesies. Generous financial support by the Research Board of the University of Illinois has made it possible to complete this study.

For the loan of materials, I am grateful to Harold Anthony, W. Frank Blair, William H. Burt, J. Kenneth Doutt, Stephen D. Durrant, Elton R. Edge, the late E. A. Goldman, E. R. Hall, the late J. Eric Hill, Emmet T. Hooper, Hartley H. T. Jackson, Stanley G. Jewett, David H. Johnson, Remington Kellogg, Robert T. Orr, the late Wilfred H. Osgood, C. C. Sanborn, Kenneth Stager, the late A. J. van Rossem, Jack C. von Bloeker, and the late Charles T. Vorhies.

For assistance with photographs and obtaining photographic material, I am grateful to W. W. Goodpaster, B. Villa R., R. G. Beidleman, F. A. Pitelka, L. S. Miller, Jay C. Quast, O. P. Pearson, and D. H. Ecke. Katharine Paul prepared the drawings of the teeth.

Notebooks filed in the Museum of Vertebrate Zoology have provided much data about habitats of piñon mice.

Materials

In this study, 2,627 specimens of *Peromyscus truei* have been examined. Most were conventional study skins accompanied by cleaned skulls and external measurements. A few specimens were preserved in alcohol or formalin or as complete skeletons. Additionally, several hundred specimens of *Peromyscus nasutus* and *Peromyscus difficilis* together with seven specimens of *Peromyscus bullatus* were examined. Of the specimens of *P. truei* studied, nearly five hundred were examined in eastern museums after much of the manuscript was nearly completed. These specimens are recorded, but most of them have not played an important part in formulating the accounts.

Under "Specimens examined," those without special designation are in the Museum of Vertebrate Zoology, University of California; the source of others is designated. Museums and institutions which have loaned additional material include:

Arizona, University of
American Museum of Natural History
California Academy of Science
Carnegie Museum
Chicago Natural History Museum
Donald R. Dickey Collection, University of California at Los Angeles
Ralph Ellis Collection, University of Kansas
Stanley G. Jewett Collection, Portland, Oregon
Los Angeles Museum
Museum of Natural History, University of Kansas
Museum of Zoology, University of Michigan
Museum of Zoology, University of Utah
San Bernardino Valley College
Texas Natural History Collection, University of Texas
Tulsa, University of
United States National Museum
United States Fish and Wildlife Service, formerly U.S. Biological Survey (herein designated U.S.B.S.)

Methods of measuring skins and skulls are explained in a special section on page 27.

I. Variation in a Population

Nongeographic variation, resulting from age, individual, or sexual differences, has been studied in several population-samples of *Peromyscus truei*. The largest sample was that from the Berkeley Hills, within a 2½ mile radius of Berkeley, California; it consisted of 124 (83♂, 41♀) study skins and 9 live animals from 4 litters reared in captivity. Three other samples are from southern San Benito County (99 specimens, 59♂, 40♀), eastern San Bernardino County (69 specimens, 45♂, 24♀), and Kern and Ventura counties (90 specimens, 64♂, 26♀), all in California. In each sample, specimens from several localities within a restricted area were combined. These samples are of the races *gilberti*, *truei*, and *montipinoris*, respectively. The following discussion concerns the population from Berkeley, unless mention to the contrary is made.

To study changes in the cranium attributable to age, five groups were established, from youngest to oldest, according to the degree of wear on certain cusps of the molar teeth. The five age groups are distinguished as follows: group 1, including mice in which M^3 is just breaking through the bony covering of the jaw or shows no wear whatsoever, and mice in which there is only juvenal pelage; group 2, in which M^3 is worn smooth except for the labial cusps, and M^1 and M^2 show little or no wear; group 3, in which M^3 is worn smooth, but M^1 and M^2 with labial cusps showing little wear and lingual cusps not quite worn smooth; group 4, in which the lingual cusps are worn smooth, and the labial cusps show considerable wear; group 5, in which the cusps are worn smooth and most, if not all, of the re-entrant angles between the cusps have disappeared. Because this grouping is based on quantitative features, there are borderline specimens difficult to place in one or another group. The animals reared in the laboratory were used to determine as far as possible the actual age of the younger groups and to supplement the data otherwise obtained.

All captive specimens completed the first molt before the 39th day of age. Time of the first molt is less modified by captivity than is any other feature which might be used to estimate age, so presence of juvenal

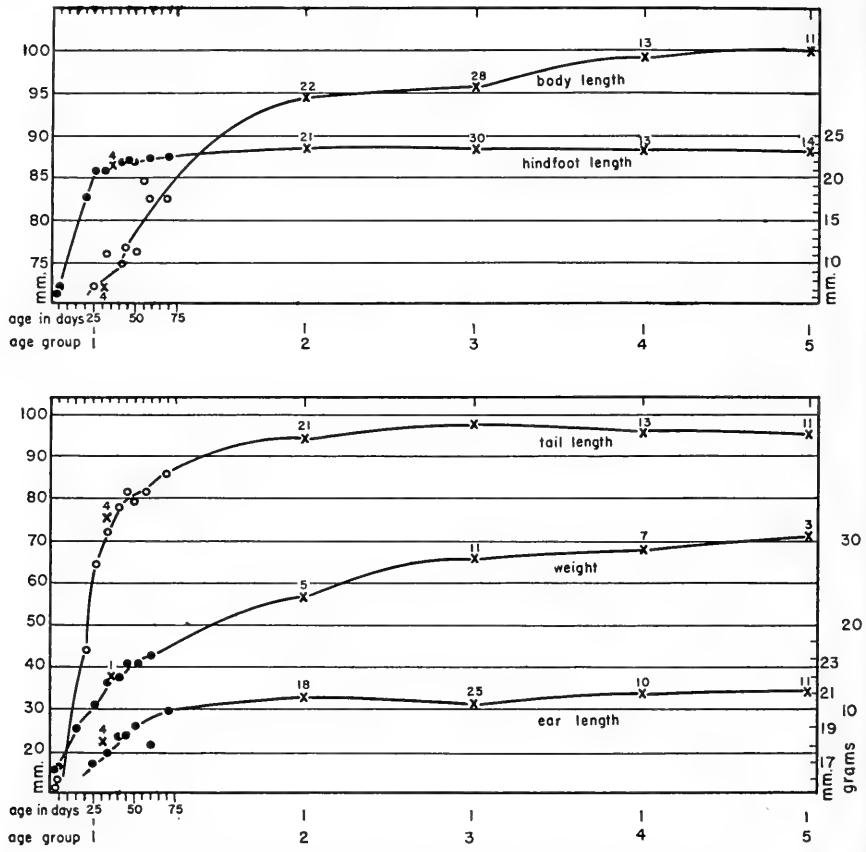

FIG. 1. Diagrams showing the changes in bodily size with increasing age in *Peromyscus truei* from the Berkeley Hills, California. Measurements represented by circles and dots are taken from one or more (averaged) of the nine animals reared in captivity, on which data are available only until the 68th day of age. Average measurements represented by crosses are from male study skins segregated according to age into groups. The youngest group is thought to be about 30 days old; the other groups are arbitrarily arranged and no age, in days, can be assigned to them. Superior numbers indicate the number of specimens averaged in each group.

pelage in noncaptives was considered indicative of an age of less than 39 days (age group 1). Group 2 probably includes the widest span of time, for the postjuvenal and adult pelages are acquired in this period. The postjuvenal pelage is fully acquired when the mouse is more than 2, and probably less than 2½, months old. It is not known when adult pelage is fully acquired for it is difficult to distinguish between adult and postjuvenal pelage. Group 5 represents the exceedingly old animals in which the crowns of the molars are so reduced that the tooth must no longer be fully effective in mastication. The other two groups are intermediate between 2 and 5.

AGE VARIATION

External Features

The length of the head and body in a nearly full term embryo is 41 mm. This is probably near the length at the time of birth, for the length of tail in this specimen is 10 mm.; in a one day old specimen it is 11.7; in two 2-day olds, 12.0 and 13.3. The length of body of specimens 25 days old (the next oldest for which this measurement is available) averages 72.3 mm. In the embryo, the tail length is 24 per cent of the body length; at 25 days of age it is 89 per cent of the body length. In specimens in group 1, the body length averages 71.7 mm. in males, 71.5 in females; in specimens reared in the laboratory, body length is 85 mm. or less up to the 68th day; in group 2, it averages 94.7 for ♂, 94.5 for ♀. From this group through the next three successive age groups, the body length increases more gradually: ♂, 95.7, 99.6, 100.1; ♀, 100.5, 101.8, 101.9. The tail length is about 100 per cent of the body length (although this is variable) in groups 2 to 5. From the foregoing, it appears that the body attains, on the average, 70 to 75 per cent of its average adult length by one month of age, about 85 per cent by two months, 95 per cent by the age represented by group 2, and after this there is a slight but gradual increase up through the oldest group (see Fig. 1). This agrees with the findings of Dice and Bradley (1942:418) in 7 subspecies of *Peromyscus maniculatus,* reared in the laboratory, for in these "At about 33 days of age, the rate of growth of most individuals of the subspecies begins to slacken and by the fifty-fourth day nearly all the stocks are growing in body length at a new and much slower rate than at first. . . . After the age of 54 days nearly all the stocks continue to increase in body length slowly but mostly rather steadily, until the age of six months, when measuring was discontinued." Although the body increases in length rapidly for a period, it does not increase relatively as rapidly as does the tail during this same period.

Weight increases more uniformly and gradually than does body length, although weights are not available on many study skins. Beyond the age which is average for group 2 the increase is slower and there is only a slight increase through the oldest group.

The length of tail at birth is only about 10 per cent of the length of this structure in the adult. During the first month the tail lengthens rapidly and at the end of this time is about 75 per cent of the length of the tail in the average adult. By the age represented by group 3, the tail has, on the average, reached its maximum growth. The ratio of body length to tail length in adult *gilberti* is very close to 1 to 1 (100 per cent), and, although there is some variation, after the age of group 1,

the body and tail grow at a similar rate with the result that the 1:1 ratio is maintained. In the laboratory animals, this same relationship is noted as early as the 39th day. An analysis of Dice and Bradley's (1942) graphs shows that for 4 subspecies of *Peromyscus maniculatus*, the ratio of the body length to tail length remains constant within 2½ per cent or less from about the first until the sixth month of age, when measuring was discontinued. The ratio of length of body to tail remained constant, within the limits stated, after the 45th day in *P. m. assimilis*, after the 39th day in *sonoriensis*, the 51st day in *osgoodi*, and the 15th day in *rufinus*. The other populations of *Peromyscus truei* indicate that this proportional increase in both body and tail is similar in at least the races *gilberti*, *truei*, and *montipinoris*. Thus, after the mice begin a postjuvenal molt, the relative length of tail or body is of systematic significance regardless of age.

The hind foot grows rapidly in length from birth until about the 25th day, having tripled its length in that time and having increased from 27 per cent to 88 per cent of the average adult length, assuming the latter to be 23.5 mm. There is a gradual increase from 25 days up to the age represented by group 2 and after this there is little or no lengthening. Dice and Bradley (1942:421) found in subspecies of *P. maniculatus* that there is an abrupt break in the growth curve for the hind foot between the fourth and sixth weeks and that there is little or no increase whatever in foot length between the ages of 6 weeks and 6 months.

The pinna of the ear at birth, and until betwen the third and sixth day, is small and folded down flat against the lower part of the ear, thus covering the otic orifice. In the youngest laboratory animals for which I have records, the ear averaged 16.9 mm. when measured from the notch at 25 days. There must have been a rapid lengthening in the 25 days following birth, similar to that recorded by Dice and Bradley for *P. maniculatus* between the age of 15 to 24 or 30 days. Although data are not very complete, there seems to be a gradual increase in length after this period, with near the maximum size being reached shortly after 2½ months of age.

Pelage

Molts in *P. t. gilberti* are practically identical with those of *Peromyscus maniculatus gambelii*, as studied and described by Collins (1918 and 1923). Determination of molt sequence in *P. t. gilberti*, in this study, has been based primarily on study skins of wild stocks, except for the observations of young undyed caged-animals.

At birth, the young are devoid of any visible external hair, except for the mystacial vibrissae. The skin appears bluish-red from the color of the underlying blood vessels, but pigmentation in the skin is lacking.

Between the second and third day, the dorsal region becomes darkly pigmented, and by the fourth day, the pigmentation has extended out onto the legs. Svihla (1932:23) records, for *P. t. truei*, that the dorsal region becomes darkly pigmented in the first twenty-four hours after birth. By the eleventh day, underfur, overhairs, and guardhairs are well developed over all the body. In this juvenal pelage, the yellow or ochraceous pigment of the subterminal band is much reduced so that the

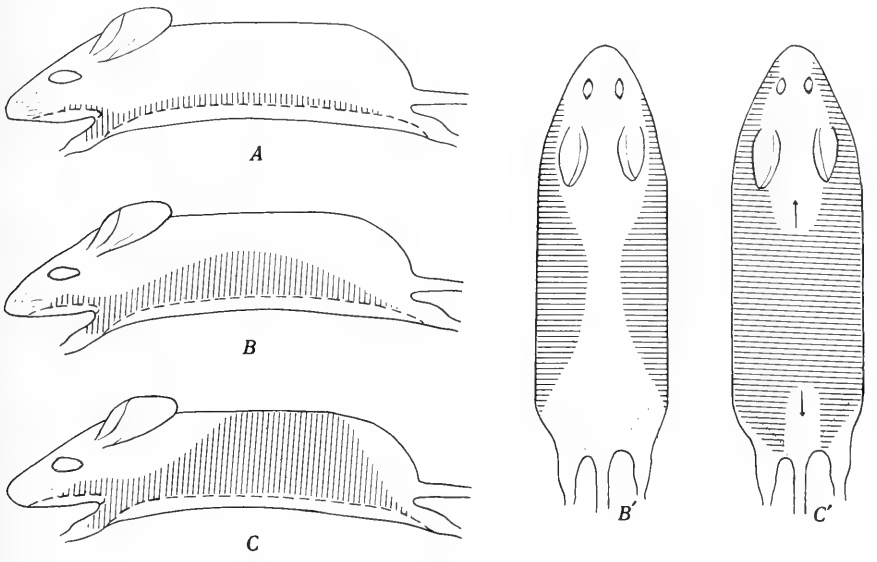

FIG. 2. Diagrammatic sketches showing the sequence (A to C) of the postjuvenal molt in *Peromyscus truei*. Note that the postjuvenal (shaded) pelage of the two sides meets in the middorsal area and moves both anteriorly and posteriorly. B′ and C′ are dorsal views of stages of molt comparable to the lateral views shown in B and C.

general dorsal coloration is nearly a uniform gray. Between the fifth and seventh week, ochraceous hairs, that is, hairs with more ochraceous pigment, suggestive of the postjuvenal pelage, appear on the upper side of the forelimbs and along the lateral line. Collins (*op. cit.*) found that *Peromyscus maniculatus gambelii* started to acquire postjuvenal pelage between the 4th and 6th week. However, in two caged specimens of *P. truei*, what appeared to be a narrow, ochraceous-colored lateral line was noted about the 18th to 19th day. This ochraceous color did not later extend up the sides in a fashion typical of the juvenal-postjuvenal molt described below. Examination of study skins of young animals indicates that there may be a molt at this stage, in which the gray juvenal pelage is replaced by a slightly lighter gray, not ochraceous, pelage. Study skins in gray juvenal pelages are lighter gray in the areas

where molt typically occurs in normal sequence, but the difference is not easily discerned. Thus, it may be that there is a molt and a new pelage between the juvenal and the postjuvenal pelage, acquired and lost before the 5th to 7th week.

The appearance of the postjuvenal pelage first on the upper side of the forelimbs is similar to the condition in *P. m. gambelii*, but unlike that found in *P. californicus insignis* or *P. eremicus fraterculus* (see Collins, 1923:75-76 and Figs. 7-11), in which the postjuvenal pelage also appeared on the ventral surface as a pectoral spot. The pectoral spot on the ventral surface in *P. t. gilberti* does not appear until the postjuvenal pelage is evident well up the sides of the animal, or until even later. In some specimens, it seems that the postjuvenal pelage first appears along the lateral line near the middle of the side. Certainly the pelage makes its appearance progressively farther up the back more rapidly in the mid-region than farther posteriorly on the side (see Fig. 2), extending posteriorly on the thighs of the hind legs and anteriorly onto the thighs of the front legs, and continuing to the cheek and posteriorly around the eye to the dorsal surface. The postjuvenal pelage on each side comes together on the dorsum (the saddle phase) and continues posteriorly rapidly over the rump and more slowly anteriorly toward the ears (see Fig. 2C′). The juvenal pelage is long retained in the region between and below the ears. The characteristic gray pelage on the dorsal surface of the snout, anterior to the eyes, is apparently juvenal or postjuvenal pelage which is retained usually throughout life. In *P. m. gambelii*, the transition from juvenal to postjuvenal pelage is completed in about 8 weeks, according to Collins (*op. cit.*).

In the large series of specimens of *Peromyscus t. gilberti* from the Berkeley Hills, the difference between postjuvenal and adult pelage is scarcely, or not, discernible. The adult pelage apparently is acquired by a molt beginning where the postjuvenal molt ended between the ears; it continues posteriorly as a wave over the entire back. At the same time there seems to be a molt moving up the side, which gives the lateral line a rich ochraceous appearance relatively early.

Molting in specimens that have already attained adult pelage is distinguishable in relatively few individuals. It is recognizable by the molt line which moves posteriorly over the dorsum. Apparently one adult molt takes place in the fall, for in many October-taken adults all stages of the molt on the dorsum from anterior to posterior are found. However, two adult specimens from Strawberry Canyon have a visible molt line in the spring; the molt on a specimen taken on March 4 is just beginning and on one taken on June 2 is half completed. This may indicate (1) an early (or late) molt in these specimens, (2) a second molt for the year, or (3) that some individuals of the population are molting at

various times throughout the year. The second of these seems probable in that the summer pelage is lighter-colored than winter pelage, and this seems not to be the result of wear or fading. This seasonal variation is most noticeable in dark-colored populations from the humid belt, as *P. t. dyselius* and *P. t. sequoiensis,* and light-colored populations from arid regions. The third is also plausible since Collins (1923:68) found in 186 skins of *P. maniculatus* taken throughout the year a continuous molt, with the peak in evidences of molt in September.

Skull

At birth, the greatest length of the skull is less than 13.5 mm., as determined by measuring the length of the head of a live mouse; by the age represented by group 1, probably inclusive of ages between 25 and 35 days old, the greatest length varies from 24.0 to 25.8 mm. in 6 specimens. The rate of postembryonic change in size of all the bones is greater between the time of birth and the 35th day than during any other period. For example, the greatest length of the skull by the 25th to 35th day is 88.5 per cent of the size that is average for the oldest group of males; by the age of group 2, which group probably represents mice from the 35th to more than the 100th day of age, the greatest length is already 98.9 per cent of the maximum average size. Beyond this age, growth in all the bones is slight. The actual increase in size of the skull and of certain cranial elements is given in Table 1 for the various age groups of each of three populations. In some instances, the averages indicate no increase or an actual decrease in size with increase in age, but this is due to insufficient numbers of specimens for a particular age group, or is the result of having carried the averages to only one decimal point.

In skulls of the youngest group, the rostrum is relatively short and narrow, both laterally and dorsoventrally. There is a rapid lengthening of the preorbital region, as well as a general increase in its size, until the age of group 2, after which, as in other elements, the increase is slight. The bones on the dorsum of the cranium, except the frontals, increase in length or breadth only slightly after birth; the frontals increase considerably in length at an early period. On the lower side of the skull the basioccipital and palate grow much. The general result of these changes is that the dorsal convexity of the skull is decreased with increasing age.

Relative changes in the skull of *Peromyscus truei* are similar to those of *Neotoma micropus,* as recorded by Allen (1894), and of *Citellus beecheyi,* as recorded by Hall (1926). The relative increase in the various parts of the skull of *P. truei* can be compared with these two other species in Table 2. I have employed the age groups of these authors. The

TABLE 1. Average measurements, in millimeters, of skulls in different age groups.

	83♂, Berkeley Hills					59♂, San Benito Co.					64♂, Kern & Ventura cos.				
Age Group	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Number Examined	3	33	20	13	14	1[a]	20	12	12	14	6[b]	20	13	7	18
Greatest length	25.3	28.3	28.4	28.5	28.6	25.8	27.8	28.4	28.6	29.0	26.1	27.6	28.2	28.3	28.8
Basilar length	18.2	20.8	20.9	21.1	21.1	18.6	20.4	21.1	21.0	21.4	19.1	20.2	20.8	20.8	21.2
Breadth braincase	12.9	13.2	13.3	13.3	13.3	12.9	13.2	13.1	13.3	13.4	12.7	13.1	13.0	13.2	13.2
Length nasals	8.6	10.4	10.5	10.4	10.5	9.2	10.1	10.5	10.6	10.6	9.3	10.0	10.4	10.5	10.7
Rostral length	9.2	10.9	11.0	11.0	11.1										
Rostral width	4.1	4.7	4.7	4.8	4.9										
Interorbital constriction	4.5	4.5	4.5	4.5	4.5	4.4	4.5	4.5	4.4	4.5	4.5	4.5	4.4	4.5	4.5
Length frontals	8.4	9.1	9.1	9.1	9.0										
Length parietals	5.3	5.4	5.3	5.3	5.3										
Length interparietal	3.5	3.7	3.7	3.7	3.7										
Supraoccipital	3.5	3.5	3.6	3.4	3.6										
Length basioccipital	3.4	3.9	3.9	3.9	3.9										
Shelf bony palate	3.8	4.1	4.2	4.2	4.2	3.9	4.1	4.1	4.2	4.2	3.9	4.0	4.1	4.1	4.2
Palatine slits	5.2	5.9	5.9	6.0	6.0	5.5	5.8	6.0	6.0	6.0	5.4	5.6	5.7	5.8	5.9
Postpalatine length	8.6	10.0	9.9	10.1	10.0	8.9	9.8	10.2	10.1	10.3	9.1	9.7	9.9	10.0	10.3
Length diastema	6.0	6.9	7.0	7.1	7.2	6.1	6.8	7.0	7.1	7.2	6.4	6.7	7.0	7.0	7.3
Maxillary toothrow	4.3	4.4	4.4	4.4	4.4	4.3	4.4	4.4	4.4	4.4	4.3	4.3	4.3	4.2	4.3

[a]Estimated to be about 48 (rather than 25-35) days old by comparison with laboratory stock since some postjuvenal pelage is present. Perhaps specimen belongs in group 2.

[b]Some of these judged to be older than 35 days.

TABLE 2. Relative increase, expressed as percentage of greatest length, in skulls of different ages.

	Peromyscus truei[a]					*Neotoma*[b]			*Citellus*[c]				
Age group	1	2	3	4	5	juv.	juv.	old	E	H	K	N	Q
Greatest (occipito-nasal) length	100	100	100	100	100	100	100	100	100	100	100	100	100
Length of nasals	34.0	36.8	37.0	36.8	36.8	32.3	35.4	41.5	25.4	33.1	34.9	36.2	36.3
Length of frontals	33.2	32.2	32.2	32.2	30.7	42	36.6	34	39.7	39.8	39.9	37.0	.....
Length of parietals	21.0	19.0	18.7	18.6	18.2	19.4	14.6	15					
Length of interparietal	13.8	13.1	12.9	13.2	12.9	14.5	13.4	13.2					
Rostral breadth	16.2	16.6	16.5	16.9	17.1	17.7	15.4	12.3	26.1	23.7	21.9	22.0	22.5
Interorbital constriction	17.8	15.9	15.9	15.8	15.7	19.4	14.6	11.3	26.1	25.8	22.4	24.0	25.6
Breadth of braincase	51.0	46.6	46.9	46.7	46.5	51.6	45	38	53.3	46.2	43.0	42.3	39.9
Length of toothrow (alveolar)	17.0	15.4	15.5	15.5	15.4	25.8	19.5	17.7					
Length of palatine slits	20.6	20.8	20.8	21.0	21.0	19.3	20.7	21.7					
Shelf of bony palate	15.0	14.5	14.8	14.7	14.7	16.1	17	13.2	59.2	55.7	53.2	54.7	56.0
Postpalatal length	34.0	35.4	34.9	35.3	35.0				29.6	.....	32.7	33.3	34.5
Diastema	23.7	24.4	24.6	24.9	25.2				21.3	24.9	25.7	25.4	27.4

[a]Based on Table 1, male *P. t. gilberti*, Strawberry Canyon, Berkeley, California.
[b]Adapted from Allen (1894:234) for *Neotoma micropus*. (Toothrow = crown length).
[c]Adapted from Hall (1926:368-369) for *Citellus beecheyi*.

youngest *Citellus* (the age "groups" are here based on individuals, not averages), a 15-day-old animal, is probably relatively younger than the youngest *P. truei,* and the *Citellus* of age "H" is probably more nearly comparable to group 1 in *Peromyscus.* In both *Citellus* and *Peromyscus,* the greatest relative change occurs between the younger groups "E," "H," and "K" and 1 and 2. Probably the same would be true for *Neotoma* if data were available for intermediate age groups.

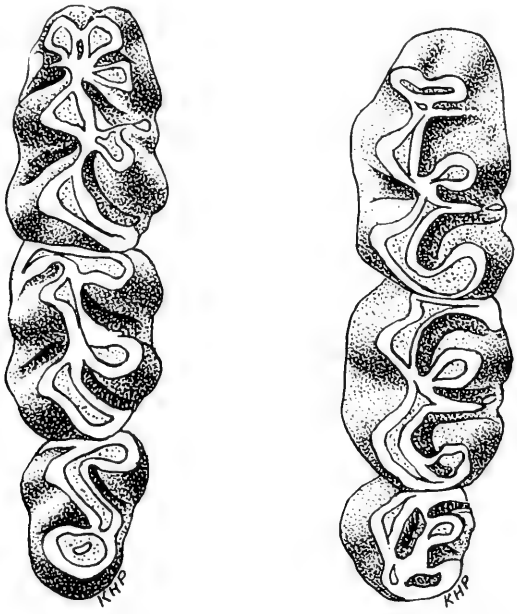

FIG. 3. Occlusal view of upper (left) and lower (right) molar teeth of *Peromyscus truei gilberti,* nos. 27971, 42670, University of California, Museum of Vertebrate Zoology, juvenile, from Berkeley, California. x17.

From an analysis of Tables 1 and 2, the following can be noted concerning *P. truei.* No actual decrease in size with increasing age occurs in any bone or measurement. A relative decrease occurs in the size of those cranial elements housing the brain, particularly the frontals, parietals, interparietal, and supraoccipital, and in the breadth of the braincase and breadth of the interorbital region (interorbital constriction). The greatest relative and actual increase is in the length of the nasals, rostrum, diastema, palatine slits, and breadth of rostrum, as well as in the length of the basioccipital. In the parts measured, the greatest change after the age of group 1, and probably after the 35th day, occurs in the preorbital region. Less increase occurs in those parts of the skull enclosing the brain. This difference in change of the various parts of the skull with change in age is probably correlated with the immediate

necessities of the animal, particularly feeding and the housing of a brain which is relatively large at birth.

Other structures of the skull that have not been measured in the large series, but that are of importance from the developmental and taxonomic standpoint, are the auditory bullae, auditory meatus, and maxillary processes of the zygomatic arches. One skull, average in most measurements, of each age group has been used in measuring these changes. Auditory bullae increase little in inflation external to the basioccipital

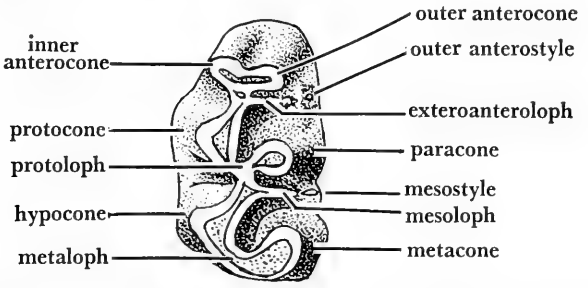

FIG. 4. Left M^1 of *P. t. gilberti,* no. 27971, Univ. Calif. Mus. Vert. Zool., age group 1, Berkeley, California. x17.

with aging; measurements of the projection of the bullae ventrally from the basioccipital of each skull, of increasing age groups, are: 1.75 mm., 1.8, 1.85, 1.6, and 1.85. The greatest diameter of the auditory meatus in the smallest skull is 2.85 mm. and in the largest, 3.1 mm. The maxillary breadth, which gives a rough measure of the horizontal extent of the maxillary processes of the zygomatic arches, increases as follows: 10.2 mm., 12.8, 12.6, 12.6, and 13.8.

TEETH

The incisors are ever-growing teeth that are worn away at the tips through normal attrition and there are no peculiar changes accompanying increase in age. With the molariform teeth, there are marked changes with increasing age and greater attrition or wear. This is further complicated by individual variation in "pattern" of molars in any one population. To study these changes in the molars, the series from the Berkeley Hills has been employed.

In *Peromyscus truei,* the last teeth to erupt are $M\frac{3}{3}$. The crown of M^3 (last upper) is not on the same level as the other teeth and not functional until between the 30th and 35th day of age. This age was estimated from the stage of molt and pelage. M_3 (last lower) is fully erupted a few days earlier. Wear on all the teeth at an early period is probably the result of occlusion only and not the result of action by abrasive foods, for the animals are probably not weaned before a month of age.

Upper Molars

M^1: The anterocone (see Fig. 4) is partly divided by an anterior groove. In skulls of age group 1, in which M^1 is completely unworn, the anterocone has two cones which are fused medially. Each is fused by a narrow loph with the exteroanterloph; a small lake is thus formed, which soon disappears. In age group 3, or slightly before this age, wear has obliterated the bilobed condition of the anterocone. The exteroanterloph may extend to the cingulum and may be fused completely with the

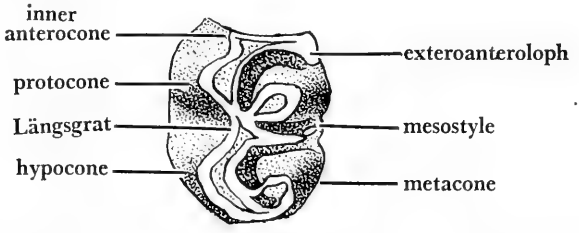

FIG. 5. Left M^2 of *P. t. gilberti*, no. 27971, age group 1, Berkeley, California. x17.

anterocone early and at least always shortly after the age of group 2. An outer anterostyle may have a cingular connection with the anterocone or paracone, neither, or both. In the latter case, the re-entrant angle is dammed off and a lake formed. With advanced wear (group 3 or 4), the anterocone, exteroanterloph, and outer anterostyle become fused into a single anterior cusp.

