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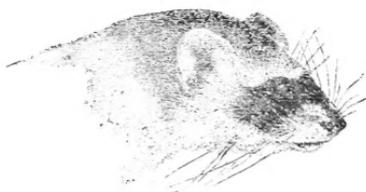
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DIVISION OF ORNITHOLOGY AND MAMMALOLOGY

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Results of a Biological Survey of the San Francisco Mountain Region and
Desert of the Little Colorado, Arizona

1. General Results, with special reference to the geographical and vertical distribution of species
2. Grand Cañon of the Colorado
3. Annotated List of Mammals, with descriptions of new species
4. Annotated List of Birds

BY DR. C. HART MERRIAM

5. Annotated List of Reptiles and Batrachians, with descriptions of new species

BY DR. LEONHARD STEJNEGER

WASHINGTON
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U. S. DEPARTMENT OF AGRICULTURE, *June 4, 1890.*

SIR: I have the honor to transmit herewith No. 3 of NORTH AMERICAN FAUNA. It contains part of the results of a Biological Survey which I had the honor to conduct, under your instructions, in the San Francisco Mountain region in Arizona during August and September, 1889.

Respectfully,

C. HART MERRIAM,
*Chief of Division of
Ornithology and Mammalogy.*

Hon. J. M. RUSK,
Secretary of Agriculture.

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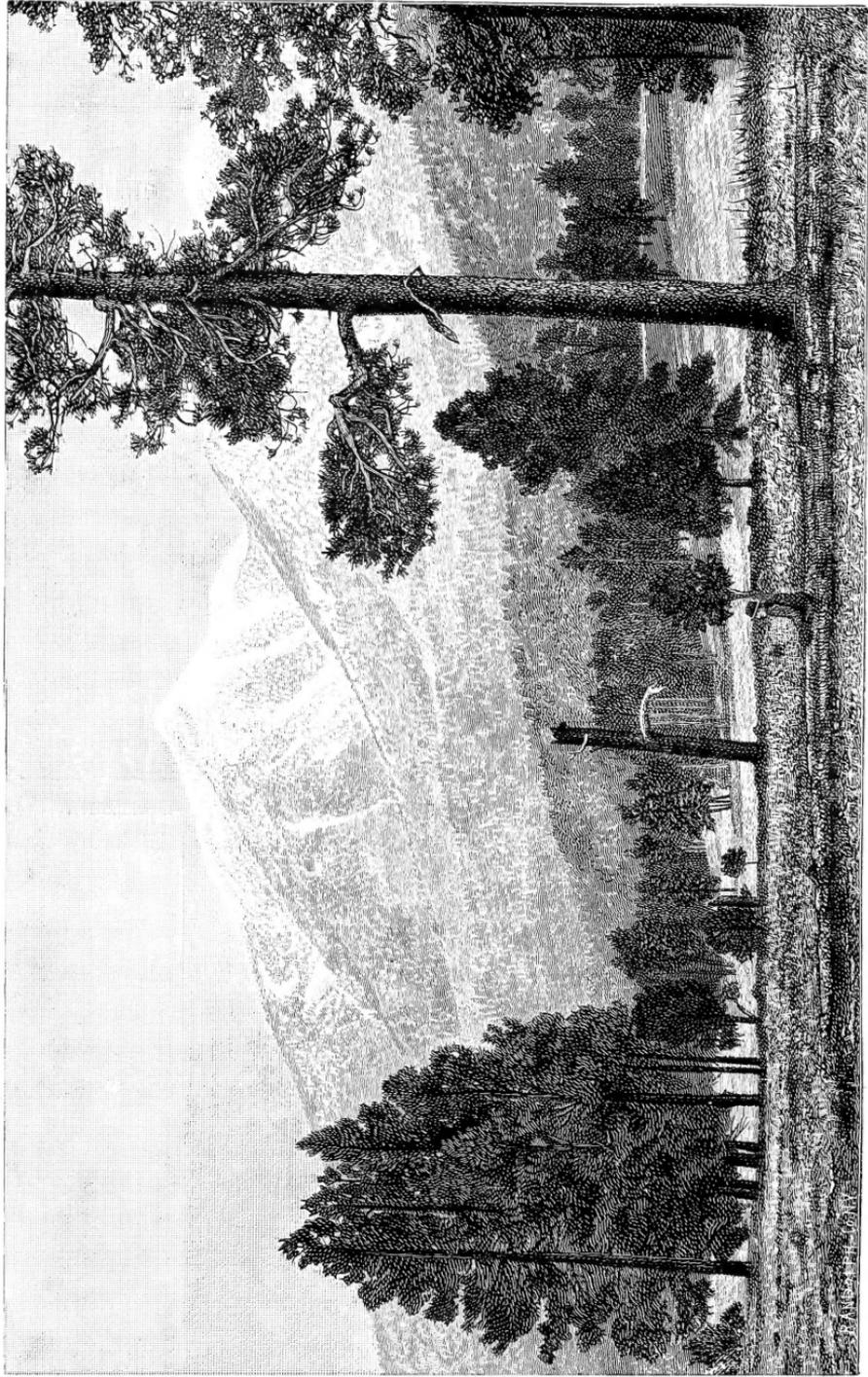
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SAN FRANCISCO PEAK.

AGASSIZ PEAK.

SAN FRANCISCO MOUNTAIN—FROM THE SOUTHWEST.

RESULTS OF A BIOLOGICAL SURVEY OF THE SAN FRANCISCO MOUNTAIN
REGION AND DESERT OF THE LITTLE COLORADO IN ARIZONA.

By Dr. C. HART MERRIAM.

PREFATORY NOTE.

Recent explorations in the west, conducted by the Division of Ornithology and Mammalogy of this Department, led to the belief that many facts of scientific interest and economic importance would be brought to light by a biological survey of a region comprehending a diversity of physical and climatic conditions, particularly if a high mountain were selected, where, as is well known, different climates and zones of animal and vegetable life succeed one another from base to summit. The matter was laid before the Assistant Secretary of Agriculture, the Hon. Edwin Willits, and I was authorized by the Secretary, the Hon. J. M. Rusk, to undertake such a survey of the San Francisco Mountain region in Arizona. San Francisco Mountain was chosen because of its southern position, isolation, great altitude, and proximity to an arid desert. The area carefully surveyed comprises about 13,000 square kilometers (5,000 square miles), and enough additional territory was roughly examined to make in all about 30,000 square kilometers (nearly 12,000 square miles), of which a biological map has been prepared. No less than twenty new species and subspecies of mammals were discovered, together with many new reptiles and plants; and the study of the fauna and flora as a whole led to unexpected generalizations concerning the relationships of the life areas of North America, necessitating a radical change in the primary and secondary divisions recognized.

The most important of the general results are :

(1) The discovery that there are but two primary life areas in North America, a northern (boreal) and a southern (subtropical), both extending completely across the continent and sending off long interpenetrating arms.

(2) The consequent abandonment of the three life areas commonly accepted by naturalists, namely: The Eastern, Central, and Western Provinces.

(3) The recognition of seven minor life zones in the San Francisco Mountain region, four of boreal origin, and three of subtropical or mixed origin.

(4) The correlation of the four boreal zones with corresponding zones in the north and east.

The present paper consists of five parts: (1) an announcement of the general results of the survey, with special reference to the geographic and vertical distribution of species; (2) results of a brief visit to the Grand Cañon of the Colorado; (3) an annotated list of the Mammals of the San Francisco Mountain region including the desert of the Little Colorado, with descriptions of new species; (4) an annotated list of the Birds; (5) an annotated list of the Reptiles and Batrachians, with descriptions of new species.

Prof. F. H. Knowlton, assistant paleontologist, U. S. Geological Survey, joined the party in the summer and collected the plants upon which many of my generalizations are based. He has placed me under great obligations by allowing me the unreserved use of this material and the privilege of announcing important results from the stand-point of the geographic distribution of species. I am indebted also to Mr. Frederick V. Coville, assistant botanist, U. S. Department of Agriculture, for the determination of many of the more difficult plants.

Dr. Leonhard Stejneger, curator of reptiles in the U. S. National Museum, joined the expedition in September. Though unable to visit the desert region, he made notes and colored sketches from the living animals collected by Mr. Bailey and myself, and has prepared the report on Reptiles and Batrachians which constitutes part four of the present bulletin.

My assistant, Mr. Vernon Bailey, deserves special recognition for the faithful and efficient performance of the duties assigned him, and it should be added that much of the success of the season's work is due to his zeal and intelligence.

It is proper also to acknowledge the assistance rendered by Mr. D. M. Riordan, and his brothers Thomas and M. J. Riordan, of Flagstaff, Arizona.

Much more would have been accomplished but for the insufficient fund available for the survey (only a little more than \$600 to cover the total cost of transportation, outfitting, hire of animals and men, purchase of tents, supplies, etc.), thus permitting the employment of but one man as cook and general camp-hand; while the animals, both in number and quality, were far below the standard usually considered necessary for field work, which circumstance caused many annoying delays. All our traveling was done on horseback, and our packing on burros.

The altitudes given in the present paper were determined by means of aneroid barometers, and too much confidence must not be placed in their extreme accuracy.

The base maps made use of are those of the U. S. Geological Survey, for which I am indebted to the Director of the Survey, Maj. J. W. Powell, and to the chief geographer, Mr. Henry Gannett. The picture of San Francisco Mountain, which forms the frontispiece of this report, is from the sixth annual report of the U. S. Geological Survey.

The colored map of Arizona, showing the life areas of the Colorado plateau south of the Grand Cañon (map 1), is based upon the present survey, supplemented by information derived from the U. S. Geological Survey.

For the sake of convenience, the names employed to designate the various life areas are those in common use; and the author wishes to state that he does not commit himself to these names, or to the relative value of the terms indicating rank (Province, Region, Zone, etc.), all of which have been employed in diametrically opposite ways by different writers.

ITINERARY.

The following brief itinerary, in connection with the accompanying maps, will enable the reader to trace the routes of the expedition and determine the positions of the localities mentioned in the report.

Flagstaff, Arizona, a station on the Atlantic and Pacific Railway, is the point of departure for San Francisco Mountain. I reached Flagstaff July 26, 1889, and was joined next day by my assistant, Mr. Vernon Bailey. After spending three days in outfitting, we proceeded to Little Spring, at the north base of San Francisco Mountain, and pitched our tents in a grove of aspens and pines, on a knoll just northwest of the spring, at an altitude of 2,500 meters (8,250 feet). This was our base camp for two months, and from it numerous side-trips were made into the surrounding country. Three of these were of special importance, namely, two trips across the Painted Desert and one to the Grand Cañon of the Colorado. During these expeditions I crossed the Painted Desert and the Rio Colorado Chiquito four times, spending in all sixteen days on the desert. I visited also Walnut Cañon, about 9 kilometers (5½ miles) south of Elden Mountain; and local collections were made in the piñon and chaparral near a volcanic crater containing ruins of cliff dwellings 8 kilometers (5 miles) east of O'Leary Peak, and in various other directions. A branch camp was established just below timber line on the main peak of San Francisco Mountain, and the rocky summit above timber line was climbed several times. Kendrick and O'Leary Peaks also were ascended.

