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MAMMALS OF DEATH VALLEY

BY
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Museum of Vertebrate Zoology
University of California

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The present account pertains exclusively to that portion of Death Valley, Inyo County, California, which lies below sea-level. The boundary thus arbitrarily set is the topographic contour marked "00" on the Ballarat and Furnace Creek sheets, United States Geological Survey. No species is listed in this paper that has not been found in the mapped area surrounded by this contour. The lowest point in this area as shown on the maps cited, at the sink marked "Bad Water," has been variously given as 280 to 310 feet below sea-level.

The materials upon which this contribution is chiefly based are contained in the Museum of Vertebrate Zoology and were gathered during three trips made into Death Valley. In 1917, on April 2, in company of Mr. Joseph Dixon, then also of the Museum staff, I entered the Valley by the way of the road down Furnace Creek Wash, and I left on May 2 by the way of Ryan; Mr. Dixon remained, and at intervals he collected mammals in below-sea-level parts of the Valley, until May 22, when he left by the road up Emigrant Cañon. In 1920, in company of Dr. Francis B. Sumner, of the (then) Scripps Institution of Biological Research, I came into the Valley

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down the Emigrant Cañon road on April 2 and left by the Furnace Creek Wash road on April 22. In 1933, in company of Mrs. Hilda W. Grinnell, I entered the Valley over the (then) Eichbaum Toll Road on October 13 and left over the highway to Death Valley Junction on October 30.

During each of these three trips specimens of vertebrate animals were collected, and field notes gathered, by my companions as well as myself. The vigorous cooperation of each one of them is hereby acknowledged, and specific instances of help are mentioned in the course of the following accounts. Headquarters on each trip were made at Furnace Creek Ranch, but numerous collecting stations were occupied up and down the Valley, though some of them were merely one-night "dry" camps. Localities have been described and some peculiarities of the natural history of the area discussed in my preceding papers on the birds: "Observations upon the Bird Life of Death Valley" (Proc. Calif. Acad. Sci., ser. 4, vol. 13, 1923, pp. 43-109); "Further Observations upon the Bird Life of Death Valley" (Condor, vol. 36, 1934, pp. 67-72). Place-names are employed throughout the present account of the mammals as used in my other papers, which are as shown on the old U.S.G.S. topographic sheets. No attempt is made to concord with the new place-names on various later maps, resultant from the current great human "development" of the Valley.

I have made no effort to incorporate in this report facts from outside sources. The Death Valley Expedition of 1891, under the leadership of Dr. C. Hart Merriam, traversed the general region; while mammals were collected at places on the floor of the Valley, no single report on them, as originally was planned, has ever appeared. The specimens obtained, most of them probably, have been recorded here and there, in connection with general systematic revisions of single species or genera. Edmund Heller collected in the Valley briefly in 1903, and his mammals were reported upon by Elliot (Field Columb. Mus., zool. ser., vol. 3, no. 16, 1904). Other collectors have visited Death Valley, but no species other than those listed herein, has to my knowledge been found.

The collection of mammals in the Museum of Vertebrate Zoology from the restricted portion of Death Valley under consideration numbers 305 specimens. These represent 25 out of the 26 species known to date from that area—all of them except *Homo*. The total list follows.

[Since this paper was written, Miss Annie M. Alexander and Miss Louise Kellogg did some field work in Death Valley, chiefly in search of the elusive pocket mouse, *Perognathus penicillatus stephensi*. In

this quest they were successful, and I am permitted to include an account of their findings herein, under the appropriate species heading.]

MAMMALS KNOWN FROM BELOW-SEA-LEVEL PORTION OF DEATH VALLEY

- Myotis californicus pallidus* Stephens. Desert Little California Bat.
Lasionycteris noctivagans (LeConte). Silvery-haired Bat.
Pipistrellus hesperus hesperus (H. Allen). Western Canyon Bat.
Nycteris cinerea (Peale and Beauvois). Hoary Bat.
Antrozous pallidus pallidus (LeConte). Desert Pallid Bat.
Tadarida mexicana (Saussure). Mexican Free-tailed Bat.
Taxidea taxus berlandieri Baird. Mexican Badger.
Vulpes macrotis arsipus Elliot. Desert Kit Fox.
Canis latrans estor Merriam. Desert Coyote.
Lynx rufus baileyi Merriam. Desert Wildcat.
Homo sapiens americanus Linnaeus. American Indian.
Citellus tereticaudus eremonomus Elliot. Death Valley Round-tailed Ground Squirrel.
Ammospermophilus leucurus leucurus Merriam. Desert Antelope Ground Squirrel.
Perognathus formosus formosus Merriam. Utah Long-tailed Pocket Mouse.
Perognathus penicillatus stephensi Merriam. Stephens Desert Pocket Mouse.
Dipodomys merriami merriami Mearns. Merriam Kangaroo Rat.
Dipodomys deserti deserti Stephens. Big Desert Kangaroo Rat.
Onychomys torridus longicaudus Merriam. Long-tailed Grasshopper Mouse.
Reithrodontomys megalotis megalotis (Baird). Desert Harvest Mouse.
Peromyscus crinitus stephensi Mearns. Stephens Canyon Mouse.
Peromyscus eremicus eremicus (Baird). Desert White-footed Mouse.
Peromyscus maniculatus sonoriensis (LeConte). Sonora White-footed Mouse.
Neotoma lepida lepida Thomas. Desert Wood Rat.
Lepus californicus deserticola Mearns. Desert Jack Rabbit.
Sylvilagus audubonii arizonae (Allen). Arizona Cottontail.
Ovis canadensis nelsoni Merriam. Desert Bighorn.

I have collated from the collectors' notebooks, and present herewith, the records of rodent traps out and the "catch" for the five general localities worked in the below-sea-level portion of Death Valley. The resulting figures do not include those of Dr. Sumner at Furnace Creek Ranch; these are given in toto in a table elsewhere in this paper. Also, in 1917, there were rodents captured and saved as specimens, from trap-lines, record of which was, unfortunately,

not kept. It should further be understood that nowhere nearly all mammals caught were saved as specimens; there were "discards", but these are included in the records of catch which enter into the figures now given.

A total of 2445 trap-nights definitely of record produced exactly 300 rodents, of 12 species. This means 8+ trap-nights per rodent caught, on all sorts of ground, or a 12+ per cent "catch." I tried to tabulate this catch by habitats, but the record is not satisfactory for determining traps-out per habitat. Of the rodents caught (300), 217 are definitely recorded as taken under or near mesquites (on sand dunes, sandy ground, or silty ground). This substantiates the general impression gained that the mesquite growths are productive of the greatest amount of animal life. Still, here, the data per se are not to be given full reliance, for trapping was undoubtedly done most extensively and intensively in and around mesquites for the reason that series of topotypes of mammals named from Death Valley were, from a systematic point of view, greatly desired and these (*Citellus*, *Perognathus penicillatus*, *Dipodomys* and *Neotoma*) are inhabitants, chiefly at least, of the areas where mesquites grow.

My field work in Death Valley, the character of which has been indicated in preceding paragraphs, has led me to designate eleven mammalian habitats there, each occupied by a separate plant-animal association. The main factors determining these habitat dependencies are: Kind and continuity of food available, appropriate to each species; nature of accessible cover, especially as providing protection from sunshine, varying with the structural peculiarities of each species; and soil-texture, varyingly important in accordance with the digging abilities of the animals concerned, to secure sufficiently safe breeding and resting places, and escape from sunshine.

Curiously, even on this driest of dry deserts, few mammals seem to have any need of free water. I found no evidence that any rodent or lagomorph visits water, even when accessible. It is probable that bats and carnivores require water, at least occasionally. Tracks of *Canis* and *Vulpes* were seen at springs or wells regularly enough to indicate water as the objective of these animals. Only *Homo* and *Ovis* appear to be water-dependent. The water factor, therefore, does not figure directly as an important habitat component for the general mammal fauna of this region. Free water is doubtless obtained indirectly by some mammals, such as lagomorphs and probably certain cricetids, which feed on green vegetation. (For an illuminating discussion of this and other factors in the problem of desert existence, see Sumner, *Ecology*, vol. 6, 1925, pp. 352 ff).

Vegetation is, of course, the fundamental food source, here as elsewhere; and the several sharply marked off plant formations in Death Valley provide separate kinds of food, accessible to mammals in different ways, so as to contribute to the habitat restriction observable severally among the different species. Also, vegetation figures similarly with respect to its service varyingly to many different kinds of mammals as cover, securing for them protection from sun and safety from enemies. However, rocks, and soil (to fossorial kinds), serve also in this way.

The mammalian habitats in Death Valley thus can be distinguished, and briefly defined in the terms chosen, as follows. In the discussions of species this terminology is followed.

- [Borax flat — abiotic ?]
- Ink-weed (*Allenrolfea*, on strongly alkaline ground)
- Tule (or cane—along streams, or at springs or seepages)
- Salt-grass (on alkaline ground)
- Arrow-weed (on silty or clayey ground)
- Cultivated ranch-land
- In or near buildings [edificarian]
- Mesquite (on either silty or sandy ground)
- Aeolian sand (sand-dune)
- Creosote bush (on either sandy or gravelly ground)
- Desert holly (wash-fan)
- Rocky gorge (cliff)

On the evening of April 18, 1917, a line of 86 traps (26 rat traps and 60 mouse traps) was put out on the low-lying desert one to two miles north of Furnace Creek Ranch. These were set on three types of ground: (a) sandy, beneath creosote bushes, 9 mouse traps; (b) sandy, beneath mesquite thicket, 25 rat traps and 31 mouse traps; (c) clayey, beneath arrow-weed clumps, 1 rat trap and 20 mouse traps. This line, set with proper spacing of traps and regard for "sign", thus cut through three distinct habitats. It was run five consecutive nights and days, with no change in locations of traps, save that involved in re-setting and re-baiting. Results are shown in the following table.

	<i>Citellus tereticaudus</i>	<i>Ammospermophilus leucurus</i>	<i>Perognathus formosus</i>	<i>Dipodomys merriami</i>	<i>Dipodomys deserti</i>	<i>Onychomys torridus</i>	<i>Peromyscus eremicus</i>	<i>Neotoma lepidus</i>	Total rodents
Apr. 19..	.....	.....	3 in a 1 in b	13 in b 3 in c	1 in b	.....	2 in b 1 in c	1 in b	25
Apr. 20..	.....	.....	2 in b	1 in a 2 in b 2 in c	.....	1 in b	.....	6 in b	14
Apr. 21..	.....	1 in c	1 in a 1 in b 2 in c	1 in a 5 in b 4 in c	3 in b 1 in c	1 in b	2 in b 4 in c	1 in b	27
Apr. 22..	.....	.....	2 in b	1 in b 2 in c	1 in c	.....	1 in b 1 in c	3 in b	11
Apr. 23..	1 in b	.....	.....	2 in b	1 in b	.....	1 in b 3 in c	.....	8
Habitat Totals	1 in b	1 in c	4 in a 6 in b 2 in c	2 in a 23 in b 11 in c	5 in b 2 in c	2 in b	6 in b 9 in c	11 in b	6 in a 54 in b 25 in c
Grand Totals	1	1	12	36	7	2	15	11	85

This is the most extended and complete trap-record for a single station that the Death Valley notebooks contain. A total of 430 trap-nights on one line brought a catch of 85, which is approximately a 20 per cent yield. Eight species of rodents were represented. Only two of these, *Citellus* and *Ammospermophilus*, are diurnal in habits, and only two individuals, or $2\frac{1}{3}$ per cent of the total catch, were of these species; all the rest are strictly nocturnal.

As to habitat preference, the sandy mesquite produced most kinds (7 out of the 8 species), the sandy creosote fewest kinds (2 out of the 8). The trap-habitat figures (9-56-21), however, as compared with the catch-habitat figures (6-54-25) show a slightly greater incidence of individuals in the clayey arrow-weed habitat, but again least in the sandy creosote. There are factors appreciable here, however, that prevent reliance upon these sparse figures for purposes of generalization.

As to population numbers the percentage yield in this instance was large, up to the average maximum for almost any area in Cal-

ifornia, desert or otherwise. However, this trap-line was on extra productive terrain, as clearly shown by the trap-records, even though less complete, from other parts of Death Valley. Nothing can, of course, be inferred as to actual population numbers per unit of area. Nor can relative abundance of the species be very definitely inferred beyond the one case, of *Dipodomys merriami*, which is obviously the most numerous rodent on this part of the desert. Difficulties in accepting these figures in this regard have to do with kinds of traps used, kinds of bait used, and cruising radius (unknown) of each kind of mammal present.

Dr. Sumner's trapping was all done with the "Delusion" brand of "live" trap. This has the advantage that several mice may be taken in a single night without any re-setting. A disadvantage, however, is that rodents any larger than a *Peromyscus* tend to be excluded. A total of 773 trap-nights produced 356 mice. Of these, 168 were *Peromyscus m. sonoriensis*, 165 *Peromyscus e. eremicus*, 12 *Reithrodontomys m. megalotis*, 9 *Perognathus f. formosus*, and 2 *Onychomys t. longicaudus*. Also one very young *Neotoma l. lepida* was caught and one *Dipodomys m. merriami*. The captures of these larger species were, of course, without significance in the present connection.

It should be emphasized that it was the two species of *Peromyscus* that Dr. Sumner especially wanted, for use in connection with his genetics problem. His growing experience in trapping was used to good effect in guiding his later efforts accordingly. The other species were by-products. Even so, there is indicated something of decided significance as to habitat preferences.

I have checked Dr. Sumner's notebook records of captures, April 5 to 14, inclusive, 1920, with results of some further interest. Certain minor variation in totals will be observed, due to the circumstance that occasionally the age of an animal was recorded, when its sex was for some reason not ascertained; also in a few cases habitat was recorded for a given capture when age and (or) sex was not, or vice versa.

Of 168 *Peromyscus m. sonoriensis* concerning which age was definitely recorded, 65 were adults and 103 were juveniles. Dr. Sumner writes me that he listed mice as "juv." when "not in mature pelage; many of these were really post-juvenile." Thus in April the majority of foraging *sonoriensis* were probably less than four months old. Of 168 mice of this species, 84 were males and 84 were females.

Of 165 *Peromyscus e. eremicus*, 80 were adults and 84 were juveniles; 85 were males, 77 were females.