The mesoloph may connect with the mesostyle or may project only part way toward it. With advanced wear it is always connected, but previous to this, the connection, or lack of connection, is not dependent on stage of wear. In specimen no. 53347, Univ. Calif. Mus. Vert. Zool., there is only a very short mesoloph, but a mesostyle; in no. 12, coll. D. F. Hoffmeister, there is no mesoloph or mesostyle. In an old animal (group 5), there seems to be no mesoloph in LM^1 and only a slight loph in RM^1. In other teeth examined, regardless of how advanced the stage of wear, a mesoloph is discernible.

A posterolabially directed spur from the hypocone, called the posterloph, is discernible in young (group 1 and 2) specimens. It almost, or more commonly completely, connects with the cingular border of the metacone and with wear (after the age of group 2) the loph becomes completely fused with the metacone.

M^2: The general pattern is much as in M^1, but the anterocone has been either completely suppressed or only the posteriomost part, fused with the exteroanteroloph, remains. The loph situated most anteriorly is primarily the exteroanteroloph. It may become connected to the paracone *via* the cingulum and outer anterostyle, as in M^1.

The mesoloph was present in all, except in the LM^2 of specimen no. 47714, M.V.Z., in which it was absent. In slightly less than 10 per cent of the specimens examined, the mesoloph was only weakly developed. The mesoloph may rarely appear to arise from the paracone rather than from the central axis (Langsgrat) of the tooth and it may or may not fuse with the mesostyle, except in much worn teeth, in which it always fuses.

The posteroloph is as in M^1.

M^3: This tooth is reduced, particularly the posterior hypocone and metacone. The exteroanteroloph is about as in M^2, with a connection

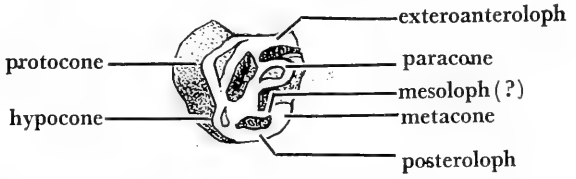

FIG. 6. Left M^3 of *P. t. gilberti*, no. 27971, age group 1, Berkeley, California. x17.

between it and the medial part of the paracone, thus forming a medial lake (lake 4).

The hypocone is so reduced that with slight wear there is little or no indication of it; the hypocone is situated not directly behind the protocone but posterolabially to it and the angle anterior to the hypocone is shallow or absent. Mesoloph and mesostyle may be absent or questionably present as indicated in Fig. 6. In young specimens (group 1 and 2), a posteroloph which is fused with the metacone is usually discernible. With wear, the metacone, paracone, and exteroanteroloph become connected along the labial cingulum. Four lakes are thus formed (see Fig. 6 in which the lake anterior to paracone has not been isolated yet). The one formed by the posteroloph disappears early. The other two labial lakes disappear at about the age of group 3. The cusps are worn smooth relatively early (by the age of group 3) except for the cingular edge of the paracone, which is elevated slightly longer.

Lower Molars

M_1: The anteroconid is partly divided by an anterior groove, but with wear the posterior portion of the groove becomes isolated as a small lake which soon disappears, and the reduced anterior groove disappears by the age of group 3. There is a cingular outer anterostylid which, with wear, becomes continuous with the outer anteroconid. An exteroanterolophid (similar to the exteroanteroloph of upper M^1) is present and fuses with the outer anterostylid, but it may fuse first with the posterior edge of the outer anteroconid and then indirectly with the anterostylid. This

exteroanterlophid, the fused outer anterostylid, and probably the posterior part of the outer anteroconid represents the anterior internal small lophid of M_{2-3}. With advanced wear of M_1, all of these structures anterior to the protoconid-metaconid become fused into a single unit and even the metaconid becomes fused with it, with only a shallow lingual notch anterior to this cusp.

An ectolophid and ectostylid may or may not be developed and like the mesoloph and mesostyle of M^1 are labial in position. Nevertheless, in relation to the other cusps they have a different position. The ecto-

FIG. 7. Left M_1 of *P. t. gilberti,* no. 42670, Univ. Calif. Mus. Vert. Zool., age group 1, Berkeley, California. x17.

lophid was present in 18 of 99 specimens; the ectostylid was present in an additional 9 specimens. These structures were noted in all age groups.

A mesolophid or mesostylid may be present but less frequently than the ectolophid or ectostylid. A mesolophid was present in 13 of the 99 specimens (and in all age groups) and in 10 of the 13 it was accompanied by a mesostylid. In some specimens the lophid was merely a slight protuberance, and in others it extended to the cingulum. From the mesoloph of upper teeth the mesolophid differs in being more closely associated with the posterior cusp, seemingly having a common origin with the lophid (in this case, metalophid) of this cusp whereas in upper teeth the mesoloph is situated about midway between the anterior and posterior cusp and connects to the central axis of the tooth (the Langsgrat). It should also be noted that, in accordance with the terminology employed here, the mesolophid is situated betwen the metaconid and entoconid, whereas in upper teeth the mesoloph is situated between the paracone and metacone.

The posterior, lingually directed arm of the hypoconid, should perhaps be designated the hypoconulid, in accordance with the terminology suggested by Wood and Wilson (1936). However, in the very youngest, unworn teeth, these (hypoconid and "hypoconulid") appear as a single cusp, except for the extreme occlusal, enamel-free surface, on which there are two slight enlargements of the enamel-free area as indicated in Figure 7. With wear, the hypoconid appears as a single cusp with a

posterior, lingually directed arm (the Hypoconidhinterarm and Schlusscingulum of Schaub, 1925).

M_2: The general pattern is the same as in M_1 except that possibly the posteriormost part of the outer half of the anteroconid has disappeared completely. The outer anterostylid is apparently fused at all stages with the exteroanterolophid; thus, this lophid continues to the labial cingulum.

An ectolophid and ectostylid were present about as frequently as in M_1; whenever these were present in M_2, they were present also in M_1

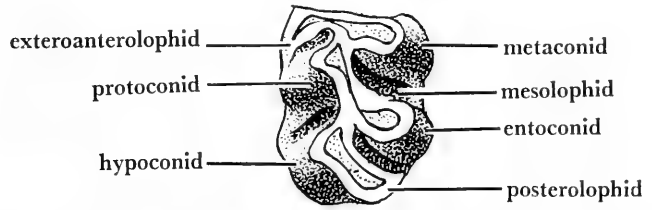

FIG. 8. Left M_2 of *P. t. gilberti*, no. 42670, age group 1, Berkeley, California. x17.

FIG. 9. Left M_3 of *P. t. gilberti*, no. 42670, age group 1, Berkeley, California. x17.

and usually better developed in the latter. When the ectostylid is present, it may become connected with wear (age of group 3 and older) to the protoconid and hypoconid, and thus the re-entrant angle is transformed into a lake. This latter condition is not common.

Mesolophids and mesostylids are present less frequently even than in M_1 but are present in M_2 only when they are present in M_1.

M_3: The anterior and posterior parts of this tooth are suppressed. The anteroconid has disappeared and the exteroanterolophid and outer anterostylid are less well developed than in M_2. The other cusps are greatly reduced with the hypoconid and entoconid reduced most. The entoconid has been so reduced that the hypolophid has been necessarily lengthened but narrowed. The posteriorly and lingually directed arm of the anteroconid has fused with the entoconid. This, thus, forms a lake which soon disappears so that the hypolophid, hypoconid, and its lingual arm collectively are here called the hypoconid, and appear as a single cusp with wear. The details of this can be determined better in a form in which the entoconid is less reduced, as in *P. maniculatus*. The entoconid with slight wear loses its individuality, becomes continu-

ous with the posterior, lingual arm of the protoconid, and forms a diagonal loph. The resulting pattern is primarily S-shaped.

M_3 wears very rapidly and usually after the age of group 2 there is no longer an angle between the entoconid and hypoconid. With slightly more wear, the angle anterior to the entoconid disappears and the S-pattern is altered, with only one small and one large outer re-entrant angle, anterior and posterior to the protoconid, respectively.

Ectolophids or mesolophids (or stylids) are lacking.

TABLE 3. Variation in certain measurements of 26 adult (age-groups 4 and 5), male *P. t. gilberti* from Berkeley, California.

	Mean with standard error	Standard deviation	Coefficient of variation
Total length	196.8 ±1.05	5.04	2.56
Body length	100.4 ±0.90	4.60	4.57
Tail length	96.1 ±0.84	4.12	4.16
Hind foot length	23.4 ±0.25	1.28	5.47
Greatest length skull	28.58±0.07	.349	1.22
Basilar length	21.12±0.12	.597	2.83
Greatest breadth braincase	13.28±0.05	.246	1.85
Interorbital constriction	4.50±0.02	.111	2.46
Length nasals	10.47±0.095	.476	4.55
Shelf bony palate	4.23±0.03	.148	3.50
Palatine slits	5.97±0.06	.280	4.68
Diastema	7.11±0.05	.261	3.67
Postpalatal length	10.07±0.08	.372	3.47
Maxillary toothrow	4.41±0.03	.144	3.27
Rostral length[a]	11.03±0.065[a]	.330[a]	2.99[a]
Rostral width[a]	4.84±0.04[a]	.181[a]	3.74[a]
Length frontals[a]	9.05±0.06[a]	.302[a]	3.32[a]
Length parietal[a]	5.27±0.06[a]	.301[a]	5.71[a]
Length interparietal[a]	3.75±0.05[a]	.260[a]	6.93[a]
Supraoccipital length[a]	3.52±0.06[a]	.296[a]	8.41[a]
Basioccipital length[a]	3.92±0.03[a]	.131[a]	3.34[a]

[a]These measurements are not used in making comparisons of subspecies in the accounts beyond.

INDIVIDUAL VARIATION

Although no two individuals of a population are genetically alike, with the exception of identical twins, the discernible differences between most individuals in any population of *P. truei* are slight. This is well exemplified in the population from Berkeley, California. Measurements of external parts are more variable than most measurements of the skull. This is due, in some degree, to the difficulties in accurately measuring "soft" parts of the anatomy. Length of hind foot is the most variable of the external measurements. In "groups" of young mice, any particular meas-

urement is more variable than for the next older group. For example, in young males (age group 2), the coefficient of variation for tail-length is 7.38 per cent, for age group 3, 6.40 per cent, and for "adults" (age groups 4 and 5), 4.16 per cent. Greater variability in younger groups of mice is correlated with a more rapid growth during the ages represented. Of measurements of the skull, greatest length is the least variable. However, measurements of short structures of the skull show a larger

TABLE 4. Coefficients of variation for certain measurements of *Peromyscus truei.*

Subspecies	Locality	N	Body	Tail	Hind foot	Greatest skull length
truei	NW Colo., NE Utah	21	4.51	6.99	3.87	...
"	Valencia Co., New Mexico	27	4.52	7.19	4.02	1.82
"	Wupatki, Arizona	22	3.91	5.46	...	1.64
gentilis	S Chihuahua, Mexico	15	3.28	6.15	...	1.30
gratus	Tlalpan, Mexico	27	6.24	6.06	2.96	2.16
"	Michoacán, Mexico	13	6.12	5.77	4.97	2.66
sequoiensis	Guerneville, California	14	7.09	5.58	3.41	2.09
gilberti	San Benito Co., California	41	4.46	5.70	...	2.05
"	Marysville Buttes, California	35	5.67	7.01	...	3.03
"	Berkeley, California	26	4.57	4.16	5.47	1.22
dyselius	Stanford, California	28	7.57	4.41	5.88	2.18
montipinoris	Tehachapi Mts., California	48	6.22	6.41	...	2.02
martirensis	San Pedro Mártir Mts., L. Calif.	24	4.35	4.60	3.87	1.68

percentage of variation than do measurements of long structures. This is due, in part, to the fact that all measurements are taken only to 0.1 mm., and this, combined possibly with slight errors in measuring, magnifies the variability in "short" measurements. The length of maxillary toothrow is probably no more variable, even possibily less variable, than length of skull. Of those cranial measurements which average between 4.0 and 9.0 mm., the following are arranged in order from least to most variable: interorbital constriction (width), length of maxillary toothrow, length of basioccipital, length of shelf of bony palate, length of rostral diastema, width of rostrum, length of palatine slits, length of parietal, length of interparietal, and length of supraoccipital. Of the "larger" measurements of the cranium, greatest length of skull and greatest breadth of braincase are less variable measurements than basilar length.

Coefficients of variations for certain measurements are given in Table 4. The variation of the coefficients between populations of one subspecies is in some cases less than that between populations of several subspecies. Clark (1941:296) has shown for *Peromyscus maniculatus*

and *P. leucopus* that the coefficients of variation for one feature are very nearly the same for several populations of any one subspecies.

Since color of pelage has not been mathematically measured, statistical analysis of variation has not been made. Variability of the time of inception of the juvenal molt has been noted in caged animals. The same seems to be true of the inauguration of the postjuvenal molt. There is some variation in the length of time juvenal pelage is retained between the ears. Spotting, in the nature of white patches of pelage between the ears and over the hips, was noted in 2 of the 124 specimens from Berkeley.

Individual variation in the pattern of the molariform teeth has been mentioned above. Certain structures of the skull, not readily measurable, which reveal individual variation are as follows: Shape, as well as size, of the interparietal, in which the lateral wings may taper off gradually toward the sides of the skull, or the wings may remain broad (anteroposteriorly) far laterally. The posterior border of the interparietal may be nearly straight or it may have a pronounced median projection. All stages of intermediacy, and other variation in shape not here described, can be noted. There is some variation in the degree of inflation and the size (anteroposteriorly) of the auditory bullae. The palatine slits (incisive foramina) and nasals may vary in size and shape between the two sides of one skull. Extreme modifications of the skull, apparently of a nongenetic nature, were noted in only a few instances in all of the more than 2,000 specimens examined. In two specimens (*P. t. gentilis,* no. 76863 and *P. t. gratus,* no. 92185), the rostra were bent between 5 and 10 degrees to one side of the mid-line. This was probably the indirect result of partial or complete degeneration of the masseter muscle on one side. The lower jaws show no such asymmetrical development. The glenoid fossae have so altered their positions that the lower incisor of each articulating ramus occludes normally with the corresponding upper incisor. In one specimen (*P. t. montipinoris,* no. 60200) a tooth, left M^2, is absent.

SECONDARY SEXUAL VARIATION

With the relatively small number of specimens available of the same age (or age group) of one sex from any one population, it is difficult or impossible to draw accurate conclusions as to the amount of sexual difference in the various parts measured. Since the largest numbers of specimens are available in the four "populations" originally designated, namely, Berkeley (race *gilberti*), southern San Benito County (*gilberti*), eastern San Bernardino County (*truei*), and Kern and Ventura

counties (*montipinoris*), secondary sexual variation has been checked in them. Comparisons were made of specimens of the two sexes in the same age group in each population. Although the mice in each population were segregated into 5 age groups with the result that there were 20 such groups for the 4 populations, in only 12 of these were numbers of specimens sufficient to warrant close comparison. In 9 of the 12 groups, the females, and in 2, the males, averaged longer in total length; in one instance both were the same. In 10 instances females averaged longer tailed; in 2 instances, males averaged longer. Combining the two oldest age groups, the total length is greater in females in three instances and equal in the fourth. In these three cases, the males average 4.9, 1.7, and 1.0 per cent shorter than the females. Animals of the two oldest groups are the "adult" specimens in the systematic accounts beyond. In tail length, for mice of these two oldest groups, males average 7.2, 2.8, and 2.4 per cent shorter than females in 3 populations, but in one population, males average 2.1 per cent longer. The number of "adult" specimens involved for each population are 24♂, 11♀; 23♂, 14♀; 26♂, 22♀; 23♂, 10♀. In the population on Marysville Buttes, California, adult males are nearly one per cent longer than females in total length but 1.5 per cent shorter in length of tail. Examination of secondary sexual variation in total length, body length, and tail length in these and other populations indicates that males usually average from 1 to 3 per cent shorter than females. I am aware that measurements given by Dice, in numerous papers, of large series of caged *Peromyscus maniculatus* indicate that males and females are not significantly different in body length and tail length. Whether significant differences would have been revealed had he or I made finer segregations according to age, I cannot say.

The hind foot is longer in males than in females in 8 instances, the reverse in 3 instances, and equal in one. Adult females (age groups 4 and 5) average smaller than males by 0.9, 0.2, 0.8, and 2.1 per cent, respectively, in the four populations. Sumner and Dice found in *Peromyscus maniculatus* that the hind foot was likewise longer in males.

In measurements of the skull, there is in nearly every instance, an approximately equal number of age groups in which males are larger than females or females larger than males. For example, in 4 of the 12 instances, males have longer skulls (from 0.7 to 1.1 per cent), in 5 instances females have longer skulls (from 0.4 to 3.4 per cent), and in 3 instances, the length is equal. As regards breadth of braincase, in 4 instances, males are broader, in 5, females are broader, and in 3, both sexes average the same.

SUMMARY OF VARIATION IN A POPULATION

In *Peromyscus truei* from California, body, tail, hind foot, and ear attain nearly their maximum length sometime between the 75th and 125th day of age, the latter figure assumed to represent the age of "group 2" (or an average of 100 days of age). The body attains between 70 and 75 per cent of its average adult length during the first month, 85 per cent by the end of the second month, and 95 per cent by the age represented by group 2 (100 days). The tail lengthens allometrically during early postnatal development, lengthening more rapidly than does the body. After the completion of the juvenal-postjuvenal molt, at between 30 and 40 days of age, the tail and body lengthen isometrically. The hind foot and ear likewise lengthen rapidly early in life, each structure having attained between 85 and 90 per cent of its average adult length by the end of the first month. Mice continue to gain weight, on the average, throughout life, but the increase is slight after the age represented by group 3.

The skull has nearly completed its growth by 100 days or the age represented by group 2. Many measurable parts do not increase in size after about one month of age (age group 1). Such features which show no increase after the age of one month are interorbital constriction (width), length of maxillary toothrow, length of parietal, length of supraoccipital, and auditory bullae, at least as to inflation of this structure. Most of the elements housing the brain dorsally have attained full development by one month of age, although there is a lengthening of the floor of the braincase, as expressed by the increase in postpalatal length, after this age. The greatest increase, at any period of postnatal development of the skull, occurs in the preorbital region. There is no actual decrease in size with increasing age in any feature of the skull measured. The increase is so small in all parts of the skull measured, except for greatest length and basilar length, that those specimens which have M^3 worn (those of age group 2 or older) could be combined into one group. This increases greatly the number of specimens, beyond the number of "adults" (age groups 4 and 5), which can be grouped together to study a particular feature.

The mesoloph in M^{1-2}, characteristic not only of *P. truei* but of the subgenus *Peromyscus,* was found to be absent in M^1 of one specimen and M^2 of another specimen, but it was never found to be absent in both M^{1-2} of the same specimen. More frequently the mesoloph was only slightly developed. Mesolophids and ectolophids in M_{1-2}, structures usually considered characteristic of the subgenus *Megadontomys,* were noted in at least six specimens.

External measurements are more variable than those of the skull and external measurements of younger mice, age groups 2 and 3, are more variable than those of adults (groups 4 and 5). Such cranial elements as parietal, interparietal, and supraoccipital are most variable; greatest length of skull and greatest breadth of braincase are least variable. Perhaps all structures show slight sexual dimorphism in *Peromyscus truei*, but in populations from California the differences are slight, and with the small number of specimens available, it is difficult to be certain what the differences are. The body and the tail usually average from 1 to 3 per cent shorter but the hind foot about 1 per cent longer in adult males. Measurements of the skull of the mice at hand show no significant secondary sexual differences.

II. The Peromyscus truei Species Group

Morphologically *Peromyscus truei* closely resembles the species *nasutus, bullatus,* and *difficilis,* and these four species can be considered as representing a natural aggregation, referred to as the "*truei* group." These species were so grouped together by Osgood (1909:30), who included in this *truei* group another species, *P. polius.* Recently the species *P. comanche* Blair (1943:7) has been referred to the *truei* group. *P. polius* is here regarded as belonging to another species group and *P. comanche* is regarded as a subspecies of a member of the *truei* group.

The *truei* group is one of eight such groups established by Osgood to emphasize morphological similarities of the various species within the subgenus *Peromyscus.* Through cross breeding in the laboratory, it has been shown (Dice, 1933) that a species of one group will not cross with a species of another group, although occasionally there are specific crosses within a species group. Not all species, and not even some species groups, have been tested in the laboratory, however.

Peromyscus truei group

Characterization: Medium-sized (length of body from 90 to 120 mm.); tail about equal to length of body; ears relatively very large (length of dry ear when measured from notch, 75 per cent or more of length of hind foot); tail well furred (showing no prominent annulations) and bicolor; auditory bullae large and inflated; skull of medium size (about 27 to 31 mm.), broader interorbitally than in some groups but without supraorbital ridges; maxillary toothrow 4.2 to 5.1 mm. in length.

Species: P. truei, P. nasutus, P. bullatus, P. difficilis.

Remarks: The *truei* group more closely resembles the *melanophrys* group and the *boylii* group than any others, but in the latter two the length of the dry ear is usually less than 75 per cent of the length of the hind foot, the auditory bullae are relatively smaller, the tail is less well furred and the annulations pronounced, and a supraorbital ridge is usually present (in *melanophrys*). The species *Peromyscus polius* has a relatively shorter ear (70.2 per cent of hind foot length) and relatively smaller bullae than any other member of the *truei* group. Perhaps *polius* should be in the *boylii* or *melanophrys* groups, and I would tentatively include it in the *boylii* group; it is not included here in the *truei* group.

The species *Peromyscus truei*

Characterization: Size medium (total length about 200 mm.); tail equal to or slightly longer than the body except shorter than body in the Great Basin and Colorado-New Mexico plateaus; ears large and about equal to length of hind foot (in most parts of the range, longer than hind foot), or measured in the dry skin, ear usually not more than 10 per cent shorter than hind foot; fur long and silky (see Plate I); tail closely haired and bicolored; skull medium (greatest length in adults 27-30 mm.); toothrow usually 4.2-4.5 mm.; auditory bullae large and well-inflated external to the occipital; braincase vaulted (not flattened); zygomata slightly converging anteriorly.

Comparisons: P. truei differs from *P. nasutus,* where the two occur together, usually in the following features: length of head and body greater, rather than equal to or less, than the length of tail; ear measured from the notch, dry, usually more than 22 mm. rather than less than 21 mm., or if measured from the notch in fresh specimens, longer than hind foot instead of equal to or shorter than hind foot; auditory bullae larger and more inflated (a comparative character not readily measurable).

P. truei differs from *P. difficilis,* where the two occur together, usually in the following features: size smaller, total length 210 mm. or less rather than more; body lighter, less than 27.0 grams rather than more in adult and subadult males; skull smaller, as illustrated by length of diastema being less rather than more than 7.3 mm. and maxillary toothrow less rather than more than 4.6 mm.; tail slightly more heavily haired dorsally.

P. truei from Mexico differs from *P. bullatus,* as known to me, in the following features: ear smaller, being less rather than 24 mm. or more measured in the flesh; hind foot shorter, being 24 mm. or less; auditory bullae smaller and less inflated by about 20 per cent.

Remarks: For accounts of subspecies, see page 30.

The species *Peromyscus nasutus*

Characterization: Size medium; tail usually equal to or longer than body (in a region where in *P. truei,* the tail is shorter than the body; see Plates II and III); ear 18-21 mm. in length in dry condition, or, in flesh, equal to or shorter than hind foot; auditory bullae relatively uninflated (a comparative character not readily measurable).

Comparison: For a comparison with *P. truei,* see account above.

Remarks: Subspecies include *P. n. nasutus* (Allen), *P. n. griseus* Benson, and *P. n. comanche* Blair. The range of the species is shown in Figure 10.

Blair (1943) has regarded the form *Peromyscus comanche* as a distinct species, pointing out "biological" and morphological features for

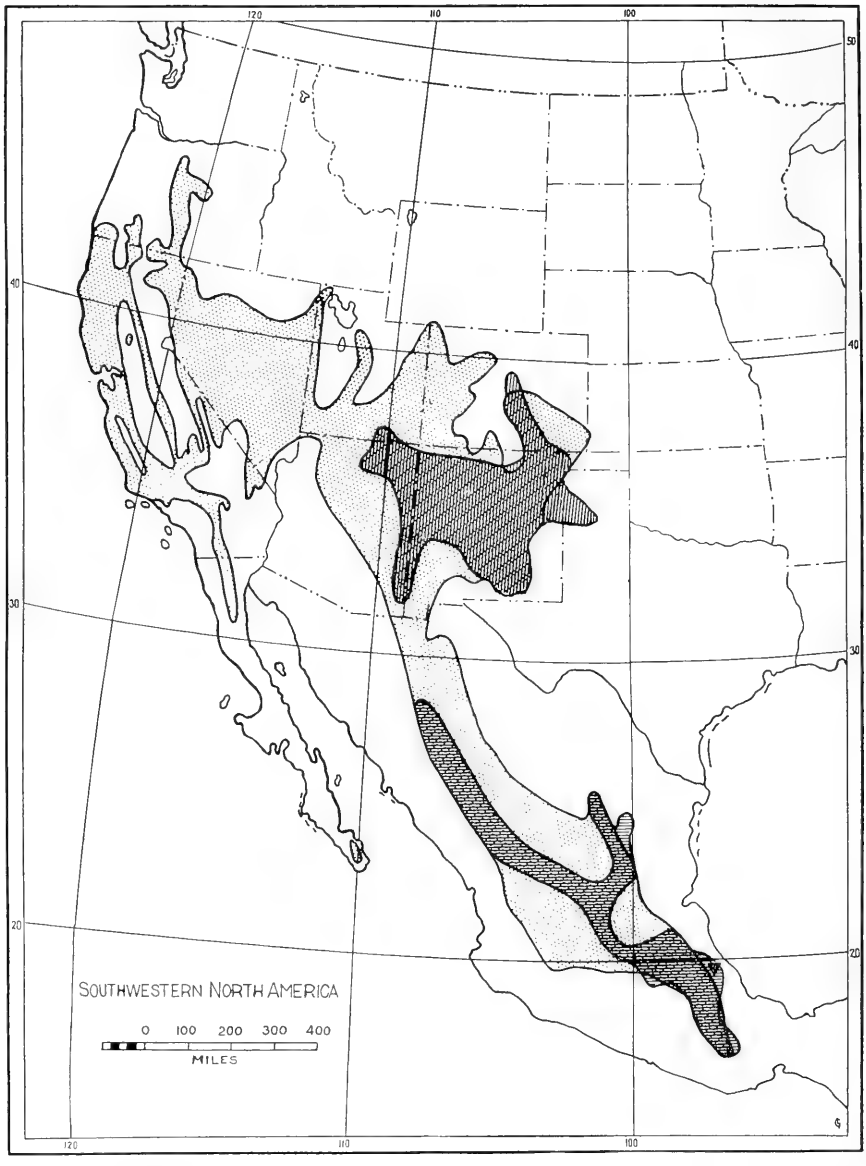

FIG. 10. Geographic ranges of the four species in the *Peromyscus truei*-species group. *Peromyscus truei* is indicated by dots, *Peromyscus nasutus* by vertical lines (in U.S.), *Peromyscus difficilis* by horizontal lines (in Mexico), and *Peromyscus bullatus* by a triangle.

this conclusion. The "biological" data are based on fertility relations between this and other members of the *truei* group. To me, the evidence he presents on this is inconclusive and offers no basis for specific distinction. In the absence of sufficient evidence of a physiological nature, consideration of morphological evidence is necessary. Morphologically, the population of *comanche* differs in several ways from populations of *P. n. nasutus.* However, the degree of morphological difference between *comanche* and some *P. n. nasutus* is not as great as between *P. truei* and *P. nasutus,* or *truei* and *difficilis,* and is more nearly of the magnitude of differences between subspecies of *P. truei.* Some differences mentioned by Blair are those found within populations of one subspecies. Such is the case for the shape of the interparietal. On the basis of more reddish coloration and slightly larger auditory bullae, *comanche* is regarded as a distinct subspecies, *Peromyscus nasutus comanche.*

The species *Peromyscus bullatus*

Characterization: Size medium (total length about 205 mm.); tail slightly longer than body; ear very large, especially in relation to medium body size, and usually measuring 25 mm. or more in the flesh and more than 22 mm. dry; hind foot large, measuring 24 mm. or more; auditory bullae greatly enlarged, and nearly 20 per cent larger than in *P. truei.*

Comparison: For a comparison with *P. truei,* see account above.

Remarks: Only one form, *P. bullatus,* is known (see Fig. 10).

Only one specimen, the type, of this species had been known until recently when the University of Kansas obtained 6 from 2 and 3 kilometers west of Limón, Veracruz. These have kindly been made available to me for study. These specimens, together with the type, give us a better understanding of the species, and indicate that it does not differ as widely from *P. truei* as Osgood (1909) originally indicated.

The type specimen of *P. bullatus* consists of what appears to be a subadult skin, with some postjuvenal pelage, and an adult skull, judging from wear on the teeth. It might be well to check the series from Limón with the type to see if the skin and skull of the latter belong to the same animal.

The species *Peromyscus difficilis*

Characterization: Size large (total length more than 220 mm. and hind foot, 24-28 mm.); ears large, but relative to size, smaller than in other members of the *truei* group; skull large (usually more than 30 mm. in length) with long maxillary toothrow (4.75 mm. or more); auditory bullae large but not greatly inflated.

Comparison: For a comparison with *P. truei,* see that account.

Remarks: Subspecies include *P. d. difficilis* (Allen), *P. d. amplus*

Osgood, and *P. d. felipensis* Merriam. The range of the species is shown in Figure 10.

DISCUSSION

The range of each species in the *truei* group overlaps at least one other species of the group (see Fig. 10). One inference that might be drawn from this distributional pattern is that these various species have become separated as discrete units from a single, and perhaps more widespread and interbreeding, population. Three of the species are near the periphery of the more widespread fourth species. One species, *Peromyscus nasutus,* differs physiologically as well as morphologically from the species *P. truei,* for Dice and Liebe (1937) have shown when *P. nasutus* and *P. truei* are crossed, the offspring are incompletely fertile. The study of subspeciation in the species *P. truei* indicates that one of the most important modes by which species may arise or develop may be through the occurrence of mutations adapting some of the populations, almost completely isolated geographically from the other populations, to slightly different ecological niches. The *P. truei gilberti* unit and the *P. truei truei* unit (for a discussion of this, see section V, page 91) differ one from the other morphologically and ecologically, and may indicate "incipient speciation." The species in the *truei* group differ one from the other morphologically and ecologically (and perhaps physiologically) in about the same manner but to greater degree than do the two units. The peripheral nature of three of the four species in the *truei* group strongly indicates that they may have arisen much as indicated for the *gilberti* and *truei* units, that originally their ranges were geographically complementary, and later their ranges have overlapped with morphological and ecological distinctness and only partial fertility between any two species.

III. Geographic Variation

SUBSPECIES OF PEROMYSCUS TRUEI

Methods

The coloration of the upper parts given in each diagnosis is in general terms of the mass color effect. In the section on Color, the color name, given as a capitalized term, has been determined by direct comparison of Ridgway's (1912) color plates and (1) the subterminal band of the overhairs of the upper parts and (2) the general color of all the hairs (and all bands) in their normal position in the middorsal region. If the color of the dorsal tail stripe is the same as the general color of the upper parts, no mention is made of the color of the stripe. In all specimens of *P. truei* examined, the underparts, including body and tail, are white or whitish. If a pectoral spot is present, the color of the spot is mentioned.