FIRST TRIP TO PAINTED DESERT, AUGUST 12 TO 19, INCLUSIVE.

The route followed skirted the north and east sides of San Francisco Mountain, passing through the pine forest by way of Partridge Spring, and along the edge of O'Leary Park, keeping west of O'Leary and

Sunset Peaks, and thence turning southeasterly to Turkey Tanks. The dry bed of the Little Colorado River was crossed at Grand Falls, and Tenebito Wash was followed to the high mesa on the east side of the desert; this mesa was ascended and a trail was taken northward to a point about 25 kilometers (16 miles) north, or a little west of north, of the Moki pueblo of Oraibi; an abrupt turn to the south was then made, and Grand Falls was reached by an Indian trail south of that taken on the outward journey, a short stop having been made at Oraibi, where water and goat's milk were obtained from the Indians. From Grand Falls the course lay across the lava beds direct to the north base of the mountain, instead of by way of Turkey Tanks, as on the outward journey. The total distance traveled was 370 kilometers (230 miles). The heat was intense and much suffering was occasioned by want of water.

SECOND TRIP ACROSS THE DESERT, SEPTEMBER 20 TO 27, INCLUSIVE.

A northeasterly course was taken from Little Spring to Black Tank, thence to the Little Colorado at Tanner's Crossing, following the Mormon trail and crossing the river about 56 kilometers (35 miles) north of Grand Falls, and continuing in a northeasterly direction to Moencopie Wash, which was followed to Echo Cliffs, and the southern point of Echo Cliffs mesa was crossed from Moa Ave to Tuba. Tanner's Gulch and the Pueblo of Moencopie were visited and Moencopie Wash was followed down to the point of departure for Echo Cliffs, whence the return to the mountain was made by nearly the same route as on the way out, the total distance traveled being about 280 kilometers (175 miles). The temperature was very much lower than during the former trip across the desert, and some of the nights were even cold. The recent heavy showers had left some water in the Little Colorado and in scattered alkaline pools in Moencopie Wash, and also in the gulches in the lava beds between San Francisco Mountain and the Little Colorado.

TRIP TO THE GRAND CAÑON OF THE COLORADO, SEPTEMBER 9 TO 16, INCLUSIVE.

The usual road was followed from Little Spring to Hull Spring and Red Horse Tank, and thence to the tank known as Cañon Spring on the Cocanini Plateau, close to the cañon, which is here about 1,800 meters (6,000 feet) in depth. Mr. Bailey and myself climbed down into the cañon and remained in it two days and two nights.

PART I.—GENERAL RESULTS OF A BIOLOGICAL SURVEY OF THE SAN FRANCISCO MOUNTAIN REGION IN ARIZONA, WITH SPECIAL REFERENCE TO THE DISTRIBUTION OF SPECIES.

By Dr. C. HART MERRIAM.

GENERAL PHYSICAL FEATURES OF ARIZONA.

Arizona as a whole may be readily divided into two very distinct physiographic areas—an elevated plateau area and a low desert area. A high cliff or escarpment, one of the best marked and most extensive in the North American continent, enters Arizona from Utah and completely crosses the Territory from northwest to southeast, marking the southern limit of the great Colorado Plateau. Though it does not everywhere maintain the form of a precipitous cliff, it has an average height of at least 1,200 meters (4,000 feet), and in some places its crest is more than 1,500 meters (5,000 feet) above the plain below. In its effects upon the life of the region it is an important faunal barrier. The region to the south is in the main an arid desert, interrupted by a few irregular ranges of mountains. The region to the north, beginning at the top of the cliff and occupying the northern part of Arizona, is a southward continuation of the Great Interior or Colorado Plateau, the plateau on which the Rocky Mountains rest.

GENERAL FEATURES OF THE SAN FRANCISCO MOUNTAIN REGION.

San Francisco Mountain is on this plateau, in the north-central part of the Territory (in latitude $35^{\circ} 20' N.$; longitude $111^{\circ} 41' W.$). It is a volcanic peak rising 3,900 meters (12,794 feet) above sea-level and rests on a lava base which is everywhere more than 2,130 meters (7,000 feet) in elevation, and overlies red sandstone and carboniferous limestone. This plateau comprises about 2,000 square kilometers (800 square miles), and measures about 72 kilometers (45 miles) from east to west by 53 kilometers (33 miles) from north to south.

Four other volcanic peaks (O'Leary, Kendrick, Sitgreaves, and Bill Williams), ranging in height from 2,750 to 3,200 meters (9,000 to 10,500 feet), together with many buttes, cones, and craters, some of which contain 'crater lakes,' occupy the same elevated base level. San Francisco Mountain proper, cut off from all surrounding and attached hills and

buttes at the height of 2,450 meters (8,000 feet), is about 19 kilometers (12 miles) in north and south diameter by 15 kilometers (9 miles) in east and west diameter, and covers about 180 square kilometers (70 square miles).

The lava plateau above 2,130 meters (7,000 feet) altitude is covered throughout by a beautiful forest of stately pines (*Pinus ponderosa*), which average at least 33 meters (100 feet) in height. There is no undergrowth to obstruct the view, and after the rainy season the grass beneath the trees is knee-deep in places, but the growth is sparse on account of the rocky nature of the surface. The pine forest extends up the mountain as high as 2,675 meters (8,800 feet), but loses its distinctive character at about 2,500 meters (8,200 feet), where it is replaced in the main by a forest of Douglas fir (*Pseudotsuga douglasii*), the same as that found from California to Puget Sound and British Columbia. The Douglas fir reaches an altitude of about 2,800 meters (9,200 feet), here giving place to Engelmann's spruce (*Picea engelmannii*), which covers the mountain sides between the altitude named and timber line (about 3,500 meters (11,500 feet)). The fox-tail pine (*Pinus aristata*) begins a little lower down than Engelmann's spruce and accompanies it to the upper limits of tree growth, where both exist as depauperate forms scarcely more than a foot in height. The summit of the mountain above timber line consists of bare volcanic rock and is covered with snow about nine months of the year.

Again passing down to the plateau, and thence in an easterly direction to lower levels, a zone of cedar and piñon is first encountered—a belt varying in width from one to several miles according to the steepness of the slope. The only trees in this belt are junipers (locally known as 'cedars') and the piñon or nut pine (*Pinus edulis*), whose nut furnishes food to the Indians and the mammals and birds of the region. Descending still lower, the Desert of the Little Colorado is entered—an arid, treeless area whose upper limit may be set at the 1,800 meter (approximately 6,000 foot) contour or level. Parts of this desert are devoid of vegetation, while other parts support a scanty growth of cactus, greasewood, and a few other species.

In the foregoing account the general features of the several zones of the San Francisco Mountain region have been briefly outlined. Recapitulating, it may be said that in ascending from the hot and arid Desert of the Little Colorado to the cold and humid summit of the mountain no less than seven zones are encountered, each of which may be characterized by the possession of forms of life not found in the others. These zones, with their respective altitudes, are—first, the arid Desert region, below 1,800 meters (6,000 feet); second, the Piñon belt, from 1,800 to 2,100 meters (6,000 to 7,000 feet); third, the Pine, from 2,100 to 2,500 meters (7,000 to 8,200 feet); fourth, Douglas fir, from 2,500 to 2,800 meters (8,200 to 9,200 feet); fifth, Engelmann's spruce, from 2,800 to 3,500 meters (9,200 to 11,500); sixth a narrow zone of dwarf

spruce; and seventh, the bare rocky summit, snow covered the greater part of the year.* These facts as isolated facts would be of comparatively little interest, but in their bearing on the problems of geographic distribution a very deep interest attaches to them. This will appear by passing in review the distinctive plants and animals of the several zones, and tracing their distribution in other parts of their ranges.

REMARKS ON THE GEOGRAPHIC DISTRIBUTION OF SPECIES CHARACTERISTIC OF THE SEVERAL ZONES OF THE SAN FRANCISCO MOUNTAIN REGION IN ARIZONA.

ALPINE ZONE.

[Approximate altitude: Above 3,500 meters, or 11,500 feet.]

Nine species of plants which grow on the bleak and storm-beaten summit of San Francisco Mountain were brought back from Lady Franklin Bay by Lieut. (now General) A. W. Greely. These species are:

<i>Androsace septentrionalis</i>	<i>Cystopteris fragilis</i>	<i>Saxifraga nivalis</i>
<i>Arenaria verna</i>	<i>Saxifraga caespitosa</i>	<i>Oxyria digyna</i>
<i>Cerastium alpinum</i>	<i>Saxifraga flagellaris</i>	<i>Trisetum subspicatum</i>

One or more of them have been found at each of the following localities: British Columbia, Unalaska, Bering Strait, Kotzebue Sound, Point Barrow, Melville Island, Back's Great Fish River, Hudson Bay and Strait, Labrador, Baffin Bay, Greenland, Iceland, Spitzbergen, Newfoundland, Gulf of St. Lawrence, White Mountains of New Hampshire, Rocky Mountains, Selkirks, and Sierra Nevada. Several of them occur also in the arctic portions of the Old World, extending as far south along the coast as the island of Yeso, North Japan, and appearing again in the high mountains of Roumelia, in the Caucasus, the Carpathian Mountains, and the Alps.

Sibbaldia procumbens is another polar species inhabiting arctic America from the peninsula of Unalaska to Hudson Bay, Labrador, and Greenland, and flourishing also throughout the arctic regions of Asia. It comes south along the higher summits of the Cascade range, the Sierra Nevada, and the Rocky Mountains, and occurs in isolated colonies on the barren peaks of San Francisco Mountain in Arizona and Mount Washington in New Hampshire. In the same way it inhabits the mountains of Central Asia and Siberia, and also the Carpathian Mountains, the Apennines, the Alps, the Pyrenees, and the Himalaya.

Geum rossii belongs to the same category, growing from Greenland

* The normal altitudes here given for the various tree zones of San Francisco Mountain are averages for the northwest side of the mountain. Favorable southern and southwestern exposures carry the zones up a hundred meters or more above these limits, while similar northern and northeastern exposures, particularly in gulches and cañons, deflect the zones as much as two, or even three hundred meters. The normal average difference in altitude of the same zone on the southwest and northeast sides of San Francisco Mountain is about 275 meters (900 feet).

and the shores and islands of Hudson Strait to Melville Island and the coasts of Bering Strait and Unalaska, and also in the northern part of Siberia and Kamschatka. It comes southward in the Rocky Mountains, inhabiting the higher peaks of the Uintas and of Colorado, and is the most conspicuous plant above timber line on San Francisco Mountain, where it forms dense mats of green among the bare rocks—patches of such extent that they may be seen from the plateau level below.