RECORD BY HABITATS, FROM "LIVE" (DELUSION) TRAPS, MADE BY DR. F. B. SUMNER
IN APRIL, 1920, IN VICINITY OF FURNACE CREEK RANCH

Species	Date	In or close about ranch buildings.		Within cultivated area of ranch; mostly along irrigation ditches lined with arrow-weed; Bermuda grass, alfalfa or grain fields adjacent.		Along fence, cultivated ranch-land on one side, creosote (sandy) desert on other. ⁴		Along lines of mesquite and (or) arrow-weed on silty ground below (west of) ranch.		Near border of borax flat west of ranch; strongly alkaline ground, with salt-grass, inkweed, or farthest mesquites.	
		Traps out	Captured	Traps out	Captured	Traps out	Captured	Traps out	Captured	Traps out	Captured
<i>Peromyscus m. sonoriensis</i>	Apr. 5	15	27	51	15	.....	.....	.....	.....	.....	.....
	" 6	25	30	63	9	10	3	.....	.....	.....	.....
	" 7	20	13	.....	.....	.....	.....	.....	.....	.....	.....
	" 8	20	9	.....	.....	.....	.....	.....	.....	.....	.....
	" 9	6	6	.....	.....	74	9	.....	.....	.....	.....
	" 10	6	0	.....	.....	92	4 ³	.....	.....	.....	.....
	" 11	38	6	.....	.....	.....	.....	60	1	.....	.....
	" 12	28	5	.....	.....	.....	.....	70	4	.....	.....
	" 13	8	0	30	1	.....	.....	.....	.....	60	16
	" 14	.....	.....	.....	.....	.....	.....	.....	.....	97	10
Total ...		166	96	144	25	176	16	130	5	157	26
<i>Peromyscus e. eremicus</i>	Apr. 5	15	0	51	24	.....	.....	.....	.....	.....	.....
	" 6	25	2	63	12	10	1	.....	.....	.....	.....
	" 7	20	6	.....	.....	.....	.....	.....	.....	.....	.....
	" 8	20	6	.....	.....	.....	.....	.....	.....	.....	.....
	" 9	6	0	.....	.....	74	18	.....	.....	.....	.....
	" 10	6	0	.....	.....	92	8	.....	.....	.....	.....
	" 11	38	10	.....	.....	.....	.....	60	22	.....	.....
	" 12	28	2	.....	.....	.....	.....	70	8	.....	.....
	" 13	8	0	30	7	.....	.....	.....	.....	60	15
	" 14	.....	.....	.....	.....	.....	.....	.....	.....	97	24
Total ...		166	26	144	43	176	27	130	30	157	39
<i>Reithrodontomys m. megalotis</i>	Apr. 5	15	0	51	3	.....	.....	.....	.....	.....	.....
	" 6	25	0	63	4	10	.....	.....	.....	.....	.....
	" 7	20	0	.....	.....	.....	.....	.....	.....	.....	.....
	" 8	20	0	.....	.....	.....	.....	.....	.....	.....	.....
	" 9	6	0	.....	.....	74	0	.....	.....	.....	.....
	" 10	6	0	.....	.....	92	4	.....	.....	.....	.....
	" 11	38	0	.....	.....	.....	.....	60	0	.....	.....
	" 12	28	0	.....	.....	.....	.....	70	0	.....	.....
	" 13	8	0	30	1	.....	.....	.....	.....	60	0
	" 14	.....	.....	.....	.....	.....	.....	.....	.....	97	0
Total ...		166	0	144	8	176	4	130	0	157	0

Species	Date	In or close about ranch buildings.		Within cultivated area of ranch; mostly along irrigation ditches lined with arrow-weed; Bermuda grass, alfalfa or grain fields adjacent.		Along fence, cultivated ranch-land on one side, creosote (sandy) desert on other. ⁴		Along lines of mesquite and (or) arrow-weed on silty ground below (west of) ranch.		Near border of borax flat west of ranch; strongly alkaline ground, with salt-grass, inkweed, or farthest mesquites.	
		Traps out	Captured	Traps out	Captured	Traps out	Captured	Traps out	Captured	Traps out	Captured
<i>Perognathus f. formosus</i>	Apr. 5	15	0	51	1	.....	.....	.....	.....	.....	.....
	" 6	25	0	63	0	10	1	.....	.....	.....	.....
	" 7	20	0	.....	.....	.....	.....	.....	.....	.....	.....
	" 8	20	0	.....	.....	.....	.....	.....	.....	.....	.....
	" 9	6	0	.....	.....	74	5	.....	.....	.....	.....
	" 10	6	0	.....	.....	92	1	.....	.....	.....	.....
	" 11	38	0	.....	.....	.....	.....	60	0	.....	.....
	" 12	28	0	.....	.....	.....	.....	70	0	.....	.....
	" 13	8	0	30	1	.....	.....	.....	.....	60	0
	" 14	.....	.....	.....	.....	.....	.....	.....	.....	97	0
Total...		166	0	144	2	176	7	130	0	157	0
<i>Onychomys l. longicaudus</i>	Apr. 5	15	0	51	0	.....	.....	.....	.....	.....	.....
	" 6	25	0	63	0	10	0	.....	.....	.....	.....
	" 7	20	0	.....	.....	.....	.....	.....	.....	.....	.....
	" 8	20	0	.....	.....	.....	.....	.....	.....	.....	.....
	" 9	6	0	.....	.....	74	0	.....	.....	.....	.....
	" 10	6	0	.....	.....	92	1	.....	.....	.....	.....
	" 11	38	0	.....	.....	.....	.....	60	0	.....	.....
	" 12	28	0	.....	.....	.....	.....	70	0	.....	.....
	" 13	8	0	30	0	.....	.....	.....	.....	60	0
	" 14	.....	.....	.....	.....	.....	.....	.....	.....	97	1
Total...		166	0	144	0	176	1	130	0	157	1

³Record not quite explicit; might have been caught in house.⁴A bit of ambiguity in record here; some traps were set "between fields". When trapping was done, and the results recorded, it was not, of course, foreseen just how the ecological data would be classifiable.

The great increase in number of people within the past few years who visit Death Valley (40,996 in the season of 1934-35, October 1 to June 30) raises the question as to what influence this human invasion each winter may ultimately have upon the native animal life. Happily, Death Valley has been constituted a National Monument, to be administered under the National Park Service. This means that in normal course, under the fixed policy of this Service, there will be no more hunting or trapping of animals.

There presents itself next, then, the factor of habitat relations, and this may conceivably affect the fortunes of almost every animal in Death Valley. In my present paper on the mammals and the preceding ones on the birds, there has been brought out the principle of complete dependency of every kind of mammal and bird, directly or indirectly, each upon a more or less restricted type of environment. Upon which, and to what extent, then, among the animal habitats in the Valley, will human occupancy have influence?

The human draft upon the natural resources plainly involves two things, water and fuel. The chief native fuel source so far drawn upon is the immediately accessible mesquite, although the neighboring mountains could provide pinyon and mountain mahogany in quantity probably adequate now and for a long time to come. The mesquite supply is limited and already is approaching exhaustion locally. And the mesquite, as has been emphasized here and elsewhere, is doubtless the most important single plant component of animal habitats in Death Valley.

The mesquite is a notably water-dependent plant, though with its root system so extensive that it can go to great depths for water. Its distribution in Death Valley is obviously correlated with the presence of ground water within reach of its roots; the heaviest tracts of mesquite lie below the largest perennial springs and along the bases of the lofty Panamint Mountains. With human demand for, and diversion of, the limited water supply at its very sources, and the subsequent loss of the water largely by evaporation (rather than entry into the ground), one wonders what ultimately may happen to the water-table beneath the valley floor and consequently in future years to the tracts of mesquite with their dependent fauna. However, this is not, perhaps, a danger for most immediate concern.

With Death Valley made into a National Monument and rendered easily accessible in all its parts to visitation, *if* all its natural attractions are to be preserved, then a certain definite measure of wild life management must at once be practiced there, with all of the above ecological principles heeded. With view to helping toward establishment of such management, adapted to the conditions peculiar to this area, I ventured in November, 1933, shortly after returning from my last trip there, to submit the following set of suggestions to Colonel John R. White, Superintendent of the then just established Death Valley National Monument. I was gratified at the cordial reply received from Superintendent White;

indeed, in his letter, dated November 8, 1933, he gave it as his belief that from an administrative point of view every one of these suggestions were such as could be adopted.

These suggestions are incorporated here, therefore, not only as a matter of record, to review after the lapse of further years, but also as an illustration of how wild life studies may lead directly to considerations of an eminently practical bearing.

1. Develop flowing water from as many seepages, springs and wells, as possible, but reserve some of these watering places from regular human use, for the use of such native animals as require daily to come to water. Especially, reserve at least one watering place in each neighborhood entirely exempt from camping. Human presence usually means the frightening off of any bird or beast that otherwise would come freely to drink.

2. At "wild-life watering places" the issuing water should flow in part under protecting native vegetation. Most birds are very loath to drink or bathe in the open; they fear foes from the sky or from concealment on the ground near-by. Low spreading mesquite makes the best sort of protective cover; clumps of arrow-weed or cane are nearly as favorable.

3. Post signs warning tourists and campers not to cut or injure any living mesquite, screwbean, or arrow-weed anywhere in the Valley. Fuel can be derived for immediate use from dead parts of these plants, and especially from the long-dead stem parts of old salt-bushes, creosote bushes, and other desert shrubs. The mesquite is the most important to wild-life needs, of all the desert plants. All cutting of it for fuel, in any part of the Valley (and this should hold most rigidly for the humanly populated centers like Furnace Creek Ranch and Cow Creek) should be altogether prohibited. The mesquite grows slowly and replaces itself only under exceptionally favorable conditions. A long series of bird and mammal species is dependent directly or indirectly upon the mesquite, especially the older growths of it, for their subsistence. Conserve the mesquite and the animal numbers will be maintained. Eliminate the mesquite, and many of the most attractive and interesting kinds of birds and mammals must surely vanish.

4. The specialized, "relict" fishes in Salt Creek and Saratoga Springs are well worth making of "special feature" status. But they might easily be exterminated through heedless "development" of these waters in some way or other.

5. Needless to say, all hunting and trapping should be as strictly prohibited in Death Valley as in any other National Park area. This should apply to the ducks, doves and quail in the vicinity of Furnace Creek Ranch as well as elsewhere. The overflow ponds there, the plot of green, constitute a "lure" in the midst of the

desert, irresistible to migrating birds. Such lures should not be taken advantage of—save possibly in emergency by the Indians, on the ground that they may be considered to have natural rights which the alien white man certainly does not have.

6. Watering places for mountain sheep, adapted to their special habits, should be established at one or more points where tourists can visit them and thus see living wild Desert Bighorns. The animals would probably become tame in time, like those in the Rocky Mountain parks. Such special "tanks" for sheep would have to be maintained for this purpose alone. No camping or picnicking could be allowed.

7. The kitchen garbage (which is now incinerated) from Furnace Creek Inn should be used as at the "bear-pits" in Yosemite—put out in some ravine-mouth $\frac{1}{4}$ mile or so south of the Inn, to attract interesting animals night and morning. Such animals would be: Coyotes, Kit Foxes, Ravens, and Magpies. The Coyotes are known by tradition and through literature to most people; yet few persons ever have the chance to see one. Here these animals would, if regularly fed, soon become tame enough to be observed from near-by vantage-points. Ravens and Magpies, cleverest members of the bird world, are most amusing to watch. The resident park naturalist could make much "capital" out of this sort of attraction.

***Myotis californicus pallidus* Stephens**

Desert Little California Bat

This was the only *Myotis* found by me on the floor of Death Valley, although several other species of this genus are known to occur in the mountains in the general region. Five specimens were taken on Furnace Creek Ranch, April 4 to 19, 1917. One of these was caught in a house and brought to me by an Indian. The other four were shot at middle or late dusk. As many as ten were seen in one evening (of April 6).

Myotis was wont to fly near the ground, around shrubbery, beneath trees, or low around the "weevilly" woodpile—not often above the skyline. Individuals were thus much more difficult to shoot than *Pipistrellus*. Compared with the latter bat, *Myotis* showed paler and broader wings. One was seen among mesquites around Triangle Spring at late dusk of April 16, 1917.

Of the five specimens of *M. c. pallidus* taken, two were females weighing 3.1 and 2.8 grams, respectively, and three were males, of weights 2.4, 2.6, and 3.4 grams. None was notably fat. The measurements of the five average: Total length 78 mm., tail 39, hind foot 5, ear from crown 10.7.

***Lasionycteris noctivagans* (LeConte)**

Silvery-haired Bat

I did not find this bat in Death Valley until October, 1933. Its status there may thus be suggested as winter visitant or possibly migrant. In the afternoon of October 20, Mrs. Grinnell and I repaired to the "weevilly" woodpile on Furnace Creek Ranch. The evening was cooler than preceding ones and the sky was partly overcast with high cirrus clouds. Up to 4:40 not a bat was seen. Shortly, *Nycteris cinerea* came out (about 4 all told finally present), then *Lasionycteris* (about 4 all told), then *Tadarida* (fully 10 ultimately), and finally *Pipistrellus* (only about 6 on this date, until we gave up at late dusk because of eye-strain). On October 22, the first silvery-haired bat was out at 5:04 p.m., over the golf course; on the 27th, the first at 4:57.

Lasionycteris could be recognized far off by its broad wings, great extent of tail membranes, and its appearance of black color; its wing-beats, too, were relatively slow. Two were shot on that first night; both were males with testes small. One was notably fat and weighed 11.2 grams; the other weighed 8.7 grams. Two more taken, on October 28, female and male, weighed respectively 7.4 and 5.2 grams. The first was found by a boy in the daytime, at about 2 p.m., hanging twelve feet up, in the crotch of the stem of a tamarix tree; the second was shot at dusk above mesquites near an overflow pond west of the Ranch.

Average measurements of the four specimens taken were: Total length 98 mm., tail 40, hind foot 7.6, ear from crown 10.5.

***Pipistrellus hesperus hesperus* (H. Allen)**

Western Canyon Bat

Both in April and in October, this was the most numerous bat seen on and near Furnace Creek Ranch. Flying as a rule above the horizon, specimens were easy to shoot against the evening sky. On some evenings of "bat-shooting" this was the only species of bat seen. As many as 20 individuals were counted in sight at one time. Some spent the day hanging among the reversed dead leaves of the Washington palms on the Ranch; others seemed to drift into the neighborhood from the direction of the Black Mountains.

In 1917, the first bat seen in flight on April 3 appeared at 6:20 p.m.; on April 4 at 6:03; on April 10 (with sunshine still on the eastern hills) at 5:55. At Salt Creek, April 13, the first were out at 6:20. At the same place two were shot on the evening of May 21. In 1920, two *Pipistrellus* were seen at late dusk of April 21, in flight near Bad Water,—280 feet. In 1933 on the evening of October 14, there were "swarms" among the tamarix trees and around the auto

camp on Furnace Creek Ranch. On October 22, the first was seen abroad at 5:35p.m.; on the 27th, the first at 5:05. On October 24, one was seen in flight at 4:55 (well after sundown), at Triangle Spring. Recognition of this bat was easy, not only because of its small size, but because of its dark-colored, rather narrow wings; even though the wingbeats were usually rapid, the speed of flight seemed slow.

Of fourteen specimens preserved, 10 were males (reproductive organs inactive), 4 were females. All for which this point was recorded were lean. Their weights averaged 2.9 grams, varying from 2.3 to 3.4. Their measurements averaged: Total length 69 mm., tail 28, hind foot 5, ear from crown 8.6.

On the evening of October 27, 1933, at about 5:40 (late dusk), Mrs. Grinnell and I both saw against the western sky just off the northwest corner of Furnace Creek Ranch what we took to be a very large bat, bigger than anything we had seen here before. It hawked back and forth, now below the horizon then above—when suddenly it made an upward swoop and apparently captured a little *Pipistrellus*. Instantly, several other *Pipistrellus* which happened to be in the vicinity dived toward the captor, as if attracted by the cries or struggles of an unfortunate fellow. Then the whole group vanished to our sight down below the horizon and we were unable to discern anything further. We thought of *Eumops*; but still, the "capture" *might* have been an optical illusion!

Nycteris cinerea (Peale and Beauvois)

Hoary Bat

Prior to 1933, this winter-visiting bat was met with but once, on April 12, 1917, when one was shot at early dusk, flying heavily over the alfalfa field at Furnace Creek Ranch. This was a female, lean; weight, 19.8 grams. In October, 1933, from the 14th to the 28th of that month, every afternoon we looked for them, from one to four were to be seen in flight about the Ranch. One was shot on the 19th, a female, fat, weighing 27.1 grams.

This species was the first of the bats to appear of evenings: On October 14, at 5:20 (still broad daylight); on the 16th, at 4:00 (sun shining brightly and air still warm, about 80° F); on the 19th, at 4:00 (already abroad); on the 22nd, at 4:37; on the 27th, at 4:30; on the 28th, at 4:55. The species was easily recognized by its large size and broad and slow-flapping wings. The individuals would usually keep well up (25 to 100 feet above the ground); sometimes they would fly low and then, in the excellent light of early evening,

their color tones and even the patterns on the wings could clearly be made out.

On the late afternoon of the 19th, Mrs. Grinnell and I took our stand in the Ranch wood-yard. The tiers of mesquite stove-wood gave forth sound like gentle rain, produced by the gnawings of innumerable larvae of powder-post beetles in it. Already at 4:00, two big *Nycteris cinerea* were coursing about within a short radius of the woodpiles, often so low as to be within easy "aux" range. By 4:40, there had been four of the same species about; then two *Tadarida* had appeared, and one *Lasionycteris*; by 5:20, *Pipistrellus* and *Myotis* had joined the throng, the former in profusion. It was the emerging adult form of the beetles that, of course, attracted all these bats into such concentration of numbers.

On October 27, the first bat to appear in the vicinity of the wood-pile was a *Nycteris* at 4:30. A second of the same species appeared at 4:36, and later, just one other, making three individuals in all. They all had disappeared by 5:16, though other bats were by then out in numbers. It would seem that, a full meal obtained, these bats had gone to roost again, probably in the near-by palms or tamarix trees.

The average measurements of the two specimens preserved, females, were: Total length 133 mm., tail 54, hind foot 12, ear from crown 9.5.