Measurements of total length, tail vertebrae, and hind foot are those taken in the flesh, as recorded, in millimeters, by the collector. Body length (or head and body length) has been calculated. The ear measurement has been taken from the dry study skin by the author, measuring with calipers from the notch to the tip of the unfolded ear.

Cranial measurements employed are essentially those used by Osgood (1909:22), with certain modifications. Two measurements employed by Osgood (*loc. cit.*), namely, greatest length and width of the interparietal, are not used because in the particular group of mice here studied, I could not find variations of systemic worth. Telescoping with adjoining bones sometimes prevents locating the edges of the interparietal, and it is subject to much individual variation otherwise. Methods of measuring are shown in Figure 11. It was found advisable to take all the smaller measurements under magnification. Cranial breadth is employed rather than zygomatic breadth.

Reference is also made, in the text, to certain other measurements or characters of the skull. Maxillary breadth is the greatest external breadth measured across the maxillary processes of the zygomatic arches. Length of rostrum is measured from the posterior side of the maxillary process of the zygomatic arch to the anterior median tip of the nasals. An orbicular bulla is one that has the part outside the brain case considerably

inflated although it is not necessarily long or broad. A compressed bulla is not greatly inflated outside the brain case. In the account of age variation in the skull, certain other measurements are used. The length of the parietals, length of the frontals, and anteroposterior length of the interparietal are taken along the middorsal line. These measurements are subject to the inaccuracies mentioned in determining the limits of the interparietal. The measurement of the supraoccipital is the distance be-

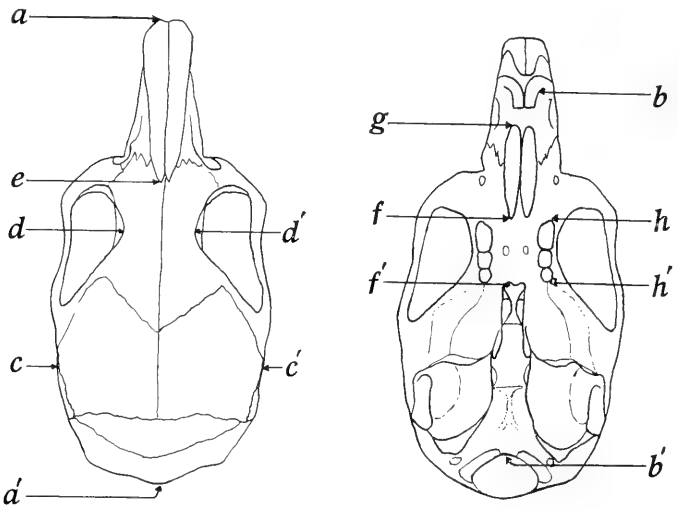

FIG. 11. Dorsal and ventral views of skull of *Peromyscus truei nevadensis,* no. 68476, topotype, showing points between which cranial measurements were taken. x2.

Greatest length	a-a′	Length of nasals (= longest nasal)	a-e
Basilar length (from posterior edge of alveolus of incisor)	b-b′	Shelf of bony palate	f-f′
		Length of palatine slit	f-g
Greatest breadth of braincase	c-c′	Diastema (from alveolus of incisor to alveolus of M^1)	b-h
Interorbital constriction (least)	d-d′	Postpalatal length	f′-b′
		Maxillary toothrow (alevolar length)	h-h′

tween the superior lip of the foramen magnum and the median posterior border of the interparietal. The measurement of the basioccipital is the distance from the suture between it and the basisphenoid to the inferior lip of the foramen magnum. Rostral breadth is the greatest distance between the premaxillo-maxillary sutures on the sides of the rostrum.

Specimens designated as adults in the subspecies accounts are those in which the major cusps are worn completely smooth, at least on the buccal side. Accordingly, age groups previously designated 4 and 5 are adults. Young specimens are those in which little or no wear shows on

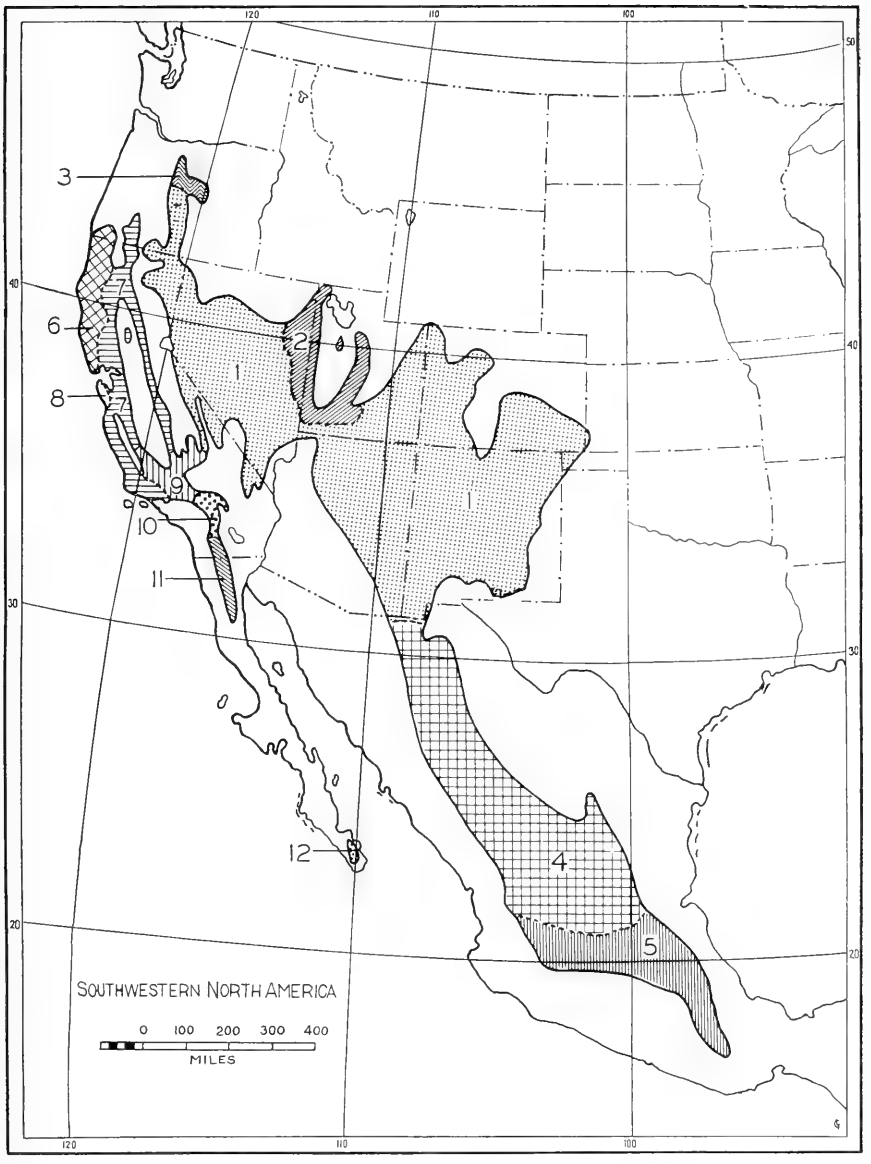

FIG. 12. Geographic range of the twelve subspecies of *Peromyscus truei:*

1. *truei*
2. *nevadensis*
3. *preblei*
4. *gentilis*
5. *gratus*
6. *sequoiensis*
7. *gilberti*
8. *dyselius*
9. *montipinoris*
10. *chlorus*
11. *martirensis*
12. *lagunae*

the cusps, particularly on M^3. Subadults are specimens comprising the intermediate stages.

Localities from which specimens have been examined in each state are listed by counties from north to south and in similar order within a county. An exception to this arrangement of counties is made under the race *gilberti*.

Under "Additional records," localities are listed from which specimens of *Peromyscus truei* have been recorded in published accounts or manuscripts which extend the range as shown by the list of specimens examined. These specimens have not been examined personally and the subspecific identification in these instances is made on the basis of geographic boundaries established by other specimens identified by me.

The synonymy consists of the first usage of the trivial name and the first use of different published combinations involving the trivial name, including the presently accepted combination if it differs from the first usage.

Accounts of Subspecies

(For a description of the species *Peromyscus truei*, see page 23.)

Peromyscus truei truei (Shufeldt)

Hesperomys truei Shufeldt (1885 *b*:407), orig. descr.
Cricetus truei, Thomas (1888:133, footnote).
V[esperimus]. truei, Allen (1891:300).
Sitomys truei, Bryant (1892:212).
P[eromyscus]. Truei, Thomas (1894:364).
Hesperomys megalotis Merriam (1890:64). Type from Black Tank, Little Colorado Desert, Coconino County, Arizona.
Peromyscus lasius Elliot (1904:265). Type from Hannopee [=Hanaupah] Canyon, ["7500 feet," near lower edge of piñons, at uppermost water where sheep come down to drink,] Panamint Mountains, Inyo County, California (see Grinnell, 1933:177).

Type. — Male, adult, skin with skull (and skeleton); no. 14954/35108, U.S. Nat. Mus. Coll.; Fort Wingate, McKinley County, New Mexico; collected alive March 16, 1885, prepared March 18, 1885, by R. W. Shufeldt. (Examined.) See under *Remarks*.

Range.—From California, east to the crest of the Sierra Nevada-Cascade Chain and the Mohave Desert, across western and southern Nevada, southern and eastern Utah, northern, central, and southeastern Arizona, to southwestern Wyoming and western and southeastern Colorado, extreme northwestern Oklahoma, and to New Mexico, except the eastern parts. Known altitudinal range from 3,150 feet as at Camp Verde, Arizona, to 11,000 feet, as in the Charleston Mountains, Nevada. Zonal range, Upper Sonoran; rarely entering the Lower Sonoran or Transition life-zones.

Diagnosis.—Size: small (see measurements); tail shorter than head and body (and less than 100 mm.); ear large (longer than hind foot and when measured from notch, in the dry skin, averaging about 103 per cent of length of hind foot). Color: light, as a result of a reduction of red and black pigment. Skull: medium-sized; rostrum relatively long; bullae inflated; maxillary breadth relatively great.

Color.—Upper parts (June 9) with subterminal band near (*c*) Ochraceous-Buff. General effect Tawny-Olive to Saccardo's Umber.

Skull.—In addition to the above-mentioned skull characters, basilar length relatively great; nasals anteriorly relatively narrow; external auditory meatus large.

Comparisons.—Compared with specimens of *P. t. gilberti* from northern California, specimens of *truei* differ in the following chararters: Size: body and tail shorter; tail averages 88 as opposed to 97 per cent of length of head and body (as in topotypes of both races); ear longer. Color: upper parts lighter, as a result of a reduction in reddish tone. Skull: similar in size, although nasals average longer, basilar length averages greater, and palatine slits average both actually and relatively shorter; external auditory meatus larger.

For comparison with *nevadensis, preblei, montipinoris, chlorus, martirensis,* and *gentilis,* see accounts of those races.

Remarks.—P. t. truei is a short-tailed, large-eared race of piñon mouse occurring in the piñon-juniper belt of much of the southwestern United States. The subspecies is absent from the area around Pleistocene Lake Bonneville where it is replaced by the race *nevadensis.* The race *truei* extends beyond the limits of the Great Basin to the eastern side of the Rocky Mountains, as in southeastern Colorado, eastern New Mexico, and western Oklahoma. The range, as here defined for the race, is the largest of any of the subspecies. This race intergrades with *nevadensis, gentilis, gilberti,* and *montipinoris* (for details concerning this intergradation, see the respective accounts), but probably does not intergrade with *preblei, chlorus,* and *martirensis* because of physical barriers. Within the range here ascribed to *P. t. truei,* some variation is shown. However, in each population the individual variation seems to be nearly as great as any geographic variation between populations. For example, from a sample of over 60 localities from which adult specimens of *truei* were measured, the average for the length of tail at each locality is 100 mm. or less, except for three in which the tail averages 101, 102, and 108 mm. in length. A short tail, of 100 mm. or less in length and 90 to 100 per cent of the body length, is characteristic of the races *truei* and *preblei.* Of 46 localities (or groups of localities, where two or more occur so closely together as to be considered one), the percentage of the average length of tail (to average head and body length) for 42

localities falls between 88 and 104 per cent. Thirty-two (70 per cent) of these localities average between 90 and 99 per cent. It may be noted that the averages for the specimens from near the type locality given in Table 6 are relatively shorter for length of tail than in most other populations of the subspecies. For 35 localities, or groups of localities, where the average of greatest length of the skull is available, 32 (91 per cent) average between 27.8 mm. and 28.8 mm. These figures show in a rough way that the amount of variation throughout the range here assigned to *truei* is small. Within the subspecies *truei,* there is no consistent clinal change in any morphological character, either in a north to south or east to west fashion (see Figs. 22-23).

Specimens from north and west of the Colorado River in California, Nevada, and Arizona, do not differ significantly from those to the south and east in Arizona, although no adult specimens are available from close along the southern side of the Colorado River in Arizona. Similarly, specimens from the eastern side of the Rocky Mountains do not differ appreciably in any measurement, proportion, color, or character, or combination of these, from specimens to the west. Apparently these mice "cross" the Rocky Mountains in the less elevated parts of central New Mexico.

I agree with Osgood (1909) in assigning the names *megalotis* and *lasius* to the synonymy of *truei.* The specimens from Wupatki National Monument, Coconino County, Arizona, are virtual topotypes of *megalotis,* for they are all from within less than 5 miles of Black Tank. These do not differ significantly in any character or group of characters from other specimens of *truei.* The "average color" of the upper parts may be slightly darker than the average for other *truei,* but the difference certainly is not significant of subspecific designation. Measurements of 22 adults from Wupatki National Monument yield the following average and extreme external measurements in millimeters: 188 (175-204); 92 (83-102); body, 96; 23.2 (21-25). Selected cranial measurements for 14 adults are: greatest length, 28.6 (28.0-29.4); basilar length, 21.1 (20.7-21.6); greatest breadth of braincase, 13.5 (13.1-13.9); length of nasals, 10.9 (10.6-11.4). These measurements should be compared with those of *truei* given in the table of measurements.

Specimens from Hanaupah Canyon, in the Panamint Mountains, Inyo County, California, the locality from which Elliot referred specimens to the race *lasius,* differ little from topotypes of *truei,* and are similar to all the specimens of *truei* occurring east of the crest of the Sierra Nevada. In coloration of the upper parts they appear slightly more reddish than topotypes of *truei.* This results from an increase in reddish tone, and is true of all the specimens as one goes from east to west across southern Nevada into eastern California. Thus, specimens from the Panamint,

Inyo, and White mountains and from the eastern edge of the Mohave Desert have the maxima of reddish coloration; those from Potosi Mountain, Clark County, Nevada, are almost as reddish (one individual is more so). Measurements of 14 adult topotypes of *"lasius"* give the following external measurements: 194 (180-205); 94 (85-97); body, 100; 23.1 (22-24). Selected cranial measurements are: greatest length, 28.3 (27.5-28.7); basilar length, 21.1 (20.6-21.4); greatest breadth of braincase, 13.2 (13.1-13.6); length of nasals, 10.5 (10.1-11.0). These measurements do not differ significantly from those of topotypes of *truei*, and no other diagnostic character has been found for distinguishing these animals.

The nine specimens examined from near Old Fort Crook, California, here are referred to the race *truei*. Osgood (1909:171) had 3 specimens, not examined by me, from near this locality (from Fall River Valley), but he referred them to *gilberti*, commenting that they were "approaching *truei*." Both localities are on the east side of the crest of the Sierra Nevada-Cascade Chain and slightly north of the Pit River, which river drains from the Great Basin, through the southern Cascades, into the Sacramento River. The four fully adult mice from near Old Fort Crook agree with specimens of *P. t. truei* in having a short tail, which averages only 88 per cent of the length of head and body. In specimens of *P. t. gilberti* just to the southeast of Old Fort Crook (but on the opposite side of the Sierras at 4 mi. NW Lyonsville), the tail averages 96 per cent of the head-body length and in topotypes of *gilberti*, 100 per cent. In most cranial characters, the Old Fort Crook specimens are closer to *Peromyscus t. truei* than to *P. t. gilberti*. However, the specimens from Fort Crook resemble *gilberti* in being short-eared; the length of ear in each of the dry skins is less, rather than more, than the length of the hind foot. I think that relative length of tail and length of ear are of prime importance in distinguishing these intermediate populations, and on this basis the Fort Crook specimens might well be referred to one or the other race. I doubt whether the mice, at the present time, are continuously distributed, and thus intergrade, along the Pit River between the Valley of California and the Great Basin (for further comments, see the account of *gilberti*).

The specimen, upon which the original description was based, is listed by Shufeldt in two tables (1885 *b*:405 and 406) as number 14904. Since this number actually refers in the United States National Museum catalogue, according to Lyon and Osgood (1909:140), to a *Neotoma*, also collected by Shufeldt at Fort Wingate, they consider this to be "evidently a mistake for 14954." I can add nothing to this information and follow their designation. The label on the type gives the date of collection as March 14, 1885. Shufeldt records (1885 *b*:403, 404, and plate

21) the date of capture as March 16 and states (*op. cit.*, 404) that "for two days I [Shufeldt] kept this engaging little creature alive in my study for the purpose of making a drawing of its head [see Shufeldt, *op. cit.*, pl. 21] and studies of its behavior and attitudes [see Shufeldt, 1885 *a*:286]. It was then killed, carefully measured, skinned, and skeletonized." This would make the actual date of preparation on March 18, 1885.

The type locality, Fort Wingate, has been recorded both as in McKinley County and Valencia County, New Mexico. According to United States topographic maps, survey of 1882-1883, Fort Wingate is located 3¼ miles south of Wingate, McKinley County; Old Fort Wingate is located ½ mile south of San Rafael or 4 miles south and 1 mile west of Grant, Valencia County. I cannot definitely say at which locality the type specimen was collected, but for reasons given below suppose it was at Fort Wingate, McKinley County. In 1885 the United States army was stationed at the Fort Wingate in McKinley County, for, according to Dutton (1885:129), it was "one of the largest and most important military stations in the Indian country, where troops were stationed. . . ." It seems unlikely that there would be another military station only 46 miles away at Old Fort Wingate, *Valencia County,* at the same time, large enough to have the services of an army surgeon, such as Shufeldt was.

Habitat notes.—This race lives in the piñon belt in close association with piñons or junipers, particularly where these trees grow among rocks or on rocky slopes. Piñons are usually found closely associated with rocks, or rocky terrain, and it follows that *P. t. truei* is found with both almost invariably. Whether the piñons (or junipers) or rocks, or both, or neither, are the limiting factor in the distribution of the mice is difficult to say. No other species of *Peromyscus,* or any other small rodent, is as exclusively confined to the piñon-juniper belt, or occurs as abundantly in it as does *P. t. truei.* An exception may be the species *Peromyscus nasutus,* where its range partly coincides with that of *P. truei.* I suspect that the rocks, and the piñons or junipers, afford suitable refuge for these mice and that the two kinds of trees, in part at least, provide food. The large pinnae of the ears, and large auditory bullae, may increase the sensitivities of these mice, and thus better adapt the mice to live in a belt in which there is otherwise little protective cover from natural enemies.

The type specimen of *P. t. truei* was taken from a "nest protruding from an opening in the dead and hollow trunk of a small piñon, at least 2 feet above the ground. . . . The nest, composed of the fine fibers of the inner bark of the piñon, was soon pulled out, and its owner dislodged. . . ." (Shufeldt, 1885*b*:403). The specimens examined from Va-

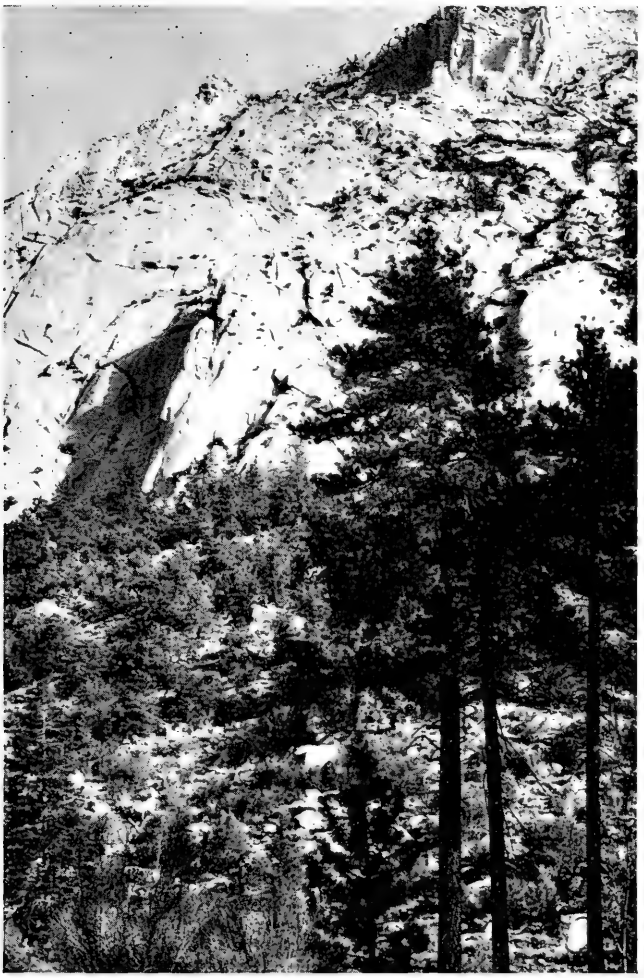

FIG. 13. Habitat of *Peromyscus truei truei* along the eastern slopes of the Sierra Nevada, California. The piñon mice are common among the rocks and piñons shown in the left foreground of this view of the north face of Lone Pine Creek Canyon, 9½ miles west and 1¼ miles south of Lone Pine, 8,200 feet, Inyo County, California. (Photograph by Frank A. Pitelka.)

FIG. 14. Habitat of *Peromyscus truei truei* and three other species of *Peromyscus* along the eastern slopes of the Sierra Nevada, California. In a trap line about 350 feet long, and in a vertical rise of about 150 feet in the area shown, the four species were caught as follows: *Peromyscus truei* beneath the piñons, *Peromyscus crinitus* among the rocks, *Peromyscus boylii* and *Peromyscus maniculatus* among the rocks where there was considerable *Artemisia*. Photograph of north facing slope above Tuttle Creek, 6 miles west and 3¼ miles south of Lone Pine, 6,300 feet, Inyo County, California. (Photograph by Frank A. Pitelka.)

lencia County, New Mexico, were taken in "rocky situations among juniper and pinyon" (Hooper, 1941:30). Bailey (1931:152-53) records similar ecological relationships for *truei* over much of New Mexico and indicates that piñon nuts and juniper seeds or fruits form an important item in the diet of these mice.

Most of the specimens in the Museum of Vertebrate Zoology from eastern California, Nevada, and Arizona, were taken in the piñon-juniper belt and usually among or near these trees and among rocks. There are numerous exceptions. For example, one young *P. t. truei*, from the slopes of Glass Mountain (=5 mi. E and 1 mi. S Mono Mills), California, was taken in a "pure stand" of yellow pines with *Artemisia* predominating as an understory cover. On Charleston Peak, Nevada, the species was taken as high as the bristle-cone pine belt (Burt, 1934:417). Some of the specimens from eastern San Bernardino County, California, were taken in the Joshua tree-juniper belt, where there were few or no piñons.

Specimens examined.—Total number, 920, from the following localities: California: *Siskiyou County:* Crescent Butte, Lava Beds Nat. Mon., 2. *Shasta County:* 3 mi. N Old Fort Crook, 3,600 ft., 1; 1 mi. NNW Old Fort Crook, 3,400 ft., 8. *Modoc County:* 4 mi. E Likely, 3 (Los Angeles Mus.). *Lassen County:* 5 mi. N Fredonyer Peak, 5,700 ft., 2. *Alpine County:* 2 mi. NE Woodfords, 5,600 ft., 1; ¼ mi. W Woodfords, 5,700 ft., 1. *Mono County:* Coleville, 6 (Calif. Acad. Sci.); Leavitt's Meadow, 2 (Calif. Acad. Sci.); Williams Butte, 7,000 ft., 4; 5 mi. E, 1 mi. S Mono Mills, 8,300 ft., 1; 5 mi. W, 4 mi. N Benton, 6,800 ft., 2; 1¼ mi. N, 2½ mi. E Benton Station, 6,900 ft., 8; Benton, 5,639 ft., 1. *Inyo County:* 2½ mi. SE head of Black Canyon, White Mts., 8,000 ft., 2; Mazourka Canyon, Inyo Mts., 7,900 ft., 4; E base Waucoba Mtn., 7,300 ft., 6; Fall Canyon, Grapevine Mts., 5,600 ft., 1; Onion Valley, Sierra Nevada, 8,500 ft., 1; Grays Meadow, Kearsarge Pass, Sierra Nevada, 6,000 ft., 1; Lone Pine Creek, 6,600 ft., 2; Lone Pine Creek, 9,000 ft., 9½ mi. W, 1¼ mi. S Lone Pine, 14; 6 mi. W, 3¼ mi. S Lone Pine, 6,300 ft., 1; Carroll Creek, E base Sierra Nevada, 5,500 ft., 3; 3 mi. NE (1), 3 mi. E (11), and 2½ mi. SW (1, in Los Angeles Mus.), Jackass Spring, Panamint Mts., 6,200 to 7,200 ft., 13; Hanaupah Canyon, Panamint Mts., 7,500 ft., 15; Coso, 1 (U.S.B.S.); Little Lake, 3,100 ft., 1. *San Bernardino County:* N side (12) and SE side (16) Clark Mountain, 5,000 to 7,400 ft., 28; Mescal Spring, 8½ mi. E Valley Wells, 2; Purdy, 6 mi. SE New York Mts., 4,500 ft., 1; 2 mi. NNE Cima, 4,100 ft., 2; 5 mi. NE Granite Well, Providence Mts., 5,400 ft., 33; Cedar Canyon, Providence Mts., 5,000 to 5,300 ft., 14; pass between Granite and Providence Mts., 4,100 ft., 1. Nevada: *Washoe County:* 17 mi. W Deephole, 4,800 ft., 1; Sutcliffe, 5,000-6,500 ft., 9 (Coll. D. G. Nichols, in Amer. Mus.); 3 mi. E Reno, 1; 3 mi. SE Incline, 6,250 ft., 1. *Douglas County:* Gardnerville, 1 (Calif. Acad. Sci.); Andersons Ranch, 3 (Amer. Mus.); Holbrook, 1 (Calif. Acad. Sci.); Desert Creek, 6,250 ft., Sweetwater Range, 2. *Storey County:* 6 mi. NE Virginia City, 6,000 ft., 2. *Lyon County:* West Walker River, 12 mi. S Yerington, 4,600 ft., 4. *Pershing County:* El Dorado Canyon, 6,000 ft., Humboldt Range, 1; S slope Granite Peak, East Range, 2. *Churchill County:* 3 mi. SW Lahontan Dam, 4,100 ft., 1; Cherry Creek (Spring), 5,000 ft., 3. *Mineral County:* 2 to 3½ mi. SW Pine Grove, 7,250 to 7,800 ft., 20; Cottonwood Creek, Mount Grant, 7,400 to 7,900 ft., 4; Endowment Mine, Excelsior Mts., 6,500 ft., 2. *Esmeralda County:* Middle Creek, 8,000 ft., 1; 2 mi. S Piper Peak, Silver Peak Range, 7,600 ft., 1. *Nye County:* Greenmonster Canyon, Monitor Range, 7,500 ft., 1; 8 mi. W Tybo, Hot Creek Range, 6,700 ft., 2; Burned Corral Canyon, Quinn Canyon Mts., 6,700 ft., 7; White River Valley, 14 to 15 mi. SW Sunnyside, 5,500 ft., 2; Garden Valley, 8½ mi. NE Sharp, 8; 1 mi. SW Cactus Spring, Cactus Range, 1; 3 mi. N Indian Spring, Belted Range, 6,700 ft., 1; Indian Spring, Belted Range, 7,100 ft., 2; ½ mi. NE Oak Spring, 6,600 ft., 3; 5 mi. W White Rock Spring, Belted Range, 7,300 ft., 6; 5 mi. E, 1 mi. N Grapevine Peak, 5,500 ft., 6; 8 mi. E Grapevine Peak, 5,000 ft., 1; 2½ mi. E, 1 mi. S Grapevine Peak, 6,700 to 7,000 ft., 30. *White Pine County:* Water Canyon, 8 mi. N Lund, 11. *Lincoln County:* E slope Irish Mtn., 6,900 ft., 12 (1 in Calif. Acad. Sci.); SW base Groom Baldy, 7,200 ft., 2; Meadow Valley Wash, 4,000 ft., 5½ mi. N Elgin, 1. *Clark County* (specimens from Sheep and Charleston mountains in D. R. Dickey Coll.): Mormon Well, 6,500 ft., 6 and Hidden Forest, 8,500 ft., 6, in the Sheep Range; Willow Creek, 6,000 ft., 3, E. slope Charleston Peak, 11,000 ft., 1, Kyle Canyon, 6,500 ft., 2, all in the Charleston Mts.; N side Potosi Mtn., 5,800 to 7,000

ft., 15. Wyoming: *Sweetwater County:* Green River, 4 mi. NE Linwood [Utah], 5,800 ft., 4 (U.S.B.S.). Utah: *Washington County:* St. George, 1 (U.S.B.S.); 16 mi. NW St. George, 4,000 ft., 2 (U.S.B.S.). *Garfield County:* Mt. Ellen, Henry Mts., 1 (U.S.B.S.). *Kane County:* East rim Zion Ntl. Park, 6,500 ft., 2 (Mus. Zool., Univ. Utah); Kanab, 5,200 ft., 1. *Carbon County:* 13 mi. SE Price, 4 (Carnegie Mus.). *Emery County:* 14 mi. N Greenriver, 2 (Mus. Zool., Univ. Utah); 7 mi. N Greenriver, 4,100 ft., 6 (Mus. Zool., Univ. Utah); 4 mi. N Greenriver, 4,100 ft., 1 (Mus. Zool., Univ. Utah); 21 mi. out of San Rafael, 1 (exact locality not known). *Daggett County:* Green's Lake, 40 mi. N Vernal, 1 (Carnegie Mus.). *Uinta County:* Vernal, 9 (Carnegie Mus.). *Grand County:* Mouth Florence Canyon, 4,306 ft., 35 mi. N Greenriver, 13 (Carnegie Mus.); 1 mi. E Hwy. 160, 6 mi. S Valley City, 2 (Mus. Zool., Univ. Utah); Castle Valley, 18 mi. NE Moab, 6,000 ft., 3 (Mus. Zool., Univ. Utah); 10 mi. N Moab, 3 (Carnegie Mus.); Colorado River above Moab, 1 (Mus. Zool., Univ. Utah); 15 mi. SE Moab, La Sal Mts., 6,000 ft., 4 (Mus. Zool., Univ. Utah). *San Juan County:* Blanding, 6,000 ft., 2; Edwin, Natural Bridge, 5,725 ft., 2; Hatch Trading Post, Montezuma Cr., 25 mi. SE Blanding, 4,500 ft., 3 (Mus. Zool., Univ. Utah); Aneth, 4,650 ft., 1; Navajo Mtn. Trading Post, 5 mi. SE Navajo Mtn., 1. Colorado: *Moffat County:* Escalante Hills, 20 mi. SE Ladore, 3 (U.S.B.S.); S bank Yampa River, 4 mi. NNW Cross Mt., 3 (Carnegie Mus.); Yampa River, 5 mi. NW Cross Mt., 3 (Carnegie Mus.); Elk Springs, [near] Lily, 2 (U.S.B.S.). *Routt County:* Douglas Spring, 6,700 ft. (not plotted, exact locality not known), 3 (Amer. Mus.). *Rio Blanco County:* 6 mi. NE Meeker, 4 (Carnegie Mus.); 5 mi. W Rangeley, 5,600 ft., 2 (U.S.B.S.); Dry Fork, 6,500 ft. (not plotted, exact locality not known), 10 (Amer. Mus.); Grand Hogback, 5 mi. S Meeker, 12 (Carnegie Mus.). *Garfield County:* 8 mi. W Rifle, 1 (U.S.B.S.); 20 mi. N Mack, 2 (Carnegie Mus.). *Eagle County:* McCoy, 1 (U.S.B.S.). *Mesa County:* DeBeque, 1 (U.S.B.S.); 5 mi. E Tunnel, Plateau Creek, 2 (U.S.B.S.); Uncompaghre Butte, 8,500 ft., Uncompaghre Plateau, 1 (U.S.B.S.). *Montrose County:* Paradox, 1 (D. R. Dickey Coll.); Bedrock, 5,150 ft., 4 (Amer. Mus.); Coventry, 6,800 ft., 1 (Amer. Mus.). *Montezuma County:* Ackmen, 4 (Chicago Nat. Hist. Mus.); Ashbaugh's Ranch, 5,350 ft., T36N, R18W [N.M.B.M.], 3 (Amer. Mus.); 5 mi. E Cortez, 3 (Carnegie Mus.); Far View House, Mesa Verde National Park, 7,700 ft., 1. *San Miguel County:* near Coventry, 6,800 ft., 2 (Amer. Mus.). *Costilla County:* Fort Garland, 1 (Mus. Zool., Univ. Mich.). *El Paso County:* 20 mi. S Colorado Springs, 2 (Carnegie Mus.). *Pueblo County:* Arkansas River, about 26 mi. below Canyon City, 2. *Otero County:* J. J. Ranch, 18 mi. S La Junta, near Higbee, 6 (U.S.B.S.). *Las Animas County:* 9 mi. W junction Purgatory R. and Chaquaqua Cr. [=Purgatoire R. and Chacauco Cr. or R. of some maps], 1; Mesa de Maya, 1 (Mus. Zool., Univ. Mich.). *Prowers County:* Rhinehart's Stage Station, 20 mi. S Lamar, 1 (U.S.B.S.). *Baca County:* Gaume's Ranch, 2 (1 in Amer. Mus.). Arizona: *Mohave County:* 6 mi. N Wolf Hole, 4,900 ft., 2; Wolf Hole, 5,400 ft., 2 (U.S.B.S.); 1 mi. W Diamond Butte, 5,000 ft., 1 (U.S.B.S.); Hurricane Ledge, 6 mi. N Mt. Trumbull, 6,000 ft., 1 (U.S.B.S.); W slope Limekiln Canyon, 4,500 and 6,000 ft., Virgin Mts. (not plotted, exact locality not known), 2 (U.S.B.S.); head Toroweap Valley, 6; lower end Toroweap Valley, 4,200 ft., 1; Peach Springs, 4,800 ft., 1 (U.S. B.S.). *Coconino County:* Navajo Mtn., 6,200 ft., 2 (U.S.B.S.); 5 mi. S summit Navajo Mtn., 1; North Canyon, House Rock Valley, 2 (U.S.B.S.); 10 mi. N Jacobs Lake, 1 (Coll. Univ. Arizona); Ryan, 6,000 ft., 6 (4 in U.S.B.S.); Slide