Other arctic plants found above timber line on San Francisco Mountain, most of them circumpolar species, are :

<i>Arenaria alpina</i>	<i>Polemonium confertum</i>	<i>Silene acaulis</i>
<i>Cerastium arvense</i>	<i>Sagina linnæi</i>	<i>Stellaria umbellata</i>
<i>Festuca brevifolia</i>	<i>Saxifraga debilis</i>	<i>Thlaspi alpestre</i>

It appears from what has been said that many of the plants found on the high rocky summit of San Francisco Mountain occur on the higher peaks of the Rocky Mountains, the Sierra Nevada* and Cascade range, and the Appalachian chain; they occur along the arctic coasts of Alaska, Hudson Strait, North Labrador, Greenland, North Siberia, and Spitzbergen; they occur in the Alps of Europe, in the Altai and Ural Mountains, the Pyrenees, and some of them even in the Himalaya. In brief, they inhabit the arctic regions of the globe and extend far south on the summits of the higher mountain ranges. Plants and animals having such a distribution are termed *Arctic-Alpine Circumpolar species*.

We collected no insects at high altitudes on San Francisco Mountain, but butterflies and diptera from great elevations in Colorado have been shown to be identical with species from Mount Washington, Labrador, and Greenland.

Among birds, the Golden Eagle—a truly circumpolar species, though not confined to the arctic zone—rears its young on San Francisco Mountain.

There are no exclusively arctic mammals on the top of this high mountain, because such mammals could not exist long in so small an area. An Ermine Weasel (*Putorius* sp. —?) inhabits the summit, and the Big-horn or Mountain Sheep, another truly circumpolar type, spends the summer there, descending in winter to lower levels.

SUB-ALPINE OR TIMBER-LINE ZONE.

[Approximate altitude, 3,200–3,500 meters, or 10,500–11,500 feet.]

Just below the barren arctic summit of the mountain is a narrow belt which may be named the Timber-line zone. Here the trees which reach timber line (in this case *Picea engelmanni* and *Pinus aristata*) lose the upright or arborescent habit and exist as stunted and prostrate trunks, whose gnarled and weather-beaten forms bear testimony to the severity of their struggle with the elements. In this narrow belt a number of

* Engler tells us that 26 per cent. of the plants found on the High Sierra Nevada are found also in the Alps and throughout arctic Europe.

hardy little plants attain their maximum development, decreasing rapidly in abundance both above and below. Among these are :

<i>Arenaria biflora carnulosa</i>	<i>Gentiana barbellata</i>	<i>Potentilla dissecta</i>
<i>Cerastium alpinum behring-</i>	<i>Gentiana tenella</i>	<i>Primula parryi</i>
<i>ianum</i>	<i>Heuchera rubescens</i>	<i>Saxifraga debilis</i>
<i>Corallorhiza multiflora</i>	<i>Lazula spadicea parryiflora</i>	<i>Sedum rhodanthum</i>
<i>Draba aurea</i>	<i>Pedicularis parryi</i>	<i>Veronica alpina</i>
<i>Epilobium saximontanum</i>	<i>Phleum alpinum</i>	

Many of them are circumpolar species found throughout the northern regions of America, and some of them throughout the northern regions of the world, coming south on high mountains and occurring in greatest perfection just at or near the edge of the northern limit of trees, and at timber-line on mountains further south. Such plants are known to botanists as 'Sub-Alpine species,' and it would be well if the term *sub-alpine* were restricted to the characteristic species of this zone.

Among birds, the Titlark (*Anthus pensilvanicus*) was found at the top of the mountain, where it probably breeds. It breeds in grassy places on the high peaks of the Rocky Mountains, and at sea-level in Labrador, Greenland, and throughout arctic America; and birds congeneric with it are known to breed throughout the arctic portions of the Old World.

(CENTRAL) HUDSONIAN OR SPRUCE ZONE.

[Approximate altitude, 2,800-3,200 meters; or 9,200-10,500 feet.]

Passing down into the next zone, the Spruce zone, a number of plants, birds, and mammals are encountered, which are characteristic of humid northern regions, but regions not quite so cold as those inhabited by the species which occur on the snowy summit and at timber-line. The characteristic trees of this zone are Engelmann's spruce (*Picea engelmanni*) and the fox-tail pine (*Pinus aristata*). Some of the small plants are :

<i>Aquilegia chrysantha</i>	<i>Pentstemon glaucus steno-</i>	<i>Solidago multiradiata</i>
<i>Lathyrus arizonicus</i>	<i>sepalus</i>	<i>Zygadenus elegans</i>
<i>Mertensia paniculata</i>	<i>Pyrola chlorantha</i>	
<i>Moneses uniflora</i>	<i>Ribes setosum</i>	

The fact of present interest is that many of the plants here enumerated as growing in the Spruce zone of this mountain are equally characteristic of the upper spruce belt of the higher Alleghanies, the Rocky Mountains, the Cascades, and the Sierra Nevada, and occur also in the great northern spruce forest of Canada. It is well known that the northernmost part of our own continent consists of bare rock and frozen tundras. There are no trees along the sea edge of Labrador or Hudson Strait, or along the coast region of arctic America from Boothia Felix to Alaska, but just south of this region a large forest begins which has been called the 'Great Pine Forest.' There is not a pine tree in it, but it is called pine because conifers in general are called pines by people who are not botanists. The tree that grows there is a species of spruce congeneric

with the spruce which occurs high up on San Francisco Mountain, and many of the humbler plants are either identical or closely related representative forms.

Among the birds which breed in the Spruce belt on this mountain are the Goshawk, Dusky Horned Owl, Dusky Grouse, Evening Grosbeak, and Clark's Crow. The Goshawk and Dusky Horned Owl range throughout the spruce forests of the north, from Labrador to Alaska, and south in the mountains; while the others are confined to its western parts and outliers.

Of mammals, the Porcupine is the only one believed to be restricted to this belt during the season of reproduction, and, like the Big-horn, it comes down to lower levels during the winter. Bears (*Ursus*), Shrews (*Sorex*), Voles (*Arvicola*), and Red Squirrels (*Sciurus fremonti mogolonensis*) range throughout the spruce and fir zones but were not found below.

(CENTRAL) CANADIAN OR BALSAM FIR ZONE.

[Approximate altitude: 2,500-2,800 meters; or 8,200-9,200 feet.]

The distinctive tree of this zone is Douglas fir (*Pseudotsuga douglasii*), which ranges northward to British Columbia. Another tree of nearly coincident vertical distribution on the mountain is the lofty Rocky Mountain Pine (*Pinus flexilis macrocarpa*), which extends north to the Kootenai region and Calgary in Canada. Wherever the Douglas fir has been burned off, its place is taken by the aspen (*Populus tremuloides*), a species of wide distribution in the north, where it ranges from New England to Newfoundland and Labrador, and thence westward to Alaska, reaching its highest perfection along the southern part of the great coniferous forest of northern Canada, and coming south in the mountains.

Among the smaller plants of the Douglas fir zone are:

<i>Actæa spicata</i>	<i>Gentiana affinis</i>	<i>Potentilla fruticosa</i>
<i>Berberis repens</i>	<i>Gentiana heterosepala</i>	<i>Ribes rusbyi</i>
<i>Ceanothus fendleri</i>	<i>Geum triflorum</i>	<i>Viola canadensis scopulorum</i>

Nearly half of the above (namely, *Geum triflorum*, *Potentilla fruticosa*, *Actæa spicata*, and *Viola canadensis*) have a wide range in the Canadian flora of the East and North, or are representative forms of such species; and probably *Ceanothus fendleri* may be safely regarded as the western representative of *C. ovatus*, which ranges eastward from the Rocky Mountains to Vermont.

One batrachian, a Salamander of the genus *Amblystoma*, has been found in this zone. Allied species inhabit the Canadian fauna of the East.

A number of species of birds are characteristic of the Douglas fir zone. At least eight of these are either identical with or closely related representative forms of species which are well-known members of the Canadian fauna of the East, most of them breeding in northern New

England, the Adirondacks, and southward in the Alleghanies. These are:

Three-toed Woodpecker (<i>Picoides americanus dorsalis</i>)	Brown Creeper (<i>Certhia familiaris montana</i>)
Olive-sided Flycatcher (<i>Contopus borealis</i>)	Ruby-crowned Kinglet (<i>Regulus calendula</i>)
Crossbill (<i>Loxia curvirostra stricklandi</i>)	Audubon's Thrush (<i>Turdus aonalaschkae auduboni</i>)
Pine Linnet (<i>Spinus pinus</i>)	
Audubon's Warbler (<i>Dendroica auduboni</i>)	

The following species which breed in the Douglas fir belt on San Francisco Mountain do not occur in the East, though but one genus (*Myadestes*) is unrepresented in the East:

Townsend's Solitaire (<i>Myadestes townsendii</i>)	Long-crested Jay (<i>Cyanocitta stelleri maculophya</i>)
Broad-tailed Humming-bird (<i>Trochilus platycercus</i>)	Louisiana Tanager (<i>Piranga ludoviciana</i>)
	Mountain Chickadee (<i>Parus gambeli</i>)

It is probable that *Parus gambeli* and *Myadestes townsendii* range up from the Fir into the Spruce zone.

Of mammals, there are two species of Field Mice or Voles (*Arvicola alticolus* and *A. mogollonensis*), one Shrew (*Sorex monticolus*), and one Red Squirrel (*Sciurus fremonti mogollonensis*), all of which extend up into the Spruce belt, but none of which were found below. It is evident that the Spruce and Balsam zones are closely related.

NEUTRAL OR PINE ZONE.

[Approximate altitude: 2,100-2,500 meters, or 7,000-8,200 feet.]

The characteristic and only tree of the Pine zone is *Pinus ponderosa*, which forms an unbroken forest over the whole of the lava plateau above the altitude of 2,100 meters (about 7,000 feet) and extends up as high, in some of the parks, as 2,675 meters (8,800 feet). As a distinctive species, however, it loses its character at about 2,500 meters (8,200 feet) where it is invaded, and soon after replaced, by *Pinus flexilis*, *Pseudotsuga douglasii*, and *Populus tremuloides*. *Pinus ponderosa* may be regarded as a tree of the middle elevations, occurring between the piñon and cedar of the lower hills, and the firs and spruces of the higher mountains. In such situations it ranges from the highlands of western Texas and northern Mexico, northward along the Rocky Mountains and Sierra Nevada to the dry interior of British Columbia, in latitude 51°, 30', avoiding the region of excessive rain-fall along the coast from northern California northward.