***Antrozous pallidus pallidus* (LeConte)**

Desert Pallid Bat

Met with by us only on Furnace Creek Ranch, and there but twice. On each of the evenings of April 3 and 4, 1917, one was shot as it flew about at rather late dusk among and under the newly leaved cottonwoods. The first one, a female, weighed but 13 grams. The second one, a male, weighed 21.7 grams. The latter had in its mouth an inch-long moth-caterpillar, undoubtedly taken off the cottonwood foliage where, at the time, many such were to be seen. The measurements of the two specimens were, respectively: Total length 107, 102; tail 46, 43; hind foot 11, 10; ear from crown 28, 28.

In the winter of 1919, when Mr. and Mrs. Dane Coolidge were camped at Furnace Creek Ranch, they obtained a specimen of this species and later presented it to the Museum (no. 31146, male, alcoholic). On the evening of December 22, this bat flew down and lit on a board a few feet from the camp fire and was caught by hand. Another individual was seen flying about on the evening of the 26th. The Indians stated that this kind of bat flew about their fires "because it likes the smoke." More likely the object was to capture the insects attracted by the fire light.

***Tadarida mexicana* (Saussure)**

Mexican Free-tailed Bat

This species was regularly seen over and around Furnace Creek Ranch, whenever bats were specially looked for, in both April and October. They would appear first of an evening in flight high overhead. I was told of colonies of bats roosting in old mine tunnels in the Funeral Mountains, whence these valley-foragers may have come.

Tadarida could be distinguished from all the other bats identified in Death Valley by the outline of the spread wings—extremely narrow fore-and-aft, with deeply incised posterior margins. The earliest seen on the evening of April 4 appeared at 6:05. On the morning of April 12, 1917, at 6:00, in broad sunshine, one was watched hawking back and forth over the alfalfa field where it was seen to capture insects.

On the afternoon of April 10, at 4:45 in full warm sunshine, two *Tadarida* appeared, foraging actively over the alfalfa. I had an idea at the time that these were abroad thus, extra early, because the gale the preceding night had kept them from foraging. Other individuals came out soon after these first ones. On the evening of October 27, 1933, at 4:47, a dozen or more *Tadarida* appeared high overhead, as if they had arrived from a distance in a flock. This bat did not show the degree of interest in the powder-post beetles emerging from the mesquite woodpile that the other species did.

Weights of four individuals (3 males, 1 female) averaged 9.4 grams. The male taken on October 27, 1933, and weighing 9.9 grams was fat; indeed it "oozed oil" from the shot-holes as it was picked up. Five specimens (4 males, 1 female) gave average measurements of: Total length 96 mm., tail 37, hind foot 8, ear from crown 13.

***Taxidea taxus berlandieri* Baird**

Mexican Badger

Badgers are certainly not common in Death Valley, despite the abundance of rodents in certain parts of it. I, myself, saw the characteristic diggings only in the vicinity of Furnace Creek Ranch, in 1917. A setting of steel traps put out where there was such "sign", a mile or so southwest of the Ranch, on April 12 produced a young female badger, of 3500 grams (about 7.7 pounds) weight.

In photographing this animal, before it was killed for a specimen, Mr. Dixon found that it was quite "willing to fight" and would readily "fly at a person or stick." The odor or scent then thrown out was pervasive. The badger would hold its stubby tail directly

aloft and a few seconds later the scent was plainly noticeable. The whole procedure was similar to that employed by a skunk, only the scent was not so strong.

In October, 1933, Mr. Monroe Wagon told me that the summer before, he had met with a badger at night at a well he had gone to for water, two miles south of Tule Spring, on the Bennett Wells side of the Valley. He had recently seen tracks elsewhere on the Valley floor. Badgers are notable wanderers, and one might be encountered almost anywhere.

The specimen captured by us, a small female (no. 25914) probably less than a year old, measured: Total length 600 millimeters, tail 110, hind foot 90, ear from crown 32. In the pelt the white dorsal mid-line extends from the nose pad clear to the root of the tail, though becoming very narrow posteriorly.

[The badger is the only mustelid mammal to be reported from Death Valley. No skunk, either striped (*Mephitis*) or spotted (*Spilogale*), has, to my knowledge, been taken there, although I heard report of the latter species from the mountains in the general region—for instance from the Lila C. Mine. Neither has any weasel (*Mustela*) ever been reported from the immediate region.]

***Vulpes macrotis arsipus* Elliot**

Desert Kit Fox

The kit fox was undoubtedly the commonest carnivorous mammal in Death Valley. Its presence and relative numbers is probably pretty much controlled by the presence and relative abundance of nocturnally active rodents. If not the foxes themselves, then their footprints in sand or in dusty parts of roads or trails after nights when there was no wind, were seen at most places traversed. The frequent association of "sign" of kit fox with that of the two kinds of kangaroo rats was significant.

In the night of October 13, 1933, when sleeping out on the desert floor at the roadside a mile or so east of Stovepipe Wells Hotel, I was awakened about 2:30 a.m. by a rustling sound near by. "I turned on the 'flash'—to see a kit fox within 25 feet, nosing about a sardine can and paper wrappings we left out last night after supper. The animal seemed in no way alarmed, looked up once or twice, nosed along the ground; then trotted off into the gloom, tail up-curved but horizontal in general trend, ears conspicuously up-pricked, facial dark markings plainly seen. Once I saw the glowing pink eye-shine."

The evening of October 25, 1933, as we were driving south over the road approaching Furnace Creek Ranch, and within about four miles of the Ranch, we saw two kit foxes, in separate places, run across the road in the light of the auto. This was at 6:30 when,

at that season, almost complete darkness had fallen. Everything indicates that this fox is wholly nocturnal in the time of its activity.

At Triangle Spring, on April 17 and 18, 1917, Mr. Dixon caught two kit foxes in steel traps set near burrows of the big desert kangaroo rat. The bait used was portions of a jack rabbit. These two foxes were probably a mated pair, although they showed no signs of immediate breeding. The data accompanying the specimens are as follows. Male (no. 25903), weight 1531 grams (about $3\frac{1}{2}$ pounds); total length 715 millimeters, tail 293, hind foot 114, ear from crown 84. Female (no. 25904), weight 1406 grams (a little over 3 pounds); total length 710 millimeters, tail 275, hind foot 110, ear from crown 85. In color of pelage and other features, these specimens are quite like others from the western parts of the Mohave Desert. An additional skull-only at hand (no. 31145) was from a yearling animal trapped by an Indian for fur near Furnace Creek Ranch about December 15, 1919. This skull was retrieved for the Museum by Mr. and Mrs. Dane Coolidge.

[While I saw a pelt of a gray fox (*Urocyon*) which had been trapped in the hills somewhere west of Death Valley Junction, I heard of none of this species ever having been seen or taken in the Valley proper.]

***Canis latrans estor* Merriam**

Desert Coyote

There was no place at which we camped or scouted about in Death Valley, save Bad Water, where we did not find sign (footprints or foeces) of coyotes. Additionally, their voices were heard frequently in the night. On one occasion, October 24, 1933, at Surveyor Well, we heard a coyote at 8:40 a.m. of a brightly sunshiny day, yelping and barking persistently from the direction of the sand dunes and mesquites out on the floor of the Valley to the westward. Rarely did we actually see one of the animals. In the early morning of October 27, 1933, at 5:45 o'clock, we saw one as we were driving south along the road within half a mile of Furnace Creek Inn. It was near the site of a garbage incinerator, and we could see it plainly, despite the dusk, at about 50 yards distance because outlined darkly against an expanse of light-colored rock at the base of the hill.

West of Furnace Creek Ranch, we could always find tracks of coyotes where the ground was soft, weaving in and out between the arrow-weed clumps and the mesquites—doubtless a productive forage ground. After still nights, footprints were to be seen meandering over sandy areas where kangaroo rats were plentiful, and also along dusty burro trails through the scanty salt-grass (as down close to the edge of the "self-rising" flat,—240 feet, west of the Ranch) where jack-rabbit sign was fairly plentiful.

Along Salt Creek, on October 30, 1933, there were many fresh coyote tracks in the slimily wet alkali mud along the channels through the pickleweed and cane. We imagined the attraction here might have been crippled birds, besides mice; for we saw evidences (empty shells) that there had been shooting there that autumn—indeed we ran across one wounded duck, a baldpate. At Triangle Spring and elsewhere, coyote tracks often led to potable water. This and other evidence guides me to the belief that *Canis* is one of the very few desert mammals that needs regularly to drink.

Foeces of coyote found both in April and October consisted either entirely or in considerable part of the resistant seeds, and the chewed-up remains of the pods, of the mesquite. At a defecating post I found April 16, 1917, on a flat rocky outcrop on the edge of the low mesa near Triangle Spring, was an accumulation of "turds" consisting of remains of mesquite bean-pods, some feathers, and bones of small mammals among which I was able at the moment to recognize only rabbit. Near Furnace Creek Ranch, April 10 to 13 of the same year, the carcass of a dead calf was being, as shown by the tracks, patronized nightly by one or more coyotes.

In 1917, on April 11 and 13, and May 3, Mr. Dixon trapped three coyotes in the neighborhood of the Ranch. All were adult females; the data obtained from them were, in the same order, as follows: Total length 1090, 1120, 1118 millimeters (43 to 44 inches); tail (without hairs) 320, 340, 320 (about 13 inches); hind foot 170, 185, 182; ear from crown 110, 115, 111. The weights were, respectively, 7.2, 8.8 and 7.9 kilos (about 16 to 19 pounds). The pelts were, at this season, in exceedingly worn and faded condition. In the first one taken, the guard hairs along the sides, and on the tail, were almost all shed, leaving the gray underfur exposed, and this was sluffing off in patches.

The coyotes of Death Valley, judging from the three skulls obtained (nos. 25896-98), belong to the small southwestern desert race with weak dentition, now called *estor*, rather than to the larger, heavier-toothed race of the Great Basin, *lestes*.

***Lynx rufus baileyi* Merriam**

Desert Wildcat

On April 21, 1917, Mr. Dixon caught an old female wildcat in a setting of steel traps placed near wood-rat houses under thick mesquites west of Furnace Creek Ranch. The weight of this animal was 7200 grams (about 16 pounds). Dimensions: Total length 850 millimeters (about 33½ inches), tail 170, hind foot 173, ear from crown (without tuft) 80. The pelt of this example (no. 25918) was seasonally deteriorated to an extent that the long overhairs as normally present in a prime skin are reduced in quantity and the remainder shortened by wear, with the result that it is mainly the

pinkish color of the underfur that is shown on most of the surface of the animal. There is also at hand a skull-only (no. 31144) of a yearling wildcat trapped for fur by "Shoshone Johnny", an Indian, 3 miles south of Furnace Creek Ranch about December 15, 1919. This skull was received through the kindness of Mr. and Mrs. Dane Coolidge.

Tracks of wildcats were seen in both 1917 and 1933 on soft silty ground in the tracts of mesquites in the vicinity of the Ranch. They were also reported to me from Triangle Spring, and from around the big springs up out of the Valley at the sources of Furnace Creek. Heavy cover of brush seems to be a desirable feature of the habitat of this carnivore—where not only shade but abundant rodent life is available.

Homo sapiens americanus Linnaeus

American Indian

The natives of Death Valley belong to the Shoshonean stock, to the Plateau branch of this stock, and to the Koso dialect group within the Shoshoni-Comanche division of that branch. This is the classification offered by Kroeber (Handbook of the Indians of California, Bull. 78, Bur. Am. Ethnology, Smithsonian Inst., 1925, pp. 574-592). Kroeber also gives facts, but all too meagerly, concerning the natural history of this original people of the Death Valley region—their habitat-relations, the sources of their subsistence, their "manufactures." My own regrets are deep, that I did not, during my first two trips into the Valley, take opportunities then offering to learn more about the dependences of the few Indians I met, upon the natural resources of the country. I did observe that in April the women and children were actively trapping rodents in the mesquite thickets around Furnace Creek Ranch. *Neotoma* and *Ammospermophilus* were the kinds mostly sought and caught—in deadfalls each consisting of a flat rock. These, along with lizards of the larger kinds caught with nooses, were boiled in kettles and eaten. Many such animals were brought to my camp, in-as-much as I was paying for certain things, mostly reptiles, to preserve as specimens.

Citellus tereticaudus eremonomus Elliot

Death Valley Round-tailed Ground Squirrel

In my experience in Death Valley, this rodent was one of the rarest mammals there; at least it successfully eluded detection to a remarkable degree, even when concentratedly searched for. None was found anywhere we trapped or hunted apart from the near

vicinity of Furnace Creek Ranch, -150 down to -200 feet altitude. Here this squirrel was restricted to hillocks of wind-accumulated sand under those mesquites that, perhaps in consequence of the rising sand masses about their bases, had assumed a sprawling habit of growth. No *Citellus* was seen on the clayey or silty type of ground where the mesquites grew tall. The critical factor here may have been level of food source; no *Citellus* was seen to climb; and as evidence from my notebook shows that the food, at least in spring, consisted entirely or mostly of the leaves of the mesquite, it would seem likely that the squirrels would limit their range locally to those mesquites the branches and foliage of which trailed on the ground. Then again, the better texture of the sand dunes for entry by a weakly equipped digger, as compared with the often firmly caked clayey earth, may have contributed to the notable habitat-restriction of this rodent.

Citellus was observed to be active in the limited neighborhood above indicated in April and early May, 1917, and in April, 1920; yet repeated search over exactly the same ground in October, 1933, revealed not a trace of the animals: no tracks, no burrows—which, of course, the recurrent two-day gales would serve to efface when not in use—and no voicings (though in that month the very different trills of *Ammospermophilus* were heard abundantly). It is quite likely, therefore, that the Death Valley *Citellus* goes into dormancy for part of the year, beginning possibly in late summer when the mesquite foliage begins to deteriorate as food, and tiding the animals over the winter period of leaflessness in that plant.

I gathered the following habit notes concerning the Death Valley round-tailed ground squirrel in the spring of 1917. The daily program of activity of the animals seemed to be correlated directly with the rising of the temperature of the air; they were not noted at all early in the morning when we went the rounds of our traps, and their voices were to be heard most frequently in the heat of midday, which on some of the days in April rose well above 100° F. in the shade. On April 10, during a two-hour hunt around noon-time, at least five individuals were heard or seen on the mesquite-crowned sand dunes within a mile southwest of the Ranch as it was then developed. The warmth of that day had seemingly brought them out; for the previous two or three days had been relatively cool and none had been noted. I caught sight of one standing upright at the mouth of its burrow, squeaking, and of two others running over the sand beneath the trailing mesquite branches. The lines of footprints in the sand centering at the mouths of their burrows are diagnostic (as compared with those of *Dipodomys*, for instance). The animals are extremely shy, going below-ground at the slightest alarm. By standing ten minutes or so "at attention" about fifteen yards from the mouth of a burrow down which one had vanished, I finally saw the top of its head emerge to the level of its eyes. This position it maintained for

many minutes, until the animal suddenly raised its whole head and neck into view, when I shot it.

Later, while I was lying prone on the sand under a mesquite, a *Citellus* came up through the screening foliage to within eight feet of me and gave its shrill, wiry cry, or squeak. A slight movement on my part, and it vanished, quick as thought. By April 22, I found that a little "screeching" (lips to back of hand) would often bring one of the squirrels stealthily "investigating" through the tangle, *provided* the observer kept perfectly motionless himself and was possessed of patience—a difficult feat, for the dead heat in those half-shaded mesquites was "terrific", and "the intense sweetish smell of the blossoms then coming out in profusion almost overpowering"; and there were gnats! The squirrel would sometimes squeak, apparently in answer to my "screech", and thus be "called" into very close "aux" range.

The burrows were as a rule situated in the periphery of a large mesquite clump where they were shaded by the radiating leafy branches which extended down the slopes of the appertaining sand hillock. Not more than three burrows certainly of this rodent were found at any one clump, and all of these entrances probably belonged to one animal. The mesquites during early April were just coming into full new foliage. The stomachs of the squirrels shot were distended with masses of finely chewed mesquite leaves—nothing else. In one instance, the total weight of the freshly killed animal was found to be 154.5 grams; of the full stomach alone, 28.7 grams or 19 per cent (near one-fifth) of the total weight. In other words, an individual squirrel of this species may eat close to one-fourth its own net weight of green mesquite leaves "at one sitting". Incidentally, out of the nine specimens of *Citellus* taken, only two (and one of these the only male taken) were caught in traps, although many traps were set for them, baited variously. At least at this particular season, it would appear that rolled oats and the like hold little attraction.