Reservoir, Kaibab Forest (exact locality not known), 1; Bass Camp, 25 mi. NW Grand Canyon P.O., 6,600 ft., 5 (U.S.B.S.); Cohinini Plateau, Grand Canyon (not plotted, exact locality not known), 1 (U.S.B.S.); Tuba City, Painted Desert, 4,500 ft., 1; Cataract Canyon, 12 mi. WSW Anita, 5,400 ft., 1 (U.S.B.S.); Tanner Tank, 1; Black Tank, 3 (2 in U.S.B.S.); 21 mi. NE Deadman Wash, 1 (Coll. Univ. Arizona); 3 mi. W (3 in Los Angeles Mus.), 2⅗ mi. W (20), and 2½ mi. W (5 in Los Angeles Mus.) Wupatki Ruins, Wupatki Nat. Mon., 28; Wupatki Ruins, Wupatki Nat. Mon., 3; Deadman Flat, 6,400 ft., NE San Francisco Mtn., 19 (8 in Calif. Acad. Sci.); 3 mi. NW Winona, 6,200 ft., 1 (U.S.B.S.); Winona, 6,400 ft., 3 (1 in Mus. Zool., Univ. Mich.); Canyon Padre, 4 (Mus. Zool., Univ. Mich.); Anderson Mesa, 6,500 ft., 30 mi. SE Flagstaff, 2 (U.S.B.S.). *Yavapai County:* 10 mi. SW Seligman, 2 (Calif. Acad. Sci.); 8 mi. S Seligman, 1 (U.S.B.S.); Pine Flat, Juniper Mts., 20 mi. NW Simmons, 3 (U.S.B.S.); Montezuma Well, 2 (U.S.B.S.); Camp Verde, 3,150 ft., 1. *Navajo County:* base Navajo Mtn., 6,000 ft. [recorded as in Navajo Co.], 2 (Amer. Mus.); 10 mi. E Rainbow Lodge, 6,200 ft., 1 (Coll. Univ. Arizona); Segi Canyon, 13 mi. WSW Kayenta, 6,500 ft., 4; Marsh Pass, 6,000 ft., 1 (Amer. Mus.); Keams Canyon, 6,200 ft., 3; Holbrook, 10 (9, U.S.B.S., 1, Amer. Mus.); 18 mi. W Snowflake, 2 (Coll. Univ. Arizona); Mesa Top, W Bubbling Spgs. Canyon, 7,200 ft. (not plotted, exact locality not known), 1 (Amer. Mus.); Mouth Long Canyon, 6,500 ft. (not plotted, exact locality not known), 1 (Amer. Mus.). *Apache County:* Eagle Crag, 23 mi. W Ganado, 1 (U.S.B.S.); Ganado, 6,500 ft., 2 (U.S.B.S.); St. Michaels, 7,000 ft., 1 (U.S.B.S.); 6 mi. S St. Johns, 5,800 ft., 1 (U.S.B.S.); 8 mi. S St. Johns, 5,800-6,000 ft., 3 (U.S.B.S.); Springerville, 10 (U.S.B.S.). *Greenlee County:* Casper Ranch, 5,100 ft., Blue River (not plotted), 1 (U.S.B.S.); Blue, 6,000 ft., 3. New Mexico: *San Juan County:* La Plata, 6,100 ft., 6 (Amer. Mus.); Aztec, 3 (2, U.S.B.S., 1, Amer. Mus.); Blanco, 3 (U.S.B.S.); Fruitland, 3 (U.S.B.S.); Chaco Canyon Nat. Mon., 2. *Sandoval County:* Jemez, 1 (U.S. B.S.). probably *Sandoval County:* Rio de los Frijoles, 1 (D. R. Dickey Coll.). *McKinley County:* Gallup, 4 (U.S.B.S.); Fort Wingate, 2 (U.S.B.S.); Thoreau, 1 (Amer. Mus.). *Valencia County:* 1½ mi. SW San Mateo, 2* (Mus. Zool., Univ. Mich.); Canyon Lobo Ranger Station, 5 (Mus. Zool., Univ. Mich.); 4 mi. WSW Cebolleta, 6* (Mus. Zool., Univ. Mich.); Grants, 2 (U.S.B.S.); 8 mi. SE Grants, 7* (Mus. Zool., Univ. Mich.); 4 mi. W McCartys, 5* (Mus. Zool., Univ. Mich.); Laguna, 2 (U.S.B.S.); Shuman's Ranch, T6N, R10W, Sec. 30, 5 (Mus. Zool., Univ. Mich.). *Catron County:* Datil Mts., 7 (U.S.B.S.); 9 mi. E State line, highway 70 [=1940 U.S. highway 60; also, 19 mi. S Salt Lake, New Mexico], 7,400 ft., 2; Luna, 7,000 ft., 1 (U.S.B.S.); 6 mi. SW Luna, 7,000 ft., 8 (U.S.B.S.); Alma, 1 (U.S.B.S.); San Francisco River (mouth of White Water), 5,000 ft., Glenwood, 1 (U.S.B.S.); W fork Gila River, Mogollon Mts., 2 (Chicago Nat. Hist. Mus.). *Socorro County:* head of Water Cañon, Magdalena Mts., 9,300 ft., 1; Water Cañon, 6,500 ft., Magdalena Mts., 1 (U.S.B.S.); 10 mi. NE Socorro, 2 (U.S.B.S.); Lava Mesa, S Clyde, 4,700 ft., 3; 10 mi. SE Clyde (lava beds), 4,800 ft., 1; north slope Salinas Peak, 6,000 ft., San Andreas Mts., 4 (U.S.B.S.). *Grant County:* Silver City, 4 (U.S. B.S.); Burro Mts., 2 (U.S.B.S.). *Sierra County:* Fairview, 6,500 ft., 1 (U.S. B.S.); 10 mi. W Chloride, 3 (U.S.B.S.); [about] 4 mi. W Kingston, 9,500 ft., 2 (U.S.B.S.). *Rio Arriba County:* Rinconada, 5,600 ft., 8 (U.S.B.S.); 5 mi. E Abiquiu, 1 (U.S.B.S.); Espanola, 6,500 ft., 1 (U.S.B.S.). *Santa Fe County:* Santa Fe, 4 (U.S.B.S.). *San Miguel County:* Pecos, 2 (U.S.B.S.); 3 mi. S

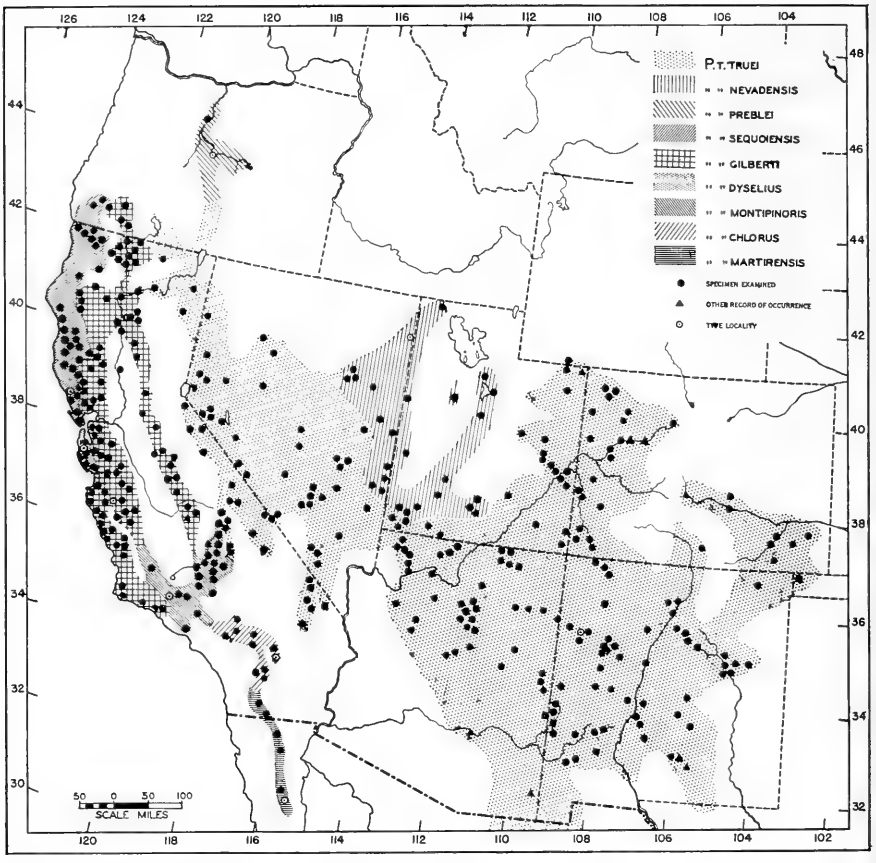

FIG. 15. Geographic range of nine subspecies of *Peromyscus truei* in the United States and northern Lower California.

Pecos, 1 (U.S.B.S.); Ribera, 3 (U.S.B.S.). *Bernalillo County:* Isletta, 4 (U.S.B.S.). *Guadalupe County:* 18 mi. N Hicks Ranch, Santa Rosa, 1 (U.S.B.S.); Cuervo, 1 (U.S.B.S.); 15 mi. E Cuervo, 2 (U.S.B.S.); Santa Rosa, 10 (U.S.B.S.); 5 mi. S Santa Rosa, 2 (U.S.B.S.); 8 mi. SE Santa Rosa, 2 (U.S.B.S.). *Lincoln County:* Corona, 6 (U.S.B.S.); [High up and northwest foothills] Jicarilla Mts., 36 (U.S.B.S.); [NW and SW foothills] Capitan Mts., 35 (U.S.B.S.). *Otero County:* Highrolls, 2 (Mus. Zool., Univ. Mich.). *Union County:* Sierra Grande, 2 (U.S.B.S.). OKLAHOMA: *Cimarron County:* Tesequite Canyon, 1 (Univ. Tulsa).

Additional records: (Osgood, 1909:169): UTAH: *Uinta County:* Browns Park. COLORADO: *Chaffee County:* Salida. ARIZONA: (Dice and Blossom, 1937: 37): *Cochise County:* Rock Creek Canyon, Chiricahua Mts., 7,800 ft. NEW MEXICO: (Osgood, *loc. cit.*): *Otero County:* Cloudcroft; Weed.

Peromyscus truei nevadensis Hall and Hoffmeister

Peromyscus (truei) truei, Osgood (1909:169), part.
Peromyscus truei nevadensis Hall and Hoffmeister (1940:401), orig. descr.

Type.—Female, adult, skin with skull; no. 68479, Mus. Vert. Zool.; ½ mile west of Debbs Creek, 6,000 feet, Pilot Peak, Elko County, Nevada; collected July 20, 1935, by A. E. Peterson, original no. 144. (Examined.)

Range.—In general, northeastern and east central Nevada and western Utah, particularly the slopes bordering the Pleistocene Lake Bonneville. Known limits of occurrence: at the north, Raft River Mountains, Box Elder County, Utah, and Pilot Peak, Elko County, Nevada; at the west, eastern slopes of the Ruby Mountains, Elko and White Pine counties, Nevada; at the south, Pine Valley, Utah, and northeastern Lincoln County, Nevada; at the east, vicinity of Escalante, Garfield County, and Provo, Utah County, Utah. Known altitudinal range from near 5,000 feet, as near Draper, to 7,500 feet, near Lehman Cave. Zonal range, Upper Sonoran; possibly enters the Transition.

Diagnosis.—Size: medium (see measurements); body long, averaging usually more than 100 mm., tail short, averaging less than 93 per cent of the length of head and body; ears large, when measured from the notch, in the dry skin, equaling the length of hind foot. Color: pale; upper parts with a small amount of blackish and with reddish or buff color of a markedly light tone. Skull: large; maxillary breadth small; rostrum long.

Color.—Upper parts (July 20) near (16′) Light Ochraceous-Buff lightly overlaid with brown and black. General effect near (16′′′) Buffy Brown.

Skull.—In addition to the above characters, rostrum relatively heavy; auditory bullae moderately inflated; dorsal curvature of skull great.

Comparisons.—From specimens of *Peromyscus t. truei* from northern New Mexico, northern Arizona, and southern and western Nevada, specimens of *nevadensis* differ in the following characters: Size: larger; total length and body length greater (body usually averaging more than 100 mm. rather than less); tail relatively (not actually) shorter, averaging less than 93 per cent of head and body length, rather than usually more than 93 per cent. Color: paler, resulting from less blackish and a lighter tone of ochraceous in the subterminal band; dorsal tail stripe usually lighter. Skull: averages larger in every measurement taken, except least interorbital constriction, palatine slits, and diastema; rostrum longer and heavier; maxillary breadth relatively narrower; auditory bullae slightly less inflated and with external auditory meatus slightly smaller.

From specimens of *P. t. gilberti,* both topotypes and specimens from north-central California, specimens of *nevadensis* differ in the follow-

ing characters: Size: body longer; tail actually and relatively shorter, averaging less than 93 per cent of length of head and body rather than more; ears longer. Color: paler, resulting from a reduction in tone of cinnamon and also from a lesser amount of blackish in the upper parts; dorsal tail stripe darker. Skull: averages larger in all measurements taken, except interorbital constriction, palatine slits, and maxillary toothrow; rostrum relatively and actually longer but not heavier; maxillary breadth less; auditory bullae slightly more inflated and external auditory meatus considerably larger.

From specimens of *P. t. montipinoris,* employing topotypes and other material from eastern Kern County, topotypes of *nevadensis* differ in the following characters: Size: body longer and tail much shorter (tail averaging 86 per cent as opposed to 107 per cent of head and body length); hind foot slightly shorter. Color: paler, resulting from a lesser amount of ochraceous and blackish in the upper parts. Skull: most measurements average about the same, but maxillary breadth much less; rostrum narrower; auditory bullae more orbicular but smaller.

For comparison with *P. t. preblei,* see account of that race.

Remarks.—The range of this longest-bodied race of piñon mouse apparently meets only that of the race *truei.* Intergradation between *P. t. nevadensis* and *P. t. truei* is gradual and complete. The three nearly adult specimens from near Escalante, Garfield County, Utah, are intergrades between the two races. In coloration they are pale, resulting from a great reduction of ochraceous, with little or no blackish in the upper parts. They are even paler than topotypes of *nevadensis.* In actual body proportions the specimens are small, in this respect resembling *truei,* but in two of the specimens the body length is 100 mm. and 102 mm., respectively, and in all three the tail is short in relation to the length of the head and body (less than 92 per cent), the latter characters all being more typical of *nevadensis.* In cranial features, particularly size, these specimens most closely resemble *truei.* Although they are intermediate in their characters, and perhaps even distinct from both *truei* and *nevadensis* in their pale coloration, they seem nearest *nevadensis* to which race they are here referred. In Nevada, intergradation with *P. t. truei* is indicated by three specimens from Pershing County, which have long bodies and proportions of *nevadensis,* but cranial features and coloration of *truei.* Similarly, a specimen from Greenmonster Canyon has a relatively long body and coloration intermediate between that of *truei* and *nevadensis,* though nearer the latter, but a small skull. Five adults from Water Canyon are nearer *truei* in size of body and coloration, and are almost exactly intermediate in cranial characters, though possibly slightly nearer *nevadensis.* All these specimens are referred to *truei.* Others from White Pine County, referred to *nevadensis,* are variously intermediate toward *truei.* Some approach to *truei* is shown by

FIG. 16. Habitat of *Peromyscus truei nevadensis* in the Wasatch Mountains of Utah. The mice occur among the mountain mahogany and scrub rose on the quartzite slope and not on the flat grown up principally with scrub oak. Photograph of Rock Canyon, 5,200 feet, 6 miles east and 2 miles north of Provo, Utah County, Utah. (Photograph by Lowell S. Miller.)

adults from 3½ miles north of Ursine, which have relatively long tails, and by specimens from 11 miles east of Panaca, Lincoln County, which have skulls intermediate in most characters.

Hall and Hoffmeister (1940:401; 402, Fig. 1) showed the range of the race *nevadensis* as extending westward in Nevada to near the Reese River. Subsequent study of additional material from Utah, and a reinvestigation of Nevadan specimens, indicates that the range should be confined to the eastern (north and central) parts of Nevada (see Hall, 1946:521) and west-central Utah.

In Utah, the subspecies occurs, in general, along the west side of the Wasatch Plateau, on some mountain ranges in far western Utah, and from within 10 miles of the Idaho boundary. Piñon mice, of this sub-

species, may occur in southern Idaho. From the isolated ranges of western Utah, only immature animals are available. Thus, the allocation of young specimens from the Raft Mountains, Deep Creek Mountains, Government Creek, and Desert Experiment Range to the race *nevadensis* is somewhat tentative. Better and more mature material indicates the specimens from the vicinity of Beaver, Paragonah, and Cedar City are referrable to *nevadensis*. A large series of adults from Rock Canyon, near Provo, are unlike *nevadensis* in that they are short bodied, long tailed (in relation to body), and with a small skull. These are features of the race *truei;* but in coloration this population is nearest *nevadensis*. Specimens from north-central Utah may possess a combination of distinctive features, but they hardly seem worthy of subspecific designation.

Specimens from northern Washington County, Utah, seem referable to *nevadensis*; those from the vicinity of St. George in the southern part of the county to the race *truei*. The immature specimens from Zion National Park are referred to *truei* also.

Habitat notes.—The specimens in eastern Nevada were taken in much the same association as were those of the race *truei* in other parts of Nevada. In Utah County, Utah, all of the specimens were taken from quartzite cliffs, with vegetation principally of squaw bush, cliff rose, and hackberry. This area is below the main mountain juniper zone. Specimens from near the eastern edge of old lake Bonneville, as in Tooele County, Utah, were caught "at the base of a dead juniper, on sandy soil one-half mile from the nearest rock outcropping, that had at one time supported a nest of *Neotoma,* but was apparently then the home of *P. truei*" (Miller, *M.S.,* 1947).

Specimens examined.—Total number, 103, from the following localities: Nevada: *Elko County:* Pilot Peak, ½ mi. W Debbs Creek, 6,000 ft., 18* W side Ruby Lake, 3 mi. N White Pine County line, 6,700 ft., 1* (Ralph Ellis Coll.). *White Pine County:* W side Ruby Lake, 3 mi. S Elko County line, 7,000 ft., 5 (Ralph Ellis Coll.); Overland Pass, E slope Ruby Mts., 8 mi. S Elko County line, 1 (Ralph Ellis Coll.); Cherry Creek, 6,800 to 6,900 ft., 6*; Cleve Creek, 6,900 ft., Shell Creek Range, 3; Lehman Cave, 7,400 ft., 1; ½ mi. W Lehman Cave, 7,500 ft., 2. *Lincoln County:* Lat. 38° 17′ N, ¼ mi. W Utah-Nevada Boundary, 7,300 ft., 1; Eagle Valley, 5,600 ft., 3½ mi. N Ursine, 2; 2 mi. S Pioche, 6,000 ft., 3; 2 mi. SE Pioche, 6,000 ft., 1; 11 mi. E Panaca, 6,500 to 6,600 ft., 5. Utah: *Box Elder County:* Pine Cr., 3 mi. N Rosette, Raft River Mts., 6,100 ft., 1 (Mus. Zool., Univ. Utah). *Tooele County:* Gov't Cr., 3 mi. S James Ranch (=2 mi. E Indian Springs), 2 (Coll. L. S. Miller). *Juab County:* Queen of Sheba Canyon, W side Deep Creek Mts., 8,000 ft., 1 (Mus. Zool., Univ. Utah); Nephi, 5,095 ft., 1. *Millard County:* Desert Exp. Station, T25S, R17, Sec. 10, 5,252 ft., 1 (Mus. Zool., Univ. Utah). *Beaver County:* 3 mi. E Beaver, 9 (Carnegie Mus.); Beaver River [exact locality not known], 2 (U.S.B.S.). *Iron County:* 4 mi. E Paragonah, 6 (Carnegie Mus.); 6 mi. SW Cedar City, 3 (Carnegie Mus.). *Washington County:* 27 mi. SW Cedar City, 1 (Carnegie Mus.); Hamblin Ranch, Mt. Meadows, 4 (U.S.

B.S.); Pine Valley, 6,400 ft., 7 (U.S.B.S.). *Salt Lake County:* Corner Canyon, near Draper tunnel, 5,000 ft., 1 (Mus. Zool., Univ. Utah). *Utah County:* Rock Canyon, 5,200 ft., (=6 mi. E, 2 mi. N Provo), 12 (Coll. L. S. Miller). *Garfield County:* 8 mi. W Escalante, 6,500 ft., 1 (Univ. Utah, Mus. Zool. Coll.); 5 mi. W Escalante, 6,000 ft., 1 (Univ. Utah, Mus. Zool. Coll.); 8 mi. S Escalante, 5,200 ft., 1 (Univ. Utah, Mus. Zool. Coll.).

Peromyscus truei preblei Bailey

Peromyscus truei gilberti, Osgood (1909:171), part.
Peromyscus truei preblei Bailey (1936:188), orig. descr.

Type.—Male, young, skin with skull; no. 78660, U.S. Nat. Mus., Biol. Surv. Coll.; Crooked River, 20 miles southeast Prineville [=12 mi. S and 6 mi. E Prineville], Crook County, Oregon; collected June 28, 1896, by E. A. Preble; original no. 1079. (Examined.)

Range.—Known only from central Oregon, along the Crooked River southeast of Prineville and in the Deschutes Valley at Warmsprings. Known altitudinal range from near 1,500 feet as at Warmsprings to 3,400 feet along the Crooked River. Zonal range, Upper Sonoran.

Diagnosis.—Size: small (see measurements), one of the smallest races; both body and tail short, the latter averaging 97 per cent of length of head and body; ears long, when measured from the notch, in the dry skin, about equal to length of hind foot. Color: dark; similar to *gilberti*, but with a reduction of reddish tone; dorsal tail stripe brownish black. Skull: small in all measurements and features, except bullae, which are relatively large.

Color.—Upper parts (June 29) Ochraceous-Buff uniformly overlaid with black. General effect Mummy Brown. Dorsal tail stripe darker distally.

Skull.—In addition to above characters, rostrum actually but not relatively short; bullae large, but depressed and not orbicular; upper incisors small.

Comparisons.—*P. t. preblei* needs close comparison with only *P. t. truei*. The more barren parts of southeastern Oregon may isolate by many miles these two races of piñon mice although the map (Fig. 15) shows the probable limits of the range of *P. t. truei* to the north. From specimens *of P. t. truei* from Siskiyou and Modoc counties, California, and Washoe County, Nevada, which are the nearest known representatives of the race *truei* to the south and southeast, respectively, specimens of *preblei* differ in the following characters: Color: upper parts slightly darker; dorsal tail stripe darker. Skull: smaller in all measurements; maxillary breadth less; upper incisors weaker. In body proportions and measurements, the forms are indistinguishable, except that the tail averages relatively slightly longer.

From specimens of *P. t. gilberti* from the type locality, from Jackson

County, Oregon, and from northern Siskiyou County, California, specimens of *preblei* differ in the following characters: Size: smaller in all measurements except ear length. Color: similar, except with less reddish tone. Skull: much smaller in all measurements, except least interorbital constriction and shelf of bony palate; rostrum shorter, lighter, narrower; maxillary breadth less; maxillary root of zygomata weaker.

From specimens of *P. t. sequoiensis* from Del Norte County, California, *preblei* differs in being smaller in all measurements taken except length of ear; tail averages less than 100 per cent of length of head and body rather than more; coloration of upper parts lighter and never with a pectoral spot; skull smaller in all measurements with lighter rostrum, lesser maxillary breadth, and weaker maxillary root of the zygomata.

From topotypes of *P. t. nevadensis* from northeastern Nevada, specimens of *preblei* differ in: body shorter; tail averages 97 as opposed to 86 per cent of length of head and body; coloration darker; and the skull much smaller in all measurements (except similar in least interorbital constriction), with less orbicular bullae and shorter, broader braincase.

Remarks.—P. t. preblei is a small-sized, not strongly differentiated race occupying the extreme northwestern part of the known range of the species, occurring northward in Oregon to within 60 miles of the Columbia River. The mice are apparently closely restricted to the juniper association, a tree replacing or at least complementing the piñon in this area. In this respect, *preblei* may be isolated from other races of the species to the southwest by the Cascade Range and to the south and southeast by the more barren, juniper-less region (see Munns, 1938:62, map 58). However, the discontinuity of the distribution of juniper is not great and it may be that mice of the race *preblei* have a range continuous with those of other races to the south (so shown on distribution map, Fig. 15).

A specimen from Lava Beds National Monument, Siskiyou County, California, is as dark as specimens of *preblei* but differs in other characters. It may be that the dark color of this specimen, occurring on dark soils and rocks of the Lava Beds, parallels that found in other *Peromyscus* in this area (*P. crinitus* [see Hall and Hoffmeister, 1942] for example), and this color may not be indicative of intergradation between *truei* and *preblei*. *P. t. preblei,* along the Crooked River, occurs among dark-colored rocks. Some of the *Peromyscus crinitus* from this area are dark colored.

Of the seven specimens upon which the original description was based, only three prove to be of the species *P. truei* (four were *Peromyscus crinitus*). Of these three, two are juveniles as shown by both pelage and dental characters and the third, the type, has juvenal dental fea-

tures but postjuvenal pelage. The description here is based on five adults in the Museum of Vertebrate Zoology from near the type locality.

The original designation of where the type specimen was obtained is apparently based on road distances. The late Vernon Bailey (*in litt.*) informed me that the type was taken along the Crooked River where the old (1896) wagon road out of Prineville struck the river. This is, as designated above, 12 miles south and 6 miles east of Prineville or 13 miles (air-line) south-southeast of Prineville.

Habitat notes.—The specimens from along Crooked River in the Museum of Vertebrate Zoology were taken among lava boulders and junipers. They were not found in extensive rock slides but where the rocks were irregularly spaced among the junipers. The species was not common in midsummer (June 29-30) of 1939 for only five specimens were taken in 660 traps, most of which were set in the above-mentioned habitat, but which also sampled all other habitats.

Specimens examined.—Total number, 9, from the following localities in Oregon: *Jefferson County:* Warmsprings, 1 (U.S.B.S.). *Crook County:* Crooked River, 4 mi. W mouth of Bear Creek, 3,100 ft., 1*; Crooked River, at mouth of Bear Creek, 3,400 ft., 5*; Crooked River, 20 mi. SE Prineville, 2 (U.S.B.S.).

Peromyscus truei gentilis Osgood

Peromyscus gratus gentilis Osgood (1904:61), orig. descr.
Peromyscus truei gentilis, Osgood (1909:175).

Type.—Male, adult, skin with skull; no. 78937, U.S. Nat. Mus., Biol. Surv. Coll.; Lagos, Jalisco, Mexico; collected June 27, 1896, by E. W. Nelson and E. A. Goldman; original no. 9702. (Examined.)