Among the more conspicuous of the small plants occurring in the Pine belt of San Francisco Mountain, and having a more or less coincident distribution with that of *Pinus ponderosa* just cited, are:

<i>Campanula parryi</i>	<i>Gilia aggregata attenuata</i>	<i>Oxytropis lamberti</i>
<i>Frasera speciosa</i>	<i>Oxybaphus angustifolius</i>	<i>Pentstemon barbatus torreyi</i>

The one distinctive mammal of the Pine belt is Abert's Squirrel (*Sciurus aberti*) which ranges through the pine regions of Arizona, New

Mexico, and Colorado, and has been reported from Durango, in Mexico. Very little can be said with certainty as to the characteristic birds of the Pine belt, the date of my arrival at the mountain being so late (end of July) that the birds had finished breeding and were beginning to wander. The following species, however, were nearly confined to the pines at that date and are known to breed there :

Red-backed Junco (<i>Junco cinereus dorsalis</i>)	Western Flycatcher (<i>Empidonax difficilis</i>)
Nuttall's Poor-will (<i>Phalacroptilus nuttalli</i>)	Richardson's Flycatcher (<i>Contopus richardsoni</i>)
	Pigmy Nuthatch (<i>Sitta pygmaea</i>)

The only reptile found in the Pine belt is a handsome horned toad (*Phrynosoma hernandesi*), which is abundant.

PIÑON ZONE.

[Approximate altitude, 1,800-2,100 meters, or 6,000-7,000 feet.]

The distinctive trees of this zone are the piñon, or nut pine (*Pinus edulis*), and the so-called 'cedar' (*Juniperus occidentalis monosperma*) both averaging about 5 meters (16½ feet) in height. The singular checker-bark juniper (*Juniperus pachyphloea*), a very handsome and conspicuous species, occurs in two or three special localities, but is rare. Several large shrubs not observed elsewhere are abundant in parts of this belt, namely, *Berberis fremonti*, *Rhus aromatica trilobata*, and *Spiraea discolor dumosa*. Near the Grand Cañon of the Colorado and again at Walnut Cañon, where the lava rock gives place to limestone, these shrubs are joined by *Cowania mexicana*, *Spiraea millifolium*, and *Robinia neo-mexicana*; and *Yucca angustifolia* is replaced by *Yucca baccata*. *Juniperus californica utahensis* also grows at the Grand Cañon. A dense chaparral (*Fallugia paradoxa*) forms extensive thickets east of O'Leary Peak and occurs sparingly over most of the Piñon belt, even extending down into the desert in places. Both the piñon and cedar occupy elevations of corresponding temperature in the arid lands from western Texas through New Mexico and Arizona and north to central Colorado, and the cedar reaches westward to southern California. Closely related and strictly representative forms extend northward through the Great Basin to the Plains of the Columbia. The other species mentioned occupy more or less of the same range, and some of them push northward over the Great Plains as well as the interior basin.

The most conspicuous bird of the Piñon belt is the Piñon Jay (*Cyanocephalus cyanocephalus*). Other characteristic species are Woodhouse's Jay (*Aphelocoma woodhousei*), the Gray Tufted Tit (*Parus inornatus griseus*), the Gnatcatcher (*Poliophtila carulea*), and the Bush Tit (*Psaltriparus plumbeus*). The range of these species, taken collectively, is co-extensive with the distribution of the cedar belt above described.

The large Rock Squirrel (*Spermophilus grammurus*) is the most char-

acteristic mammal of the Piñon belt, with which its range appears to be nearly coincident. It occurs in suitable localities from western Texas to the Great Basin in Utah and Nevada. Two or three small mammals, characterized by darkness of coloration, seem to be restricted to this belt, namely, *Spermophilus spilosoma obsidianus*, *Perognathus fuliginosus*, and *Onychomys fuliginosus*, which are here described for the first time. (See part III.)

Lizards abound in the Piñon belt, becoming more numerous toward the desert, but two species (*Sceloporus consobrinus* and *Uta ornata*) which abound in the Piñon belt were not found in the desert below.

THE DESERT AREA.

[Approximate altitude : 1,200–1,800 meters, or 4,000–6,000 feet.]

The Desert of the Little Colorado, sometimes known as the 'Painted Desert,' is a great basin about 1,000 meters (3,300 feet) in depth, situated on the top of the plateau. It was excavated, as its name indicates, by the drainage system of the Little Colorado River—the Colorado Chiquito of the Mexicans—and consequently is lowest at the north, its slope being *away* from the southern edge of the plateau. The river has cut its bed down to about 820 meters (2,700 feet) at the point where it empties into the Grand Cañon of the Colorado, and throughout the lower part of its course it flows through a cañon considerably below the level of the desert proper, the lowest part of which is but little less than 1,200 meters (approximately 4,000 feet) in altitude. Its upper limit may be set at 1,800 meters (6,000 feet). The term Painted Desert should be restricted, it seems to me, to that part of the basin which is below 1,500 meters (approximately 5,000 feet).*

The geology of the region is simple. The lowest stratum which comes to the surface is carboniferous limestone; above this is red sandstone, which in turn is overlaid by the so-called variegated marls or argillaceous clays, sometimes capped by a thin layer of impure coal or lignite. The limestone appears on the west side of the river only (?), where it is soon buried under the ancient lava floods from San Francisco Mountain and neighboring craters. The red sandstone is encountered everywhere, sometimes as surface rock, sometimes as high cliffs forming the escarpments of broad mesas, and sometimes as curiously sculptured tablets standing on the plain. The marls are widely distributed, and in many

* The area below 1,370 meters (4,500 feet) is about 120 kilometers (75 miles) in length, and that below 1,500 meters (5,000 feet), 200 kilometers (125 miles). The long axis of the desert, slightly crescentic in form, and curving from near the mouth of the Little Colorado in the northwest to New Mexico in the southeast, is 320 kilometers (200 miles) in length, with a transverse diameter of about 110 kilometers (70 miles) along the middle portion, and a total area of 29,800 square kilometers (11,500 square miles). Its eastern edge penetrates the boundary of New Mexico in two arms, following the usually dry courses of the Zuñi and the Carrizo, and nearly reaches the boundary along the Rio Puerco, the largest tributary of the Colorado Chiquito.

places, particularly south of the lower part of Moencopie Wash,* rise from the surface level in the form of strangely eroded hills and ranges of stratified cliffs whose odd shapes and remarkable combinations of colors—red, white, blue, brown, yellow, purple, and green—have given the area in which they occur the name ‘Painted Desert.’ There are hundreds of smoothly rounded, dome-shaped hills of bluish clay, utterly devoid of vegetation, and almost identical in appearance with the ‘gumbo hills,’ of the Bad Lands bordering the Little Missouri in North Dakota. Both the hills and the naked clayey flats between them abound in alkali vents—miniature craterlets—where the alkali effloresces, crusting over the surface in patches which resemble newly fallen snow. Many of the hills are capped with fossil wood, and many of the flats and lower levels east of the Little Colorado River are strewn with chips and pieces which have tumbled down during the wearing away of the hill-sides. Logs 30 to 50 centimeters (roughly, a foot or a foot and a half) in diameter and 9 to 12 meters (30 or 40 feet) in length are still common, and several sections were found, possibly from the same tree, which measured about 150 centimeters (5 feet) in diameter. There are pebble beds miles in extent, made up of agate, moss-agate, chalcedony, jasper, obsidian, and fossil wood, with not so much as a spear of grass or bit of cactus between them. On the other hand, many of the mesas and plains are covered with sand and decomposed marls which support a scanty growth of cactus, yucca, grease-wood, and a few other forms of vegetation characteristic of arid regions.

The bed of the Little Colorado River contains the only running water in this part of Arizona, and it ‘goes dry’ a large part of the year, a little water remaining in scattered pools, which are strongly alkaline. Some of the salt and alkali flats on the river-bottom support a luxuriant growth of a singular fleshy plant belonging to the genus *Salicornia*, which at a little distance looks like a leafless bush with thick green stems. During the rainy season, and whenever the river ‘runs,’ the liquid which flows down its course is red alkaline mud, about the consistency of ordinary sirup. This is the case also with its tributaries, of which Moencopie Wash and Tenebito Wash are the only ones which cross the Painted Desert proper.

The physical and climatic features of the Painted Desert are peculiar and striking, and result in the production of an environment hostile alike to diurnal forms of animal life and to the person who traverses it. The explorer is impressed with the unusual aspects of nature—the strange forms of the hills, the long ranges of red and yellow cliffs, the curiously buttressed and turreted buttes and mesas, the fantastic shapes

* The terms ‘wash’ and ‘arroyo’ are applied to the deep channels or ravines so common in arid regions. “These arroyos are natural consequences of the unequal manner in which the rain falls throughout the year. Sometimes not a drop falls for several months; again, it pours down in a perfect deluge, washing deep beds in the unresisting soil, leaving behind the appearance of the deserted bed of a great river.”—Emory, Mexican Boundary Survey, I, 1857, p. 57.

of the rocks carved by the sand-blast and rendered still more weird by the hazy atmosphere and steady glare of the southern sun, the sand-whirls moving swiftly across the desert, the extraordinary combination of colors exposed by erosion, the broad clayey flats whitened by patches of alkali and bare of vegetation, the abundance of fossil-wood, the extensive beds of shining pebbles, the unnatural appearance of the distant mountain sharply outlined against the yellow sky, the vast stretches of burning sand, the total absence of trees, the scarcity of water, the alluring mirage, the dearth of animal life, and the intense heat, from which there is no escape.*

The plant life of the desert is scattered and scanty, and consists of such characteristic arid land forms as grease-wood (*Atriplex canescens*, *A. confertifolia*, and *Sarcobatus vermiculatus*); weeds of the genera *Dicoria* and *Oxytenia* (*D. brandigei* and *O. acerosa*); a large brush-like shrub (*Tetradymia canescens*) with flowers suggesting the golden-rod; the singular *Ephedra*, which has no apparent foliage; the narrow-leaved yucca (*Yucca angustifolia*), and cactuses of several genera. But it must not be supposed that these rank and spiny forms of vegetation, whose gray or dull olive colors are in perfect harmony with the parched and barren aspects of the desert, are the only plants found there; for no sooner is the surface moistened by the passing showers of the so-called 'rainy season' than numerous plants spring into existence, and favored parts of the desert lose something of their usual desolate and dreary appearance. There are places where even the nutritious grama grass (*Bouteloua*) gains a precarious foot-hold, and where a dwarf lupine (*Lu-*

* Lieutenant Ives and Dr. Newberry attempted to cross this desert from the Little Colorado near Grand Falls, but were obliged to turn back the first day. After following up the river for three days they found an Indian trail leading north, and followed it to the Moki villages. The following quotation is from Ives's account of the first day on the desert: "The scene was one of utter desolation. Not a tree nor a shrub broke its monotony. The edges of the mesas were flaming red, and the sand threw back the sun's rays in a yellow glare. Every object looked hot and dry and dreary. The animals began to give out. We knew that it was desperate to keep on, but felt unwilling to return, and forced the jaded brutes to wade through the powdery impalpable dust for fifteen miles. The country, if possible, grew worse. There was not a spear of grass, and from the porousness of the soil and rocks it was impossible that there should be a drop of water. A point was reached which commanded a view twenty or thirty miles ahead, but the fiery bluffs and yellow sand, paled somewhat by distance, extended to the end of the vista. Even beyond the ordinary limit of vision were other bluffs and sand fields, lifted into view by the mirage, and elongating the hideous picture."