No young *Citellus* were seen. Two of the females shot, of dates April 10 and 12, contained, respectively, four and three large embryos.

An adult male trapped April 7 and "sun-cooked" (saved as a skeleton-only) weighed 101 grams and gave measurements as follows: total length 220 millimeters, tail 80, hind foot 36, ear from notch 5. Eight adult females taken April 10 to May 3 weighed 121 to 158 grams, averaging 144.3. Their measurements in millimeters (average, minimum and maximum) were: total length 249 (240-255), tail 91 (87-95), hind foot 35 (34-36), ear from crown 2.1 (2-3).

This subspecies of the round-tailed ground squirrel is of darkest color tone, near wood brown, in both winter and summer pelage. Especially is this darkness apparent in comparison with the race on the Colorado Desert, and it is hard to account for. The sand

surface in Death Valley looks as glaringly white as the sand surface in the vicinity of Salton Sea! No other race of mammal in Death Valley is characterized similarly in comparison with its adjacent races. *Citellus tereticaudus eremonomus*, as yet known, has the smallest range of any desert kind of mammal in California. It is probably a relict or disappearing stock. Incidentally, the type specimen (Elliot, Field Columb. Mus., zool. ser., vol. 3, December, 1903, p. 243) was one of three collected at Furnace Creek Ranch in 1903, by Edmund Heller. It is now no. 12862, Field Mus., and was taken April 29. According to Heller's notes published later, "The Indians catch them [*Citellus*] for food in dead-fall traps, and their shyness and scarcity is apparently due to constant persecutions of this character" (Elliot, Field Columb. Mus., zool. ser., vol. 3, 1904, p. 291).

The time of the spring molt in *eremonomus* is indicated by a specimen of date April 10, in which new, summer pelage is showing on the head, lower sides and rump; an example taken May 3 is in complete new, short summer pelage except for the tail, which seems to retain the winter pelage, becoming faded and frizzled, until the time of the fall molt—whenever that may occur. One specimen has the tail bobbed (to 40 millimeters vertebral length), and the end is adorned with a short thick brush of hairs which are white-ended, black at bases. Most of the skins show a curious spotting of the rump region. This is clearly due to the presence of places where groups of hairs are absent, so that the dark-colored skin and dark bases of the posteriorly rooted hairs show through. These spots may indicate scars from insect bites.

***Ammospermophilus leucurus leucurus* Merriam**

Desert Antelope Ground Squirrel

The antelope ground squirrel, or "desert chipmunk", is common and widely distributed in the mountains all about Death Valley up to an altitude of 6000 feet or more. While locally common in the Valley proper, there were long stretches of the below-sea-level area traversed by us on which we saw no individuals whatsoever, and no sign of any. They were common, however, along the north-east side of "Mesquite Arm" of Death Valley, from the vicinity of old Stovepipe Wells nearly to Surveyors Well; also in the neighborhood of Furnace Creek Ranch.

As with so many other animals, the mesquite affords "ammo" a requisite measure of food and shelter; but, showing wider adaptability than some mammals, ammo was also seen away from the mesquites, where there were only arrow-weed clumps, or creosote bushes. Burrows were seen in level silty ground, on the sides of mesquite-crowned sand-dunes, and in hard-pavemented stony

ground. Usually a burrow opened at the side of, or from under, a brush-clump, perhaps to give better protection against digging enemies.

Ordinarily when caught sight of, a chipmunk would be scurrying across open ground from one bit of cover to the next. Then it was the brilliantly white under surface of the tail which caught the observer's eye; for the tail is held "plastered" flat up over the animal's rump, and it is continually twitched. This factor of *motion*, in evidence also even when the animal has stopped in the shade of a bush, makes of this white under tail-surface a veritable "flag."

Ammospermophilus is rather prone to climb; individuals were frequently seen up in the tops of low bushes and occasionally in mesquites. For example, on April 5, 1917, my eye was caught by the tail-twitching of an ammo, otherwise "frozen", crouching against the slanting stem of a mesquite, some two feet above the ground.

Aside from the coyote and Indian, the antelope squirrel may be signalized as the most *vocal* mammal in the native fauna of Death Valley. In October as well as in spring, the ammos were to be heard more generally out on the desert around Furnace Creek Ranch, than most birds even. The utterance may be described "as a prolonged mellow rolling trill, weakening or falling in inflection toward the end. The tone is maintained on about the same moderately high pitch throughout, though an impression of lowering may be received because of the progressive diminution in volume [of sound]. The sound is of a quality to carry well, yet even at very close range it rarely seems loud." (Quoted from Grinnell and Dixon, *Natural History of the Ground Squirrels*, 1918, p. 691.)

"Singing" as described, and foraging, were activities most plainly sensed by the human observer during the early forenoon. Yet our trapping showed that the squirrels were searching for food all through the daylight hours. They readily entered our rolled-oats-baited traps, left unsprung through the day; and many of the animals were thus unintentionally killed, quickly to be "sun-cooked" and so spoiled for specimens.

West of Furnace Creek Ranch, the local range of *Ammospermophilus* extended down to the very edge of the borax flat, — 240 feet. Here burrows were seen (April 10, 1920) in silty, alkali soil at the bases of the farthest, dwarfed arrow-weed clumps. On the meager mounds at the mouths of these burrows many hulls of mesquite seeds were noted; and I wondered whether the ammos had gone all the way across the several hundred yards of terrain to the nearest mesquite trees in sight. Presently, a better explanation presented itself. At night, burros come down to the edge of the borax flat to graze on the sparse salt-grass there. In the daytime these burros

seek shade back in the mesquite thickets, where they feed extensively on the mesquite beanpods, often filching these from the piles stored by the wood rats on their houses under the trees. I saw that the droppings of the burros scattered along their regular routes of travel contained many of the hard-shelled, digestion-defying seeds of the mesquite; for it is the sugary, pithy part of the beanpod that furnishes nutriment to the burro. The ammos forage along the burro trails for the seeds (to store away below-ground) thus provided second-hand, even third-hand in cases where the wood rats had done the initial gathering! I even wonder whether there could persist that submarginal population of antelope squirrels, without the agency of the burros as conveyers of the mesquite seeds.

An enemy of ammo is indicated by the following incident. A Cooper hawk shot by Mr. Dixon in the early evening of April 11, 1917, in a line of mesquites west of the Ranch, held in its gullet the finely cut-up remains of an adult *Ammospermophilus*; the two hind feet of the animal had been swallowed entire, and these afforded certainty of identification.

The only breeding data concerning this rodent available from Death Valley is furnished in connection with the record of a specimen taken on April 23, 1917. This was a young female only about one-fifth grown (total length 130 millimeters, weight 17.7 grams) yet found wandering about under a mesquite near the Ranch. Even though feeble, this little squirrel persisted in holding its tail at all times over its back in characteristic ammo fashion. The date of its capture indicates breeding of the species here as early as the latter part of March.

Of the twelve adult specimens saved, the seven males gave weights of 96 to 119.1 grams, averaging 101.8; the five females, 89.5 to 115, averaging 100.7 grams. The measurements, in millimeters, of the two lots are, average and extremes: Males, total length 228 (219-255), tail 65 (62-70), hind foot 37 (35-39), ear from crown 6 (5-7); females, total length 217 (210-225), tail 61 (54-65), hind foot 36 (35-38), ear from crown 6 (4-8). It would appear that males are slightly larger than females.

Three of the males and one female have bobbed tails, and the dimensions affected are, of course, not included in the above figures. The injuries causing such mutilation were doubtless incurred post-natally and may have been suffered in fighting. The shortened tails are adorned with square-ended tufts of extra long hairs. These tufts are white-tipped and banded broadly with black subterminally. One wonders if the individuals thus mutilated for life, are in any degree thereby at a disadvantage, socially or as regards hazards of existence.

Perognathus formosus formosus Merriam

Utah Long-tailed Pocket Mouse

Only two kinds of pocket mouse have been found to occur on the floor of Death Valley, and even these two appear to be much restricted in local range. This is curious, because the surrounding desert region abounds in this group of rodents, represented in different habitats by at least four species. The present species was taken by myself and associates only in the near vicinity of Furnace Creek Ranch and near Bad Water, the lowest place in the Valley. Trapping records definitely show its presence to be controlled by terrain of gravel or coarse sand, seemingly quite independent of kind of vegetation in reach. In the few cases where individuals were trapped on fine sand or silt, the places of capture were near-by to sandy or gravelly creosote or to desert holly (rocky wash-fan). None was found on sand dunes. I got the idea that *Perognathus formosus* was found around Furnace Creek Ranch so far out of its normal habitat because there was no fine-sand-dwelling species of *Perognathus* there, such as elsewhere is complementary in local distributional restriction to *formosus*. There was no competitive exclusion.

On the night of April 21, 1920, at "Bad Water" of the U.S.G.S. map, Dr. Sumner put out a line of 55 traps. These were scattered over all sorts of accessible ground, mostly on the wash-fan at the base of the precipitous wall of the Black Mountains. Next morning, the total result was one adult male *Perognathus formosus*, from a mousetrap under a desert holly bush on the lower border of the fan very near to the level of the flat; hence nearly — 280 feet altitude. Ant-hills in the vicinity consisted of the shells of the seeds of this plant (*Atriplex hymenelytra*), and we supposed that the mice resorted to this source of food also.

Two females, taken on April 13 and 22, respectively, each contained 3 embryos. No young had appeared abroad up to the end of April.

Of 20 specimens of *Perognathus formosus formosus* preserved as skins, all adult, dates April 4 to 22, thirteen are males and 7 are females. Their weights were, for the males 13.4 to 19.1 grams, averaging 16.3; for the females 12.3 to 19.5 grams, averaging 15.6. Measurements in millimeters: Average and extremes for the males, total length 186 (175 to 195), tail 103 (95 to 105), hind foot 23.7 (23 to 24), ear from crown 8.6 (7 to 9.5); for the females, total length 183 (174 to 192), tail 102 (90 to 110), hind foot 23.6 (22 to 24.5), ear from crown 8.3 (7 to 9). In certain of the specimens the pelage has a "burnt" appearance; that is, instead of the rather clear grayish tone characteristic of this pocket mouse in fresh coat, it is of a clay color. This "yellowing" may, as with *Dipodomys*, be an effect of living in strongly alkali ground.

***Perognathus penicillatus stephensi* Merriam**

Stephens Desert Pocket Mouse

All our trapping in Death Valley produced just one example of this pocket mouse. In 1917, I visited the type locality of it, vicinity of Triangle Spring, for the express purpose of obtaining topotypes. Four nights were spent there, April 15 to 18, with a total of 381 trap-nights (Mr. Dixon was then with me). Result: no. 26532 (orig. no. 4153 J.G.), adult male; weight 11.6 grams; total length 165 millimeters, tail 94, hind foot 21, ear from crown 4.5. Pelage dorsally of extreme "alkalied" tone of color, approaching pinkish cinnamon, this invading the dorsal surface of the tail and its entire tuft. That this color is extrinsic, pertaining to the old coat, is shown by the presence of a small patch of new pelage on the top of the head between the eyes. This is of lined, avellaneous tone (toward gray) like non-alkalied specimens of *stephensi* from Barstow and Victorville, on the Mohave River.

This rarity was taken on the morning of April 16 from a mouse trap set the preceding evening at a little hole in a south-facing sand heap crowned by scrubby mesquite. The place was near the foot of the low bluff, on the general level of the lowest desert floor, perhaps a mile south of Triangle Spring as now dug out and so posted; we called its altitude -13 feet. The "hole" had no mound in front of it, nor were there any tracks showing, though the wind would have quickly effaced any left there. It was rather indefinite, as though a lizard might have used it; indeed the mouse *might* have had nothing to do with it.

However, on a chance, we dug it out. It extended into the mesquite mound about 6 feet, reaching a depth from the surface, of 18 inches. There were two blind branches, one forming a chamber 3 by 6 inches, but empty. The mouth of the burrow within 3 inches of which the lucky trap was set, was 30 millimeters high by 37 wide. The mesquite mound was found to consist, very porously, of alternate layers of dry mesquite leaves and twigs, and sand, this showing the manner of growth of such a mound. The burrow followed mostly one or another of the layers of leaves and twigs, already loose and almost open enough in places for a mouse to go through without digging. Although we found nothing conclusive as to the ownership of this particular burrow, the conditions described may be of the kind requisite for the day-time shelter of this type of rodent, of weak digging powers.

In the fall of 1933, with Mrs. Grinnell, I again visited Triangle Spring, and we ran traps there especially for *Perognathus*. A total of 150 trap-nights, October 23 to 25, produced—nothing!

The type specimen of *Perognathus stephensi* (this form was at first thought to be a full species) was taken, together with one co-type, by Frank Stephens on April 6, 1891 (Merriam, Proc. Acad.

Nat. Sci. Phila., 1894, p. 267). Under date of February 26, 1917, in reply to my request for further information concerning his original capture, Mr. Stephens wrote me from San Diego as follows: "On this part of the trip [Death Valley Expedition] I was coming down from the Grapevine Mountains, travelling southward to get to Furnace Creek. I left Grapevine Spring in the morning [of April 5], passed the 'lost wagon' about noon, and along in the afternoon found a little spring where others had camped As I now remember it, this little spring was at the edge of a low mesa I remember that there were a few smallish mesquite trees scattered about, and I think a few sand drifts in the hollows and low gulches of the mesa The spring I camped at . . . was not a rise of the creek out in the flat, but was near or at the edge of a little mesa, perhaps at the mouth of a draw [From there] it took me the best part of a day to reach Furnace Creek. . . . I put out my traps along the edge of the mesa and in the gulches."

This description enables one today very closely to fix the exact place whence came the type of *Perognathus penicillatus stephensi* Merriam. From what is now known, I would judge the subspecies to have its metropolis in the general depression into which the Mohave River at one time flowed, and of which the lowest part is Death Valley.

Addendum.—Being informed of the extreme rarity of *Perognathus penicillatus stephensi* in Death Valley, Miss Annie M. Alexander and Miss Louise Kellogg, in February, 1936, undertook to try their skill toward obtaining additional specimens of this mouse for the Museum of Vertebrate Zoology. Taking with them a copy of the manuscript of my account as just given above, this providing the gist of previously accumulated information concerning the species to be sought, they made their headquarters at the Stovepipe Wells Hotel, in the northern end of the Valley.

The evening of February 13, 123 standard mouse traps were put out on ground about one-fourth mile north of the hotel, across the flying field, averaging in altitude about -11 feet. Next morning, Miss Alexander found a *stephensi* caught in one of her traps set "about half-way across the comparatively narrow strip of atriplex and creosote between the landing field and some bare sand flats." The trap was at the south base of a sand hillock, under the drooping branches of an atriplex bush. [Sample of this bush saved, showed it to be of the species *Atriplex canescens*.] The mouse's pockets were full of the bait, rolled oats. Another trap in the vicinity, un sprung, had small tail marks about it, but possible *Perognathus* sign otherwise was not noted. On the evening of February 16, 65 traps were put out over about the same route, but no pocket mouse was caught. Miss Alexander's notes state that "very little alkali showed where the traps had been set; there were some spots blown bare, but the surface of the ground was mostly covered with

fine yellowish sand." This is significant in that the specimen taken is in scarcely any appreciable degree yellowed ("alkalied"). Other rodents caught in this place, incidentally, were only of the species *Dipodomys deserti*, five of them: results of 188 trap-nights.

On the nights of February 14-15 and 15-16, intensive trapping was done around Triangle Spring, which is close to 15 miles by road from Stovepipe Wells Hotel. On the morning of the 15th, Miss Alexander was again successful in obtaining a *stephensi*, from the line of 79 traps put out. This was in a Benson type of "live" trap, set at a clump of dead arrow-weed about 5 by 8 feet in diameter, on a slight mound of sand, altitude - 25 feet (estimated), about 950 feet (measured) northwest of Triangle Spring. The trap had been placed "on the northeast side [of the clump], facing the entrance to a runway that ran . . . under overhanging dead branches of arrow-weed for about five feet to a hole an inch or more in diameter that appeared to head toward the center of the clump, which was a tangle of salt-grass and dead branches. There were two other narrow runways on the northeast side that disappeared in the thicket; an atriplex bush sheltered the long runway on the outer side." That these runways had anything to do with the *Perognathus* is, of course, problematic. The following night, the successful trap was reset in the same spot as the day before, and another one near the end of the runway described. Next morning these traps were sprung but empty; another trap out of the 75 put out in the vicinity that second night, set at an arrow-weed bush about 15 paces south of the particular arrow-weed clump in question, caught a *Peromyscus maniculatus*. Another trap held a *Dipodomys merriami*. The first night's line of traps had produced, besides the *Perognathus*, five *Peromyscus maniculatus* and one *Dipodomys merriami*.