Range.—North-central Mexico from near the United States Boundary southward along the cordillera to eastern Jalisco and central Guanajuato.

Diagnosis.—Size: small (see measurements); tail relatively and actually long (usually more than 100 mm.) and longer than head and body (usually by 10 per cent); ear small, being shorter than hind foot when measured from notch in dry skin. Color: relatively bright ochraceous, apparently from a reduction in length of terminal dark color band of hairs. Skull: small.

Color.—Upper parts (June 26) near (*a*) Vinaceous-Cinnamon, lightly overlaid with black, which is most concentrated along middorsal stripe. General effect, Tawny to Russet.

Skull.—Auditory bullae medium-sized; rostrum short, and shortness accentuated by relative broadness of the skull through interorbital region; ascending arm of premaxillae extending posteriorly to about the same plane as posterior tips of nasals.

Comparisons.—From specimens of *P. t. truei* from the southern part of the Great Basin, specimens of *gentilis* differ in the following characters: Size: tail longer than head and body rather than shorter, and usually more than 100 mm. in length rather than less; ear shorter than hind foot, rather than longer, when measured in the dry skin from the notch, and usually at least 10 per cent shorter than hind foot. Color: slightly brighter ochraceous, being brightest in topotypes. Skull: averages smaller, particularly in over-all length; rostrum slightly shorter.

From specimens of *P. t. lagunae* from the tip of Lower California, specimens of *gentilis* differ in the following characters: Size: head and body averages slightly shorter; tail relatively longer. Color: lighter and more ochraceous. Skull: auditory bullae larger but relatively no more inflated; maxillary breadth slightly greater.

For comparison with *P. t. gratus*, see account of that race.

Remarks.—*P. t. gentilis* is a relatively long-tailed, short-eared race occurring in suitable habitat over much of the tableland of northern Mexico. The subspecies actually intergrades only with the races *truei* to the north and *gratus* to the south.

In a short distance, between southern New Mexico and northern Mexico, there is an abrupt change in some morphological characters. Therefore, the zone of intergradation between *truei* and *gentilis* is narrow. This is true of the relative length of the tail. Only three specimens of all the *P. truei truei* whose measurements were checked from New Mexico and southern Arizona have tails shorter than the body. There is a similarly narrow zone of intergradation, in this feature, between *truei* and *montipinoris*. The ear (measured from the notch in the dry specimen) is always shorter than the hind foot in *gentilis*; in *truei*, it is usually longer than the hind foot (exception should be made for the specimens from central New Mexico). Although the ear is shorter than the hind foot in specimens of *gentilis* from Chihuahua, the difference is not as great as in more southern populations and there is a gradual decrease in length of ear to the southward. The greatest length of skull averages less than 28.0 mm. in each population of *gentilis*, and decreases in length to the southward; in most populations of *truei*, the average length is 28.0 mm. or more. The difference in coloration between topotypes and a few other populations of *gentilis* and the race *truei* is as mentioned in the comparison above, but many northern populations of *gentilis* are as dark colored as typical *truei*.

Intergradation with the race *gratus* occurs in a more gradual fashion in most features, except for color. For further remarks, see under the account of *gratus*.

P. t. gentilis most closely resembles the race *lagunae* occurring on the tip of Lower California; the two are separated by the low coastal region and the Gulf of California or indirectly by the ranges of the races *truei*,

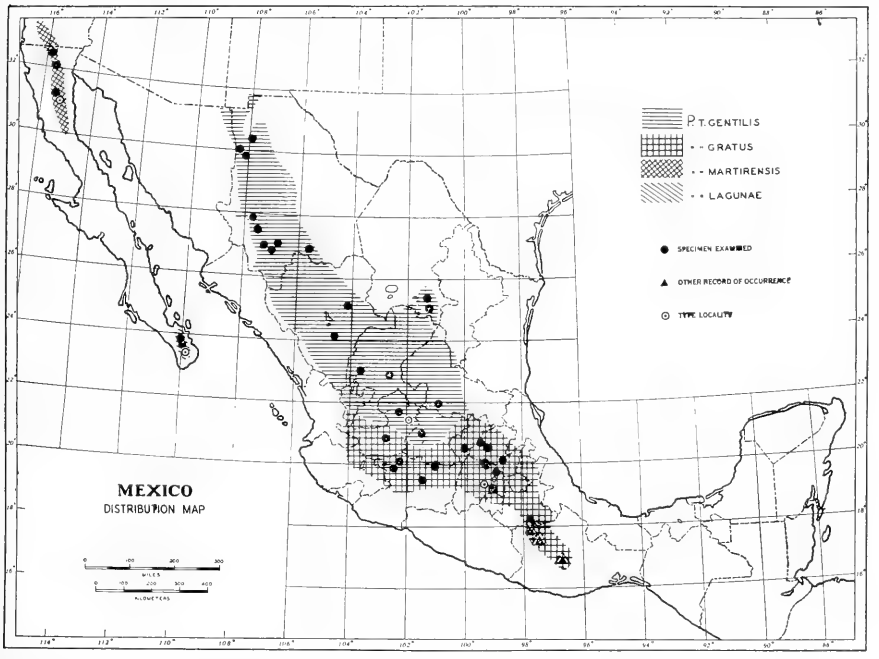

FIG. 17. Geographic range of four subspecies of *Peromyscus truei* in Mexico.

chlorus, and *martirensis*. Both *gentilis* and *lagunae* are relatively long tailed, short bodied, short eared forms with small skulls. This similarity is regarded as a parallel development as pointed out in the account of *lagunae*.

There is in the race *gentilis* a clinal change, in a north-south direction, in most morphological features, including: an increase in length of tail, decrease in length of ear, slight decrease in length of hind foot, and decrease in most measurements of the skull. These changes are slight, but uniform, between the populations, which are arrayed, in general, in a north-south direction. In that the type locality is near the southern part of the range of *gentilis*, morphological features of topotypes are not quite "average" for the race. Because a large series of specimens is not available from near the center of the range of *gentilis*, the measurement of topotypes are given in Table 3. These can be compared with corresponding measurements (measurements of head and body and ratios are not included) of fifteen adults from southern Chihuahua, which are: external: 197, 103, 23.8, 22.1; cranial: 27.6, 20.8, 4.4, 10.4, 4.1, 5.8, 7.0, 9.9, 4.2.

The one adult available from the Sierra Encarnación of southern Coahuila has a very small skull and a relatively long tail. If a larger series were available, this might be shown to be an individual variant or a distinct population worthy of separate recognition.

Specimens examined.—Total number, 76, from the following localities in Mexico: *Chihuahua:* Casas Grandes, 1 (U.S.B.S.); near Colonia García, 6 (U.S.B.S.); 9 mi. SE Colonia García, 8,200 ft., 2; Mojárachic, 1 (U.S.B.S.); 10 mi. SW Agostadero, 103 mi. by road W Parral, 8,400 ft., 11; La Unión, 10 km. N Guachochíc, 8,400 ft., 15; Sierra Madre, 40 mi. E Batopilas, 1 (U.S. B.S.); Parral, 1 (U.S.B.S.). *Durango:* Coyotes [plotted as 24° 56′ N, 104° 11′ W], 6 (Chicago Nat. Hist. Mus.); Durango, 1 (U.S.B.S.). *Coahuila:* Sierra Guadalupe, 1 (U.S.B.S.); Sierra Encarnación, 1 (U.S.B.S.). *Zacatecas:* Valparaiso, 1 (U.S.B.S.); Zacatecas, 1 (U.S.B.S.). *Jalisco:* 9 mi. N Encarnación, 1900 m., 18°; Lagos, 7° (U.S.B.S.). *Guanajuato:* Silao, 1 (U.S.B.S.). *San Luis Potosi:* Jesus María, 1 (U.S.B.S.).

Peromyscus truei gratus Merriam

Peromyscus gratus Merriam (1898:123), orig. descr.
Peromyscus (gratus) gratus, Osgood (1904:61).
Peromyscus truei gratus, Osgood (1909:173).
Peromyscus pavidus Elliot (1903*a*:142). Type from Pátzcuaro, Michoacán, Mexico.
Peromyscus zelotes Osgood (1904:67). Type from Queréndaro, Michoacán, Mexico.

Type.—Female, adult, skin with skull; no. 50619, U.S. Nat. Mus., Biol. Surv. Coll.; Tlalpan, Federal District, Mexico; collected November 30, 1892, by E. W. Nelson; original no. 3927. (Examined.)

Range.—South-central Mexico, from central Jalisco, southern Querétaro, and northern Hidalgo, south to central Oaxaca.

Diagnosis.—Size: body short (see measurements); tail relatively and actually long and longer than head and body; ear small, being shorter than hind foot when measured from notch in dry skin. Color: dark, with a short and not brightly colored subterminal band in dorsal hairs. Skull: small; ascending arms of premaxillae usually extending posterior to most posterior tip of nasals; braincase broad, the appearance of breadth being accentuated by short rostrum.

Color.—Upper parts (May 6, 2½ mi. W Tlalpan) Pinkish Cinnamon heavily overlaid with black. General effect (May 6) near *1* Sepia, (November 29, Tlalpan) slightly darker than Mummy Brown.

Skull.—In addition to above characters, auditory bullae small.

Comparison.—From specimens of *P. t. gentilis,* specimens of *gratus* differ in the following characters: Size: body slightly longer; tail relatively shorter. Color: upper parts much darker, the general color effect being near Sepia rather than Tawny or Russet in summer pelage.

Because *gratus* intergrades with only *gentilis,* and most closely resembles that form, comparison is not made with other races.

Remarks.—The seven adult topotypes examined of *P. t. gratus* from Tlalpan average from one to 3 per cent larger in most measurements than do twenty-seven adult specimens, including the seven topotypes and twenty other "near topotypes" from 2½ miles west of Tlalpan. The

fact that the topotypes are aged individuals ("old" adults), with teeth showing extreme wear, might account for their average larger size. When specimens of comparable age (nine in number) from 2½ miles west of Tlalpan are compared with the topotypes, the differences in size between the populations are less, and in some measurements the topotypes average smaller. The measurements for *P. t. gratus* in Table 4 include both "adult" and "aged" animals of both populations. By so grouping the mice of this subspecies, the measurements for the several subspecies are made more nearly comparable as to age composition. In southern populations, *Peromyscus truei* may grow throughout more of their life since aged or old individuals from Tlalpan are so much larger than adults; in the more northern races *gilberti, montipinoris,* and *truei,* but little or no increase in measured parts occurs after mice have attained subadulthood.

Many morphological features of most populations of *P. t. gratus* undergo the same clinal variation, in a north-south direction, as do those of populations of *P. t. gentilis,* but to a less marked degree. Thus, there is a decrease toward the south in length of ear, increase in length of tail, decrease in length of hind foot, and a decrease in most measurements of the skull. Coloration of the upper parts in mice of the subspecies *P. t. gratus* does not show such a gradual change or gradient, for there is a rather abrupt transition from the ochraceous upper parts of *gentilis* to the darker color of southern populations, rather than a gradient to lighter-colored upper parts if the clinal change would extend from *P. t. truei* through *gentilis* to *gratus.*

Not all populations of *gratus* display the clinal variation, outlined above, as regards features other than color. The specimens from Tlalpan, and its environs, constitute exceptions in many features. For example, the ear length averages 19.9 mm. in these specimens; in other populations of *gratus,* except that from Pátzcuaro, it averages less than 19.0 mm. Specimens from Michoacán show even less clearly (or the reverse of) the anticipated clinal change in many features. This is shown graphically for some features in Figure 22. Most specimens from Michoacán are of large size. These specimens can be characterized as having skulls whose greatest length exceeds 28.0 mm., upper toothrow of 4.4 to 4.6 mm. in length, long tail (and often long body), and dark coloration of upper parts. Perhaps these specimens from Michoacán warrant distinct subspecific designation, in which event two names are available. Exception to the above characterization must be made for the specimens, collected in 1943, from the environs of Zamora. These are smaller than other specimens from Michoacán, and thus more closely resemble specimens of *P. t. gratus* from other parts of its range, but the ears and auditory bullae average smaller than in most other populations of *Peromyscus truei* from all of Mexico. It is not clear to me whether these differences

FIG. 18. Habitat of *Peromyscus truei gratus* in the lava fissures partially grown up with sacatón, *Epicampes robusta,* and *Senecio precox* at El Pedregal, near Tlalpan, 2,245 meters altitude, Federal District, Mexico (type locality of *P. t. gratus*). (Photograph by Bernardo Villa R.)

between the specimens from Zamora and outlying localities are due to slight differences in age, coupled with continuous growth in southern populations, resulting in larger individuals, or if those specimens with shorter ears and smaller bullae represent a distinct species, closely related to *P. truei.* If the latter is the case, the situation is parallel to that in the United States where a closely related species, *P. nasutus,* is distinguished morphologically from *P. truei* principally by smaller ears and auditory bullae. Specimens from Pirámides de San Juán Teotihuacán have small bullae and short ears, much as the specimens from west of Zamora and from the Río Duero.

The specimens from El Roble, Jalisco, although from near the type locality of *gentilis,* are referred to *gratus* on the basis of dark coloration. Osgood (1909:175) considered the three specimens from Silao, also from near the type locality of *gentilis* and actually south of El Roble, as approaching *gratus,* but referred them to *gentilis.* The one specimen available to me from Silao is immature and subspecific allocation is difficult, so I follow Osgood.

Osgood (1909:175) refers five "immature and otherwise unsatisfactory" specimens from three localities in Oaxaca provisionally to the species *truei* and to this race. Two adult specimens from Oaxaca in the

collections of the University of Michigan are clearly referable to this subspecies. The central Mexican plateau extends, rather restrictedly, into Oaxaca and these localities probably represent about the southernmost geographic limits of the *truei* group.

Specimens examined.—Total number, 135, from the following localities in Mexico: *Jalisco:* El Roble, 8 mi. NE Tepatitlán de Morales, 2. *Michoacán:* 8 mi. N Zamora, 5,500 ft., 2; 11 mi. W Zamora, 5,750 ft., 11; 6½ mi. W Zamora, 5,950 ft., 4; 6 mi. W Zamora, 5,950 ft., 4; Zamora, 5 (U.S.B.S.); Río Duero, 9 mi. E Zamora, 5,500 ft., 1; Queréndaro, 1. (U.S.B.S.); 3 mi. NW Pátzcuaro, 6,700 and 6,800 ft., 11; 1½ mi. NW Pátzcuaro, 6,700 ft., 1; 2 mi. W Pátzcuaro, 6,700 and 7,700 ft., 3; Pátzcuaro, 2 (Chicago Nat. Hist. Mus.). *Querétaro:* Tequisquiapan, 1 (U.S.B.S.) *Hidalgo:* Zimapán, 1 (U.S.B.S.); Ixmiquilpan, 1 (U.S.B.S.); Pachuca, 2 (U.S.B.S.); Tula, 3 (U.S.B.S.). *México:* Templo del Sol, Pirámides de San Juan Teotihuacán, 8,000 ft., 11. *Federal District:* El Pedregal de San Ángel, 7,700 ft., 2½ mi. W Tlalpan*, 53; Tlalpan, 10* (U.S.B.S.); Pedregal, San Gerónimo, 4 (Univ. Ill. Mus. Nat. Hist.). *Oaxaca:* Huajuápan de Leon, 1,600 m., 1 (Mus. Zool., Univ. Mich.); Nochixtlán, 2,200 m., 1 (Mus. Zool., Univ. Mich.).

Additional records (Osgood, 1909:174): *Oaxaca:* Huajuápan, Tamazulapan, Oaxaca.

Peromyscus truei sequoiensis Hoffmeister

Peromyscus truei sequoiensis Hoffmeister (1941:129), orig. descr.
Peromyscus truei gilberti, Osgood (1909:171), part.

Type.—Male, adult, skin with skull; no. 20842, Mus. Vert. Zool.; 1 mi. W Guerneville, Sonoma County, California; collected June 16, 1913, by H. W. Grinnell, original no. 109. (Examined.)

Range.—In general, the narrow humid northwest coastal belt of California and extreme southwest Oregon, west of the crest of the Coast Range, from Galice, Oregon, south to Marin County, California. Eastward known limits of occurrence: Near Happy Camp and Taylor Creek, Siskiyou County; 3 miles west summit Mount Sanhedrin, Mendocino County; Freestone, Sonoma County; and Ross, Marin County. Known altitudinal range from 50 feet, as at Guerneville, Sonoma County, to 5,500 feet, as at Taylor Creek, Salmon Mountains, Siskiyou County. Zonal range, Transition; possibly entering the Canadian, as in the Salmon Mountains.

Diagnosis.—Size: large (see measurements), the largest race; body of medium length; tail actually, not relatively, long (averaging 108 per cent of length of head and body); hind foot long; ear actually and relatively short, averaging (when measured from the notch in dry skin) only 83 per cent of length of hind foot. Color: dark; upper parts with considerable blackish and with reddish of a markedly dark tone; underparts of adults usually with a small pectoral spot of ochraceous or buffy color. Skull: large (largest of any race in length and breadth); max-

illary breadth great; rostrum relatively, not actually, short; maxillary toothrow long; palatine slits, relative to the length of the palate, short.

Color.—Upper parts (June 16) near (*a*) Zinc Orange uniformly overlaid with dark brown and black. General effect near (16) Brussels Brown. Pectoral spot near (14′*a*) Zinc Orange.

Skull.—In addition to the skull characters given above, bullae large but not greatly inflated; upper incisors long, heavy, and wide apart; vaulting of skull great, the depth between the ventral surface of the bullae and median dorsal suture of parietals greater than in any other subspecies; occiput more nearly perpendicular, not sloping off toward the foramen magnum; posterior border of palate cuspidate.

Comparisons.—From topotypes and most other specimens of *Peromyscus t. gilberti, sequoiensis* differs in the following characters: Size: larger, except for length of body which is about the same; length of tail averages 108 per cent of length of head and body instead of 97 per cent; hind foot usually more than 24 mm. (averaging 25.2 mm.) instead of less than 24 mm. (averaging 22.8 mm. in *gilberti*); ear smaller, averaging 82 per cent of length of hind foot as opposed to 95 per cent in *gilberti.* Color: upper parts, including dorsal tail stripe, darker; sides more ochraceous. Skull: averages larger in every measurement except length of palatine slits; maxillary breadth greater; upper incisors longer, heavier, and wider apart; rostrum heavier; depth of skull greater with less posterior slant and thus a more nearly perpendicular occipital region.

From specimens of *P. t. dyselius, sequoiensis* differs in the following characters: Size: larger, but tail relatively shorter (108 per cent of length of head and body as opposed to 115 per cent in *dyselius*); hind foot longer; ear slightly shorter, averaging, when measured from the notch, dry, 20.9 mm. in 11 specimens of *sequoiensis* (82 per cent of length of hind foot) and 21.7 mm. in 7 specimens of *dyselius* (90 per cent of length of hind foot). Color: upper parts slightly more reddish as a result of a reduction of black, particularly a reduction in length of the dark basal hair band. Skull: averages larger in greatest length, basilar length, and length of the bony palate; slightly larger braincase; shorter palatine slits and maxillary toothrow; bullae larger and more compressed (less orbicular and inflated); depth of skull greater.

From specimens of *P. t. preblei, sequoiensis* differs in being much larger (more than 10 per cent) in all external features except length of ear, which is smaller actually and relatively, averaging only 82 per cent of length of hind foot, as opposed to 100 per cent; darker coloration, chiefly as a result of reddish of a markedly darker tone; and a larger skull in all measurements.

Remarks.—The race *sequoiensis,* occurring in the humid coastal belt

north of San Francisco Bay, exhibits the same group of characters as shown by the race *dyselius,* namely, darker coloration and an increase in external and cranial size. In *sequoiensis,* the trends in those characters apparently reach their maxima for the species, for at least external (except for ear size, in which the reverse, relatively, is true) and cranial size is the greatest in this race.

P. t. sequoiensis is a race confined primarily to the Transition life-zone, whereas *P. t. gilberti* is chiefly an Upper Sonoran inhabitant. Since *sequoiensis* is isolated from *dyselius* by San Francisco Bay and from other races by the range of *gilberti,* it intergrades only with this latter race.

In Lake, Napa, and eastern Sonoma counties, there are certain "islands" of the Transition life-zone on the higher peaks. Specimens occurring in these approach *sequoiensis* in various features, as follows: Of the specimens from the Cobb Mountain area, those from Glenbrook are typical *gilberti,* whereas those from Castle and Harbin springs are as large as typical *sequoiensis,* except for shorter hind feet. Of the specimens from the Mount St. Helena area, one from 9 miles NW Calistoga is dark colored and has a large skull, but with proportions of body as in the race *gilberti;* those from the base of Mount St. Helena, in Napa County, are intermediate in coloration and cranial characters, but typically *gilberti* in proportions of body. On the basis of the sum total of the characters shown, all the specimens from these Transitional "islands" are here referred to the race *gilberti.*

The twenty-six specimens (of which twenty-one are fully adult) from South Fork Mountain have been critically studied as to their subspecific allocation. In most features they are intergrades between the races *sequoiensis* and *gilberti.* In actual and relative length of tail they are nearer *gilberti,* in length of hind foot nearer *sequoiensis,* in actual length of ear as in *gilberti,* but in length of ear relative to hind feet, they are intermediate; the skull is large, larger than in topotypes of *gilberti* but no larger than in other *gilberti* at the same latitude, and smaller than in *sequoiensis* at this latitude, and the color is intermediate. The specimens from South Fork Mountain are intermediate in most respects and it is difficult to allocate them to a particular subspecies. However, in that they average slightly nearer *gilberti,* they are referred to that race. The series of adults from about 40 miles to the north and west, along the Trinity River near Willow Creek, in Humboldt County, agrees closely with topotypes of *sequoiensis* in external proportions, except that the hind foot is shorter; the skulls average 0.3 mm. longer rather than 0.6 mm. shorter as in the specimens from the South Fork Mountains. Specimens from along Clear Creek are typical of

FIG. 19. Habitat of *Peromyscus truei sequoiensis* in dense redwood-Douglas fir association near Freestone, Sonoma County, California. (Photograph No. 995, Mus. Vert. Zool.)

sequoiensis in all characters except color, which is paler. Specimens from Taylor Creek in the Salmon Mountains are nearer *gilberti* in body proportions, but in other characters agree with *sequoiensis*.

Specimens from Grants Pass, Oregon, were referred to the race *dyselius* by Elliott (1903*c*:186) and to *gilberti* by Osgood (1909:171). Examination of specimens from there indicates that they are more closely allied to *gilberti* and are referred to that race. The specimens have the bodily proportions and skull characters of the more inland race *gilberti*. Specimens available from Sams Valley [=20 miles ENE of Grant's Pass], although with skulls as large as in *sequoiensis*, are best referred to *gilberti*, also, because of color and size. Similarly, specimens from the eastern part of the Rogue River Valley area are referable to *gilberti*. However, the specimens from Galice and along Briggs Creek, in western Josephine County, Oregon, seem clearly referable to *sequoiensis*. They have a relatively short tail, large hind foot, and a large skull (averaging 29.5 mm. in greatest length).

P. t. sequoiensis is one of two races (the second, *P. t. dyselius*) occurring in the humid, coastal, redwood belt of California. The two races are separated one from the other by the San Francisco Bay. Hooper (1944) has presented evidence that this bay may have been an important factor in influencing speciation and distribution in several kinds of rodents. To the east of the bay proper, in the vicinity of Carquinez Strait and Suisun Bay, the mice are of the same subspecies (*P. t. gilberti*) to the north and south.

It was of interest, and of somewhat a surprise, to find late in the present study, and after the accounts of the subspecies were completed, that C. Hart Merriam had fully appreciated the distinctness of the coastal forms of *P. truei* here recognized. In unpublished notes written by Dr. Merriam before 1898, which became available to me at the Museum of Vertebrate Zoology, he says ". . . specimens from the redwood belt betwen [*sic*] Santa Cruz and San Francisco are so much darker and larger that they deserve recognition as a strongly marked subspecies (*P. t. hylocetes*). North of San Francisco Bay, in the Clear Lake region and thence northwesterly to Willits and Sherwood, a somewhat different form occurs which does not attain its full development until Oregon is reached." Merriam did not propose a name for the north coast form (*sequoiensis*) and did not formally name the south coast form (*dyselius*, Elliot, 1898).

Habitat notes.—Specimens from near the type locality were taken in an association of *Sequoia sempervirens* (redwood), *Pseudotsuga taxifolia* (Douglas fir), *Umbellularia californica* (laurel), some poison oak, fern, madrone, and blackberry. The species did not seem to be common at any place taken.

Specimens examined.—Total number, 100, from the following localities: Oregon: *Josephine County:* Galice, 500 ft., 1 (U.S.B.S.); Briggs Cr., 13 mi. SW Galice, 3,000 ft., 4 (U.S.B.S.). California: *Del Norte County:* Wimer Spring, 1,800 ft., 7 mi. E Smith River, 4; E Fk. Illinois River, 1,900 ft., ¼ mi. S Oregon line, 4; Patricks Creek, 3 (Calif. Acad. Sci.). *Humboldt County:* 1½ mi. S, ½ mi. E Willow Creek, 600 ft., 12; Briceland, 1 (U.S.B.S.). *Mendocino County:* S Fk. Eel River, 12 mi. S Garberville, 2; Laytonville, 2 (Calif. Acad. Sci.); 3 mi. S Covelo, 11; Sherwood, 4 (3 in Calif. Acad. Sci.); 3 mi. W summit Mount Sanhedrin, 1; Willitts and "near" Willitts, 6 (U.S.B.S.); 7 mi. SW Willitts, 1 (Carnegie Mus.); 10 mi. SW Willitts, 6 (Carnegie Mus.); [near] Hearst, 1 (Calif. Acad. Sci.); 5 mi. NW Yorkville, 1; 3 mi. S Hopland, 1 (Carnegie Mus.). *Sonoma County:* 7 mi. W Cazadero, 900-1,000 ft., 5*; 1 mi. W Guerneville, 2*; Guerneville, 4*; 2 mi. S Guerneville, 200 ft., 1*; Monte Rio (Bohemian Grove), 4* (Calif. Acad. Sci.); Freestone, 6*. *Marin County:* Nicasio, 2 (Calif. Acad. Sci.); Ross, 1. *Siskiyou County:* 9 mi. W Happy Camp, 1 (Calif. Acad. Sci.); Near Happy Camp, 1 (Calif. Acad. Sci.); Clear Creek, 3 mi. W Klamath River, 1,400 ft., 4; Klamath River, Mouth of Clear Creek, 1,000 ft., 4; Taylor Creek, 5,500 ft., Salmon Mountains, 2 (Los Angeles Mus.).

Peromyscus truei gilberti Allen

Sitomys gilberti Allen (1893:188), orig. descr.

Peromyscus gilberti, Trouessart (1897:516), part.

Peromyscus boylii (Elliot, 1901:132, regarded *gilberti* as a synonym of *Peromyscus boylii*).

Peromyscus truei gilberti, Osgood (1909:169), part.

Peromyscus dyselius Elliot (1903*c*:186), part.

Type.—Male, adult, skin with skull; no. 329, Natural History Museum,

Leland Stanford, Junior, University; Bear Valley, San Benito County, California; collected April 1, 1893, by C. H. Gilbert and W. W. Price (after Allen, orig. descr.; type not examined).

Range.—In general, southwestern (but not coastal) Oregon and the foothills bordering the Great Valley of California (except around the southern end of the San Joaquin Valley) and in the Coast Range south from the area of Monterey Bay to Ventura. In particular, from Josephine County, Oregon, south through the Shasta Valley of California along the western flank of the Sierra Nevada to Fresno County, possibly central Tulare County (Richardson, *MS*), and along the eastern flank of the Coast Range east of Humboldt, Mendocino, (eastern) Sonoma, and Marin counties, and the Santa Clara Valley to the Temblor Range, and in the Outer Coast Range south of Santa Cruz County to Matilija, Ventura County. Locally within the Great Valley on Marysville Buttes, Sutter County. Known altitudinal range from near sea level, as at Seaside, to 5,900 feet, as on Santa Lucia Peak, both localities in Monterey County. Zonal range, Upper Sonoran; rarely Transition.

Diagnosis.—Size: medium (see measurements); body and tail length usually about equal (and both near 100 mm. in adults); hind feet and ear short, the latter averaging 95 per cent (when measured from the notch, dry) of the length of hind foot. Color: upper parts slightly darker than average for the species and with more reddish tone; winter pelage dark. Skull: medium; palatine slits actually and relatively long; maxillary breadth relatively great; bullae medium-sized.

Color.—Upper parts (no. 28163, July 10) Pinkish Cinnamon overlaid with black. General effect near (16″) Saccardo's Umber. General effect (no. 72950, May 28) near (16″) Sepia, resulting from a heavier overlay of black. Dorsal tail stripe slightly lighter brown than upper parts. Pectoral spot, when present, Pinkish Cinnamon.

Skull.—In addition to the above characters, rostrum relatively long and narrow; external auditory meatus small.

Comparisons.—For comparisons with other races, see accounts of those forms.

Remarks.—P. t. gilberti is a medium-sized race typically found in the Upper Sonoran life-zone around the Great Valley of California, the southern part of Oregon, and the coastal region of California between 34° and 37° N latitude. This race intergrades with *sequoiensis, dyselius, montipinoris,* and *truei.* With the first two, there is a long, not particularly wide, zone of intergradation. The zone of intergradation with the latter two, *montipinoris* and *truei,* is narrow. Intergradation with the race *truei* may occur in northern California and southern Oregon. The populations of *gilberti* in Shasta Valley and along the Klamath River which may intergrade with *truei* are, in turn, probably isolated from the

populations of *gilberti* in the northern part of the Sacramento Valley. These specimens in Shasta and Klamath River valleys, northward into Oregon, would seem to be best referred to the race *truei* on the basis of geographic continuity and environmental conditions. Therefore, these specimens were critically studied. In most features, these specimens are intermediate between the two races, but I have assigned them to *gilberti*, because of the 12 adult specimens, 6 have the tail slightly longer than the body and 3 have tails the length of which is between 96 and 99 per cent that of the body. The ear, measured from the notch when dry, averages slightly shorter than in *truei*. These features are similarities to *gilberti*. In coloration, these animals are intermediate between nearby populations of each subspecies, but darker than most specimens of *truei*. In cranial features, specimens from Oregon have shorter palatine slits, and thus resemble *truei*; those from Siskiyou County have longer foramina, as in *gilberti*. *Truei* and *gilberti* probably do not intergrade along the Pit and Feather river gaps through the Cascade-Sierra Nevadas because the mice most likely are not continuously distributed along these canyons. However, the three specimens from Montgomery, here assumed to be the same as Montgomery Creek, along the Pit River and in the Cascade-Sierra Nevadas, may indicate that piñon mice are continuously distributed through this low pass.

Specimens from the Rogue River Valley at Grants Pass, Oregon, are in all features examined referable to *P. t. gilberti*. Specimens from a few miles to the west, near Galice, probably taken in the Transition Zone, are large and are typical *P. t. sequoiensis*.