Woodhouse, in speaking of a somewhat similar desert which he crossed in western Arizona, states that a coyote, "becoming desperate, rushed to the spring, and was killed by one of the men with a stone." He says further: "The ravens were hovering over us while we remained here, eagerly watching our famished mules. Since we left Bill Williams's Fork there have been clouds seen every day, and anxiously did we watch for rain; but this seemed a thing impossible, to rain in this miserable country, where everything appears to be an enemy, and is armed with a thorn or a poisonous sting."

pinus capitatus) is abundant; and the higher levels are adorned by a kind of painted-cup (*Castelleia*) and scattered beds of a rather coarse plant (*Mirabilis multiflora*) which suggests the morning glory. The delicate pink blossoms of the graceful *Malvastrum*, and the more showy yellow and orange flowers of *Riddellia tagetina* and *Zinnia grandiflora* would attract attention anywhere, and their beauty is here heightened by contrast with their sombre surroundings.

Without going into details it may be said that these plants, taken collectively, occur in the arid parts of northern Mexico,* Texas, New Mexico, Arizona, and southern California, and some of them extend north in the Great Basin, even reaching the Plains of the Columbia; and a few spread northward over the Great Plains east of the Rocky Mountains.

Large black beetles of the genera *Eleodes* and *Asida* are common on the Painted Desert and are characteristic arid land forms, occurring also in Mexico.

Toads of the peculiar genus *Spea*, modified for life in desert regions, were found after rains in some of the arroyos or washes, which are dry the greater part of the year.

Lizards are the most conspicuous forms of animal life and many species abound throughout the desert. Among them are :

<i>Crotaphytus baileyi</i>	<i>Sceloporus elongatus</i>	<i>Holbrookia maculata flavilenta</i>
<i>Crotaphytus wislizenii</i>	<i>Uta stansburiana</i>	<i>Phrynosoma ornatissimum</i>
<i>Sceloporus graciosus</i>		

We saw only one rattlesnake, but others have been recorded. Several of the species and all of the genera of reptiles here mentioned occur also in Mexico.

Birds are scarce, both in species and individuals, and but few breed on the desert of the Little Colorado. The following species were observed there :

Black-throated Desert Sparrow (<i>Amphispiza bilineata</i>)	Brewer's Sparrow (<i>Spizella breweri</i>)
Nevada Sage Sparrow (<i>A. belli nevadensis</i>)	Sage Thrasher (<i>Oroscoptes montanus</i>)
Boucard's Sparrow (<i>Peucaea ruficeps boucardi</i>)	——— Thrasher (<i>Harporhynchus</i> sp. —?)
	Burrowing Owl (<i>Speotyto cunicularia hypogaea</i>)

All of these are characteristic arid land birds, which come into the United States from Mexico and extend northward various distances. Boucard's Sparrow ranges north from the table-lands of Mexico to western Texas, New Mexico, and Arizona; the Black-throated Desert Sparrow, from Mexico and Texas westward to southern California and north in the Great Basin to Utah and Nevada; the Sage Sparrow, from Mexico north to the Plains of the Columbia; Brewer's Sparrow, from

* The number of Arizona plants which occur in the northern part of Mexico is very large. Hemsley, in the botanical part of *Biologia Centrali-Americana*, states that of the 560 genera of Arizona plants mentioned by Rothrock, no less than 402, or 72 per cent., occur also in northern Mexico.

Mexico north over the Great Plains and the Great Basin; the Sage Thrasher, from Mexico north through the Great Basin; and the Burrowing Owl, from southeastern Texas to California and northward to Canada wherever suitable localities exist. Another characteristic arid land bird, the Road Runner or Chaparral Cock (*Geococcyx californianus*), was not seen, but has been recorded from the Little Colorado, and, like the others, enters the United States from Mexico. It ranges from Texas to California and north to Colorado.

The characteristic mammals of the desert are small nocturnal forms, such as Kangaroo Rats (*Dipodomys*), Pocket Mice (*Chaetodipus*, a subgenus of *Perognathus*), Big-eared Mice (*Hesperomys*—of the *eremicus* group), and Free-tailed Bats (*Nyctinomus*). All of these groups reach the United States from Mexico, and none of the species of the Painted Desert range much north of Arizona.

Thus it appears that most of the forms of life inhabiting the desert of the Little Colorado—its mammals, birds, reptiles, and plants—occur also in Mexico and extend northward as far as the arid lands are suited to their requirements; and some of its species range east into Texas and west into southern California.

In like manner it has been shown that the characteristic forms of life of the Piñon belt occur in similar areas in different parts of the arid lands from Mexico to the Plains of the Columbia; that lands which rise above the level of the Piñon belt are covered with forests of tall pines and in the main possess the same species from western Texas to British Columbia; that still higher elevations are clothed with balsam and spruce, and that the humbler plants, the birds, and the mammals of these balsam and spruce forests are essentially the same throughout the Rocky Mountains and the great northern forest of Canada from northern New England to Alaska; that the mountain peaks, if sufficiently high, are bare at the summit, or capped with snow and ice, and sustain the same species of plants that grow in the arctic regions of the world and come south on the high mountain ranges in all parts of the Northern Hemisphere; in brief, it has been found that the same species, or closely related representative species of animals and plants inhabit the remotest parts of these several zones that inhabit them on San Francisco Mountain.

INTERRELATIONS AND AFFINITIES OF THE SEVERAL ZONES.

The contemplation of the phenomena here described leads naturally to comparisons of similar areas throughout the country; to attempts to bring together these areas into natural biological zones and provinces, and to inquiries concerning their origin.

Without going into the history of the subject, it may be said that most zoologists recognize three primary zoo-geographical divisions in the United States—an 'Eastern,' extending from the Atlantic Ocean to the Great Plains; a 'Central,' from the eastern border of the Plains westward to the Sierra Nevada; and a 'Western,' from the eastern

base of the Sierra Nevada to the Pacific. The arid region of the Southwest which enters the United States from Mexico has been recognized as a distinct division by many naturalists, and has been named the '*Chihuahuan*' or '*Sonoran*' region.

The region east of the Great Plains was subdivided by Agassiz as early as 1854 into three areas which he called Faunas, namely: (1) a '*Canadian Fauna*,' (2) an '*Alleghanian Fauna*,' or Fauna of the Middle States, and (3) a '*Louisianian Fauna*,' or Fauna of the Southern States. Subsequent writers, particularly Verrill and Allen, have circumscribed these Faunas, reduced their rank, and increased their number until at the present time ornithologists recognize eight faunal areas in eastern North America, as follows: (1) Arctic; (2) Hudsonian; (3) Canadian; (4) Alleghanian; (5) Carolinian; (6) Louisianian; (7) Floridian; and (8) Antillean. Cope, from a study of the reptiles and batrachians, united the Louisianian and Floridian Faunas into a district of primary rank, which he named the '*Austroriparian*' region—the exact equivalent of Agassiz's Louisianian Fauna. Passing over this region as clearly of southern origin, there remain the Carolinian, Alleghanian, Canadian, Hudsonian, and Arctic Faunas. The three latter are boreal in their affinities, while the Carolinian is suffused with southern forms, and the Alleghanian seems to be neutral ground.

In studying the several life-zones of the higher declivities of San Francisco Mountain it became apparent not only that each has its corresponding zone in the East, but that in many instances the zones of the mountain may be recognized by the presence of the identical species which characterize them in New England and Canada. In short, it was found that the faunal and floral zones which go to make up the Boreal Province in the East may be traced in a northwesterly direction around the northern end of the Plains of the Saskatchewan and then south along the sides of the Rocky Mountains, even to this isolated peak in Arizona.* This has been pointed out somewhat in detail in the discussion under the head of each zone, and has been indicated further by the headings themselves.

Each zone, while possessing throughout a certain number of common or strictly representative species, undergoes a notable change in pass-

* This will be made clear by a glance at the accompanying map of North America (map 5), on which the Boreal Province is represented in clear green.

Scudder, under the head of "Anomalies in the Geographical Distribution of our Butterflies," mentions a number of cases in which northern species of butterflies occur in supposed isolated colonies at remote points, all of which, it is significant to observe, fall within the boundaries of the Boreal Province here defined. He cites the brown elfin butterfly (*Incisalia augustus*) as a species throwing some light on this 'anomalous' distribution. It occurs, he states, in New England and New York, and south in the Alleghanies to West Virginia. North of the United States it has been found at Halifax, Quebec, Montreal, and thence westerly as far as Cumberland House on the North Saskatchewan. In the West it again enters the United States along the Rocky Mountains, and extends as far south as Colorado. A better example of a typical boreal distribution could hardly be desired.

ing from the East to the West, each extreme being occupied by certain species not found in the other. It is necessary to recognize this difference in the names applied to the zones; hence the prefix 'central' has been used in each case to distinguish the Rocky Mountain arm from the eastern arm.

The several zones of the San Francisco Mountain region are interrelated in different degrees, some very closely and others very remotely. Many species and even genera which are common to two or more zones, and consequently of no value whatever in defining the single areas, become of the utmost importance in studying the interrelations of the several zones. For instance, in the highest group of all—the mammalia—there are representatives of four distinct types, namely, Bears, Shrews, Voles, and Red Squirrels, which range from the top of the timber-line belt to the bottom of the Canadian or Douglas fir zone.* All of these are circumpolar types, ranging over the boreal parts of the whole world and coming south in the mountains. It is clear, therefore, that they are of boreal origin. On the other hand, there are several very different types of mammals, among which may be mentioned the Kangaroo Rats, Pocket Mice, and Grasshopper Mice, which do not occur above the Piñon zone. These are southern types reaching the United States from the table-lands of Mexico and extending northward over the arid lands as far as the conditions are suited to their requirements. It is clear, therefore, that they are of southern origin. In short, it may be stated, as a result of this biological survey of the San Francisco Mountain region, that all the forms of life inhabiting Arizona were derived from one of two directions—the north or the south. And in extending these researches and generalizations so as to embrace the Great Interior Basin, the Rocky Mountain region, and the Great Plains, which together constitute the so-called 'Great Central Province,'† of naturalists, I was astonished to be forced into the belief that no such province exists. Indeed, the present investigation demonstrates that there are but two primary life provinces in this country: a northern, which may be termed *Boreal*, and a southern, which, for our purposes, may be termed *Sonoran*, since it comes to us from Mexico through Sonora. In attempting to arrange all the life zones of Arizona under these two headings the following conclusions have been reached: The Arctic-Alpine, Timber-line, Hudsonian, and Canadian zones, having been shown to be derived from the north, fall naturally under the *Boreal* division. The Desert and Piñon zones, having been shown to be derived from the south, fall naturally under the *Sonoran* division. There remains but one area, namely, the Pine area, whose relationships are in any way obscure. This area has

*Bears range over the lower levels at certain seasons of the year, but are not known to breed away from the spruce and fir forests.