Meanwhile, on the evening of the 14th, Miss Kellogg put out 94 traps along a narrow line of dunes about one-fourth mile west of Triangle Spring. These produced only *Peromyscus maniculatus* (3) and *Dipodomys deserti* (1). The following evening she selected a new trapping ground, along the road about six-tenths of a mile southeast of Triangle Spring, altitude about - 13 feet. Here she put out her 94 traps, some of them at bases of small sandy hillocks heaped up around arrow-weeds, some at larger mounds covered with mesquite, and others under arrow-weeds and near mesquite clumps where there were no wood-rat houses. The morning of the 16th brought one *Peromyscus maniculatus* (in a Benson-type trap at an arrow-weed clump) and one *Perognathus*. This latter was "in the 68th [standard] mouse trap set out, about 50 feet north of the road, under an arrow-weed growing on the edge of a small wash and near a sandy hillock covered with mesquite . . . There was no hole near the arrow-weed, so it may have come from the hillock."

The three examples of *Perognathus penicillatus stephensi*, resulting thus from 530 trap-nights of special effort, reached the Museum in perfect condition. The data accompanying them are as follows.

No. MVZ	Orig. No.	Sex	Locality	Date	Weight (grams)	Total length	Tail	Hind foot	Ear from Crown
70122	3082 A.M.A.	♂	Stovepipe Wells Hotel.	Feb.14,'36	11.7	166	95	22.5	5
70120	3083 A.M.A.	♂	Triangle Spring	Feb.15,'36	11.5	167	96	23.0	5
70121	3085 L.K.	♂	Triangle Spring	Feb.16,'36	13.0	171	95	23.0	5

While all three of these examples are adult, the last is decidedly the older, as shown by the much greater degree of wear on the crowns of its molariform teeth. The first two may have been about one year old, the last, two years old, or older. The color tone of the pelage varies, but in none is it anywhere near as "alkalied" as in the example I took (no. 26532), on April 16, 1917—thus two months later in the season. The one taken by Miss Kellogg, a little southeast of Triangle Spring, is darkest, clearest avellaneous in color tone, almost identical with specimens of *stephensi* in hand taken March 15 to 17, 1914, near Barstow, on the Mohave River. No. 70122, from Stovepipe Wells Hotel, is nearly as dark; but no. 70120, from a little northwest of Triangle Spring, is decidedly on the alkali side, showing a distinct pinkish buff suffusion. Two months later, this mouse might have reached the condition of no. 26532.

Dipodomys merriami merriami Mearns

Merriam Kangaroo Rat

This smaller of the two species of kangaroo rats present in Death Valley was the more widely spread of the two, apparently because it could get along with less depth of diggable soil—silt or sand. The big *deserti* required veritable mounds—ideally sand dunes. *Merriami* could "dig in" where there was only a shallow accumulation of wind-carried silt or sand about the base of a creosote, atriplex or arrow-weed clump. Easily recognized "sign" consisted of open mouths of burrows in such accumulations with, after quiet nights, clearly defined hind-foot and tail tracks about them. The lesser foot-print length easily distinguished *merriami* from *deserti*.

Thus, without the results of any trapping, it was easy to see where the Merriam kangaroo rat abounded. This, as indicated, was over most of the floor of the Valley, save on the "borax" flats and on stone-paved wash-fans where there were no patches of loose soil at all. Since tracks were seen after windless nights on dusty or sandy surfaces hundreds of yards from any detected burrows, it is to be inferred that individual *merriami* has a long cruising radius. This gives it access to a large area such as must be covered to collect sufficient seeds in the long periods between crops, when the seeds

from the sparse vegetation have been widely scattered, and buried and exposed again, by the alternating south and north winds. It would seem that from the *Dipodomys* standpoint, Nature had hit upon the most economical and efficient sort of way to support a continuing population of these spermophilous rodents. Or, to put it more biologically, "dipo" has specialized in cruising equipment (speed, noiselessness, capacious cheek pouches for carrying loads of seeds) enabling it to glean from a large acreage of meager food production. That there is success and an enlarged measure of individual safety in this attainment is indicated by the relatively large as well as widespread population in spite of low birthrate.

In the north end of Death Valley, in the vicinities of Triangle Spring and Surveyors Well, *Dipodomys merriami* was found on and around the mesquite-crowned sandhills far out across Salt Creek, as well as here and there on the sloping mesa well up toward the Grapevine Mountains, then, of course, above sea-level. Around Furnace Creek Ranch, the species was common in the mesquite tracts, whether on sandy or silty ground, and individuals were trapped or sign was seen down to within a few yards of the edge of the "self-rising borax", altitude -240 feet. The individuals taken here showed reddish color-tone of upper surface and tail tuft, which seems to be correlated with the presence of much "alkali" in the soil in which the animals live.

Of 20 females trapped, and of which record was kept, from April 5 to April 21, seven were pregnant. In four there were two embryos each, in three females there were three embryos each. As early as April 8, a young-of-the-year already two-thirds grown (weight 22.5 grams) was taken, betokening the beginning of the breeding season back in middle or even early March. By April 22, immature individuals were abroad commonly.

The 38 adult specimens of *Dipodomys merriami merriami* preserved from Death Valley furnish the following figures. Twenty males averaged in weight, 41.2 grams (extremes 34.0 and 49.5); eighteen females averaged 38.3 grams (range, 32.0 to 46.3). Measurements, in millimeters, of the same two groups: Males, total length 246 (225-270), tail 143 (125-160), hind foot 38.3 (36-40), ear from crown 10.8 (9.5-13); females, total length 241 (225-250), tail 139 (123-150), hind foot 38.5 (36-40), ear from crown 11.4 (10-13). It appears from these figures that in this rodent body and tail are slightly longer in males than in females, while the reverse is true of hind foot and ear. It must be recalled that total length and tail are measured to end of caudal vertebrae, not to end of the long hairs which make up the prominent tail tuft.

A specimen (no. 12863, Field Mus.) taken by Edmund Heller at Furnace Creek Ranch April 26, 1903, became the type of *Dipodomys merriami mortivallis* (Elliot, Field Columbian Mus., zool. ser., vol. 3, December, 1903, p. 250). The chief character claimed for this supposed "new" subspecies was the "russet" color of the pigmented

parts of the tail. This is exhibited likewise by those specimens in our present series that were taken on strongly alkali ground. This character is obviously adventitious; and the other features set forth by Elliot, as distinctive, do not prove to hold for specimens from the Death Valley region in comparison with long series from elsewhere on the deserts of southeastern California and southern Arizona (see Grinnell, Univ. Calif. Publ. Zool., vol. 24, 1922, p. 76).

Dipodomys deserti deserti Stephens

Big Desert Kangaroo Rat

If one were choosing a wild mammal to point to as most characteristic of the below-sea-level portion of Death Valley, he would probably select, all things considered, the big desert kangaroo rat. Even though this rodent is strictly nocturnal in its activities above-ground, and to be seen ordinarily only at night when an individual may cross a road in the glare of an automobile's lights, the abundant "sign" left by it, and the association of this sign (the big burrow mouths and abundant foot and tail tracks) with the picturesque sand dune areas, at once attract the attention of the observant visitor. In structure so obviously specialized for existence amid just those conditions, it is not surprising that locally, as well as generally, this species is closely restricted in its occurrence to the areas where accumulations of wind-driven sand have reached considerable depths. Elsewhere it is present sparingly or not at all.

Especially in the northern "arm" of Death Valley, from the vicinity of the old road-crossing at Salt Creek northward past Triangle Spring, were conditions seemingly perfect for *Dipodomys deserti*. I guessed that the population over that area in April reached the figure of 128 adult individuals per square mile—on the basis of a pair to every ten acres; and in places the population density was evidently far greater. Burrows were not made in the areas of most rapidly shifting dunes. Rather, those dunes which were mesquite-crowned, therefore relatively permanent, even though low (say, down to two feet in depth of the sand upon the clayey substratum), were the ones selected mostly as burrow sites. Judging from foot-prints, easily to be traced after a spell of quiet weather, the cruising radius of an individual *deserti* in the course of a single night may reach an extent of hundreds of yards. The seed-product of large areas must thus become accessible to the animals from their localized safety-refuges.

In the vicinity of Furnace Creek Ranch, *deserti* lived on silty ground as well as where sandy. When dry, this clayey silt becomes flour-like almost, and hence easily diggable to an animal with weak powers of digging. But when wet, as when flooded after one of the rare downpours of rain, this type of soil "melts down" and

must then become uninhabitable; the elevated and porous sand dunes then remain the strongholds of the "dipos", and the silty areas become re-inhabitable only as they again thoroughly dry out.

While typically an animal of quite open terrain (after the fashion of the jack rabbit), our trapping showed that *Dipodomys deserti* scouts out over all sorts of food-producing ground, even into the densest mesquite thickets. For example, an adult female that I trapped under a mesquite west of Furnace Creek Ranch, on April 12, 1917, was carrying in its cheek pouches many pieces of hardened sap ("gum arabic") which could have been gathered only from the mesquite trunks. However, this source must have been within reach of a position on the ground, as there is not the slightest evidence that "dipo" ever climbs.

As bringing out first-hand facts and inferences concerning the habits of the big desert kangaroo rat, I now quote from the field notes of Mrs. Grinnell and myself (dictating), set down at the time of observation. These are given almost verbatim—edited slightly, and with certain bracketed additions.

"7:00 a.m. [October 20, 1933]: Observing *Dipodomys deserti* burrows in lower slopes of rounded, rather permanent dunes of fine sand and silt, one mile west of Furnace Creek Ranch. These dunes are on the south side of the main lines of mesquite; hence they have been formed by winds blowing from the south gradually piling the sand and silt picked up from the open ground down the Valley and checked behind (that is, on the north sides of) some old outlying clumps of arrow-weed and small sized mesquite thickets. There is so much silt in the composition of the dunes that the rain has caked much of their surface, so as to render it semi-permanent; yet on the exposed sides (those especially toward the south) the wind has already etched into this 'caking,' and elsewhere there has been laid down a fresh layer of sand and silt in which the animal tracks show quite plainly. This is especially to be seen on the north sides of the dunes where the air currents are retarded. Here it is that the dipos have their burrows.

"The total height of the east-west line of dunes at this point, above base level, is about eight feet. The *deserti* burrows that we are examining are on the lower north slopes, all of them opening below the three-foot level; wherever there is a surface layer of newly sifted sand an abundance of tracks show, most conspicuously the sinuous tail tracks. Some of these, radiating from closed burrow mouths, are pretty nearly straight and continuous, up to a distance in one case, of 38 inches. Mostly, however, the tail tracks are intermittent, as if the animal were 'on the jump.' In one place a tail track meanders, with much side-to-side breadth at the short curves, as if the animal had been loitering along. Prints of the hind feet do not show so very clearly, because of their relatively great breadth. Also, the padded foot does not sink into this new veneer of loose sand. Each individual foot print is surprisingly wide,

18 to 20 millimeters across the toes in several measured. The heel rarely shows at all. Where clearly made out, hind footprints are side by side, though not always perfectly opposite with regard to the direction of movement; for example, in one pair, one print is 22 millimeters behind the other. Because of the multiplicity of tracks and their general indistinctness, I am unable to measure leap lengths. I am also not able to distinguish with certainty any track that I would ascribe to the front feet.

"Other animal tracks on the terrain under examination include those of desert quail, cottontail rabbit, and, under the edges of the mesquite, mouse (probably *Peromyscus eremicus*); and also of *Eleodes* beetles everywhere.

"The particular 'lay-out' we are planning to dig into consists on the surface, of four burrows, two of which are open and two closed—the latter plugged, it looks to me, from the inside. They are all on the lower north slope of the dune, opening thus to the northward; three are in line up-hill, 38 inches apart, and the fourth is the same distance off to the west of the uppermost one of the three, that is, on a level with it. At the front of each burrow mouth is a down-hill mound of spread-out sand and silt. The largest mound is in front of closed burrow mouth no. 3 (counting up-hill); it is approximately 3 feet long down-hill, by 2 feet wide. The surfaces of all the mounds are plentifully sprinkled with tail and hind-foot marks, showing use last night. The widths and heights of the burrow openings are: No. 1 (lowest, closed), 130 by 60 mm.; no. 2, open, 75 by 95 mm.; no. 3, closed, 110 by 85 mm.; no. 4, open, 65 by 70 mm. The latter has the most symmetrical, well-defined entrance of the four and may have been made last. I am assuming that the four burrow-mouths all belong to one rat. [The idea that there are 'colonies' of dipos may not be well-founded. Several entrances, or exits, to one burrow-system in a single large dune gives a first impression that there must be several rats concerned.]

"I begin digging with a shovel at the lowermost burrow, no. 1, at 7:45 a.m. The ground proves to be very soft, absolutely dry; it caves in very readily, the successive layers of caked dune surface breaking off freely. A cavity encountered 5 feet in from entrance no. 1 is 12 inches below the surface of the dune; diameter of cavity 200 mm. wide, 170 high; but parts of these dimensions are probably due to cave-in. Floor of cavity a mixture of sand, sections of mesquite pod, shreds of pod walls, and fresh and old leaves of mesquite. Some of this latter material is, however, just such as is included within the layers of which the dune is composed. Plugged segment encountered in no. 3, about 9 inches long.

"8:30 a.m. Baffled! Entrances 1, 2 and 3 found to join and lead off in irregular course, and with several loops, to a used entrance 12 feet to the east of, and on a level with, no. 1. Also, branches are numerous and in various directions, with some anastomosing. Farthest passages uncovered to south and southeast, 12 feet from

entrance no. 1; south into dune, 9 feet. Estimated total length of burrow uncovered, 45 feet; but cave-in's undoubtedly meant my loss entirely of one or more passages. Greatest depth reached, about 2 feet; then face of cut would automatically cave in, because loose inter-cake layers of sand would run out until weight of caked layers overhead would make latter break off. This sort of process is continuous!

"Digging, for the rats, must be exceedingly easy. Indications are that dune to depth of 2 feet on north side has been pretty well honey-combed; probably earth moved back and forth repeatedly within system; indeed soft plugs often encountered, of sand inter-mixed with bits of mesquite pod (unripe when gathered); foecal pellets also mixed with sand here and there along passages. No special living compartment found, nor any trace of any nest. Only co-inhabitants found, a spider and a fish-tail [thysanuran?].

"No rat showed itself. Some branches of the burrow-system came up to surface of dune at inconspicuous places, where ceiled over by most recent caking—possibly used as 'duck-outs'. Thus, *Dipodomys deserti*, here as elsewhere, appears to rely upon accumulations of exceedingly loose soil within which, with its limited digging powers, it can establish a labyrinth of burrows; in this labyrinth with connecting exits it can, as a rule, easily elude such digging enemies as the badger and coyote."

At Triangle Spring, on the morning of October 25, 1933, one of our quart-size, "live", can-traps produced an adult *Dipodomys deserti*. This we took with us on our hike to the sand dunes out in the middle of the valley. Quoting in essence: "We selected an area of about two acres of ripple-marked, freshly wind-laid sand, very gently undulating in relief pattern—most favorable for our purpose [of observing how dipo would behave when released upon it]. After release by Mrs. Grinnell out in the middle of this selected area [I with watch in hand near-by], in 42 seconds the rat had reached, and disappeared in, an arrow-weed clump which proved to be 76 paces away from point of release [my pace found to be $34\frac{1}{4}$ inches, heel to heel]. [This would be gross progress, then, at the rate of 5.2 feet per second, or but $3\frac{1}{2}$ miles per hour.] The rat's course was not straight, but was somewhat meandering. Two or three times the rat stopped momentarily. It progressed by springy bounces, entirely on its hind legs. Tail, when animal was in motion, did not touch the ground, but was held a bit above horizontal, the end flopping up and down so that the white tuft was visible in up-and-down movement to the last.