Some variation within the subspecies is shown. A large part of this, however, seems to be in the nature of a cline. Thus, from the populations at the north with short tails there is an increase in length toward the south and toward the coast. The relative length of the tail follows the same general increase toward the south. See Figures 23-24 for diagrammatic portrayal of this variation in some populations.

Within the Sacramento Valley, *gilberti* occurs on Marysville Buttes. These buttes represent Upper Sonoran "islands" within a Lower Sonoran life-zone which the species has been successful in populating. These "insular" populations do not differ significantly in most characters from *gilberti* occurring in the Upper Sonoran life-zone immediately to the east or west. It will be noted (Fig. 24) that the ear is especially small in this population.

Specimens from the general area north of Carquinez Straits, Suisun Bay, and the mouth of the Sacramento River do not differ significantly in any measurement or in color from those to the south, and no character or group of characters has been found which separates animals from these two areas. Adults from Napa County on the north (4 miles SSE

FIG. 20. Habitats of *Peromyscus truei gilberti* (A, above) under the canopy of low growing *Ceanothus* at the San Joaquin Experimental Range, west side of the Sierra Nevada, Madera County, California, and (B, below) in the Berkeley Hills, Strawberry Canyon, Alameda County, California, along the sides and bottoms of the canyons in woods of coastal live oak and bay. (Photograph of (A) by Jay C. Quast, and (B) by Frederick H. Test.)

Monticello and 5 miles NW Napa) differ from adults from Contra Costa County on the south (vicinity of Orinda) in slightly smaller average size, particularly hind foot, and slightly less reddish coloration of the upper parts. For the Napa County (9) and Orinda (6) specimens, respectively, external measurements and greatest length of the skull average (with extremes) as follows: 202 (196-205), 206 (190-212); 100 (95-103), 105 (93-109); 22.2 (21.4-23), 24 (24-24); ear, measured from the notch in the flesh by the author in both series, 22.6 (21.5-23), 22.3 (22-23); skull, 28.2 (27.7-28.9), 28.5 (28.9-29.9). Specimens from the vicinity of Mount Diablo, 15 miles to the east of Orinda, average smaller rather than larger in external measurements, including the hind foot, than the specimens from Napa County and there is no difference in color.

Specimens from the east and west side of the Great Valley of California do not differ significantly. Local variation is greater than geographic variation between these two areas. Mice from the Sierra Nevada a short distance north of the Tehachapi Mountains approach *montipinoris* in several morphological features, namely longer tail, ratio of body to tail, and larger ears. Mice from near Coulterville and Raymond show intergradation with *montipinoris* (see Figs. 23-24) in these mentioned features.

Specimens from the Santa Ynez Mountains and from along the coast in Santa Barbara County have the smallest skulls. However, even in these, the palatine slits are relatively long, as is characteristic of the race *gilberti*. These animals have long tails, but this is characteristic of the southern populations of *gilberti*.

Specimens examined.—Total number, 837, from the following localities [arranged for California from the north to south by counties on first the west and then the east side of the Great Valley]: Oregon: *Josephine County:* Grants Pass, 4 (U.S.B.S.). *Jackson County:* Sams Valley, 2 (S. G. Jewett Coll.); 6 mi. S Medford (½ mi. S Belmont Orchard), 5; Ashland, 1 (S. G. Jewett Coll.). California: *Siskiyou County:* East Ridge, Beswick, 5 (U.S.B.S.); Hornbrook, 3 (Calif. Acad. Sci.); Table Rock, 10 mi. E Montague, 3,840 ft., 1; Forest House Mtn., 8 mi. W Yreka, 2 (Calif. Acad. Sci.); Mayten, 1; Scott Valley, 1,400 ft., 4 mi. S Ft. Jones, 2 (U.S.B.S.); (caves) 11 mi. NE Weed, 3,600 ft., 7; Gazella Mtn., 1 (Calif. Acad. Sci.); Parks Creek, 1½ mi. SW Edgewood, 2,900 ft., 6; Stewarts Springs, near Weed, 1 (Calif. Acad. Sci.). *Trinity County:* Helena, 1,405 ft., 6; 4 mi. N Mad River Rock, 2,800 ft., South Fork Mtn., 6; 3 mi. NNW Mad River Bridge, South Fork Mtn., 2,900 ft., 2; 1 mi. NW Mad River Bridge, 2,300 ft., 2; 1 mi. N (1) and Reilley's Ranch (2), 3,700 and 3,000 ft., South Fork Mtn., 3; Mad River ford, above Ruth, 2,700 ft., 13. *Glenn County:* Winslow, 5 mi. W Fruto, 700 ft., 2. *Colusa County:* Sites, 1 (U.S.B.S.); 3 mi. W Stonyford, 800 ft., 2; Fout's Spring, 1 (Calif. Acad. Sci.); Sites, 2 (1 in Calif. Acad. Sci.). *Sutter County:* Marysville Buttes, 3 to 4 mi. NW Sutter, 300 to 500 ft., 38. *Lake County:* Rattlesnake Island, Clear Lake, 8; Blue Lakes, 2; Stubbs (K3 Lodge), 1; Glenbrook, 3 (Calif.

Acad. Sci.); Castle Springs, near Middletown, Cobb Mtn., 2,700 ft., 3 (Calif. Acad. Sci.); Harbin Springs, near Middletown, 3 (Calif. Acad. Sci.); Lake County, 1 (Calif. Acad. Sci.). *Sonoma County:* 9 mi. NW Calistoga, 1; O'Connor's Ranch, 3 mi. NNE Kellogg, 2; Santa Rosa, 1 (Calif. Acad. Sci.); Eldridge, 4 (Calif. Acad. Sci.). *Yolo County:* Rumsey, 500 ft., 2. *Napa County:* 5 mi. NW Calistoga, 8; foot Mt. St. Helena (=4 mi. N Calistoga), 34; Mt. St. Helena, 5 (Calif. Acad. Sci.); Mt. Mill Hotel, E base Mt. St. Helena, 2 (Calif. Acad. Sci.); Calistoga, 9; 4 mi. SSE Monticello, 8; 1½ and 2 mi. SW Angwin, 1,300 and 1,200 ft., 2 (D. V. Hemphill Coll.); 5 mi. NW Napa, 1; Huichica Creek, 250 ft., 1. *Contra Costa County:* 2 mi. W Lafayette, 1; 1 mi. E Orinda (=6 mi. W Walnut Creek), 4; Wildcat Cañon, 7; 1 mi. S Orinda, 3; Mount Diablo (and slopes), 1,500 to 3,000 ft., 19 (7 in Los Angeles Mus.); Walnut Creek, 4 (Los Angeles Mus.); 2 mi. SW Walnut Creek, 2. *Alameda County:* Berkeley (including Strawberry Canyon, 700 to 1,200 ft.; Claremont Canyon, 600 ft.; Hamilton Gulch, 700 ft.; ¼ mi. W Grizzly Peak), 138 (2 in Calif. Acad. Sci.; 3 in Univ. Kansas Coll.; 11 in Los Angeles Mus.); Redwood Cr., 1 mi. ESE Redwood Peak, 4; Miller Cr., 5 mi. N Hayward, 300 ft., 4; Dublin Canyon, 2 mi. W Dublin, 800 ft., 2; Niles Canyon, 2 mi. W Sunol, 300 ft., 5 (1 in Calif. Acad. Sci.); Corral Hollow, 1 mi. E Tesla, 250 ft., 2; Arroyo Valle Creek, 2. *Santa Clara County:* Calaveras Valley, 5 (Calif. Acad. Sci.); Alum Rock Park, 1 (Calif. Acad. Sci.); Isabel Cr., 2½ mi. NW summit Mt. Hamilton, 1,800 ft., 14; 2½ mi. NE summit Mt. Hamilton, 5; Isabel Cr., 3 mi. ENE summit Mt. Hamilton, 2,200 ft., 15; Mt. Hamilton, 2 (Calif. Acad. Sci.); O'Connor Ranch [=10 mi. E Gilroy Hot Springs], 3; near Gilroy, 3 (Calif. Acad. Sci.). *Stanislaus County:* 10 mi. W Gustine, 5. *Merced County:* Sweeney's, Herrero Cañon, 22 mi. SW Los Banos, 1,200 ft., 1; Sweeney's Ranch, 22 mi. S Los Banos, 12. *Monterey County:* 2 mi. S mouth Salinas R., 1; Pacific Grove, 1 (Calif. Acad. Sci.); Monterey, 5 (4 in Calif. Acad. Sci.); Seaside, 13; Johnson Ranch, 800 ft., Chular Canyon, 1; Muddy Cr., 1,000 to 1,400 ft., 1 mi. S Chular Canyon, 7; Stonewall Cr., 6¾0 mi. NE Soledad, 1,300 ft., 7; Big Pines, 3,800 to 4,000 ft., 8; N. fork Little Sur River, 2 (Calif. Acad. Sci.); forks Little Sur River, 1 (Calif. Acad. Sci.); Abbotts Ranch, Arroyo Seco, 1; Santa Lucia Peak, 5,600 to 5,907 ft., 2; San Lorenzo Cr., Peachtree Valley, 1,475 to 1,600 ft., 7; 1¼ mi. S Chalk Peak, 3,000 ft., 2; Jolon, 6 (4 in Los Angeles Mus.); Mount Mars, 1 (Calif. Acad. Sci.). *San Benito County:* 1 mi. N Cook Post Office, Bear Valley, 1,300 ft., 13°; Cook (and near Cook) Post Office, Bear Valley, 1,300 ft., 26°; Bear Valley, 1 (Los Angeles Mus.); Butts Ranch, 5 mi. NNE San Benito, 3,000 ft., 18; 5 mi. ENE San Benito, 3,700 ft., 2; 6 mi. ESE San Benito, 1,600 ft., 5; 2 mi. NNE New Idria, 1,900 ft., 3; 1 mi. S New Idria, 3,700 ft., 1; summit San Benito Mtn., 5,250 ft., 4; 1 mi. SE summit San Benito Mtn., 4,400 ft., 9; Hernandez, 1; Laguna Ranch, 4 mi. S Hernandez, 4,000 ft., 20. *San Luis Obispo County:* near San Simeon, 1 (U.S.B.S.); 2 mi. S San Miguel, 620 ft., 1; 5 mi. W Paso Robles, 1 (Los Angeles Mus.); Paso Robles, 1 (Los Angeles Mus.); Santa Margarita, 996 ft., 9. *Santa Barbara County:* 1½ mi. N La Purisima Mission, 600 ft., 3; Bulito Cr., 7 mi. W Gaviota, 100 ft., 1; 11 mi. NW Santa Barbara, Santa Ynez Mts., 2,400 ft., 5; Russell Mesa, 2 mi. ENE Carpinteria, 400 ft., 1. *Ventura County:* Matilija, 2. *Shasta County:* Montgomery [Creek], 3 (U.S. B.S.); McCloud River, near Baird Station, 1; Tower House, 1268 ft., 2. *Tehama County:* Manton, 2,300 ft., 1; Inskip Forebay, 6 mi. SW Manton, 1; Dale's, W and S sides Paines Cr., 600 ft., 15; ¼ mi. E Dale's, 600 ft., 1; ¼ mi. S Dale's,

600 ft., 2; Lymans, 4 mi. NW Lyonsville, 3,300 ft., 4; 2 mi. N Red Bluff, 350 ft., 3; 1 mi. NE Red Bluff, 300 ft., 2; Red Bluff, 8 (Calif. Acad. Sci.); Mill Creek, 2 mi. NE Tehama, 260 ft., 1. *Butte County:* 10 mi. NE Chico, 1 (U.S. B.S.); Feather River, 5 mi. NE Oroville, 1. *Eldorado County:* Limekiln, Middle Fk. American River, 1,000 ft., 2; mouth Middle Fk. American River, 1. *Amador County:* 5 mi. E Carbondale, 500 ft. 2. *Calaveras County:* 1½ mi. NW Sheepranch, 2,400 ft., 1. *Mariposa County:* Dudley, 3,000 ft., 4; 3 mi. NE Coulterville, 3,200 ft., 12; 1 mi. W Coulterville, 1,600 ft., 1; Varain, 4; Pleasant Valley, 600 to 700 ft., 13; 1¾ mi. W El Portal, 1,800 to 1,900 ft., 3; El Portal, 2,000 to 2,500 ft., 6; 7 mi. E Mariposa, 3. *Madera County:* Bass Lake, 1; Raymond, 940 ft., 14; Coarsegold, 8 (U.S.B.S.). *Fresno County:* 2 mi. N Friant, 350 to 550 ft., 5; 3 mi. SE Friant, 4; Dunlap, 2,000 ft., 1; 1 mi. S Dunlap, 2,000 ft., 9; 3 mi. W Miramonte, 2,900 ft., 1; ½ mi. E Miramonte, 3,500 ft., 2; Waltham Cr., 4½ mi. SE Priest Valley, 1,850 ft., [this locality in Fresno County on western side of San Joaquin Valley], 18.

Additional records: CALIFORNIA: *Tulare County:* Canyon Creek, 700 ft., 7 mi. E Orosi (Richardson, *MS*).

Peromyscus truei dyselius Elliot

Peromyscus gilberti, Allen (1896:267).
Peromyscus dyselius Elliot (1898:207), orig. descr.

Type.—Male, subadult, skin only; no. 3562, Chicago Nat. Hist. Mus.; Portola, San Mateo County, California; collected December 23, 1895, by [W. W.] Price and [D.] Coolidge (original no. 24, according to Elliot's original description, *op. cit.,* p. 208). The specimen in the Chicago Nat. Hist. Museum designated "Type" does not have the original label and the type label bears no original collector's number, but has measurements identical with those of Elliot's "type no. 24," and in addition the date, collectors' names, and a museum number. This apparently is the type specimen. (Examined.)

Range.—In California, the Santa Cruz Mountains and slopes to the westward in San Mateo, Santa Clara, and Santa Cruz counties. Known altitudinal range from near sea level as at Redwood City and Palo Alto to near 2,787 feet on Black Mountain. Zonal range, Upper Sonoran and Transition.

Diagnosis.—Size: large (see measurements); tail actually and relatively long, averaging 115 per cent of length of head and body; hind foot long, but not as long as in *sequoiensis*; ear of medium length, similar to *gilberti* but longer than in *sequoiensis,* averaging 90 per cent of length of hind foot. Color: dark, as a result of a reduction in the size of the ochraceous subterminal band; dorsal tail stripe dark; buffy pectoral spot or wash present in most adults. Skull: large; rostrum long and heavy; maxillary breadth great; palatine slits relatively and actually long; alveolar length of maxillary toothrow great.

Color.—Upper parts (May 1) near (*a*) Ochraceous-Salmon uniformly

overlaid with dark brown and black. General effect near (16′) Mummy Brown. Pectoral spot Light Ochraceous-Buff.

Skull.—In addition to the above characters, auditory bullae orbicular (not compressed); posterior border of palate usually with spine.

Comparisons.—From topotypes of *Peromyscus t. gilberti, dyselius* differs in the following characters: Size: tail actually longer, being longer than the body (averaging more than 110 per cent of length of head and body instead of usually less than 100 per cent); hind foot longer. Color: darker, upper parts with less reddish and more black; dorsal tail stripe darker. Skull: larger in all measurements; nasals and maxillary toothrow much longer; maxillary breadth slightly greater; rostrum heavier; auditory bullae more orbicular.

From specimens of *Peromyscus t. montipinoris* from the Techachapi Mountains and the extreme southern Sierra Nevada, *dyselius* differs in the following characters: Color: much darker on all the upper parts as a result of more blackish and reddish of a markedly darker tone; presence of a pectoral spot. Skull: greatest length slightly more; maxillary toothrow and palatine slits much longer; maxillary breadth slightly greater; auditory bullae smaller, less flattened (more orbicular). The two races have bodies of the same size but the ear is shorter in *dyselius.*

For comparison with *P. t. sequoiensis,* see account of that race.

Remarks.—*P. t. dyselius,* a long-tailed, long-footed, dark-colored race, intergrades along the eastern and southern border of its range with the race *gilberti.* Specimens to the west of the Santa Clara Valley are typical of the race *dyselius*; those to the east, as around Mount Hamilton, are lighter colored and have body proportions and skull characters typical of *gilberti.* A specimen from Alum Rock Park, on the eastern edge of Santa Clara Valley, approaches *dyselius,* particularly in having a long tail and long hind feet. In other characters it is similar to *gilberti,* to which race it is referred. Three specimens from 10 miles E Gilroy Hot Springs are slightly nearer to *dyselius* in all of their characters, but they are here referred to *gilberti,* because the average of all the specimens from the eastern side of the Santa Clara Valley is nearer that of *gilberti.* Specimens from the northwest part of the Santa Lucia Range and outer coastal belt south of Monterey Bay are similar to *dyselius* in body proportions, particularly the long tail, but in coloration and cranial characters are more closely related to *gilberti,* to which race they are referred.

The race *P. t. dyselius* possesses the same combination of characters as *P. truei sequoiensis* and *Peromyscus maniculatus rubidus* occurring in the humid coastal belt north of San Francisco Bay. A large series of specimens of the species *P. truei* available from the region adjacent to the eastern side of San Francisco Bay, particularly from the vicinity of Berkeley, Alameda County, exhibits some of these characters, particularly darker

coloration. However, the ratio of tail length to body length averages about 1 to 1, which is typical of *gilberti*, the hind foot is short, and the skull is not as large as *dyselius* or *sequoiensis*, and most similar in the sum of the characteristics to *gilberti*. Apparently the populations occupying the habitats along the western slopes of the Berkeley Hills, which have some transitional zone plants and climatic conditions, approach *dyselius* and *sequoiensis* in certain features. These populations probably do not represent a line of continuous distribution for the two races of the humid, coastal belt – *sequoiensis* and *dyselius* – but more probably they represent "extremes" of *gilberti*.

Osgood concluded, in 1909 (*op. cit.*, pp. 170-71), that the race *dyselius* was "an extreme" in coloration, and if recognized would leave *gilberti* "as an indefinable intermediate between *truei* and *dyselius*." However, *dyselius* is distinguishable by body proportions and cranial characteristics as well as by color. Furthermore, as pointed out elsewhere in this paper, *gilberti*, in its more restricted range, is not an indefinable intermediate, but differs markedly from *truei* in certain characteristics.

In the table of measurements, the average for *P. t. dyselius* is based on five adults specimens from near the type locality. A larger number of specimens (twelve adults) from southwest of the type locality, but in San Mateo County, namely from Pescadero and Butano creeks, give nearly identical averages. The same measurements (ear and calculated measurements omitted) for this larger series are: External: 203, 106, 23.7; cranial: 29.1, 21.7, 13.4, 4.5, 10.9, 4.4, 6.2, 7.2, 10.2, 4.5.

Specimens examined.—Total number, 118, from the following localities. CALIFORNIA: *San Mateo County:* Spring Valley Lakes, 5 (Calif. Acad. Sci.); Redwood City, 6*; Menlo Park, 1; Portola, 2 (1 in Calif. Acad. Sci.); Pescadero Creek (and Basin), 21 (10 in Calif. Acad. Sci.); Butano Creek (and Basin), 6 (3 in Calif. Acad. Sci.). *Santa Clara County:* Palo Alto, 5 (4 in Calif. Acad. Sci.); Stanford University, 3*; Stephens [=Stevens (?)] Creek Canyon, 1; Stevens Creek, 6 (Calif. Acad. Sci.); Black Mountain, 5 (3 in Calif. Acad. Sci.). *Santa Cruz County:* S slope China Ridge, Big Basin, 1 (Calif. Acad. Sci.); E fork Waddell Creek, near Woodwardia Falls, Big Basin, 1 (Calif. Acad. Sci.); Sky Meadow, Big Basin, 2 (Calif. Acad. Sci.); Big Basin, 2 (Calif. Acad. Sci.); Redwood Park, 1,000 ft., 10; 6 mi. NW Boulder Creek, 500 ft. 2 (Coll. D. V. Hemphill); Boulder Creek, 500 ft., 1; Covey's Cottage, 1 mi. W Ben Lomond, 1; 1 mi. NE Bonny Doon, 1,700 ft., 1; Felton, 2 (1 in Calif. Acad. Sci.); Eagle Creek, Paradise Park, 4; Santa Cruz, 1; 3 mi. E Santa Cruz, 1; Valencia Park Ranch, 2; Doyle Gulch (Head Doyle Gulch, 800 ft.), 3; summit Santa Cruz Mountains, 22 (Calif. Acad. Sci.); Berglund Ranch, 1,450 ft., 5 mi. N Corralitos, 1.

Peromyscus truei montipinoris Elliot

Peromyscus montipinoris Elliot (1904:264), orig. descr.
Peromyscus truei, Osgood (1909:166), part.
Peromyscus truei truei, Grinnell (1913:307), part.

Type.—Male, subadult, skin with skull; no. 12267, Chicago Nat. Hist. Mus.; Lockwood Valley, Mount Pinos, Ventura County, California; collected October 5, 1903, by Edm[und] Heller, original no. 3250. In the original description, Elliot did not designate a type specimen but the above type locality. Later (1907:235), he designated, although not by museum number, the only specimen he had available from this locality as the type. This proves to be no. 12267. (Examined.)

Range.—In California, from the Sierra Nevadas south of the Kaweah River (and west of the south fork of the Kern River) south in the Tehachapi Mountains to Calabasas, Los Angeles County, and northwest in the San Emigdio and Tembler ranges to 35° 20′ N latitude. Known altitudinal range from 1,200 feet, as at Calabasas, to 10,650 feet, as along Whitney Creek, Tulare County. Zonal range, Lower Sonoran to Transition, locally Canadian; principally Upper Sonoran.

Diagnosis.—Size: medium (see measurements); tail longer than head and body (more than 100 per cent and usually more than 100 mm.); hind feet and ears long, ear nearly as long as (averaging 98 per cent of) hind foot. Color: light; general effect of upper parts more grayish than average for the species resulting from a reduction of reddish tone. Skull: large; rostrum long and heavy; auditory bullae large; maxillary breadth actually, not relatively, great.

Color.—Upper parts (near-topotype, July 3) near (*c*) Light Vinaceous-Cinnamon overlaid with brown. General effect near (*1*) Snuff Brown.

Skull.—See above under *Diagnosis.*

Comparisons.—From specimens of *Peromyscus t. truei* from California to the east of the Sierra Nevada and from southern Nevada, specimens of *montipinoris* differ in the following characters: Size: larger; tail longer than head and body, being usually more than 100 mm. in length and more than 100 per cent of length of head and body instead of less; hind foot averaging longer. Color: more grayish in both summer and winter pelage as a result of a reduction of reddish tone. Skull: averages larger in all measurements except least interorbital constriction, length of palatine slits, and maxillary toothrow, which average about the same; rostrum longer and heavier; braincase larger; zygomatic width greater. From "near" topotypes of *P. t. truei,* specimens of *montipinoris* differ in the same above-mentioned characters and even more strikingly in length of tail.

From topotypes of *P. t. gilberti,* specimens of *montipinoris* differ in

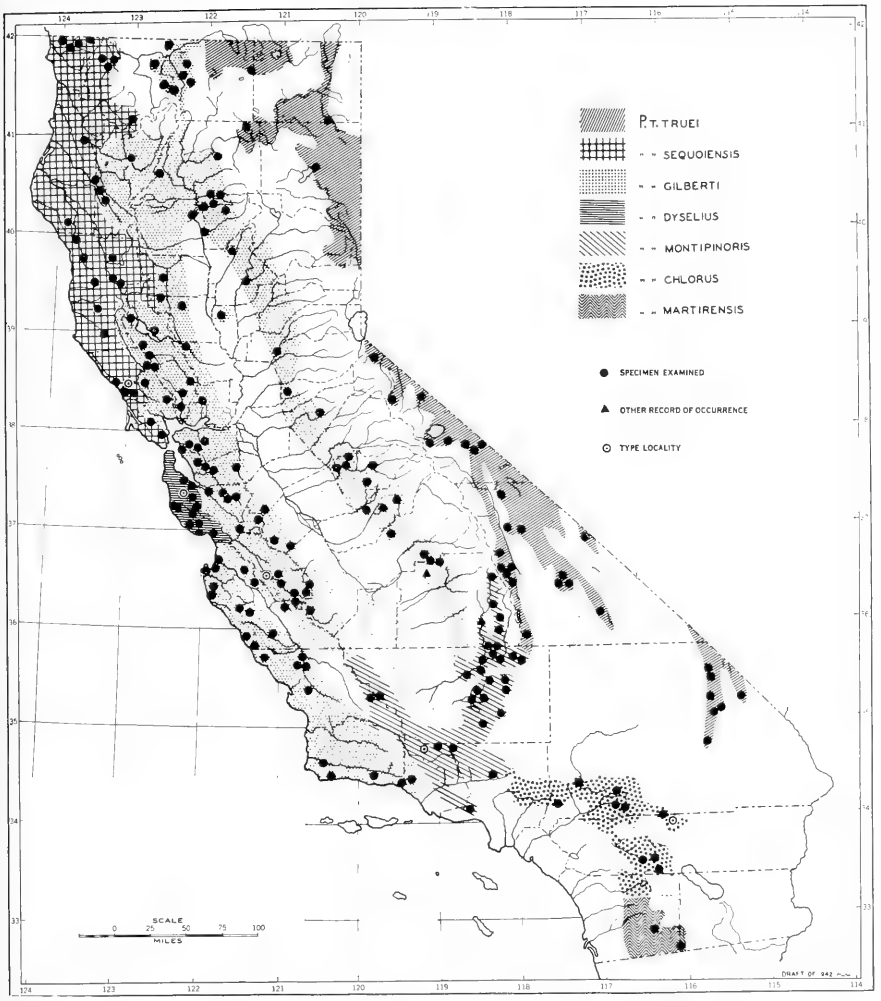

FIG. 21. Geographic range of seven subspecies of *Peromyscus truei* in California.

the following characters: Size: tail averaging longer and body slightly shorter with the tail averaging usually more than 100 per cent of length of head and body rather than 100 per cent or less; hind foot longer; ear much longer. Color: upper parts more grayish, resulting from a reduction of reddish tone. Skull: averages larger in all measurements except greatest breadth of braincase, least interorbital constriction, length of palatine slits, and maxillary toothrow, which average about the same; braincase relatively narrower; palatine slits relatively shorter; rostrum longer; auditory bullae larger with external auditory meatus slightly larger; dorsal curvature of skull less.

For comparisons with *dyselius, chlorus,* and *nevadensis,* see accounts of those races.

Remarks.—The race *montipinoris,* although intermediate geographically between at least three other races, is well marked by such characters as relatively and actually long tail, grayish coloration of upper parts, and large skull. Most characters of the race are not of an intermediate nature between those of contiguous races. For example, specimens of *P. t. montipinoris* have tails averaging more than 100 mm. in length and more than 100 per cent of head and body length (averaging more than 100 per cent for adults from all localities here assigned to the race), whereas specimens of *P. t. truei* from along the eastern slope of the Sierra Nevada north of Walker Pass and from the eastern edge of the Mohave Desert, have tails less than 100 mm. in length and less than 100 per cent of head and body length. From this latter region, in southern Nevada and eastern California, south of 39° latitude, averages for adult specimens of the race *truei* from 32 localities show: Specimens from 27 localities have tail lengths averaging less than 100 per cent, specimens from four localities have tail lengths averaging 101 per cent, a single specimen from the remaining locality has a tail length averaging 115 per cent. Of the same 32 localities, specimens from 29 have tails averaging less than 100 mm. in length, specimens from two localities have tails averaging 101 mm. in length, and a single specimen from the remaining locality (the same one that had a relatively long tail) has a tail length of 108 mm. This shows, in a rough way, the striking differences in body proportions between the races *truei* and *montipinoris.* Similarly, *montipinoris* has a relatively and actually longer tail than the average for specimens of *gilberti* from most localities within the range of the latter subspecies. However, some specimens from near the coast and in the Sierra Nevada in the southern part of the range of *gilberti* have slightly longer tails than more northern populations, and thus closely approach *montipinoris.* In coloration, *montipinoris* is darker but with the reddish element of a markedly lighter tone than in either the race *truei* or *chlorus,* and lighter, more grayish, and with a lighter tone of reddish than in *gilberti.* The skull averages larger in *montipinoris* than in any of the contiguous races, and in this feature is comparable with the large-sized skulls of the humid coastal races *sequoiensis* and *dyselius,* but the race is readily distinguishable from these by other characters including larger ear, lighter coloration, larger auditory bullae, and shorter toothrow.

Intergradation between *montipinoris* and *truei* is indicated by specimens from near the crest of the Sierra Nevada in Tulare County. An adult specimen from Jordan Hot Springs has a tail length of 95 mm. and

a small skull, features characteristic of the race *truei*. However, the relative length of tail (to head and body length) is 104 per cent and the coloration is as in *montipinoris* to which race the specimen is referred. No adult specimens are available from farther up the western slope of the Sierra Nevada, but a juvenile from along Whitney Creek, at an elevation of 10,650 feet, has a relative tail length of 109 per cent of the head and body length. Four specimens of comparable age to the northeast on the eastern slopes of the mountains in Mono County have tails averaging only 100 per cent of the length of the head and body. However, three juveniles from Carroll Creek, Inyo County, at the east base of the Sierra Nevada, and due east of Whitney Creek, have relative tail lengths of 110 per cent. All of these young specimens, and adult specimens, from Mono and Inyo counties, are referred to the race *truei*. In Kern County, *montipinoris* is not restricted only to the "Valley" side of the Sierra Nevada or Tehachapi Mountains, but occurs on both sides. Of the twenty-five specimens from along the east slope of the relatively low, piñon-covered Walker Pass, on the east side of the Sierra Nevada, all are subadults or younger, yet twenty-one of the specimens have a tail as long as or longer than the head and body, and have, also, other characters of the race *montipinoris*. A short distance to the north, along the east side of the Sierras, at Coso, an adult is clearly referable to *truei* and a juvenal animal from Little Lake is, with some uncertainty, referred to *truei* also.

Intergradation between *montipinoris* and *gilberti* is indicated by specimens from the Coast Range and the west slopes of the Sierra Nevada. Specimens from near Miramonte, Dunlap, and Friant, all in Fresno County, have actually and relatively long tails. In ear length, these specimens are intermediate between *montipinoris* and *gilberti*, as they also are in most characters of the skull, although in the series from Friant the nasals are even longer than in specimens of *montipinoris*, but in coloration, are all darker and more reddish as in *gilberti* to which race they are referred. An adult from near McKittrick, Kern County, and a juvenile from Santiago Springs, San Luis Obispo County, have long ears and tails, and the skull of the adult is large as in *montipinoris*, although in coloration this specimen has more reddish as in *gilberti*. These two specimens are referred to *montipinoris* as is a subadult from Cuyama Plain, Santa Barbara County, although the latter is intermediate in the sum of characters between the two races. Specimens from farther west in Santa Barbara County, as those in the Santa Ynez Mountains, and near the coast, as at Bulito Creek, Russell Mesa, and near La Purisima Mission and at Matilija, Ventura County, have actually and relatively long tails, and are intermediate in coloration, but their ears average

shorter than in *montipinoris,* the skulls average smaller, the palatine slits are relatively longer, and the auditory bullae are smaller. These specimens are referred to *gilberti.*

For remarks concerning intergradation with *chlorus,* see account of that race.