†This province was outlined by Agassiz as long ago as 1854, and has been accepted so far as its essential features are concerned by LeConte, Baird, Wallace, Allen, Cope, Binney, Gray, Packard, and nearly all recent writers.

been shown to consist of a mixture of Boreal and Sonoran types, more or less modified by adaptation to environment. In other words, it is neutral territory. But since the number of its Sonoran types is greatly in excess of its Boreal types, it may be more properly referred to the Sonoran Province. Therefore, of the seven life-zones of the San Francisco Mountain region in Arizona, four may be referred to the Boreal Province and three to the Sonoran.

The zones composing each of these primary divisions are related to one another in different degrees. Thus, the Timber-line, Hudsonian, and Canadian zones are much more intimately related than the Timber-line and the Alpine; and the affinities of the Piñon and Desert are much closer than those of the Piñon and Pine. Hence it becomes possible to group the zones into categories of intermediate rank between the primary provinces and the tertiary zones or areas. These secondary divisions are here termed regions. Under the Boreal Province we may recognize two regions, an Arctic and a Boreal. The Arctic region contains but one zone, the Alpine. The Boreal region contains three zones, namely, the Timber-line, Hudsonian, and Canadian. The Sonoran or southern province may be likewise split into two regions, a Sub-Arid and an Arid. The Sub-Arid consists of a single zone, the Pine. The Arid region comprises two zones,* the Piñon and the Desert. The facts here set forth may be graphically represented by means of a table, thus:

Life Areas of the San Francisco Mountain Region in Arizona.

Provinces.	Regions.	Zones or Areas.
Boreal	Arctic	Alpine.
	Boreal	Timber-line.
		Hudsonian.
Sonoran	Sub-Arid	Canadian.
	Arid	Pine.
		Piñon.
		Desert.

The primary divisions are based on the possession of distinctive genera; the secondary and tertiary chiefly on distinctive species, though some of them possess distinctive genera also.

ORIGIN OF THE BOREAL FAUNA AND FLORA OF SAN FRANCISCO MOUNTAIN.

The Boreal zones of San Francisco Mountain are separated from corresponding areas elsewhere by a broad interval occupied by the upper faunas and floras of the Sonoran Province. The arctic summit of the mountain is distant more than 400 kilometers (250 miles) from the nearest peak of similar character in Colorado, and nearly 3,200 kilometers (2,000 miles) from the nearest point in the Arctic zone proper—all

* The Desert of the Little Colorado contains but two arid zones; further south a third is encountered.

the arctic areas within the United States being mere dots upon the map, and even the lower zones of the Boreal Province being widely separated from similar areas in the north. The question naturally arises as to the origin of these small colonies of arctic life which appear here and there over a great continent. It is perfectly evident that they could not have reached their present positions during existing climatic conditions; hence it is necessary to search the records of the past for the explanation. The period immediately preceding the present is known as the glacial age, because the northern parts of the globe were then buried in ice. This ice cap, which in places was several thousand feet in thickness, underwent two principal movements of advance and retreat, first crowding the life of the region far to the southward, then allowing it to return, to be again driven south by the next advance. The southern terminus of the great ice sheet extended from New Jersey to southern Illinois, and thence northwestward to British Columbia, and its effects upon the climate must have been felt throughout the United States and even into Mexico. The advance of the glacial period was so gradual that plants as well as animals had time to escape by extending their ranges southward, and during the return movement were enabled to keep pace with its slow retreat. Had either the process of refrigeration or the return of heat taken place more rapidly, most of the forms of life inhabiting the northern parts of the globe would have been exterminated. During the recession of the glacier many boreal plants and animals were stranded on mountains, where, by climbing upward as the temperature became warmer, they were able to find a final resting place with a climate sufficiently cool and moist for their needs; here they have existed ever since. This is the commonly accepted explanation of the presence of arctic forms on isolated mountain peaks widely removed from the southernmost limit of their continuous distribution.

Incidentally the ancient origin of arctic-alpine faunas leads to conclusions which might be of use to the geologist. For instance, San Francisco Mountain is a volcanic peak composed entirely of lava rock. Its summit is inhabited by species of animals and plants which could not have reached it since the recession of the glacial period. Hence the mountain itself can not be of more recent origin than this period. Here the living fauna and flora afford evidence of the age of a great mountain.

ORIGIN OF THE FAUNA AND FLORA OF THE PAINTED DESERT.

The Desert of the Little Colorado, it will be remembered, is a deep basin on top of the Great Colorado Plateau. It is wholly disconnected from the desert region of southern Arizona by the elevated and timber-covered highlands occupying the crest of the plateau escarpment. In fact the highest part of Arizona south of the Grand Cañon, except a few isolated mountains, is the edge of this plateau, which is nowhere below 2,130 meters (7,000 feet), and in places rises to the height of 2,740

meters (9,000 feet), as at the Mogollon Mesa. On the east, the desert is separated from the valley of the Upper Rio Grande by a broad area covered with cedar and piñon, through which the continental divide passes, at an elevation of upwards of 2,130 meters (7,000 feet). Therefore, the only possible channel through which the fauna and flora of the Painted Desert could have reached this desert during existing climatic conditions is by way of the Grand Cañon of the Colorado. At first thought it seems incredible that a fauna and flora should extend several hundred miles through a chasm of this character; but the evidence at hand indicates that it does. Our descent into the cañon from the Cocanini Plateau was made at a point about 25 kilometers (15 miles) below the mouth of the Little Colorado. Here the cañon is about 1,800 meters (more than a mile) in depth and nearly 25 kilometers (15 miles) wide at the top. Numerous side cañons cut into it, and there are many shelves and bottoms which support a flora of cactuses, yuccas, agaves, greasewoods, and other typical Sonoran forms. Pocket Mice of the sub-genus *Chatodipus*, Large-eared Mice of the *Hesperomys eremicus* group, and the Little Spotted Skunk (*Spilogale*) were secured, together with several birds (among them *Peucea ruficeps boucardi*) and reptiles of the Sonoran fauna, some of which occur also on the Painted Desert.*

The inference is that the life of the Painted Desert is derived from the deserts of western Arizona, and that it came by the roundabout way of the Grand Cañon of the Colorado.

It might be urged that the climate of the Plateau region in the past may have been enough warmer than at present to admit of direct communication between the life of the Painted Desert and that of the deserts of southern Arizona; but Major C. E. Dutton, who has made a special study of the physiographic history of the Plateau region, assures me that its climate has not been warmer than now since glacial times.

GENERALIZATIONS CONCERNING THE DISTRIBUTION OF LIFE IN NORTH AMERICA.

OVERTHROW OF THE SO-CALLED 'CENTRAL PROVINCE' OF NATURALISTS.

The region almost universally recognized by recent writers as the 'Central Province' is made up of the Great Plains, the Rocky Mountains, and the Great Basin. A critical study of the life of the Rocky Mountains has shown it to consist of a southward extension of the Boreal Province, with an admixture of southern forms resulting from an intrusion or overlapping of representatives of the Sonoran Province, some of which, from long residence in the region, have undergone enough modification to be recognized as distinct subspecies or even species. A similar analysis of the life of the Great Plains and Great Basin has shown them to consist of northward extensions of the So-

* Among the reptiles found near the bottom of the cañon were two lizards (*Sceloporus clarkii* and *Uta symmetrica*) which belong to the torrid fauna of southern and western Arizona, and are not known to reach the Painted Desert.

noran Province, somewhat mixed with the southernmost fauna and flora of the Boreal Province. Thus the whole of the so-called 'Great Central Province' disappears.

This explains a multitude of facts that are utterly incomprehensible under the commonly accepted zoological divisions of the country. These facts relate particularly to the distribution of species about the northern boundaries of the supposed Central and Pacific Provinces, and to the dilemma we find ourselves in when attempting to account for the origin of so many primary life areas in a country where there are no impassable physical barriers to prevent the diffusion of animals and plants.

EVIDENCE ON WHICH THE 'CENTRAL PROVINCE' WAS BASED.

The conclusions here announced are so diametrically opposed to the long-accepted and current views of zoologists that it may be interesting to examine for a moment the evidence on which their generalizations were based. This evidence, stated briefly, consists in the presence, in the region in question, of a large number of genera and species not found in the Eastern States. It has just been shown that the vast majority of these forms were derived from the north or from the south. The remainder fall naturally into two categories: (1) Those so closely related to forms now living in adjoining regions as to leave no doubt that they are the immediate descendants of the same, modified by environment; and (2) isolated generic types, of which the number is small.

SIGNIFICANCE OF ISOLATED TYPES.

The presence of isolated types, however few, might be regarded as an obstacle to the acceptance of the views here advanced, but their significance becomes apparent as soon as an attempt is made to trace the life of the present back to the life of the past. The colonies of big trees and redwoods of California (*Sequoia gigantea* and *S. sempervirens*) have no nearer relatives than the bald cypress (*Taxodium*) of the Gulf States and a related species from China (formerly recognized generically under the name *Glyptostrobus*). This was pointed out many years ago by Dr. Asa Gray in connection with the circumstance that the ancestors of these trees once ranged throughout the boreal regions of the world. A fossil species (*Sequoia langsdorfii*) closely related to the California redwood has been found in Spitzbergen, Iceland, Greenland, the north of Europe, Alaska, at the mouth of the Mackenzie River, and also in the Rocky Mountains, the Great Basin in Oregon, and the Bad Lands in Dakota. Many parallel cases might be cited. Thus the records of the rocks show that many of the types which have survived the perils incident to the successive shiftings of the fauna and flora during and subsequent to the ice age were formerly conspicuous over large areas in the north. These facts are in complete accord with a general law which may be thus formulated:

When the physiographic conditions of a region are in process of change,

those forms of life which are sufficiently plastic to adapt themselves to the rapidly changing conditions survive, while those which cannot so adapt themselves become extinct.

Isolated generic types are illustrations of this law and may be regarded as remnants of the past—the only living representatives of types once abundant and widely diffused. Such types are not confined to plants, but may be found in nearly every branch of the animal kingdom. Among North American mammals the genera *Neurotrichus* and *Aplodontia* may be cited as examples, both of them being confined to a narrow strip along the Pacific coast from northern California to British Columbia. The former has a near relative in Japan (*Urotrichus*), and the intermediate forms which connect it with the Shrews on the one hand and the Moles on the other are still living in eastern Asia (the genera *Scaptonyx* and *Uropsilus*). *Aplodontia* is a large rodent, the type and sole representative of an isolated family, and has no known living relative in any part of the world.

PRINCIPAL LIFE REGIONS OF NORTH AMERICA.

[See map 5.]