"We were disappointed in the lack of speed shown; [after seeing what the 24-gram desert white-footed mouse could do] we were looking for prodigious leaps, rapidly executed [on the part of this 120-gram, specialized jumping rat]! Possibly this particular animal was confused by the glare, even though the sunlight was somewhat dimmed by cirrus clouds; or it might have been below par because

of having been cooped up in the trap-can all or most of the night. Some measurements between foot prints, toe-tips to toe-tips, because these *dig in* on the harder sand surface: 380 mm., 590, 750, 710, 760, 540, 760. When under full gait, only the broad forward part of the foot leaves a track, involving the toes only—a roundish track; only when stopping does the hind foot clear to the heel show; also only then does any tail mark show.

"I then routed the rat out of its arrow-weed refuge, when it took to the open, I after it as if to catch it. He then went faster than I could run on the soft sand surface; now and then he resorted to quick side-to-side dodges that left me entirely at a disadvantage and out of breath. When *I* stopped *he* stopped, putting front feet to ground and also terminal half or so of tail. He then had five points of contact with the ground. To repeat, in locomotion the tail was held rather stiffly horizontal, or a bit above horizontal, the end bobbed up and down in unison with the bounces. The white tuft jerking up and down held the observer's eye. The animal, when no longer pursued, kept on, stopping now and then, until it took refuge in an arrow-weed thicket 100 yards or so off, where we left it in peace. I measured some more leap-lengths down a gentle slope off the edge of the sand patch: 670 mm., 620, 630, 670, etc.—pretty uniform.

"After the first 'heat' I was able to go back and check upon the tracks in the sand, these indicating 81 bounces in a distance of 55 of my own paces. [Calculated thus, the dipo when in full swing was progressing at an average rate of 23 inches per 'bounce'—which pretty closely accords with the measured distances, in millimeters, just given.] This rat, by daylight, showed no special concealing quality of coloration against the sand; it was quite visible even at rest, the big black eyes and white of feet and tail-tip being conspicuous. [The shadow that it cast, even though the sunlight was dull, added to its conspicuousness. Conditions at night, however, may make a very different impression upon a pursuer.]"

On the evening of April 21, 1917, Mr. Dixon spent some time attempting to get flashlight photographs of the big dipos west of Furnace Creek Ranch. He says: "They were out foraging by 8 o'clock, and I could hear them running about. At my approach they all ducked into their burrows, and I could hear a warning signal pass around the 'colony' under-ground. This warning signal was a sharp thumping sound similar to that made by a cottontail rabbit. This noise stopped after I remained quiet, but was renewed whenever I stirred." On April 23, Mr. Dixon's notes record further that "The flashlight was set up at a *deserti* hole in a sand dune where I had been feeding the rats rolled oats for a couple of nights. Although they had been taking this bait freely before, last night they refused to come anywhere near the burrow." Later, one individual became used to the presence of the camera and would come out

7 to 10 minutes after the apparatus was set up and the place left. The flash was sprung several successive times by this rat.

As to the breeding habits of *deserti* we learned little. A female trapped on April 8 contained one small embryo; two females taken on April 17 contained each two embryos. On April 13 the first young-of-the-year was trapped, this one weighing 52.5 grams, so less than half grown, yet foraging abroad. This animal must have been born back in mid-April.

Thirty-seven adult specimens were preserved from the floor of Death Valley. The 17 males gave weights, average and extremes, as follows: 116.1 grams (95.3–138.5); 20 females: 101.9 grams (82.8–118.5). The same two groups showed dimensions in millimeters as follows: Males, total length 348 (325–370), tail 201 (185–220), hind foot 54 (53–57), ear from crown 14.4 (13–16); females, total length 331 (304–377), tail 192 (155–211), hind foot 52.4 (48–55), ear from crown 13.8 (12–16). Differences between the sexes in these respects may thus often be rather noticeable; males average decidedly the larger.

As with *Dipodomys merriami*, individuals of *D. deserti* trapped on or closely adjacent to strongly alkaline ground, such as that at Triangle Spring, usually show a distinct reddish cast of color on the dorsal surface of the body, this reaching an extreme of rust-color on the normally blackish areas of the tail. Sometimes even the white "flag" terminating the tail is discolored with this rusty tone.

***Onychomys torridus longicaudus* Merriam**

Long-tailed Grasshopper Mouse

Little was learned concerning grasshopper mice save as afforded by trapping them; and this did not disclose any distinctive "sign" of their presence, as compared with *Peromyscus*. The species was found only in the vicinity of Furnace Creek Ranch, perhaps simply because most trapping was done there. Getting an *Onychomys* in a night's trap-line was always considered merely a matter of luck. Kind of bait used did not seem to matter.

Of the total of thirteen individuals taken, one was on gravelly ground at a creosote bush, two were on silty, alkali ground down almost to the border of the "borax", — 240 feet, where there was sparse arrow-weed, mesquite and salt-grass, and the rest (as far as note-book record shows) were on sandy or silty ground under mesquites. Thus, no narrowly restricted habitat preference was discerned. I suspected, however, that the metropolis of the species would be comprised in the gently sloping, flat terrain, of gravelly soil, where the creosote bushes grew of rather large size.

The thirteen specimens, of dates April 4 to 22, consisted of ten adult males, one immature male, and but two females, both adult.

It would look as though males are more venturesome or far-ranging than females, at least at this time in the annual cycle. A strong musky smell was given off by the dead males, even before handling in the process of skinning. This smell was different from that pertaining to white-footed mice or to wood rats.

The two females, taken April 20 and 21, 1917, each contained two large embryos. The small size of the litter thus indicated must be significant of a mode of existence that renders the individual *Onychomys* safer from the dangers that beset the more rapid breeding *Peromyscus*. The immature male was taken April 10, 1920; length 128 millimeters, weight 17 grams, pelage gray; possibly a month old, yet the testes were large.

The ten adult males weighed in grams, 18.6 to 22.9, averaging 20.6; the two pregnant females, 26 and 27 grams, respectively. As to dimensions, there seems to be no difference between the sexes. The twelve adults gave figures as follows: total length 140 millimeters (135-145), tail 50 (44-54), hind foot 20 (19-21), ear from crown 14.3 (13-15).

The adults are all bright-colored, the usual rather clear pinkish cinnamon characteristic of the race *longicaudus*. The brightest of the lot, in which this color tone may have been heightened by the extreme alkalinity of the surroundings, was taken April 22, 1917, nearest the borax flat, below Furnace Creek Ranch. In this one (no. 25932) the trend is strongly toward ochraceous-salmon (of Ridgway's Color Standards and Color Nomenclature, 1912, pl. XV).

***Reithrodontomys megalotis megalotis* (Baird)**

Desert Harvest Mouse

Harvest mice were found only in the vicinity of permanent water, and where a hydrophytic growth of considerable extent exists. It is to be inferred that this type of environment, now restricted to a few relatively small and far-separated areas, must have been present continuously down through time since an era of much greater rainfall, when marshland or lush meadow was widespread and along the lowlands continuous. It would certainly be impossible for a harvest mouse long to survive exposure to open desert conditions in their extreme present-day manifestation.

To be more explicit, we found harvest mice in three places: Along Salt Creek in the growths of *allenrolfea*, tule and cane; at Eagle Borax Works, in the similar marsh-dependent kinds of plant growth there; and on Furnace Creek Ranch, along the irrigation ditches the banks of which were grown to lush vegetation inclusive of much bermuda grass. Regarding the latter locality, it must be remembered that the ranch lands were originally reclaimed from the dry desert by conducting the water down an open ditch from the original

Furnace Creek which was fed by the big permanent springs to the eastward, well above sea level. This was the condition when I was there in 1917 and 1920; but now the water is piped down. Riparian conditions were thus originally continuous down from the upland sources of the water to the ranch lands, and these are now (1933) being more and more extended—which means enlargement of the area occupiable by *Reithrodontomys*.

Such breeding data as was obtained from Death Valley was furnished by the mice trapped. On April 7, 1920, a female taken was found to contain five small embryos. On April 10, 1920, a young "reithro" was caught in one of Dr. Sumner's "live" traps; it was scarcely half grown, weighing but 5.2 grams. The above records were from Furnace Creek Ranch. At Salt Creek, on April 14, 1917, a female was found to contain three embryos; and at Eagle Borax Works, May 5, 1917, a female contained also three embryos.

Scrutiny of the tabulated measurements of the sixteen adult specimens of *Reithrodontomys megalotis* from Death Valley (12 males and 4 females) discloses no appreciable sexual differences. Therefore the figures, in millimeters, are given here in one summary, as follows (average, minimum and maximum): Total length 142 (132–152), tail 70 (60–78), hind foot 17.4 (17–18), ear from crown 12.1 (11–14). Weights range from 8.8 to 11.2 grams (both extremes are males), averaging for the sixteen, 10.2 grams. In color-tone of pelage the series is no paler than other population samples from the Mohave Desert and Great Basin; and curiously there is none of the supposedly alkali-caused discoloration that is shown by so many individual kangaroo rats and other dry-ground dwelling rodents.

***Peromyscus crinitus stephensi* Mearns**

Stephens Canyon Mouse

The presence of this mouse was detected at only one point in the below-sea-level portion of Death Valley, although the species was found commonly in the surrounding mountains. The reason for this general absence from the Valley floor is clearly that the inherent restriction of the species is sharply to the rocky gorge (cliff) type of habitat, and this type of habitat encroaches upon the valley bottom only along a small part of the "oo" contour.

On the evening of October 13, 1933, near Bad Water, -180 feet, Mrs. Grinnell and I put out 55 mouse and rat traps on all sorts of ground within easy walking distance of the road at the side of which on a gravelly wash-bottom we had camped. To us, fresh from Berkeley, the prospects of any returns at all were poor; we failed to see any rodent sign whatsoever, there were no traces of sand-dunes, vegetation of any sort was exceedingly meager, the heat, even after the shadows from the Panamints had finally overspread

our side of the Valley, was oppressive; and this heat, especially the "glare" from the bare ground surface and from the cliff-faces close at hand, continued all night. Yet, in the morning we found in our traps no less than seven rodents, of two genera, *Neotoma* and *Peromyscus*, the latter of the species *crinitus* which was new to our Death Valley list. This was a 12 per cent yield, quite as good as the average a person obtains in far more promising sections of California!

The two wood rats taken, and one of the white-footed mice, were in traps in or near bouldery debris fallen from the cliffs of the Black Mountains; the mouse was in a trap under the edge of a large angular rock. The dominant (indeed, almost the only) plant in sight was the "desert holly" (*Atriplex hymenelytra*). But the astonishing thing was the capture of the other four *Peromyscus* in the 24 mouse traps we had set, "on a chance", out on the "self-rising" borax flat in some small tracts of low ink-weed bushes (*Allenrolfea*). These tracts were located 50 yards or so out on the forbiddingly rough "borax" ground, then dry and hard as rock. The traps were put in under the bushes where, however, no runways or other sign was seen even when we had learned the mice were there.

Upon reflection, the finding of this kind of *Peromyscus*, normally rock-inhabiting, in the ink-weed habitat in this particular place, is not difficult to explain. The rough, "self-rising" ground is full of crevices and holes, in this respect resembling the near-by steep mountain side, thereby meeting *that* requirement of *crinitus*; and the allenrolfea plants (absolutely the only kind of plant we could see out on the borax flat at this point) must through its seeds have provided the food. In a way, perhaps from a mouse's-eye view, the borax flat, when dry, is a cliff *prone*. This ink-weed population of *crinitus* we sampled, may thus be looked upon as an outlying, pioneer group—overflow from the near-by cliff habitat where conditions from the food-limitation standpoint must be severe.

Of the five specimens of *Peromyscus crinitus stephensi* taken, on October 14, 1933, all were preserved (nos. 61354-58). Four were males (all those caught under *Allenrolfea* bushes). None was sexually active, and the males were rather fat. Weights: ♀, 8.7 grams; ♂♂, 10.7 to 12.5, averaging 11.8 grams. In measurements, the ♀ gave figures as follows: Total length, 164 mm.; tail, 91; hind foot, 20; height of ear from crown, 15. The males averaged, same dimensions: 160, 85, 19.5, 16.2. Both as to skins and skulls these five specimens looked small as compared with series of the race *stephensi* from elsewhere in southeastern California. But condition of teeth shows that all were relatively young, probably born the preceding spring. That the four "pioneers" were thus all first-year males may have significance. One would suppose that in a period of very wet weather, the borax-flat population would be destroyed, and that re-invasion, when again possible, would be first, or farthest, by young males.

Peromyscus eremicus eremicus (Baird)

Desert White-footed Mouse

The desert white-footed mouse was trapped, save on Furnace Creek Ranch proper, only on clayey or finely sandy ground beneath, or in the near vicinity of, mesquites. While its presence was detected by us only in the neighborhood of Furnace Creek Ranch and at Eagle Borax Works, it probably occurs also wherever the soil conditions stated, plus extensive growths of mesquites, occur. Arrow-weed, salt-grass, and other indicators of habitats for some other mammals, were believed to be only incidental for this one. *Eremicus* had invaded the cultivated ground of the Ranch and even entered the buildings and become "house mice" there, but not to the extent that *sonoriensis* had (see record of Dr. Sumner's trapping in April, 1920, in table p. 122); in or close about buildings, where a total of 96 *sonoriensis* were caught, 26 *eremicus* were taken.

This mouse is a climber, as witness the notes of Mr. Dixon, made at Eagle Borax Works, May 5, 1917: "I spent considerable time [last night] watching a pair of *Peromyscus eremicus* run up and down a large mesquite tree. The moon was full, so the light was good; the mice paid no attention to me as I lay in bed. They . . . ran fearlessly about, even on the smaller limbs no larger than a man's thumb. They gave a sharp 'rapping' signal, similar to that of *Dipodomys*, but I could not see how the sound was made." On April 11, 1920, Dr. Sumner trapped five *eremicus* on or under the roof of the (then) ranch house at Furnace Creek Ranch. No *sonoriensis* were taken so high up in buildings.

In October, 1933, Mrs. Grinnell and I ran some "live", can-type traps several nights in a tract of mesquite two miles south of Furnace Creek Ranch. We had been impressed by the speed of liberated individuals of *Peromyscus* in getting to cover, and we planned a way of measuring this speed. On the morning of the 17th a can-trap contained an *eremicus*. With the shovel, I smoothed an open level section of the silty ground, so as to provide a perfectly clean, dusty surface several feet square. With watch ready, the mouse was released from the can in the center of this area. In just 2 seconds he was out of sight in the adjacent mesquite thicket, having traversed in that time 3 feet of the specially smoothed space plus the additional 6 feet intervening toward the thicket. That equals 9 feet in two seconds, and he must have taken sufficient of this time to orient himself; for he followed the shortest route to the nearest edge of the cover! He had hit the ground on all fours (as shown by the tracks left in the dusty surface) 8 times in a distance of 6 feet 2 inches; the first three springs covered $14\frac{1}{2}$, 14, and 16 inches, respectively,

again as shown precisely by the 4 bunched footprints, the two in front (those of the hind feet) wider apart than those behind (of the front feet). To the human eye, his gait was a series of bounces almost too rapid to follow.

On the morning of October 21, we tried the same kind of experiment with two more can-trapped *eremicus*. This time, I prepared a smoothed area 8 feet or so square next to a mesquite. Mrs. Grinnell liberated the mice, one at a time, on the far side of this area from the nearest edge of the thicket. Mouse number one hit the ground 9 times, as shown by the dust-record left, in 3 seconds; intervals between heel marks: 18 inches, $13\frac{1}{2}$, $9\frac{3}{4}$, $8\frac{1}{2}$, $7\frac{1}{4}$, $7\frac{3}{4}$, $8\frac{1}{4}$, $8\frac{1}{2}$, successively (equals a total of $81\frac{1}{2}$ inches of distance covered in 3 seconds). This was a slower rate than that of the first mouse tried out. Such variations might be due to individual differences but also to greater amount of chilling after capture in the traps, of one mouse than another.

Mouse number two seemed more alert. When released it instantly took off, more to the right where a mesquite branch extended farthest toward it along the ground. He bounced 13, 25, and 18 inches, then off the smoothed area, having made a distance of 56 inches in approximately $1\frac{1}{2}$ seconds.

Breeding data are as follows: Litter-size as indicated by embryo-records from mice collected in 1917, averages only 3; the figures for 12 pregnant females are: 4, 4, 3, 1, 4, 4, 3, 3, 3, 4, 2, 1. The dates of these records extend from April 4 to May 5. In 1920, Dr. Sumner's trapping produced 165 *eremicus*, of which 85 were males, 77 females; 80 were adult, 84 were juveniles (see p. 121). While these data indicate the main breeding period to be in the spring months, on October 19, 1933, I trapped a female under a woodpile at the Ranch, which contained 3 five-millimeter foetuses.