Two specimens from as far south, and as near the coast, as Calabasas, Los Angeles County, which locality is south of the Santa Clara River, seem best referred to *montipinoris.* Additional material may show the population there to be nearer *chlorus,* however.

Although the type locality for *montipinoris* is in the vicinity of Mount Pinos, examination of material from the whole range here assigned to this race shows that specimens from this locality are not truly representative of the race. Rather, in most characters they approach *gilberti.* More representative material, and the basis for measurements and comparisons here employed, is that from the vicinity of Kelso Valley and Walker Basin in eastern Kern County. For completeness, however, measurements (the same as those given in the table of measurements except that ear and calculated measurements are omitted) of fourteen adults from Mont Pinos are given, and are as follows: External: 206, 108, 23.6; cranial: 28.8, 21.2, 13.3, 4.5, 10.8, 4.2, 5.9, 7.2, 10.3, 4.2.

Habitat notes.—In valleys opening out into the Mohave Desert, as Kelso Valley, *montipinoris* was found in association with Joshua, cholla cactus, sage brush, rabbit brush, and *Dipodomys panamintinus mohavensis.* In Walker Basin, piñon mice were taken among rocks with *Ceanothus* or other brush forming the vegetative cover. They often were taken in the same area that *Peromyscus boylii* were.

Specimens examined.—Total number, 182, from the following localities. California: *San Luis Obispo County:* Santiago Springs, Carrizo Plains, 1. *Santa Barbara County:* Cuyama Plain, 1 (Cailf. Acad. Sci.). *Tulare County:* In the Sierra Nevada: Whitney Creek, 10,650 ft., 1; Jordon Hot Springs, 1; Jackass Meadows, 7,750 ft., 2; Trout Creek, 6,000 ft., 5; Cannell Meadow, 7,500 ft., 1; Taylor Meadow, 7,000 ft., 2. *Kern County:* Fay Creek, 6 mi. N Weldon, 4,100 ft., 3; Isabella, Kern River, 2,500 ft., 1; Weldon, 2,650 ft., 1; Onyx, 2,750 ft., 3; Kiavah Mtn., near Walker Pass, 7,000 ft., 1; Freemans Canyon, E slope Walker Pass, 4,900 ft., 25 (22 in D. R. Dickey Coll.); E side Walker Pass, 4,800 to 5,000 ft., 3 (Los Angeles Mus.); W slope Walker Pass, 4,600 ft., 11; Bodfish, Kern River, 2,400 to 2,600 ft., 5; 12 mi. below Bodfish, Kern River, 2,000 ft., 2; Piute Mts., 6,000 ft., 5 (3 in Los Angeles Mus.); head of Kelso Creek Valley (W slope), 16 mi. SSE Weldon, 5,000 ft., 1; 2 mi. N Sorrell's Ranch (=NW part Kelso Valley), 4,100 to 4,500 ft., 7*; Thompson Canyon, Walker Basin, 3,900 ft., 10*; Rankin Ranch, Walker Basin, 3,300 ft., 5*; 1 mi. SE Rankin Ranch, Walker Basin, 3,500 ft., 2*; Walker Basin, 3,300 ft., 1; E end Walker Basin, 3,300 to 3,500 ft., 4; 1½ mi. N Tehachapi, 4,250 ft., 4; Tehachapi Peak, 4 (U.S.B.S.); Mojave, 9 (U.S.B.S.); W of McKittrick (divide at 3,000 ft.), 1; Cuddy Valley, 5,000 ft., 4 (D. R. Dickey Coll.); head of Cuddy Valley, near Mt. Pinos, 5,900 ft., 3; Mt. Pinos, 5,000 to 6,000 ft., 11

(7 in Los Angeles Mus.; 4 in D. R. Dickey Coll.); Fort Tejon, 2 (Carnegie Mus.). *Ventura County:* Mt. Pinos, 5,500 to 8,500 ft., 32 (1 in Calif. Acad. Sci.; 3 in Los Angeles Mus.); Cuddy Canyon, Frazier Mtn., 4,400 ft., 1. *Los Angeles County:* Gorman, 2; Mint Canyon, 2,100 to 2,400 ft., 3; Calabasas, 1,200 and 1,300 ft., 2 (U.S.B.S.).

Additional records, from the following locality in California: *Tulare County:* (Osgood, 1909:171): 25 mi. above Kernville.

Peromyscus truei chlorus Hoffmeister

Peromyscus truei chlorus Hoffmeister (1941:131), orig. descr.
Peromyscus truei truei, Grinnell (1908:145).
Peromyscus truei, Osgood (1909:169), part (?).
Peromyscus truei martirensis, Osgood (1909:171), part.

Type.—Female, young adult, skin with skull; no. 77194, Mus. Vert. Zool.; Lost Horse Mine, southern end of Little San Bernardino Mountains (= 69 miles east of Riverside), Riverside County, California; collected March 9, 1929, by Robert D. Moore, original no. 163. (Examined.)

Range.—Interior mountains and adjacent slopes of southern California, particularly those mountain ranges bordering the western edge of the Mohave and Colorado deserts, including the eastern San Gabriel and the San Bernardino, Little San Bernardino, San Jacinto, and Santa Rosa mountains. Known altitudinal range from 2,000 feet, as at Hesperia, to over 7,500 feet, as at Saragossa Spring, both in San Bernardino County. Zonal range, Lower and Upper Sonoran; possibly enters the Transition.

Diagnosis.—Size: medium (see measurements); hind feet short; ears large, as long as hind feet. Color: pale, resulting from a reduction of black; dorsal tail stripe light brown. Skull: small; maxillary breadth small; auditory bullae relatively large.

Color.—Upper parts (March 9) Pale Yellow-Orange overlaid with brown (and blackish near middorsal line). General effect Tawny-Olive mixed with blackish. Dorsal tail stripe light brown.

Skull.—In addition to the above characters, rostrum short, dorsal curvature less convex, bullae not depressed, external auditory meatus relatively large.

Comparisons.—From specimens of *Peromyscus truei truei* from Clark Mountain and the Providence Mountains, San Bernardino County, *P. t. chlorus* differs in the following characters: Size: larger; tail longer than body rather than equal to or shorter than body; length of tail averages 113 per cent as opposed to 101 per cent or less of length of head and body; ears and hind feet slightly shorter. Color: upper parts paler, with less black and an increase in buffy tone; cheeks lighter. Skull: averages smaller in all length measurements except that of palate, palatine slits, and maxillary toothrow; breadth of braincase less; zygomata weaker and more compressed anteriorly; palatal width less.

From specimens of *P. t. montipinoris* from Mount Pinos, Ventura and

Kern counties, and from the Tehachapi of eastern Kern County, *P. t. chlorus* differs in the following characters: Size: hind feet shorter; ear slightly shorter; other body measurements and proportions about the same, except that *montipinoris* has a relatively slightly shorter tail in relation to the length of head and body. Color: conspicuously paler, with a smaller amount of black and with red and buff of a markedly lighter tone; dorsal tail stripe lighter. Skull: averages smaller in all measurements, except least interorbital constriction; maxillary breadth less; auditory bullae more compressed; rostrum narrower and shorter.

From specimens of *P. t. gilberti* from the Santa Ynez Mountains, Santa Barbara County (for remarks concerning these specimens, see under account of *P. t. gilberti), P. t. chlorus* differs in the following characters: Size: larger; body and tail averaging longer; ear slightly longer. Color: conspicuously paler dorsally, including the face, ears, and tail stripe. Skull: slightly larger (in this population, but averaging smaller than skulls of other populations farther north, particularly in greatest length and breadth of braincase); auditory bullae larger; external auditory meatus slightly larger; maxillary breadth less.

From specimens of *P. t. martirensis* from the Sierra Juárez and Sierra San Pedro Mártir of Lower California, *P. t. chlorus* differs in the following characters: Size: averages smaller; ears larger, usually longer than hind foot rather than shorter. Color: upper parts paler as a result of the markedly lighter tone of the ochraceous and basal color-bands; dorsal tail stripe lighter. Skull: averages about the same in measurements, but nasals narrower posteriorly; rostrum slightly shorter and heavier; auditory bullae larger but less orbicular (more compressed); external auditory meatus larger.

Remarks.—P. t. chlorus is the palest-colored race of the species, has a relatively long tail, and a small skull. Specimens of *chlorus* from the slopes adjacent to the Mohave and Colorado deserts are slightly paler in coloration than those from the slopes bordering the San Bernardino Valley, but even these latter are of lighter pelage than any of the adjacent races. Grinnell and Swarth (1913:333) recognized that specimens from the San Jacinto and Santa Rosa mountains were paler colored and also shorter tailed than *martirensis.*

The race *chlorus* is apparently isolated from the subspecies *truei* by the more barren parts of the Mohave Desert, and thus the two do not intergrade directly. Intergradation, however, probably occurs to the northwest by way of the San Gabriel Mountains, *chlorus* intergrading with *montipinoris* and *montipinoris* with *truei.* The specimen from Lytle Creek, in the southeastern end of the San Gabriel Mountains, although similar to *P. t. montipinoris* in external measurements and proportions, is intermediate in coloration, and similar to *P. t. chlorus* in cranial measure-

ments and proportions, and is here referred to the race *chlorus*. Specimens from Mint Canyon, Los Angeles County, to the north of the San Gabriel Mountains and Santa Clara River, although approaching *chlorus* in some characters, are more nearly like *montipinoris*, to which race they are referred. Intergradation between *chlorus* and *martirensis* probably occurs in the area of the Laguna Mountains of San Diego County. Two alcoholic specimens from this area are similar to *martirensis* in body measurements and proportions, but in coloration, insofar as can be determined, they are intermediate. These specimens are referred to *martirensis*, but more material may show the average of the population there to be nearer *chlorus*. The two specimens from ¾ miles south of Mountain Spring, San Diego County, are of little help as they are immature. They tentatively are referred to *martirensis*. A specimen from "summit, San Diego County," is nearer *martirensis* in most features, including color, and the specimen is referred to that race. Judging from Mearns's account (1907:133), "summit" is only two miles west of Mountain Spring.

Osgood (1909:169) records under *Peromyscus truei* [*truei*] three specimens as from "near Morongo Valley," but does not identify the locality further than California. If these specimens are from anywhere near the Morongo Valley situated 25 miles west and 1 mile north of the type locality of *P. t. chlorus*, and well within the geographic range of this race, he does not show, probably by oversight, the occurrence of the race *truei* on his distribution map of *Peromyscus truei* (*op. cit.*, p. 166, Fig. 6) from near here.

Habitat notes.—In the vicinity of the type locality, the species occurs in association with piñons, junipers, and Joshua trees. Along the valley (coastal) side of the San Bernardino Mountains, it occurs in the piñon belt, as along Fish Creek, and below this belt in the scrub oak, as near Seven Oaks. The specimens from the San Jacinto and Santa Rosa mountains were all taken on dry, chaparral-covered hillsides (Grinnell and Swarth, *loc. cit.*). It may be that certain peaks and regions along the western edge of the Mohave Desert, as at Oro Grande and Hesperia, provide suitable habitat for these mice. At these places the mice apparently occur below the piñon belt but probably in the juniper belt.

Specimens examined.—Total number, 53, from the following localities. CALIFORNIA: *San Bernardino County:* Oro Grande, 3 (D. R. Dickey Coll.); Hesperia, 2,000 ft., 1 (Dept. Zool., San Bernardino Valley College); Lytle Creek, near Stockton Flats, 5,000 ft., 1 (Dept. Zool., San Bernardino Valley College); Big Bear Valley, 6,700 ft., 3 (Los Angeles Mus.); Saragossa Spr., 7,538 ft., 1; Seven Oaks, 5,000-5,100 ft., 2; Barton Flats, 6,400 ft., 2 (Dept. Zool., San Bernardino Valley College); Santa Ana River, 5,500 ft., 1; Fish Creek, 6,500 ft., 4; S. Fork Santa Ana River, 6,200 ft., 2; Quail Spring, 17 mi. E Morongo Valley, 4,200 ft., 6*. *Riverside County:* Joshua Tree National

TABLE 5. Selected measurements of *Peromyscus truei*.

Subspecies	Locality	No.	Length of body: Mean with standard error	Length of body: Standard deviation	Length of body: Coefficient of variation	Length of tail: Mean with standard error	Length of tail: Standard deviation	Length of tail: Coefficient of variation	Length of hind foot: Mean with standard error	Length of hind foot: Standard deviation	Length of hind foot: Coefficient of variation	Greatest length of skul: Mean with standard error	Greatest length of skul: Standard deviation	Greatest length of skul: Coefficient of variation
truei	NW Colo., NE Utah	21	95.38± .94	4.30	4.51	86.62±1.32	6.06	6.99	23.52± .20	.91	3.87	...	...	...
"	Valencia Co., New Mexico	27	100.80± .88	4.56	4.52	87.56±1.31	6.30	7.19	22.89± .18	.92	4.02	28.45± .10	.52	1.82
"	Wupatki, Arizona	22	96.64± .81	3.78	3.91	91.45±1.06	4.99	5.46	...	...	...	28.57± .15	.47	1.64
gentilis	S Chihuahua, Mexico	15	93.34± .79	3 06	3.28	102.87±1.63	6.33	6.15	...	...	...	27.66± .11	.37	1.30
gratus	Tlalpan, Mexico	27	93.48±1.12	5.83	6.24	106.36±1.09	6.45	6.06	22.67± .44	.67	2.96	27.33± .13	.59	2.16
"	Michoacán, Mexico	13	99.92±1.70	6.12	6.12	108.83±1.81	6.28	5.77	23.35± .32	1.16	4.97	28.16± .23	.75	2.66
sequoiensis	Guerneville, Calif.	14	104.57±1.98	7.42	7.09	114.42±1.85	6.39	5.58	25.21± .23	.86	3.41	29.71± .21	.62	2.09
gilberti	San Benito Co., Calif.	41	101.20± .70	4.52	4.46	102.00± .95	5.76	5.70	...	...	...	28.80± .10	.59	2.05
"	Marysville Buttes, Calif.	35	96.40± .90	5.46	5.67	96.70±1.10	6.78	7.01	...	...	...	28.55± .18	.87	3.03
"	Berkeley, Calif.	26	100.40± .90	4.60	4.57	96.10± .84	4.12	4.16	23.40± .25	1.28	5.47	28.58± .07	.35	1.22
dyselius	Stanford, Calif.	28	97.82±1.40	7.41	7.57	108.64± .91	4.79	4.41	23.64± .26	1.39	5.88	28.90± .13	.63	2.18
montipinoris	Tehachapi Mts., Calif.	48	95.40± .85	5.91	6.22	104.80±1.02	6.71	6.41	...	...	...	28.70± .09	.58	2.02
martirensis	San Pedro Mártir Mts., L. Calif.	24	97.38± .87	4.24	4.35	109.79±1.16	5.05	4.60	22.71± .19	.88	3.87	28.02± .11	.47	1.68

Monument, 1½ mi. N Lost Horse Well, 4,000 ft., 2* (Dept. Zool., San Bernardino Valley College); Lost Horse Mine, S end Little San Bernardino Mountains, 6*; Joshua Tree Nat. Mont., 4,500 ft., 13 mi. SW Twenty-nine Palms, 5*; Strawberry Valley, San Jacinto Mountains, 6,000 ft., 2; Kenworthy, 4,500 ft., 5; Dos Palmos Spr., Santa Rosa Mountains, 3,500 ft., 1; Santa Rosa Peak, 7,500 ft., 6.

Peromyscus truei martirensis Allen

Sitomys martirensis Allen (1893-187), orig. descr.
Peromyscus martirensis, Trouessart (1897:516).
Peromyscus truei martirensis, Osgood (1909:171), part.
Peromyscus hemionotis Elliot (1903*b*:157). Type from Rosarito Divide, San Pedro Mártir Mountains, Lower California.

Type.—Female, adult, skin with skull; no. 6315/4949, Amer. Mus. Nat. Hist.; San Pedro Mártir Mountains, 7,000 feet, Lower California, Mexico; collected May 8, 1893, by A. W. Anthony.

Range.—The Laguna Mountains of southern California (not to be confused with the Laguna Mountains of extreme southern Lower California) and the Sierra Juárez and Sierra San Pedro Mártir of northern Lower California. Known altitudinal range from 4,200 feet as at Los Pozos to 8,500 feet as at Vallecitos. Zonal range, Upper Sonoran and Transition, chiefly the latter.

Diagnosis.—Size: large (see measurements); tail actually as well as relatively long, averaging 113 per cent of length of head and body; hind foot short. Color: upper parts pale, as a result of a reduction of black, with the reddish tone thus more prominent. Skull: medium-sized; nasals and rostrum short; interorbital breadth great; auditory bullae small but orbicular.

Color.—Upper part (May 27) Ochraceous-Buff mixed with brown and black dorsally. General effect near (*j*) Snuff Brown. Dorsal tail stripe dark brown to black.

Skull.—In addition to the above characters, skull light; maxillary breadth medium; dorsal outline less convex.

Comparisons.—For comparison with *P. t. chlorus* and *P. t. lagunae*, see accounts of those races.

Specimens of *P. t. martirensis* differ from specimens of *P. t. truei* from eastern San Bernardino County, California, in the following characters: Size: larger; tail averaging longer than body (113 per cent) instead of equal to body length (100 per cent); hind foot and ear shorter. Color: upper parts darker as a result of more blackish and shorter ochraceous subterminal band; dorsal tail stripe darker. Skull: slightly smaller; nasals and rostrum shorter; bullae smaller and more orbicular; broader interorbitally. From specimens of the race *truei* from Wupatki Ruins, Coconino County, Arizona, specimens of *martirensis* differ in having ac-

tually and relatively much longer tails (111 mm. as opposed to 90 mm.; 113 per cent as opposed to 94 per cent); upper parts darker in adult October pelage; and further in the other characteristics as given above for *truei* from San Bernardino County.

Remarks.—Apparently *P. t. martirensis* intergrades only with the race *chlorus.* Since suitable habitat is not afforded for the piñon mouse in southwestern Arizona and probably not in extreme southeastern California, this area separates the ranges of *martirensis* and *truei.* Remarks concerning intergradation with *P. t. chlorus* are made under that subspecies.

The type specimen of "*hemionotis*" from Rosarito Divide, in the Sierra San Pedro Mártir, only 36 miles south of the type locality of *martirensis,* does not differ from the latter subspecies in any significant detail and is a synonym of the earlier name.

Habitat notes.—The specimens from Laguna Hansen were taken among rocks and brush at the foot of slopes covered with juniper, scrub oak, and some piñon. At La Grulla and Vallecitos the mice were taken in a higher association, among rocks along the slopes and near meadows grown with yellow pine, and tamarack and Jeffrey pine, respectively. At Los Pozos, the specimen was taken in an association of manzanita, piñon, scrub oak, chamise, and sage brush.

Specimens examined.—Total number, 60, from the following localities: California: *San Diego County:* Laguna Mountains, 5,500 ft., 2; Summit [2 mi. W Mountain Springs], 1 (Amer. Mus.); ¾ mi. S Mountain Springs, 3,300 ft., (actually Imperial Co.!), 2. Mexico: Lower California:Los Pozos, 4,200 ft., 1; Laguna Hansen, 5,200 ft., Sierra Juárez, 13 (6 in U.S.B.S.); and the following localities in the Sierra San Pedro Mártir: Concepción, 6,000 ft., 1; Piñon, W slope Sierra San Pedro Mártir, 11 (U.S.B.S.); La Grulla, 7,200-7,500 ft., 20*; Vallecitos, 7,500-8,500 ft., 9; Rosarito Divide, 1 (Chicago Nat. Hist. Mus.).

Additional records (Osgood, 1909:172): California: *San Diego County:* "Summit Coast Range." Mexico: Lower California: Aguaje de las Fresas; Agua Escondido; Santa Eulalia; Santa Rosa; San Matías Spring.

Peromyscus truei lagunae Osgood

Peromyscus truei lagunae Osgood (1909:172), orig. descr.

Type.—Female, old adult, skin with skull; no. 147004, U.S. Nat. Mus., Biol. Surv. Coll.; La Laguna, Sierra Laguna, Lower California, Mexico; collected January 26, 1906, by E. W. Nelson and E. A. Goldman, original no. 19012. (Examined.)

Range.—Restricted to the Laguna and Victoria mountains of southern Lower California. Known altitudinal range from 4,000 feet as at El Sauce [=El Sauz] to 6,000 feet as in Laguna Valley. Zonal range, Upper Sonoran.

Diagnosis.—Size: medium (see measurements); body short; tail long, averaging 112 per cent of head and body length; hind feet relatively

large; ears short; animals light in weight (averaging 20.7 gms. in 5 adult males). Color: similar to *P. t. martirensis;* possibly slightly darker. Skull: small; maxillary breadth small; nasals actually short, but relatively long; auditory bullae small but not compressed.

Color.—Upper parts (July 13) near (*c*) Light Ochraceous-Buff uniformly mixed with blackish. General effect Dresden Brown.

Skull.—In addition to the above characters: Light-weight (for example, nearly half the weight of a *sequoiensis* skull, the type of the latter weighing 0.37 grams, that of an adult *lagunae,* number 43074, ♀, 0.22 gms.); depth of skull reduced, due to lack of vaulting and small auditory bullae.

Comparisons.—From specimens of *P. t. martirensis, P. t. lagunae* differs in the following characters: Size: smaller; tail actually, but not relatively, shorter; body smaller and lighter (five adult males average 20.7 gms. as contrasted with 24.6 gms. for five adult male *martirensis*); hind foot longer and ear shorter, the ear, measured from notch, dry, averaging 85 per cent of the hind foot length as opposed to 96 per cent. Skull: smaller; narrower interorbitally; maxillary breadth less; auditory bullae slightly smaller. In coloration, *lagunae* appears slightly darker than *martirensis.*

Compared with specimens of *P. t. truei* from eastern San Bernardino County, California, *lagunae* differs in the following characters: Size: tail relatively and actually longer, averaging 112 per cent of length of head and body rather than 100 per cent; ear shorter; hind foot slightly longer; body lighter, averaging 20.7 gms. rather than 23.7 gms. Color: darker, resulting from a reduction in reddish tone; dorsal tail stripe less prominent. Skull: averages smaller in all measurements; bullae smaller; maxillary breadth less; rostrum actually and relatively shorter; depth of skull less.

Compared with topotypes of *P. t. chlorus,* specimens of *lagunae,* though similar in body proportions, differ in having longer hind feet, shorter ears, darker coloration, and a slightly smaller skull in all measurements taken except length of maxillary toothrow.

For a comparison with *P. t. gentilis,* see account of that race.

Remarks.—*P. t. lagunae* is a long-tailed, short-eared form with a small skull, restricted to the Cape of Lower California and isolated from other races by the Gulf of California and the central portion of Lower California. Morphologically it most closely resembles the race *gentilis* from the mainland opposite the Cape. The similarity to *gentilis* is so marked that the question arises as to whether the populations of *lagunae* were not derived from the mainland of Mexico. Yet there is no evidence that the Cape and the Mexican mainland have been connected very recently geologically. Furthermore, the species *P. truei* does not now occur along, or near, the coast on the mainland opposite the Cape, so that

TABLE 6. Average, minimum, and maximum measurements, in millimeters, of adult specimens of the subspecies of *Peromyscus truei*.

Total length	Tail length (vertebrae)	Head and body length (calculated)	Ratio, tail to body (percentage)	Hind foot length	Ear length, from notch, dry	Greatest length of skull	Basilar length	Greatest breadth of braincase	Interorbital constriction	Length of nasals	Shelf of bony palate	Length of palatine slits	Diastema	Postpalatal length	Maxillary toothrow
	P. t. truei; 17 (9♂, 8♀), vicinity of Mt. Taylor, New Mexico														
188[15]	*88*[15]	100	88	*23.1*	*23.7*	*28.5*	*21.4*	*13.1*	*4.5*	*10.7*	*4.1*	*5.8*	*7.1*	*10.2*	*4.3*
171	76			22.0	22.1	28.0	20.6	12.8	4.3	10.1	3.8	5.4	6.9	9.6	4.1
200	100			25.0	25.9	29.7	21.9	13.7	5.0	11.2	4.3	6.1	7.6	10.5	4.5
	P. t. nevadensis; 6 (3♂, 3♀), northeastern Nevada														
201	*93*	108	86	*23.2*	*23.2*	*29.3*	*21.6*	*13.4*	*4.5*	*10.9*	*4.3*	*6.0*	*7.2*	*10.5*	*4.3*
191	88			22.0	22.4	28.7	21.0	13.1	4.3	10.6	4.1	5.8	7.0	9.9	4.2
212	97			24.0	24.8	31.1	22.9	13.6	4.7	11.5	4.5	6.2	7.8	11.0	4.4
	P. t. preblei; 5 (2♂, 3♀), near topotypes														
189	*93*	96	97	*23.0*	*22.9*	*27.9*	*20.5*	*13.0*	*4.5*	*10.5*	*4.1*	*5.6*	*7.0*	*9.8*	*4.2*
180	90			22.0	22.5	27.7	20.0	12.9	4.3	10.3	3.9	5.4	6.8	9.6	4.0
197	98			24.0	23.5	28.3	20.8	13.3	4.7	10.6	4.3	6.0	7.2	10.0	4.5
	P. t. gentilis; 12 (5♂, 7♀), topotypes and near topotypes														
201	*110*	91	121	*23.3*	*19.2*	*27.4*	*20.4*	*12.9*	*4.4*	*10.0*	*3.9*	*5.7*	*6.9*	*9.8*	*4.2*
190	103			21.0	18.0	26.5	19.8	12.3	4.1	9.3	3.6	5.5	6.6	9.2	4.0
213	115			25.0	21.1	28.4	21.2	13.3	4.6	10.6	4.2	6.1	7.0	10.3	4.3
	P. t. gratus; 27 (12♂, 15♀), topotypes														
200[25]	*106*[25]	94	113	*22.6*	*19.9*	*27.3*[25]	*20.5*[25]	*13.0*[25]	*4.4*	*9.9*	*4.1*	*5.7*	*6.8*	*9.7*[25]	*4.3*
183	91			21.0	19.0	25.3	19.3	12.3	4.1	9.1	3.7	5.0	6.3	8.6	4.0
225	120			24.0	21.6	28.4	21.5	13.6	4.8	10.6	4.6	6.1	7.1	10.4	4.5

	P. t. sequoiensis; 12 (9♂, 3♀), topotypes and near topotypes													
220	*114*	106	108	*25.2*	*20.9*	*29.7*	*22.2*	*13.7*	*4.6*	*11.0*	*4.5*	*6.0*	*7.4*	*10.5*	*4.5*
200	104			24.0	20.2	28.3	20.9	13.0	4.3	10.3	4.3	5.6	7.0	9.8	4.2
231	123			27.0	22.0	30.7	23.1	14.0	5.0	11.3	5.0	6.2	7.8	11.0	4.8
	P. t. gilberti; 11 (8♂, 3♀), topotypes													
203[10]	*100*[10]	103	97	*22.8*	*21.6*[10]	*28.5*[9]	*20.0*[10]	*13.3*	*4.5*	*10.4*	*4.2*	*6.1*	*7.1*	*10.1*	*4.3*
183	89			21.0	21.3	27.5	19.8	12.8	4.2	9.8	3.9	5.9	6.9	9.3	4.2
215	110			24.0	22.0	29.4	21.6	13.9	4.7	10.9	4.6	6.4	7.4	10.4	4.5
	P. t. dyselius; 5 (2♂, 3♀), Redwood City and Palo Alto													
206	*110*	96	115	*23.8*	*21.5*[4]	*29.3*[3]	*21.5*[2]	*13.5*[2]	*4.6*[4]	*10.9*	*4.3*	*6.3*	*7.4*	*10.2*[2]	*4.6*
197	103			23.0	21.1	28.2	21.2	13.5	4.5	10.1	4.0	6.0	7.0	10.2	4.5
216	118			25.0	22.7	30.1	21.7	13.5	4.7	11.2	4.6	6.6	7.6	10.2	4.7
	P. t. montipinoris; 14 (8♂, 6♀), SE Kern County													
205	*106*	99	107	*23.9*	*23.4*	*29.1*[13]	*21.5*[13]	*13.3*[13]	*4.5*	*10.9*	*4.3*	*5.9*	*7.4*	*10.4*[13]	*4.3*
192	100			23.0	21.6	28.5	21.0	13.0	4.2	10.4	4.0	5.6	7.3	9.9	4.1
215	118			25.0	24.5	29.7	21.8	13.6	4.6	11.3	4.5	6.2	7.6	10.7	4.5
	P. t. chlorus; 14 (10♂, 4♀), topotypes and near topotypes													
201[13]	*105*[13]	96	109	*22.7*	*22.7*[12]	*28.0*[11]	*20.9*[11]	*13.1*[12]	*4.5*[12]	*10.4*	*4.2*[13]	*5.8*[13]	*7.1*[13]	*9.9*[12]	*4.2*
188	95			21.0	20.9	26.8	19.7	12.8	4.2	9.6	4.0	5.4	6.5	9.4	4.0
221	111			24.0	23.9	28.7	21.5	13.4	4.6	11.0	4.3	6.2	7.4	10.3	4.5
	P. t. martirensis; 8 (5♂, 3♀), La Grulla													
209	*111*	98	113	*22.5*	*21.5*	*28.1*	*20.6*	*12.9*	*4.6*	*10.3*	*4.1*	*5.7*	*7.2*	*10.0*	*4.2*
198	104			20.0	21.0	27.6	20.2	12.8	4.4	10.0	3.9	5.4	6.8	9.5	4.0
227	116			24.0	22.8	28.9	21.4	13.2	4.7	10.5	4.3	6.1	7.4	10.6	4.4
	P. t. lagunae; 7 (5♂, 2♀), Laguna Valley													
199	*105*	94	112	*23.4*	*19.9*	*27.4*	*20.2*	*12.6*	*4.3*	*10.3*	*4.0*	*5.6*	*6.8*	*9.7*	*4.2*
190	100			22.0	19.2	26.8	19.8	12.4	4.2	10.0	3.7	5.4	6.7	9.4	4.1
213	119			24.0	21.1	27.9	20.6	12.7	4.4	10.5	4.1	5.9	7.1	10.0	4.3

Note: Exact localities from which adult specimens are included in these averages are indicated by asterisks under *Specimens examined* in the respective accounts. Superior numbers indicate the actual number of specimens for a particular measurement if fewer than originally stated.