The most important generalization arrived at in the present investigation is that the whole of extratropical North America consists of but two primary life regions, a *Boreal* region, which is circumpolar; and a *Sonoran* or *Mexican table-land* region, which is unique.*

The *Boreal Province* [colored green on map 5] extends obliquely across the entire continent from New England and Newfoundland to Alaska, conforming in direction to the trend of the northern shores of the continental mass. It gives off three long arms or chains of islands which reach far south along the three great mountain systems of the United States—a western arm in the Cascades and Sierra Nevada, a central arm in the Rocky Mountains, and an eastern arm in the Alleghanies—and these arms interdigitate with northward prolongations of the Sono-

* Since the present paper was written (December, 1889) the author has been engaged in the preparation of an historical synopsis of the attempts that have been made to define the faunal and floral areas of North America. In the course of this investigation several important papers have been found which confirm, and in part anticipate, the general conclusions here announced, though none of them attempt to explain the significance of the areas recognized or to correlate them with the northern and southern origin of the life of the continent. For instance, the late Dr. Asa Gray stated that it is certain "that two types have left their impress upon the North American flora, and that its peculiarities are divided between these two elements. One we may call the *boreal-oriental element*; this prevails at the north, and is especially well represented in the Atlantic flora and in that of Japan and Manchuria; the other is the *Mexican-plateau element*, and this gives its peculiar character to the flora of the whole southwestern part of North America, that of the higher mountains excepted" (Bull. U. S. Geol. and Geog. Survey, VI, 1, Feb. 11, 1881, 62). At the same time, and in the same communication, Dr. Gray adopts the three great divisions usually recognized by zoologists—Eastern, Central, and Pacific.

ran Province, which latter completely surround the southern islands of the Boreal system.

The *Sonoran Province* [colored orange or yellow on map 5] comes into the United States from the south and is divisible into six subregions, namely: (1) an *Arid* or *Sonoran* subregion proper, occupying the tableland of Mexico and reaching north into western Texas, New Mexico, Arizona, and southern California; (2) a *Californian* subregion, occupying the greater part of the State of that name; (3) a *Lower Californian* subregion; (4) a *Great Basin* subregion, occupying the area between the Rocky Mountains and the Sierra Nevada and extending as far north as the Plains of the Columbia; (5) a *Great Plains* subregion, occupying the plains east of the Rocky Mountains and extending north to the Plains of the Saskatchewan; and (6) a *Louisianian* or *Austroriparian* subregion, occupying the lowlands bordering the Gulf of Mexico and the Mississippi, and extending eastward, south of the Alleghanies, to the Atlantic seaboard, where it reaches as far north as the mouth of Chesapeake Bay.

The latter region requires a word of comment, since its true affinities have not been heretofore pointed out, though the region itself has been long recognized.* That it is an offshoot of the Sonoran region is evident from the fact that most of its peculiar or distinctive animals and plants belong to Sonoran genera, and many of its species are identical with or closely related to Sonoran forms. It contains no less than eight Sonoran genera of mammals, namely: *Spilogale*, *Urocyon*, *Neotoma*, *Sigmodon*, *Ochetodon*, *Geomys*, *Piccotus* (subgenus *Corinorhinus*), and *Nyctinomus*, most of which extend northward near the Atlantic seaboard as far as Norfolk, and at least one of them (*Urocyon*) considerably further. It contains also a number of Sonoran genera of birds, reptiles, batrachians, and plants. At the same time, it contains two Tropical American genera of mammals, namely, *Didelphys* and *Oryzomys*; and perhaps *Urocyon*, *Sigmodon*, and *Nyctinomus* belong as much to one as to the other. It contains also a number of Tropical genera of birds, reptiles, and plants. Hence the *Austroriparian* subregion consists of a mixture of Sonoran and Tropical forms; but since the number of its Sonoran types is greatly in excess of the Tropical, it may be fairly regarded as a subdivision of the former.

The *Tropical Province* [colored red on map 5], so far as North America is concerned, occupies Central America and the Antilles and pushes north along the lowlands on both sides of Mexico, reaching the mouth

*As early as 1817 the entomologist Latreille made it one of his circumpolar divisions. In 1822 the botanist Schouw named it the *Realm of Magnolias*; and in 1854, Agassiz named it the *Louisianian Fauna*. These authors, and several other early writers (including Meyen, Martius, Berghaus, and Schmarida) regarded it as a region of primary rank. More recent writers (including LeConte, Cooper, Binney, Baird, and Allen) looked upon it as a subdivision of the eastern forest region or *Eastern Province*. Cope, in 1873, restored it to independent rank and named it the *Austroriparian region*.

of the Rio Grande on the Gulf of Mexico, and a little north of Mazatlan on the Pacific coast. It occupies also a narrow belt encircling the southern half of the peninsula of Florida. This tropical element in Florida is of comparatively recent origin, and consists mainly of a chain of island-like colonies of birds, insects, and plants which may easily have reached its shores and keys from the neighboring West Indies, as pointed out by Schwarz in an article on its peculiar Insect Fauna (*Entomologica Americana*, IV, No. 9, 1888). The interrelations of the Tropical and Sonoran Provinces are such as suggest that the chief difference may be due to humidity as much as temperature.

In the light of the general conclusions here announced, the only part of North America which is in any way obscure, so far as the relationships of its faunas and floras are concerned, is the so-called '*Pacific Province*;' and, like the '*Central Province*' already discussed, it is evidently made up of two distinct elements, a *mountain* element derived from the Boreal Province, and a *valley* element derived from the Sonoran; but owing to the peculiar physiographic conditions of the west coast it has undergone a greater amount of differentiation.

CAUSES WHICH DETERMINE DISTRIBUTION.

It is not the purpose of the present paper to discuss the causes that have to do with limiting the distribution of terrestrial animals and plants further than to point out a generalization which seems to have been overlooked. Omitting reference to the effects of physical barriers, which explain the differences in the life of disconnected continents, it may be stated that temperature and humidity are the most important causes governing distribution, and that temperature is more potent than humidity.* Authors differ as to the period during which temperature exerts the greatest influence, some maintaining that it is the temperature of the whole year, and others, that it is the temperature of a very brief period which determines the range of species. In the case of birds, it has been shown by Verrill and Allen that it is the temperature of the *breeding season*.

If this is true of birds, why is it not true of other forms of animal life and of plants as well? The season of reproduction for the plant, as for the animal, is the warm part of the year. After the period of reproduction the plant withers; after it flowers and fruits and matures its seed, it dies down or becomes physiologically inactive. And what the plant accomplishes in one way the animal accomplishes in another. To escape the cold of winter and its consequences the sensitive mammal hibernates; the bird migrates to a more southern latitude; the reptile and batrachian dig holes in the mud or sand and remain in a torpid condition; the insect sleeps in its cocoon or buries itself under leaves

*In arid districts humidity is an element of vastly more consequence than in regions of moderate or copious rain-fall, particularly in regard to the inception of the period of reproduction in plants.

or decomposing vegetation ; and none but the hardier forms of life are left to be affected by winter temperatures. Freezing does not hurt most plants when not in a state of reproductive activity. In the north, trees five and six feet in diameter freeze through to the heart every winter. It is obvious, therefore, that plants are not exceptions to the law that *the temperature during the season of reproductive activity* determines the distribution of life. In high arctic latitudes this period is very brief, while in the humid parts of the tropics it seems to extend over nearly if not quite the whole year.

Some eminent writers have assumed that plants and animals do not agree in distribution—that a faunal map (a map showing the distribution of an association of animals) must differ essentially from a floral map (a map showing the distribution of an association of plants). This assumption is illogical, for, as just stated, plants and animals are subjected to the same conditions during the season of reproduction—the season during which they are most affected by their surroundings. Furthermore, the field work on which the present paper is based, which was conducted with special reference to the determination of this point, demonstrated that complete coincidence exists in the limitation of the life-areas as defined independently by the study of the mammals, birds, reptiles, and plants of the San Francisco Mountain region.

Since the distribution of animals and plants depends primarily upon temperature, it follows that the physiographic conditions which influence temperature influence distribution also. In obedience to this law certain axioms of distribution may be thus expressed :

The distribution of species *in the same latitude* depends primarily on *altitude*.

The distribution of species in the same latitude and altitude is influenced notably by—

- (a) Elevation above base-level.
- (b) Slope-exposure.
- (c) Proximity to and direction from large bodies of water.
- (d) Meteorologic conditions affecting temperature.

In the case of mountains of equal altitude and low base-level:

- (1) The number of faunal and floral zones (up to the limit of zones possible for the range of temperature) is inversely proportional to the distance from the equator.
- (2) The width of the zones and the abruptness of the change from one to another is proportional to the steepness of the slope.

By elevation above base-level is meant the height of a given point above the plane it faces. This may be made clearer by an example. The mean altitude of base-level below the plateau rim in Arizona is less than 900 meters (3,000 feet), and above it more than 2,130 meters (7,000 feet). A mountain standing on the edge of the plateau will have a

higher temperature at a given altitude on the north side than on the south side, because the plateau level (base-level) on the north side carries up the temperature. Many years ago Humboldt cited an instance of this kind in the Himalaya. The temperature on the north side of this lofty range is much higher than on the south side at the same elevation; or, to state it differently, the snow line and the timber line on the north side are about 900 meters (3,000 feet) higher than on the south side. This is due to the great height of the Tibetan Plateau as compared with the altitude of base level on the south side, and is in opposition to the influence of slope-exposure. By slope-exposure is meant the inclination of the surface of the earth in relation to the angle of reception of the sun's rays. The sun strikes the east side of a hill or mountain in the early part of the day, the south side a little later, the southwest and west sides in the afternoon, when its heat is greatest, and the northwest and north about sundown or not at all. But in case there is a high plateau on the north side, the heat from the plateau will force the timber line up. Therefore, of the influences under consideration, base-level is more powerful than slope exposure.

About half a century ago the elder Binney, in a work which he did not live to see published, made the following observation:

"The relations which the different levels of elevation bear to the parallels of latitude, although as interesting to the zoologist as to the botanist, have not yet been made the subject of examination in this country. But the Rocky Mountains * * * offer, in the great extent of their table-land and in the height to which they rise, a vast field of research to future naturalists, where they will be able to solve many of the most important questions connected with the geographical distribution of the terrestrial mollusks of our country."*

If the word 'mollusks' in the above quotation be changed to the more comprehensive word 'life,' Binney's remarks may be regarded as a prophecy fulfilled, in part at least, by the present Biological Survey of San Francisco Mountain. At the same time it should be remembered that the present report is little more than an announcement of the general conclusions resulting from a brief survey of a limited area, and that anything approaching a final discussion of the subject must be deferred until similar surveys of many regions result in the accumulation of a multitude of facts now unknown. As the late Leo Lesquereux once said of his favorite study:

"This science is in its infancy; and the childhood of science is marked, like that of man, by a series of trials and failures, from which strength and proficiency are derived. The first astronomers did not measure the distance from the earth to the fixed stars, nor weigh the planets by the diameter of their orbits."†

* Amos Binney, *The Terrestrial Mollusks of the U. S.*, 1851, vol. I, 116-117.