One of Dr. Sumner's papers is based importantly upon the stock of this mouse he obtained in Death Valley (Sumner, F. B., and Huestis, R. R., Studies of Coat-color and Foot Pigmentation in Subspecific Hybrids of *Peromyscus eremicus*: Biol. Bull., 48, 1925, pp. 37-55).

A total of 32 specimens of *Peromyscus eremicus eremicus* are in the Museum's collection from Death Valley. The data accompanying those that were adult, taken April 4 to May 5, show weights of 14 males to average 24 grams, of 12 females 27 grams. Variation is great (18.4 to 39.5 in the males, 21.4 to 35.0 in the females). Degree of fatness in males, and stage of pregnancy in females, accounts for this variation, as also, doubtless, amount of food recently taken; for example, the stomach contents of one female weighing 32 grams were found alone to weigh 6.5 grams, or 20 per cent of the total weight. Measurements of 27 adults give averages in millimeters as follows: 15 males, total length 194, tail 99, hind foot 21, ear from crown 17; 12 females, same dimensions, 198, 102, 21, 17.

Peromyscus maniculatus sonoriensis (LeConte)

Sonora White-footed Mouse

The species *Peromyscus maniculatus* has been pointed to as the most widely distributed mammal in California; its range within this State extends through all the life-zones from Lower Sonoran to Arctic-Alpine, through all the faunal and subfaunal areas from most arid to most humid, and through nearly all the habitats to which, severally, many other rodent species are restricted. In other words, this white-footed mouse is tolerant of the widest gamut of physical and biotic conditions. Yet in Death Valley the species (in its race *sonoriensis*) does seem to find the limits of its tolerance in certain directions. For our trapping there has revealed its presence definitely in only five out of the eleven recognized habitats; it did not invade the driest, truly "desert" parts of the area.

Specimens came to our traps, sparingly, at Triangle Spring and Eagle Borax Works, and more numerous on and around Furnace Creek Ranch. The native plants most constantly associated with the presence of *sonoriensis* were arrow-weed and salt-grass. Such other plants as mesquite, tule and ink-weed seemed likely incidental. The presence of ground moisture, or at least of more or less succulent vegetation, seemed requisite for this mouse. At Furnace Creek Ranch it was found everywhere on the cultivated lands, and along the "overflow" water courses westwardly down to the edge of the "borax" flat, altitude — 240 feet (see table showing results of Dr. Sumner's trapping). It freely invaded the lower parts of ranch houses, and became the "house mouse" there. [No example of the true house mouse, *Mus musculus*, has yet been identified from Death Valley, to my knowledge.]

Dr. Sumner's trapping (see p. 121) was concentrated upon this rodent. A total of 773 trap-nights on and below Furnace Creek Ranch brought to his "live" traps 358 rodents. Of these, 168 were *Peromyscus maniculatus sonoriensis*, more than of any other species caught. This is not indicative of relative abundance, however, for it was this species that Dr. Sumner particularly wanted, alive, for experimental purposes and he adapted his efforts accordingly. Dr. Sumner's 168 *sonoriensis* were taken from April 5 to 14, 1920. Of these, exactly one-half were males, one-half females; 65 were definitely adult and 103 more or less immature. On April 14, a female with seven young was found in a nest in the superintendent's house. On April 19, 1917, a female weighing 31.5 grams and containing six large fetuses was trapped in the store-room at the Ranch. Three individuals taken at bases of arrow-weed clumps close to Triangle Spring, October 24 and 25, 1933, were in adult pelage and showed no sign of breeding. The breeding period of this species in Death Valley is thus indicated to be during the spring months.

Of the 8 specimens in the Museum's collection from Death Valley, one is a blue-pelaged juvenile (weight 9.1 grams), taken in the Ranch

store-room, April 19, 1917. The other 7 specimens, including the female above referred to as pregnant, are in adult pelage. One of these was taken at Eagle Borax Works, May 7, 1917. This, and one other individual discarded, was trapped by Mr. Dixon on the swampy ground where tule, cane and mesquite grew abundantly. Weights of 3 males average 18.3 grams; of two non-pregnant females, 24.1. The measurements of 4 males and 3 females average: Total length 159 mm., tail 68, hind foot 20, ear from crown 16.

Neotoma lepida lepida Thomas

Desert Wood Rat

The desert wood rat proved wide-spread in the Death Valley region. Its range extended to an altitude of 7500 feet on certain of the surrounding mountain masses; and on the floor of the Valley proper it was abundant in suitable places down nearly to the edges of the "borax" flat, close to -280 feet at Bad Water. We found its presence to be governed more by availability of shelter (stout-stemmed bushes or trees, and fractured rock outcrops or talus masses) than by any obvious vegetational factor having to do with food. In other words, *Neotoma* could use for food some, at least, of the kinds of plants present almost anywhere, provided shelter of a proper sort were at hand. True, it could dig, and thus supplement, by burrowing, the natural facilities for safety. But its own digging powers are weak, and only in silty or sandy ground could these suffice to help much toward security; indeed, these powers were evidently insufficient in themselves, without the defense provided by stout plant stems or by rocks, against digging carnivores. Another vital factor was shelter through the daytime, from the sunshine and extremest heat. Our observations showed the wood rats in Death Valley to be strictly nocturnal in time of their activity.

Considerable stretches of the Valley floor showed no sign of wood rats, these stretches comprising not only the lowest "self-rising" borax flat, but the wind-pavemented, open desert, marked only with sparse, small bushes, and also the nearly bare, broad, stony-surfaced wash-fans spreading down from the mountain canyons. But the tracts of mesquite, screw bean and arrow-weed, the gullied margins of ravine-cut mesas, and the steep-walled, rocky canyons wherever these invaded the area here under special consideration, were sure to disclose the presence of these rodents in greater or less numbers. Undoubtedly, the greatest concentration of numbers was where the stands of mesquite were closest and densest, as around Furnace Creek Ranch and Eagle Borax Works.

In the "Mesquite Arm" of Death Valley wood rats proved fairly common around Triangle Spring, there inhabiting the mesquite "crowns" of the sand dunes far out on the flat, the low patches of

mesquites at the base of the low mesa, and the holes and cave-like chambers in the steep sides of the gullies and ravines which cut the margin of that mesa. Along Salt Creek the same kinds of habitat showed signs of wood rat, as also did some of the arrow-weed thickets which reach great size in certain places there. Where the Black Mountains rise cliff-like from the lowest part of the Valley, at Bad Water, sign was plentiful among the fallen rock masses at the base. The cliff-face above was honey-combed with cavities; hidey-holes of many calibers were plenteous. Here, on October 14, 1933, two wood rats were trapped, one of them among the rock debris, the other under a little bush of *Atriplex hymenelytra* growing on a little wash-fan out from the cliff-base a few yards. This was practically the only shrub in the vicinity and may be inferred to furnish the rats there with some of their food—along with whatever remains from the brief-lived "annual" herbage. Foraging at night to some distance (up to ten yards at least) over open ground, from their safety refuges, is thus indicated.

"Sign" of wood rats consists most prominently of the "houses", which are especially easy to see when beneath mesquites; for then they reach largest size, possibly because much building material is there available. These always, in our observation, rest on the ground; none was seen up in the branch-work, off the ground. Houses are conical accumulations of all sorts of removable objects: twig-ends, chunks of wood, mud-cakes, flakes of rock, dry cow and burro manure, and pods of mesquite and screw bean. One house consisted of clods of dried alkali mud, mixed with dry mesquite leaves and leaf-stems, and a few thorny cuttings.

Among rocks, the "houses" are represented by irregular accumulations of sticks and stones beneath and between them. Often such collections are meager, or else they can scarcely be seen because located far in under the boulders. Indeed, in places I have been able to see no trace of any accumulation. Then "sign" is restricted to the characteristic black (when fresh), elliptical fecal pellets, grouped, or piled in special spots under rocks, or scattered along regular routes of travel—these frequently recognizable as trails, because regular use has cleared the way of the finer surface material.

At night, the rats climb everywhere. They go all over the mesquite trees, despite the thorns, and they cut off the terminal twigs, doubtless for food. In places, the mesquite must provide the entire subsistence of *Neotoma*, both food and shelter; for example, in a tract two miles south of Furnace Creek Ranch where, in October, 1933, we could find no other vegetation seemingly within their cruising radius. Where the rats *were*, and mesquites were wanting, then the entire needs of these rodents were, of course, supplied from other sources. *Neotoma* is thus resourceful, compared with some mammalian species.

On the mornings of October 18 and 19, 1933, we selected one wood rat's "house" from the very many seen in the mesquite tract below

(west of) Furnace Creek Ranch, for special examination. The selection of this house was made on the basis of its near maximum size, its accessibility to us, and because by clearing out some branches it could be photographed *in situ*. The following account, with very slight change in wording, is as written down by Mrs. Grinnell from my dictation, while I did the "dissecting".

The general site of this house is in a continuous east-west "line" of mesquites, one "unit" of which, the one immediately concerned, consists of eight large-sized trunks radiating from a center, which center presumably marks the union of these trunks below-ground where emanating from the main water-gathering root system far below. Only one of the trunks approaches vertical; one foot above the ground it is 40 inches in circumference. The rest of the trunks more or less approach horizontal position; at least some of their terminal branches lie on the ground. By estimate, the greatest height of this "unit" is 20 feet; its radius from the center, 25 feet.

Our wood rat's house is on the ground, due south of the center of the "unit". Its center is 12 feet from the center of the "unit". The house is built up so as to include within its mass a horizontal trunk (which is $4\frac{1}{2}$ inches in diameter where it traverses the nest) together with a large number of smaller branches, the latter all dead. Also on the far side of the nest, and partly built into, is an old, long dead clump of arrow-weed, now consisting of a large mass of sticks, the longest broken-off tips of which, directed upwards, are about 5 feet long. Near the ground some of the sticks radiating slantingly from this arrow-weed clump reach a length of 6 feet.

The wood rat has thus insured well against successful ransacking of its house by a digging enemy, such as a coyote, in that the constitutive materials are well reinforced by the anchored thorny branch-work of the tough mesquite and by the great number of sharp-pointed arrow-weed sticks constituting a sort of chevaux de frise on the peripheral side of the mesquite clump.

In looking about the vicinity and thinking of all the conditions to be met from a wood rat's point of view, with its limitations for getting away and the consequent necessity for a safety refuge and unassailable nursery, I could suggest no better place to have started this particular nest. The large size and clean symmetry of this house betokens, I judge, success in the accomplishment of these aims; no successful assault has yet been carried out against it.

That the wood rat at night climbs all over the mesquite branch-work overhead is indicated by cut ends of twigs as far aloft as I can see, up to a diameter of 3 millimeters each. All such twigs have been cut diagonally; the fresh ones show incisor marks. Cuttings of obviously this source enter into the composition of the nest. In the top are some fresh, green twig tips with leaves, some so fresh as likely to have been added last night. Such material is, however, in very small proportion to the entire mass, which to superficial examination consists basally of a very large mass of coarse sticks and

sections of branches long weathered and broken to pieces by agencies other than the rats themselves, while toward the top of the house there is an almost pure constituency of the long, yellow mesquite pods, comprising by estimate a bushel (but see below).

The ground beneath our particular mesquite "unit" is centrally rather cleanly carpeted with dead mesquite leaves, fallen mesquite pods, and dead twigs and branches. Right around the house the ground is rather clean of bean pods and cut twigs, which makes it seem that the rat had used nearby materials first in accumulating the structural materials of its house.

It is probable that this house basally represents the work of several years and possibly of several successive tenants. But certainly all the great quantity of bean pods are of last summer's crop. It is assumed from evidence gathered elsewhere that only one adult rat is in residence at any one house at one time. There are near neighbors to this one; a much smaller house is ensconced in a tangle of arrowweed and prone mesquite branches not more than 35 feet to the northward; and there are others a bit farther off up and down the mesquite "line."

The house we are examining is bluntly conical in lateral profile. On the ground it is 63 inches in diameter; its summit, the highest bean pods on it, is 27 inches above the ground level. Nine inches below the summit, following along the side of a sub-branch, is a well-defined entry-way, with rat feces showing among the bean pods on its floor. At lower levels, along the mesquite branches, there are openings of a diameter to admit free passage of a wood rat. Openwork construction is to be seen elsewhere also, though with no regularity of apertures.

We proceeded to pick bean pods from the wood rat's nest and to stack them on the clean ground near-by, working thus since 7:45. Save for broken fragments and for a few in interstices of the arrowweed thicket, all are now (9:15) segregated. They constitute a pile as steeply conical as they will rest, 29 inches in diameter at base and 15 inches high to peak (straight up). There is no evidence of an older crop of beans in the nest, and the present, bright yellow, this year's crop, has been taken by us from the surface and the upper fourth of the peak of the nest, where more or less mixed with sticks, cakes of dried surface-mud, and an occasional burro dropping. The basal half of the "house" still remains, with at least four holes (passages) entering it. We have a stack of sticks, separately removed to one side, higher than the house now is, and also a separate pile of the mud cakes.

9:35: Just finished counting the entire number of "beans", doing so by counting them out into piles of 100 pods each. Result, 29 stacks, plus 63 pods: total, 2963 pods.

Very few bean pods still hang in position on the mesquite branches; this year's crop has almost all fallen and it litters the ground picturesquely beneath those clumps which bore heavily this year; in fol-

lowing the mesquite "lines" it is clear that production of beans was not uniform; some "units" bore much more heavily than others. The heaviest crops we have seen have been under the lines of mesquites down west of the ranch, where presumably best watered subterraneously.

The great majority of pods from the wood rat house are entire; perhaps one in twenty has been split and the "beans" within split and the kernels removed. (This is not quite correct, since the seed proper is inside a capsule which is part of the pod, with the sweetish pith between this capsule and the outer wall of the pod.) Very many of the pods have little holes in them, each about one millimeter in diameter, made by a pea-weevil (*Bruchus* sp.). Adults of this beetle lay eggs in the flowers at the time the seeds are "setting"; the new insects, when mature, emerge, each through the little round hole, when the pods are ripe and dry. Such holes penetrate to the seed proper and may be scattered along a given pod to the number of 16 in a pod of 188 mm. chord. All the pods, be it noted, are more or less curved, varying from a slight crescent to the shape of a capital C, even to a complete circle, with spiral trend. Diameter of one of the latter in hand is 50 mm. Some slightly curved pods are: 162, 141, 149, 148, 172, 159 mm., respectively, in chord.

The mesquite pods are now rigidly dry, strong, break brittly under lateral pressure. The nutriment in them is the sugary pith within the substance of the pod. The seed proper, of which there may be as many as 24 in one pod, and its capsule, comprised in the innermost layers of the pod, are exceedingly hard, at least in the fully-ripened pods. I see an occasional split pod, evidently gathered before ripe, in which the capsules have been split and the seeds themselves removed.

Two hundred forty-seven mud cakes, by count, were taken from the upper structure of the nest and very many more remain *in situ*. Continuing with the demolition of the house: Entrances near the ground lead to considerable cavities along which are many more mesquite beans and also mid-ribs of green leaves, this material mixed with fecal pellets. Ensnconced at the base of the arrow-weed clump, best protected perhaps of any part of the whole structure, is a cavity 140 mm. high by 190 mm. wide. The walls of this cavity are kept from caving in by the arrow-weed stalks which extend out through the surrounding mass. In the bottom of this cavity is a very neat nest whose concavity opens up diagonally and is symmetrically rounded—108 mm. deep and 68 mm. in diameter. The wall of this nest, about 25 mm. thick, is loosely felted, "pure culture", finely shredded inner bark of dead mesquite, such as we find on the smaller branches an inch or less in diameter. This material has a very soft texture; it is perfectly dry and absolutely clean of any excrementitious material.

Further demolition uncovers hundreds more mesquite pods! In the lower levels some of them were evidently gathered green and are

still green in color. Further galleries are uncovered, communicating with the nest chamber already described; and there are holes into the ground at the base of the arrow-weed clump. We have seen nothing of the rat; it evidently has made use of avenues of escape beyond our reach or notice.

We have saved, for the Museum, samples of mesquite pods, mud cakes, and nest lining. Among the pods are samples of various sizes and shapes; ripe ones and ones evidently picked green; some "split" and some evidently gnawed into after dry and hard, seemingly just for the sugary pith.