TABLE 7. Measurements of Examined Type-specimens of *Peromyscus truei*

Total length	Tail length	Hind foot length	Greatest length skull	Basilar length	Greatest breadth braincase	Interorbital constriction	Length nasals	Shelf bony palate	Length palatal slits	Diastema	Postpalatal length	Alv. length maxillary toothrow
P. t. truei, ♂, adult, 14954/35108, U. S. Nat. Mus.												
(no ext. meas.)		29.0	22.0	13.7	4.6	10.9	4.3	5.7	7.6	10.2	4.2	
P. t. nevadensis, ♀, adult, 68479, Mus. Vert. Zool.												
212	97	24.0	31.1	22.9	13.5	4.5	11.5	4.5	6.1	7.8	11.0	4.4
P. t. preblei, ♂, young, 78660, U. S. Nat. Mus.												
175	86	23.0	27.4	20.1	13.1	4.4	10.2	4.1	5.4	6.8	9.8	4.1
P. t. sequoiensis, ♂, adult, 20842, Mus. Vert. Zool.												
222	122	26.0	30.1	22.4	13.9	5.0	11.2	4.6	6.2	7.7	10.5	4.5
P. t. dyselius, ♂, subad., 3562, Chicago Nat. Hist. Mus.												
193	101	26.0	(no skull)									
P. t. montipinoris, ♂, subad., 12267, Chicago Nat. Hist. Mus.												
214	118	24.5	28.7	21.1	13.2	4.4	10.4	4.1	5.9	7.2	10.1	4.3
P. t. chlorus, ♀, young adult, 77194, Mus. Vert. Zool.												
196	104	21.0	27.8	21.0	12.8	4.6	10.7	4.1	5.9	7.2	10.1	4.1
P. t. gentilis, ♂, adult, 78937, U. S. Biol. Surv.												
205	115	23.5	27.3	20.8	12.9	4.5	9.7	4.1	5.6	6.9	9.9	4.2
P. t. gratus, ♀, adult, 50619, U. S. Biol. Surv.												
209	114	23	27.2	19.9	13.1	4.5	9.9	3.7	5.7	6.6	9.6	4.4
P. t. lagunae, ♀, old, 147004, U. S. Biol. Surv.												
198	107	22	27.7	20.3	12.7	4.1	10.4	4.0	5.3	6.9	9.7	4.3
P. t. megalotis, ♂, subad., 17943/24854, U. S. Biol. Surv.												
200	108	24	29.1	21.9	13.3	4.2	11.0	4.2	5.5	7.2	10.4	4.4
P. t. pavidus, ♀, old, 8895, Chicago Nat. Hist. Mus.												
238	130	23	...	...	...	4.7	11.8	4.4	6.2	7.6	...	4.5
P. t. martirensis, ♀, adult, 6315/4949, Amer. Mus.												
(no ext. meas.)		28.3	21.2	12.7	4.6	10.1	3.9	5.8	7.1	10.3	4.2	
P. t. hemionotis, ♂, adult, 10156, Chicago Nat. Hist. Mus.												
222	126	22.5	27.6	20.6	13.1	4.6	10.3	4.0	5.8	6.9	9.8	4.0
P. t. lasius, ♀, young adult, 12034, Chicago Nat. Hist. Mus.												
208	105	24	29.3	22.1	13.6	4.3	11.8	4.5	5.6	7.6	10.4	4.2

there is, in addition to the width of the Gulf of California, a wide expanse of land separating the two subspecies. It seems more likely that the populations near the tip of Lower California resemble those of *gentilis* through parallel evolution, for there is, in general, throughout the range of the species *P. truei,* to the southward, an increase in tail length, decrease in body length, decrease in ear length, and decrease in size of skull. The smaller auditory bullae of *lagunae* seemingly were derived from a more northern race with small bullae, such as *gilberti,* whereas the auditory bullae of *gentilis* and *gratus,* slightly larger than those of *lagunae,* seemingly were derived from a more northern form with large bullae, such as *truei.*

Although *lagunae* is not known to intergrade geographically at the present time with any other race of *Peromyscus truei,* it apparently belongs to this species. However, in many respects it shows similarity to *Peromyscus boylii,* a species not known to occur south of the Sierra San Pedro Mártir. It is similar to the latter species primarily in the small size of the external ear. The bullae likewise are small. Nevertheless, the bullae in *lagunae* are larger than those in *P. boylii* from the Sierra San Pedro Mártir. Also, as already pointed out, decrease in size of the ears, and auditory bullae, is to be expected in more southern populations.

Habitat notes.—The race *lagunae* seems to find suitable ecological niches in the piñon-covered mountains of extreme southern Lower California. The range of this race is coincidental with the local distribution of the Mexican piñon, *Pinus cembroides* (see Munns, 1938:11, map 7). Interestingly, the piñon of the Cape region is the same as that of the mainland of Mexico, whereas the species to the north in the San Pedro Mártir is *Pinus edulis.* Up the peninsula from the Cape, piñons are not known to occur again for about 550 miles (a few miles above 30° N latitude, Munns, *op. cit.,* pp. 12-13, maps 8-9) and *P. truei* is similarly not known from this intervening region.

The specimens from Laguna Valley were taken near or among granitic rocks, which are found along the sides of the valley where there is a cover of piñons and black oaks. The specimens from El Sauce, in Agua Caliente Canyon, were all taken among, or near, rocks, but this area is some distance ("an hour's ride," horseback, according to notebook record) from piñon forest, and is grown with black oaks, palms, yucca, and cascara.

Specimens examined.—Total number, 35, from the following localities. Lower California: Laguna Valley, 6,000 ft., Victoria Mountains, 26° (6 in D. R. Dickey Coll.); El Sauz, 4,000 ft., Victoria Mountains, 7; Sierra de la Laguna, 2 (Calif. Acad. Sci.).

Additional records, from the following localities in Lower California: (Osgood, 1909:173): La Chuparosa; Mount Miraflores.

RESUMÉ OF GEOGRAPHIC VARIATION

The variation displayed in the species *Peromyscus truei* is expressed as (a) clinal changes in size (actually this involves several genetical factors for body size, tail length, and other characters), (b) resemblance, in general, between color of pelage and color of the substrate, and (c) variations in size and proportions other than those of a clinal nature. The first two features, clinal variation and color resemblance, are adaptive, and seem to be correlated with certain aspects of the environment. Nonclinal variation, the last feature, is most likely dependent upon chance or random mutations, random elimination of genes, or some feature not apparent.

Clinal Variation

Much of the intraracial variation in *Peromyscus truei* is clinal in nature, that is to say, it shows a gradual trend or geographic gradient. This continues not only within a subspecies but through several subspecies and the clines or gradients usually are interrupted and therefore not smooth and continuous. These clines in *Peromyscus truei,* and in most if not all species of *Peromyscus* in western North America, run from north to south (southward) and east to west (coastward), any one being transected by the other. For example, there is, in a general way, with exceptions to be pointed out beyond, a (1) decrease in size of body, (2) increase in length of tail, (3) decrease in size of ear, (4) decrease in length of hind foot, and (5) decrease in size of skull from north to the south. The same changes, in these same features, with certain exceptions, occur from the interior toward the Pacific Coast.

In the Great Basin-Mexican cordilleran series of populations, representing the races *preblei, nevadensis, truei, gentilis,* and *gratus,* there is a gradual decrease in body size to the southward. *P. t. preblei* is an exception in most character-gradients for individuals of it are small, yet *preblei* is the most northern race. Another exception is to be made for certain populations of the most southern race which have longer bodies than many more northern populations. There is a more consistent clinal increase in actual and relative length of tail, decrease in size of ear, and decrease in size of skull to the southward. There is little change in length of hind foot. These clinal changes in certain features are shown in Figure 22. In this and subsequent figures attempt has been made to portray the spatial relations of the various populations in order to give a better picture of the clinal changes. The species is almost continuously distributed along this cline and almost any population has opportunity to crossbreed with the next.

From east to west — from the eastern side of the Rocky Mountains

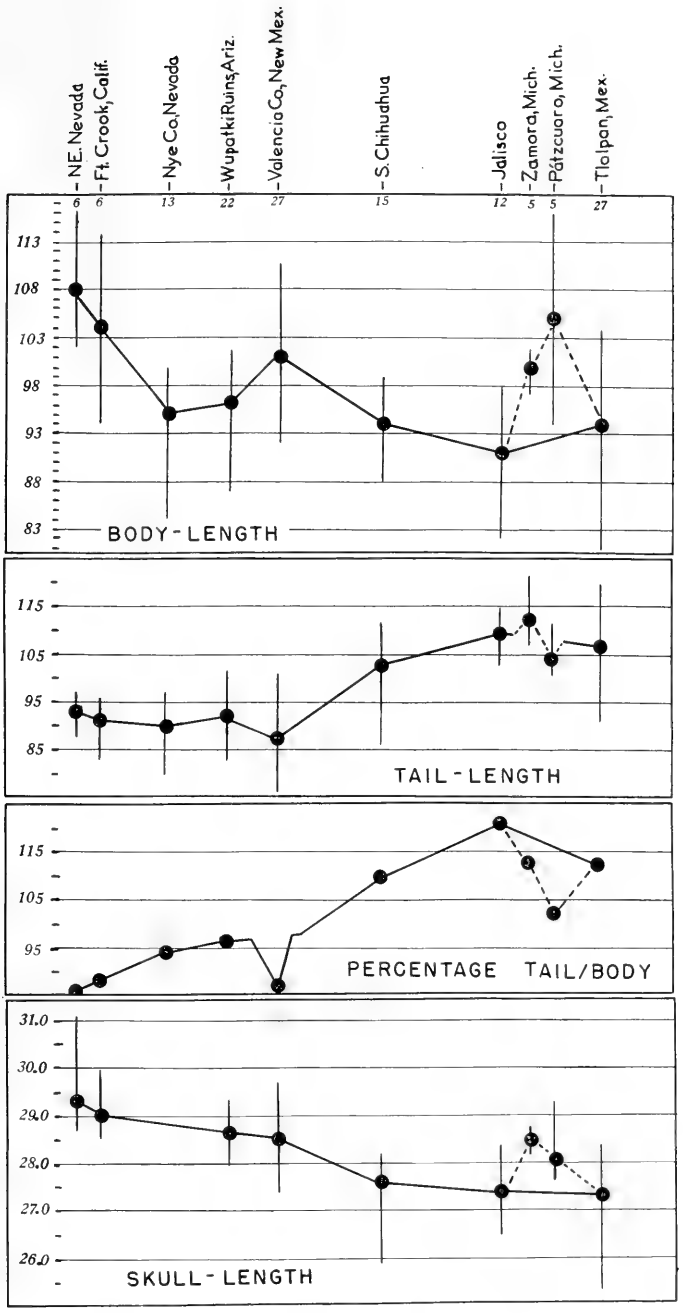

FIG. 22. Diagrams showing geographic and individual variation in populations from northern Nevada and California to the Federal District, Mexico, with each centimeter between localities equaling approximately 330 miles in a north-south direction. Populations represented are of the subspecies *nevadensis*, *truei*, *gentilis*, and *gratus*. Length of vertical lines shows range of individual variation; points connected by lines indicate averages; superior numbers indicate number of specimens measured.

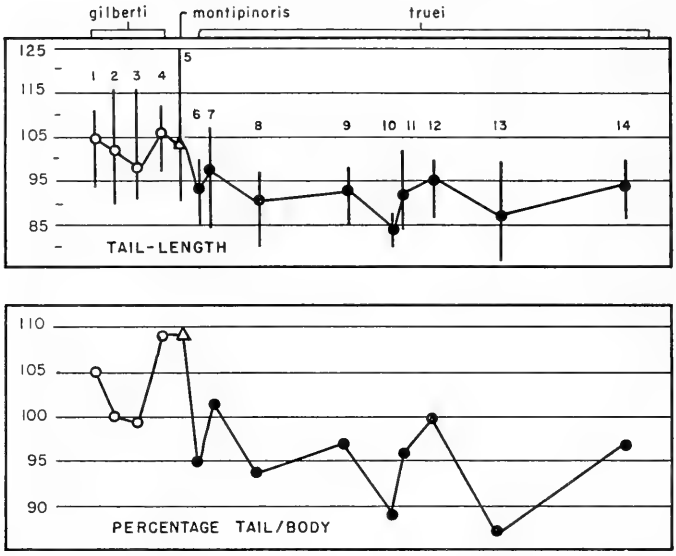

FIG. 23. Diagrams showing variation in *P. truei* from some localities mostly between the 36th and 38th parallel, with the westernmost locality at the left and 1 centimeter equaling about 180 miles. Vertical lines indicate range of variation; points connected by lines mark averages.

Localities, by number, are: *1*, Soledad, Monterey Co., Calif. (7 specimens); *2*, San Benito Co., Calif. (37); *3*, Coulterville and El Portal, Mariposa Co., Calif. (15); *4*, Raymond, Madera Co., Calif. (9); *5*, Kern and Ventura cos., Calif. (48); *6*, Panamint and Inyo mts., Inyo Co., Calif. (33); *7*, Granite and Providence mts., San Bernardino Co., Calif. (25); *8*, southern Nye and Lincoln cos., Nevada (13); *9*, Mohave Co., n.w. Ariz. (8); *10*, Deadman Flat, Coconino Co., Ariz. (5); *11*, Wupatki Ruins, Coconino Co., Ariz. (22); *12*, Navajo Co., n.e. Ariz. (6); *13*, Valencia Co., New Mex. (27); *14*, southeastern Colo. (4).

across the Great Basin to the coast of California — there is an increase (relative and actual) in length of tail, decrease in size of ear, and decrease in size of auditory bullae. More in detail: The tail is short in all *P. t. truei* (although there is considerable local variation), it is markedly longer in *montipinoris*, the next race to the west, slightly shorter in *gilberti*, and longest of all in the westernmost subspecies *dyselius*. Ears are large in *truei* and *montipinoris*, shorter in *gilberti*, and shortest in *dyselius*. Variation in the size (that is, inflation) of the auditory bullae behaves in the same way as does the size of the pinna of the ear. Many features show no clinal change along this series, as, for example, length of body and greatest length of skull. Gradient variation along this cline is primarily between populations of different subspecies, whereas the variation within a subspecies is not clinal. Figure 23 shows, in graphic fashion, some of this clinal and nonclinal variation.

From central Oregon to the tip of Lower California, in populations of the races *preblei*, *gilberti*, *montipinoris*, *chlorus*, *martirensis* and *lagunae*, several characters show gradient or clinal variation (see Figure

24). Here, as in the other north-south series, there is an actual and relative increase in length of tail and decrease in size of ear and skull to the southward. Nevertheless, many populations from the Tehachapi Mountains and from near the coast are relatively longer tailed than the most southern populations. This is one of the complications resulting from an east-west cline crossing a north to south cline. Most populations from the Tehachapi and San Bernardino mountains, races *montipinoris* and *chlorus,* are long eared and consequently do not form part of an otherwise graded series. Interestingly, these two races of long-eared mice inhabit areas of piñons and rocks, and not dense brush as does the short-eared *gilberti.* There is no significant variation in length of hind foot in this series.

From the interior of California to the coast there is an increase in body size, length of tail, hind foot, and skull, and an increase in dark pigmentation. The change between populations in the less humid area and those in the humid redwood belt is abrupt as to length of hind foot. There is also a sharp intensification of both the dark and ochraceous pigment. As a result, the general color effect is dark and reddish, with an ochraceous wash even on the underparts. The extreme of humus in the soil in the redwood belt makes the substrate dark. Mice with those characters just described occur not only in the redwood belt proper, but in isolated patches of redwoods, as along the east side of San Francisco Bay or in the "islands" of Transition life-zone north of this bay.

Within this redwood belt there again are north-south clines superimposed on east-west clines. There is a decrease in body size, increase in relative length of tail, and decrease in size of skull to the southward. Clinal trends in length of hind foot and length of ear are the reverse of those in the other north-south clines, for the ear is shortest and the hind foot longest to the north.

Much of the clinal variation in *P. truei* is of such a nature that it does not conform to certain "ecological" rules formulated by Bergmann, Allen, or Gloger. From the north to the south or from the Great Basin to the coast, that is to say from cooler to more temperate (warmer) climates, there is a lengthening of the tail, as suggested by Allen, but there is a decrease in size of ear (the reverse of Allen's rule). The largest bodied animals are from near the Pacific Coast, not at the northernmost part of the range of species, as one would expect according to Bergmann's rule. Although northern subspecies are large in body, the populations farthest to the north average little if any larger in body size, and specimens of *P. t. preblei* are even smaller than most southern populations. Similarly, the increase in the amount of both melanin and phaeomelanin pigment in specimens from the cooler areas does not wholly conform to Gloger's generalization that reddish pigment is intensified in warm areas and, conversely, dark pigment in cool areas. These ecological rules, just men-

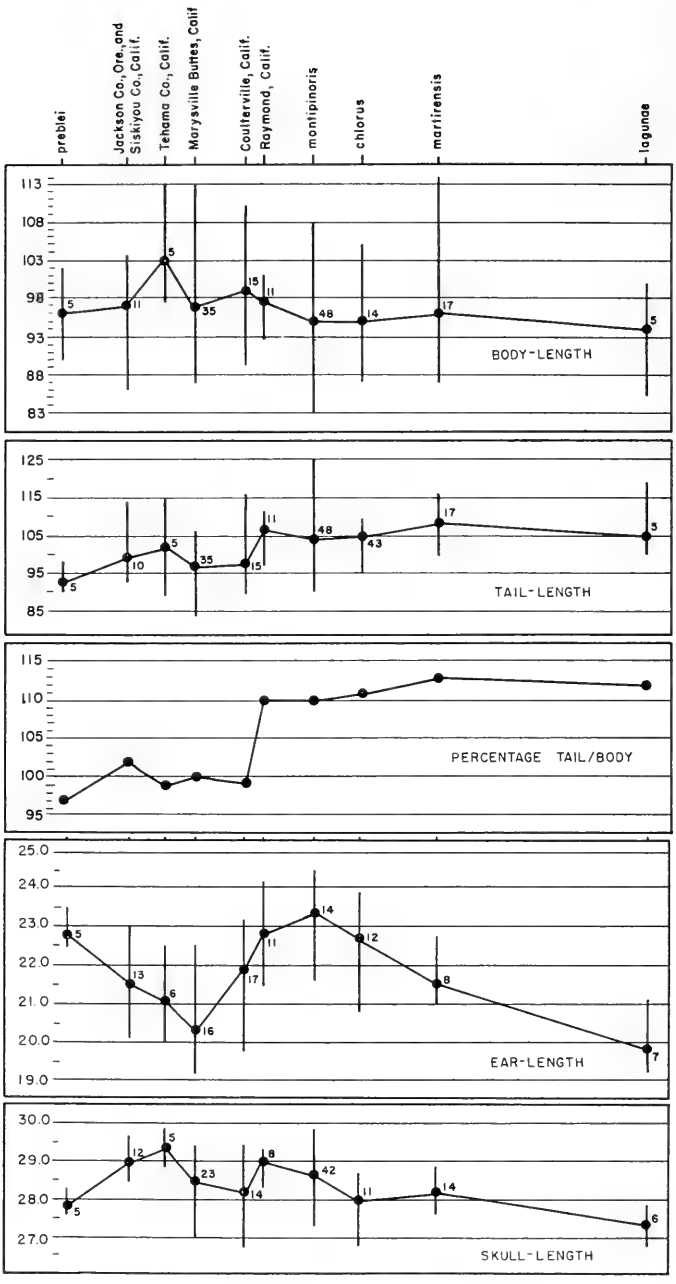

FIG. 24. Diagrams showing variation in: length of head and body, length of tail, tail length expressed as a percentage of body length, length of dry ear, and greatest length of skull. Localities are arranged in a north-south direction, from central Oregon southward along the east side of the Valley of California to the tip of Lower California, and, in this sequence, from left to right on the diagram, with 1 centimeter equaling roughly 240 miles. Localities referred to by subspecific names are type localities or their immediate vicinities. Length of vertical lines shows range of individual variation; points connected by lines mark positions of averages.

tioned, have to do principally with correlating variations in the temperature of the environment with geographic variation in morphological characters of the animals. Since environmental factors other than temperature seem to be most closely correlated with variation in *P. truei,* it is not to be expected that these rules would apply.

Since clinal changes are relatively uniform in any one direction, longitudinally or latitudinally, it is not surprising that examples of parallelism are found in *P. truei.* A good illustration of this is found in the subspecies *P. t. lagunae* and *P. t. gentilis.* These two races resemble each other closely. They are separated from each other by the Gulf of California and the many miles of coastal country inhospitable to piñon mice (see Figure 17). To the north, around the head of the Gulf, they are separated through parts of the ranges of *truei, montipinoris, chlorus,* and *martirensis. P. t. lagunae* occurs near the tip of Lower California, and *P. t. gentilis* occurs nearly opposite on the mainland of Mexico. Both occur at about the same latitude, although *lagunae* occurs nearer the coast. The fact that these two races resemble each other so closely, even more closely than they resemble adjacent races to the north, and to the south in the cases of *gentilis,* probably is the result of parallel clinal changes, and not the result of close genetic relationships of the two subspecies. The same parallel clinal changes probably account for the resemblances between populations of mice in the northern humid coastal belt and those in the isolated "islands" of Transition life-zone in an otherwise Sonoran area. It is not inconceivable that with such clinal variation, groups of populations or microgeographic races of *Peromyscus,* one indistinguishable from the other yet separated from each other, may have arisen through the effects of selection in similar environments. Dice (1940:218) has suggested that *Peromyscus maniculatus rufinus,* as this race is now defined, may be of this nature ("polyphyletic" in Dice's terminology). The nearest approach to this condition in *Peromyscus truei* is that of the populations in the coastal redwood belt. The mice in this belt, both north and south of San Francisco Bay, have many characters in common, and in these features differ rather sharply from the race to the eastward. Differences between the two races in the redwood belt, north and south of San Francisco Bay, are of less magnitude than those between either of these races and the race *gilberti* to the eastward. The populations in the coastal belt on opposite sides of the Bay probably have been isolated since or before the Pliocene. During this lapse of time, probably both races have become differentiated, and probably both independently, with parallel selectional processes operating under parallel ecological conditions. Both have probably differentiated from different segments of the race farther inland. Yet the two coastal races are so similar that some authors may prefer to apply a single subspecific name to both. This has been the case, up to the present

time, with *Peromyscus maniculatus:* populations in the redwood belt both north and south of San Francisco Bay are called *P. m. rubidus.* Also in this instance the two parts of the subspecies appear to have evolved independently.

Color Variation

If there are interracial trends or clinal changes in coloration, comparable to changes in the skull and external measurements, my analysis has failed to disclose them. Where variation in color does occur along a cline, it seems to be correlated with variations in the color of the substrate. For example, where dark-colored or black lavas are present, as around Wupatki National Monument, Arizona, or on the slopes of volcanoes in southern Mexico, the mice are darker colored. Because the extremely dark-colored and light-colored substrates are discontinuously distributed, corresponding color variants in the mice are similarly distributed. In spite of this general correspondence between color of mouse and substrate, *truei* never differs as much from the basic color as do some other mice, such as *Peromyscus crinitus.*

In humid climates, and in areas of correspondingly heavier brush and increased humus in the soil, the pelage of the mice is darker. This is the result of a slight increase of eumelanin pigment, but there seems also to be an increase of phaeomelanin pigment. In areas of dark substrate, irrespective of the climate, there is an increase of eumelanin pigment. Likewise, increase in density of the vegetational cover seems to be correlated with darker color of pelage in piñon mice.

Nonclinal Variation

Variation which is not clinal in its expression or variation other than that of color is not important as far as can be ascertained. Often in many species nonclinal variation is the indirect result of isolation, whereby a nonselective feature becomes fixed in a small population. Since piñon mice are closely restricted in their ecological predilections, and since their ecologic niches are not continuously distributed, it follows that many populations are now isolated one from another. Some populations have been completely isolated for thousands of years — witness the populations isolated on Marysville Buttes, in California, or those on the tip of Lower California. But isolation has not been an important factor in effecting variation in *Peromyscus truei.* Although each of these examples is completely isolated, geographically, from other piñon mice, it differs only slightly from nearby populations. For further comment concerning these populations, see the accounts of *Peromyscus truei gilberti* and *P. t. lagunae,* respectively. Probably ecological conditions have remained uniform in these isolated areas of habitation, and selection has not favored the establishment or fixation of random mutations.

IV. Variation and Subspeciation

The geographic races or subspecies of piñon mice differ, one from the other, as the result of clinal variation, with the clinal variation within a unit or subspecies less than that between adjacent subspecies. These clinal variations in *Peromyscus* are genetical differences, as has been demonstrated by Sumner (1918;1932). This raises the question as to what controls or effects such clinal variations. Undoubtedly there are many contributing factors. One obvious correlation is that of variation in morphology and color with variations in certain features of the environment. One of the most striking, to me, is that of variation of density of vegetational cover and variations in such morphological features as the external ear, hind foot, auditory bulla, and tail. The correlation exists of the less dense the vegetational cover (as for example, the underbrush and shrubs), the larger the ear, the more inflated the auditory bulla, the shorter the hind feet, and the shorter the tail. The cover is sparse, relatively speaking, in the Great Basin, the Colorado plateau, in parts of the Mexican plateau, and parts of southern and Lower California. Here, *Peromyscus truei* live principally among piñons or junipers and rocks. These mice possess the morphological features mentioned above. In this region any slight adaptations that would increase the acuteness in hearing, and thus enable the mouse to detect potential predators while still some distance off, would also give that mouse more time to seek proper refuge in the sparse cover. In other words, larger sound receptors, in the form of larger external ears and greater resonating chambers, in the form of more inflated auditory bullae, have definite value — survival value perhaps — to these mice. To the westward or to the southward, as around the valley of California and toward the coast or in southern Mexico, the vegetational cover of the area inhabited by *Peromyscus truei* is, in general, more dense. For example, in the coastal area, the mice live in thickets of blackberry, poison oak, fern, and other shrubs and trees. For these mice, in denser cover, more and perhaps louder noises are made by enemies moving through the brush, and safe retreats for the mice are less widely spaced. To escape predators, these mice have less need than their kin for acute hearing, and accordingly the ears and bullae are smaller. These mice may need only to run, swiftly

and surely, along or over some branches to find refuge. Sureness of grasp and balance are advantages here, and an increase in size of feet and length of tail provide such advantages. These advantages, slight though they may seem, very possibly could have really selective value. Thus, environmental features, indirectly and through selection, may easily account for much of the subspecific differentiation in *Peromyscus truei*.

Clinal variations in body size and skull size are not readily correlated with environmental factors, but these variations may be indirectly correlated with certain environmental factors.

V. Variation and Speciation

Various subspecies of *Peromyscus truei* may be grouped together into larger units, based on their morphological similarities. One such grouping might be: (1) a unit in which the mice have a short tail (shorter than head and body), long ears, and large bullae — *truei, nevadensis, preblei*; (2) a unit with a tail of medium length (may be slightly longer or slightly shorter than the body) and with small to medium-sized bullae — *gilberti*; (3) a unit with a long tail (longer than body)— *gentilis, gratus, lagunae, sequoiensis, dyselius, montipinoris, chlorus, martirensis*. The long-tailed mice of unit 3 could be divided into those with shorter ears and small bullae (*gentilis, gratus* and *lagunae*) and those with bullae and ears of medium or large size (the remaining subspecies of the unit). Although such a grouping into three or four units portrays morphological similarities, it may not represent the true phylogenetic relationships, because these similarities probably have arisen independently and probably through parallel development in many subspecies.

A more natural grouping would include all the subspecies in two major units: (a) one unit comprising the subspecies of the Great Basin and Mexican mainland, namely *truei, nevadensis, gentilis, gratus*, and *preblei*, and characterized usually by larger ears and more inflated bullae than in populations of mice of the other unit at the same latitude and (b) a second unit, west of the Sierra Nevada-Cascade Chain, and characterized usually by smaller ears and less inflated auditory bullae. These two units might be called the *truei* unit and *gilberti* unit. These two units intergrade only in a limited area: across Walker Pass in the southern end of the Sierra Nevada and possibly in the region north of Mount Shasta, in California and Oregon. Possibly the species is continuously distributed through the canyons of the Pit or Feather rivers in California, but there is no positive evidence now available that such is the case. At the one place where the two units are known to intergrade, through Walker Pass at the southern end of the Sierra Nevada, the zone of intergradation is exceedingly narrow. The morphological features of the *gilberti* unit distinguishing it from the *truei* unit east of the Sierra Nevada are of the same kind but of slightly less magnitude than those

distinguishing the species *truei* from the full species *nasutus, bullatus,* and *difficilis.* Although the *gilberti* and *truei* units intergrade now, a slight ecological change at the top of the pass would isolate them. Thus, if separated for a time, further divergence might ensue, resulting in partial or complete infertility. This would be comparable to the only partial infertility between the species *truei* and *nasutus.* The *gilberti* unit and the *truei* unit, under such circumstances, might each be considered full species.

Geographical isolation, together with morphological, ecological, and perhaps physiological divergence, has resulted in two groups of subspecies which may represent potential or "near" species. Certain species closely related to *Peromyscus truei* must have arisen in this fashion, and some of these species have not attained the degree of differentiation (both morphologically and physiologically) that others have. Thus, within the *Peromyscus truei* species complex, several stages in the dynamic process of speciation can be detected: populations; subspecies; subspecies units (*P. t. truei* and *P. t. gilberti* units); poorly or weakly differentiated species, incompletely inter-fertile (*P. nasutus* or *P. truei*); and strongly differentiated species.

Plates

PLATE I. *Peromyscus truei truei* from 2 miles west of Santa Fe, Santa Fe County, New Mexico. Note the large ears, short, well-furred tail, and long, lax pelage. Specimen obtained by Edward Kudla and Dean Ecke, March 16, 1951. (Photograph by Woodrow W. Goodpaster and Karl H. Maslowski.)

PLATE II. *Peromyscus nasutus*, a member of the *truei*-species group, from Bingham Hill, 6 miles northwest of Fort Collins, 5,300 feet, Larimer County, Colorado. Note that the ear is slightly smaller than in *Peromyscus truei*. Obtained November 8, 1950, by R. G. Beidleman. (Photograph by Woodrow W. Goodpaster and Karl H. Maslowski.)

PLATE III. *Peromyscus nasutus* from Bingham Hill, 6 miles northwest of Fort Collins, 5,300 feet, Larimer County, Colorado. Note that the tail is long (actually longer than head and body) and considerably longer than in *Peromyscus truei truei*. Obtained November 8, 1950, by R. G. Beidleman. (Photograph by Woodrow W. Goodpaster and Karl H. Maslowski.)

PLATE IV. *Peromyscus truei gilberti* from the San Joaquin Experimental Range, Madera County, California. Note the large ear and long tail, which is about equal to the length of head and body. Specimen obtained by Jay C. Quast, January, 1951. (Photograph by Woodrow W. Goodpaster and Karl H. Maslowski.)

PLATE V. *Peromyscus truei gilberti* from San Joaquin Experimental Range, Madera County, California. Obtained by Jay C. Quast, January, 1951. (Photograph by Woodrow W. Goodpaster and Karl H. Maslowski.)

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