Elsewhere a small wood rat's nest was seen with a few screw-bean pods, or clusters of pods, at its summit—no mesquite pods, as apparently none was available near-by.

On October 28, in the same neighborhood, we selected another wood rat house for dissection. This one was in the periphery of one of the "units" of an old row of mesquites; it was $17\frac{1}{2}$ feet west of the main stem of the unit. This stem was one of the biggest in the line and its crown topped the line for some distance either way. The main trunk was 55 inches in circumference one foot above the ground. The height of the house was 22 inches; its diameter, lengthwise of the protecting mesquite branches, was 42 inches; diameter at right angles to this, 35 inches. The prone, main mesquite branch, at the edge of the nest toward the center of the unit, had a diameter of $4\frac{3}{4}$ inches; it was alive and it branched repeatedly, one set of branches extending up over the peak of the house, and other branches (part of them dead) traversing the mass of the house. The latter was thus effectively reinforced against being dug to pieces.

The upper part of the house (fully the upper half in altitude) consisted almost purely of mesquite pods; only a few sticks were mixed in. A hole at the level of the ground entered the mass just beneath one branch and parallel to it. There were other openings on the opposite side among the emerging branchlets. We found that the pods, despite their "pure culture" at the peak, could not be lifted off en masse; they clung together and to the penetrating mesquite branches like jackstraws because of their interlocking curvatures. So we laboriously picked them out, forming, apart, a steep-sided heap 20 inches high. We then counted them out into separate piles of 100 each; results, 36 piles plus 83 pods—or a total of 3683 pods, in this one house! We found them intermixed into the base clear to the ground level; indeed, over half the total bulk of the house appeared to consist of pods! Further dissection showed not a trace of lined nest above-ground; but holes went down into the soft, silty earth. We did not follow them.

The superintendent of the ranch told me of "rats and mice" about the buildings and haystacks. On the chance that we might find real house mice and house rats here, thus species new to the mammal fauna of the Valley, on the evening of October 18 we put out 41 traps—in a grain shed, in the blacksmith shop, in garages, and under

the edges of big haystacks margined by horse and cow corrals. Results: Desert wood rat (adult male in grain shed); *Peromyscus eremicus* (adult male under pile of fence posts within ten feet of haystack). Thus neither "rat" nor "mouse" was of a non-native species. Maybe the latter, even having gotten here, would be unable to survive the summer temperatures, even at night, under which they would have to forage abroad.

No indication of breeding activity on the part of *Neotoma* was found in October; but in April the specimens taken, and all other sources of information in this regard, showed that the annual reproductive program was then about at its peak. A female taken April 21 (1917) contained one embryo; one taken April 24 contained two embryos, as did also one taken April 25; one taken April 11 contained three embryos, as also did two females taken April 20 and one taken May 7. On April 8, 9 and 10 (1917 and 1920), young animals weighing but 33, 32 and 30 grams, respectively, were caught in traps, betokening an unexpected degree of precocity, as well as earliest dates of birth. On May 2, a nest was found containing three young wood rats, well covered with hair but eyes not yet open. The mother had been caught previously and the nest and young were located by the collector's hearing the hungry squeaking of the latter, one of which in crawling about had gotten out of the nest and into the entrance burrow. The nest proper, under a buried mesquite limb, beneath a house and 10 inches below the surface of the surrounding ground, was about "8 by 10 inches" in diameter, with walls 2 inches thick; the component material was entirely of shredded inner bark of mesquite.

The small size of the litter shown by these data (one to three, averaging $2\frac{1}{2}$) would seem to indicate relative individual "security" of these Death Valley wood rats. However, we do not definitely know that more than one litter is not born per year; the series of specimens taken does show, though, that none is born before April—and this despite the long period of warmth correlated with low altitude and other physical factors. The wood rats have "biotic controls" upon their numbers in the forms especially of wildcats and coyotes, tracks of which, in 1917, were seen plentifully in the dry silt along the burro trails around and through the mesquite tracts west of Furnace Creek Ranch. A Cooper hawk (*Accipiter cooperii*) I shot there on the morning of April 19 contained in its crop considerable portions of an adult male wood rat. Rattlesnakes were known then to inhabit those mesquite tracts; and in October, 1933, a great horned owl, well known as a wood-rat-catching species, was flushed from them.

Of 42 mature specimens of *Neotoma lepida* preserved from the below-sea-level portion of Death Valley, 16 are males and 26 are females. These provide measurements as follows, in millimeters (average, minimum and maximum). Males, total length 302 (270-337), tail 129 (115-148), hind foot 31.7 (30-35), ear from crown

25.6 (22–31); females, total length 295 (270–315), tail 128 (118–145), hind foot 30.5 (29–33), ear from crown 25.5 (21–31). Weights of the same groups are, in grams, as follows: Males 159 (112–201); females 137 (108.3–178).

The type specimen of C. Hart Merriam's *Neotoma desertorum* was taken at Furnace Creek [Ranch], by T. S. Palmer, January 31, 1891 (Merriam, Proc. Biol. Soc. Wash., vol. 9, July 2, 1894, p. 125). This name stood for many years as the name to use for the desert wood rat, until the older name, *lepida*, was brought forward (Goldman, Journ. Mammalogy, vol. 13, 1932, pp. 59ff).

***Lepus californicus deserticola* Mearns**

Desert Jack Rabbit

The jack rabbit was present far and wide on the floor of Death Valley, both up the rock-strewn wash-fans and down on the lowest alkali reaches just short of the "self-rising" ground. For example, on April 10, 1920, I saw "sign" about some wisps of salt-grass at the very edge of the "borax", —280 feet, west of Furnace Creek Ranch. The rabbits were more numerous in 1933 than they were in 1920 or in 1917; yet their numbers never reached those commonly met with on the Mohave Desert. Never in Death Valley did I "jump" more than one individual in one day; and on many days none would be "checked" on a 2 to 4 hour tramp, even though "sign", more or less fresh, could be found wherever specially looked for.

Activity, in foraging, was clearly altogether at night. The animals occupied "forms" during the day-time. One such, near Triangle Spring, was in (beneath) a clump of the tall bunch-grass there ("sacaton"). Another, from which a jack rabbit was jumped in the forenoon of April 16, 1917, was beneath an *allenrolfea* bush affording rather scant shade. This was a suckling female; search far and wide failed to disclose any young.

I found no evidence that jack rabbits visit water to drink; presence in the vicinity of springs was merely due to the forage available there. Salt-grass appeared to be the "staff of life." The sacaton, prevalent in tracts in the vicinity of Salt Creek, Triangle Spring and Surveyors Well, was in October, 1933, seeding abundantly. The clumps of tall filmy seed-stalks, where these clumps grew close together, then lent a distant appearance of yellow, ripening grain fields. The rabbits were eating this grass freely, but not the blades and not the seed-heads, only the stems bearing the seeds. Moreover, certain clumps would be chosen, and very many others in the near vicinity apparently not touched at all. This was shown by the circle of droppings and cuttings about a selected clump.

On October 29, up Furnace Creek Wash, we saw where a jack rabbit had cut off the terminal leafy twigs from a creosote bush

(*Covillea*). We wondered if this bitter "greasewood" was actually eaten by a rabbit. Even burros, as far as I know, do not touch it!

One specimen of *Lepus californicus deserticola* was preserved, an adult female shot near Triangle Spring, April 16, 1917; weight 2086 grams (about 4½ pounds); dimensions: total length 552 mm., tail 95, hind foot 120, ear from crown 158. The pelage dorsally has the "singed" and faded-to-brownish sub-surface color tone in more extreme degree than specimens of nearly the same date from elsewhere on the deserts of the Southwest.

Sylvilagus audubonii arizonae (J. A. Allen)

Arizona Cottontail

Judging from my observations in Death Valley, the entire fortunes of the cottontail rabbits there are bound up with the mesquite: no cottontail, nor sign of any, was seen elsewhere than in the immediate vicinity of tracts or at least heavy clumps of the mesquite. Other shrubby growths, such as of arrow-weed and atriplex, were used on occasion by the rabbits for safety refuge or daytime cover; but it was the mesquite that furnished the final line of defense against pursuing enemies, as also the main source of food.

Cottontails were unexpectedly active in the daylight hours; only during midday, from 9 or 10 o'clock until 4 or 5, did they keep entirely out of sight. This was not merely a matter of "jumping" them: the observer would see individuals at considerable distance in the hot sunshine crossing open spaces between thickets. For example, a pencil census taken on October 21, west of Furnace Creek Ranch, from 7:40 to 10:30 a.m., included 5 cottontails seen. On the early morning of April 5, 1917, I counted 10 cottontails during the rounds of my trap-line west of the Ranch; and nearly all of these were sighted out of shotgun range. They were certainly keen of hearing as well as of eyesight; I thought at the time that the extra large ears seemingly characterizing the population in Death Valley, might be correlated with the greater distances apart there of the tracts of mesquites, which followed, apart from one another, the routes of underground water courses down toward the borax flat. However that may be, each rabbit, whether under cover or in the open, seemed always fully aware of *my* presence by the time I had caught sight of *it*!

As for possible water-requirement, no definite evidence was forthcoming that any of the rabbits in Death Valley sought water to drink. Cottontails were present in the vicinity of Salt Creek, but as far as shown by the "sign" they did not go out into the ink-weed or cane habitats, where the salt and alkali saturated water flowed. Nor were they seen more frequently near the overflow streams of relatively "fresh" irrigation water west of Furnace Creek Ranch than

two miles south of the Ranch, where there was no trace of surface water.

On October 15 and 17, 1933, in the latter locality, we were struck by the complete dependence of the cottontails on the mesquites. These here grew in great flattened masses. The preponderance of any one mass lay close to the ground; indeed, from the center all the major stems of a mass would radiate 10 to 25 feet, prone or resting at least in part upon the ground. This habit of growth brought the minor branches and twigs and much of the leafage within reach of such a non-climbing mammal as *Sylvilagus*; and, in truth, I found very much cutting of twigs up to 2 or 3 millimeters in diameter at this low level (up to 15 inches above the ground—the "reaching" height of a rabbit). That this low-level work was that of *Sylvilagus* and not of *Neotoma* was shown by the abundant droppings of the former strewn over the ground beneath. The cut ends of the stems were mostly on a 45° "bevel". Old stems were "pollarded"; that is, a clump of new shoots and (or) leaves had sprung forth just short of the previously cut ends, and these in turn had often been browsed: the evidence showed that crop after crop of this rabbit-food had been produced!

We set large-sized rat traps on the ground beneath and amid the prostrate mesquite branches, and in the morning found in them within fifty feet of one another two male cottontails. Each, upon being "put up", was found to have some fat next to the skin; their physical condition was excellent. In each instance the rabbit was caught by its head; it had been attracted, at least for the moment, by the bait, which was scattered rolled oats, with dried apricot and prune adhering to the treadles of the traps. The finely silty, almost floury, soil in this vicinity supported at this time no other plant growth, beside the mesquite, than the arrow-weed; and I saw no indication that the cottontails ever draw upon this latter plant in any degree whatsoever for food.

In April (but not in October), breeding was in full sway. No actual nest was found. But a litter of three, or possibly more, small young on Furnace Creek Ranch had its home under a pile of mesquite wood. One of these met its death, on April 8, 1917, by drowning in a near-by irrigation ditch. This one, although thus already venture-some, weighed only 41 grams—scarcely one-sixteenth the mass of an adult. Another from the same litter, shot on April 20, had reached a weight of 243 grams, over a third the mass of an adult. Growth is rapid! On April 3 a female shot was found to contain 3 fetuses each two inches long; on April 5, a female taken contained 4 embryos; on April 17, 1920, a female shot but not preserved as a specimen was found to contain 6 small embryos. A rather high rate of reproduction is thus indicated. The fact that in 1933 the cottontails were fully as abundant as in 1917, shows perhaps that the decrease apparent in natural enemies (wildcats and coyotes) had not been any more than balanced by the levy upon their numbers by

the increasing numbers of human hunters—who were still active, since full protection of the native animal life in Death Valley had not yet been enforced.

Nine adult cottontails, 6 of them males and 3 females, gave average measurements as follows: Total length 345 mm., tail 45, hind foot 83, ear from crown 93. Their weights averaged 685 grams (1½ pounds); extremes, 571 (a male) and 872 grams (a pregnant female). The Death Valley specimens have larger ears than specimens of the same species from the Mohave Desert proper. Also the tone of color in fresh-pelaged, October-taken examples is paler dorsally—ashier on the sides and rump. But these differences are slight, and in view of the geographic variation observable in populations here and there throughout the general range of the race *arizonae*, do not warrant the use of a separate name for them—*rufipes* of Elliot (Field Columb. Mus., zool. ser., **3**, December, 1903, p. 254); type (no. 12631, Field Mus.) taken by Edmund Heller at Furnace Creek Ranch, April 28, 1903. Data as to type specimen in this and other instances were furnished me through the kindness of Mr. Colin C. Sanborn, Assistant Curator of Mammals at the Field Museum of Natural History, Chicago.

Ovis canadensis nelsoni Merriam

Desert Bighorn

The Desert Bighorn or Mountain Sheep is, interestingly, the only native ungulate mammal known to occur in the immediate neighborhood of Death Valley. Neither deer nor antelope have ever been reported authoritatively, to my knowledge, from anywhere in the surrounding mountain ranges, let alone from the Valley itself. The Desert Bighorns, however, evidently find in this region about the optimum conditions for their existence, and they remain [in 1933], as they doubtless have been for long aeons, about as numerous as the limits of subsistence at the periods of least food-supply allow. They can forage over practically the entire region despite its roughness; by reason of their superb climbing ability they get to the sparse vegetation they depend upon, in the remotest places, and still are within reach of springs or "tanks". For we know these animals must drink at intervals depending in number of days upon the season of the year and the succulence of the plant food available to them.

As for the below-sea-level floor of Death Valley, we know from a consensus of testimony that, although sheep as a rule avoid remaining long on flat, open ground, even the "self-rising" mid-portion of the Valley is occasionally crossed by them. For example, Mr. Monroe Wagon, who had prospected in the vicinity off and on for ten years, told me in October, 1933, that sheep frequently go back and forth across the "Devil's Golf Course" between the Black

Mountains and the Panamints. He has seen them himself and they showed no special difficulty in negotiating the rough ground. They go in the day-time and mostly in summer. He thinks this movement is caused by desire for new forage or "change of feed", coupled with disappearance of water in the rain-filled "tanks" in the Black Mountains. There are stated to be no permanent springs in the northern section of this range. So late as December or January (1932-33) a truck-driver told Mr. Wagon of nine sheep seen by him on the floor of the Valley south of Furnace Creek Ranch, thought to have been crossing over from the Panamints to the Black Mountains.

Supporting the above ideas in a general way, was the finding by Mrs. Grinnell and me, on October 14, 1933, of a weathered fragment of the skull of a bighorn among the rocks of a talus at the foot of the steep face of the Black Mountains close to "Bad Water" of the U.S.G.S. map. This specimen (now no. 61368, Mus. Vert. Zool.) consists of part of the cranium, with one horn-core, of a young ewe. The altitude of this find was close to -280 feet. There was nothing to indicate how the animal met its death; possibly it had been shot on the cliff-side above.

While, to repeat, bighorns occur on all the ranges around Death Valley, the greatest numbers exist on the Panamint Mountains. This was stated to me in the different years of my visits by a number of persons acquainted with the region. The latest word, that of Mr. Wagon, above cited, was that "quite recently" he himself had seen 80 sheep in one band in those mountains. He believes they are "on the increase." A few may still be killed by Indians, but the old-time "jerky-hunter" has gone out of business. Perhaps the only non-human restrictive factor in this region is the Golden Eagle. Mr. Wagon once found a cliff-side nest of this bird within a few miles of Ryan, about which were the remains of several lambs. But eagles are rare in this country; and anyway what they do does not affect the total sheep population, since it is a perfectly normal factor.

Interesting from the nomenclatural standpoint is the fact that the type of C. Hart Merriam's *Ovis nelsoni* was shot June 4, 1891, by the late Edward W. Nelson at a point on the Grapevine Mountains about ten miles due north of Surveyors Well. More exactly, as later stated to me by Dr. Nelson (letter of March 3, 1917, in files of Mus. Vert. Zool.), this was on "the high limestone ridge forming the middle of the range, about five miles southerly from Grapevine Peak At the time these sheep were taken, we were camping at Bighorn Spring, in a canyon in the midst of the range".