† A Review of the Fossil Flora of North America. *Bull. U. S. Geol. and Geog. Survey Terr.*, No. 5 (2d series) Jan., 1876, 248

CLIMATE OF THE SAN FRANCISCO MOUNTAIN REGION AND DESERT
OF THE LITTLE COLORADO, ARIZONA.

The traveler in the Plateau region of Arizona is awed by the grandeur and energy with which the processes of nature manifest themselves. The multitude of volcanic craters and lava cones, culminating in San Francisco Mountain, attest the former activity and intensity of the subterranean forces; the Grand Cañon of the Colorado, the most stupendous chasm known, is a gigantic illustration of the surface forces now in operation—of the cutting power of water and the carving power of sand; while the terrific thunder-storms and cloud-bursts which shake the very foundations of the earth in their fury, shattering the tall pines with the lightning, and sending mighty torrents down the hillsides to plow deep gorges in the desert, serve to indicate the resistless energy of the forces of the air.

In its climatological aspects the Plateau region of Arizona presents a field of surpassing interest and diversity, and problems of the utmost importance to physiography and to agriculture may be there advantageously studied. Climates which usually characterize widely remote regions are here brought near together, appearing in successive strata from the desert levels to the summits of the mountains, thus permitting their several effects to be comprehended at a glance, and their differences contrasted. In a general way it may be said that the climate of the region abounds in extremes. Protracted periods of drought are interrupted by deluges of rain; and the snows of winter suddenly give place to the intense heat of summer. As a natural consequence, most of the mammals and all of the reptiles and batrachians hibernate for longer or shorter periods, even on the desert.

It is not the purpose of the present essay to discuss meteorologic conditions further than is necessary to indicate in a very general way the peculiarities of temperature and humidity which characterize the several zones herein defined.

TEMPERATURE.

The tropics are characterized by great uniformity of temperature, the daily and yearly fluctuations being insignificant. The absence of a marked fall in temperature at night is due in great part to the large quantity of moisture in the atmosphere. This moisture acts in two ways: (1) by diminishing the loss of heat by radiation; (2) by directly increasing the temperature of the atmosphere. As stated by Wallace, "the warmth given off by the heated earth is very largely absorbed by it [the aqueous vapor], thus raising the temperature of the air; and as it is the lower strata of air which contain most vapor, these act as a blanket to the earth, preventing it from losing heat at night by radiation into space." (*Tropical Nature*, 1878, p. 9.)

The excessively dry atmosphere of Arizona acts in exactly the opposite way, interposing no obstacle to free radiation and presenting no medium to retain the heat given off at night. Hence the change in temperature from day to night is always great. The summer heat of Arizona, except on the high mountains, is greatly in excess of the summer heat of the tropics, while the winter temperature is vastly lower, and sudden contrasts are common.

The law of latitudinal equivalent in altitude was discovered in the last century and was early formulated by Humboldt. Omitting reference to local disturbing influences and seasonal variations, it may be stated as a general proposition that temperature decreases from the equatorial zone to the poles at an average rate of a little less than 1° Fahr. for each degree of latitude; and from base-level to higher altitudes, at the average rate of about 3° Fahr. for each 1,000 feet of elevation. In temperate and cold regions the differences due to latitude and altitude are greatest in winter and least in summer. It follows that places having the same mean annual temperature may have widely different summer temperatures; and conversely, that places receiving the same amount of summer heat may have widely different mean annual temperatures. The significance of these facts becomes apparent in studying the distribution of life, for, as will be shown later, the distribution of species in temperate and cold regions is governed in the main by the temperature of the warm season, the mean annual temperature being of little consequence.

It has just been stated that the mean average decrease in temperature with altitude is about 3° Fahr. for each 1,000 feet. The exact rate in any particular case may be obtained by dividing the difference in temperature of the extremes by the difference in altitude. The Signal Service records show that the actual rate of decrease in midsummer on the Colorado Plateau is 4° .* At this rate the temperature of the summit of San Francisco Mountain in summer would be 20° Fahr. lower than that of the cedar belt and 35° lower than that of the Painted Desert.

Seven life zones are described in the following pages as crowded into the narrow space between the arctic-alpine summit of San Francisco Mountain and the torrid desert of the Little Colorado, only 40 kilometers (about 25 miles) distant. Each of these zones has a distinctive temperature during the period of growth and reproduction—a period of less than three months' duration at the summit, but extending over half the year on the desert. Unfortunately, the time spent in any one of the several zones was insufficient to furnish the thermometric data necessary for the determination of its distinctive temperature. Therefore the only way in which it is possible to obtain information on this

* Denver and Pike's Peak were selected for this computation because of their proximity to the San Francisco Mountain region and because they afford a vertical range of about 2,450 meters (8,000 feet).

subject is by examination of the records of the nearest stations in the same or corresponding zones. Data from several such stations may be found in the publications of the United States Signal Service and in Schott's Tables, published by the Smithsonian Institution.* Compilation of these data leads to interesting results. Fort Apache, in Arizona, and Fort Wingate, just over the line in New Mexico, are in the piñon belt of the Great Plateau, Apache near the lower, and Wingate near the upper, limit of this zone. They are 232 kilometers (145 miles) apart. The mean temperature for the five months (April to August, inclusive), assumed to cover the period of reproduction in this belt is found to be 65.6° Fahr. at Fort Apache, and 65.03° at Fort Wingate, showing a really remarkable agreement over this part of the piñon belt. The mean temperature of the same period at Holbrook, on the edge of the Little Colorado Desert (at the junction of the Puerco and Little Colorado), 124 kilometers (77 miles) from Fort Apache, is a little above 70° (70.9°) Fahr. Albuquerque, in the valley of the Upper Rio Grande in New Mexico, though on the other side of the Continental Divide and 309 kilometers (192 miles) distant, has essentially the same altitude and essentially the same summer temperature (70.1° Fahr.).

Data are wanting for the determination of the distinctive temperatures of the several zones of San Francisco Mountain above the cedar and piñon belt, but they may be obtained hypothetically by substituting those from remote stations in the same zones. For instance, the temperature of the summit of Mount Washington, in the timber-line or subalpine zone of the east, during the season of reproduction (June to August, inclusive), is 46.15° Fahr., which may be assumed to agree very closely with the temperature of the subalpine zone of San Francisco Mountain. Similarly, the corresponding temperature of Pike's Peak, Colorado, in the arctic-alpine zone, is 38.23° Fahr. But Pike's Peak is more than a thousand feet higher than San Francisco Peak, hence it is necessary to add about 4° Fahr. to the temperature of the former to make it represent that of the latter, which would then be in round numbers 42° Fahr.

Therefore, though the actual mean temperatures of the several zones of the San Francisco Mountain region during the season of reproduction are unknown, it is possible to arrive at very close approximations to these temperatures by utilizing the records from distant stations in the same life areas. By this process the following means have been obtained. While not supposed to represent the actual means for each zone, they are believed to fall within the normal range of variation between the upper and lower borders of the zones to which they

* The observations here referred to were taken at different periods and by voluntary observers. They lack, probably, the extreme precision and uniformity attained by the trained observers of the Signal Service; at the same time, most of them may be relied upon as sufficiently exact for purposes of comparison.

severally pertain, and are therefore provisionally submitted as a step toward a goal as important as it is difficult to attain.

Table of assumed mean temperatures for the several zones during the period of reproduction.

Zone.	Cent.	Fahr.
	°	°
Arctic-alpine zone.....	4	39.2
Subalpine or timber line zone.....	7	44.6
Hudsonian or spruce zone.....	10	50.
Canadian or fir zone.....	13	55.4
Neutral or pine zone.....	16	60.8
Piñon or cedar zone.....	19	66.2
Desert zone.....	22	71.6

In attempting to ascertain the temperature of climatic zones, in connection with the distribution of their characteristic forms of life, it should be borne in mind that the recorded temperatures are taken *in the shade*, while the plants and diurnal animals of non-forested areas, particularly of deserts and prairies, *live in the sunshine*, and consequently endure much higher temperatures, as well as much greater extremes than indicated by the recorded observations. In attempting, therefore, to ascertain the quantity of summer heat necessary for a particular species, it should be first noted whether the species inhabits areas exposed to the full heat of the sun or dense forests where the sun's rays rarely penetrate; and in the case of animal life it should be noted also whether the species is diurnal or nocturnal, and the temperature observations should be made accordingly.

A series of carefully conducted meteorologic observations, made with special reference to temperature and humidity, and carried on simultaneously in the spruce belt of the mountain and on the Painted Desert, or, better still, in each of the seven zones herein defined, would be productive of information of much scientific and economic value.

HUMIDITY.

The Plateau region of the interior of North America is noted for its scanty rain-fall, and the same may be said of Arizona as a whole. The annual precipitation and mean humidity are greatest on the high mountains and least on the low plains and deserts. Thus San Francisco Mountain has many times the rain-fall of the Little Colorado Desert, near by, and the quantity of aqueous vapor in the air is correspondingly higher. Evaporation is retarded by the clouds which frequently rest upon the summit, and by the dense spruce forests which protect the soil from the direct rays of the sun, enabling it to retain enough moisture to permit the growth of plants requiring a humid atmosphere for their existence.

There are two rainy seasons on the San Francisco Mountain plateau: one in summer, usually in July or August, the other in mid-winter. The summer rainy season is characterized by daily thunder-showers. As a rule, several such showers occur each day, and not infrequently several may be seen at the same time from any of the volcanic cones. The area covered by each is very small, its diameter rarely exceeding half, or even a quarter of a mile; and its duration is brief, though the rain-fall may be considerable. The accompanying thunder is often terrific, and the lightning vivid and destructive. Tall pines are shattered on every hand, and cattle are frequently killed; three were killed by one stroke near our camp about the middle of August. The showers almost always take place in the day-time, and are most common at mid-day and in the early afternoon. In fact, it is a common saying in this region that it never rains at night. Two partial exceptions to this rule occurred during our stay, one in which an unusually severe and protracted rain lasted from about 3 o'clock in the afternoon until 9 or 10 in the evening; the other, a light shower which actually took place in the night. During the latter part of the rainy season the showers became less frequent, but extended over a larger area and lasted longer. The axis of abundance seems to be between San Francisco and Kendrick Peaks, but the greatest precipitation occurs on San Francisco Mountain, as would be expected from its great altitude. The summit of the mountain is so cold that it is occasionally whitened with snow while rain falls at its base; and hail storms are frequent both on the mountain itself and throughout the plateau region, many sudden storms taking this form.

Over much of the pine plateau the soil consists of decomposed lava, and is so porous that the rain sinks out of sight as it falls, and the atmosphere is so dry and evaporation so rapid that a few minutes after a shower no traces of it are visible.

On the arid desert of the Little Colorado rains are infrequent, but usually of great violence, producing torrents which cut deep washes or 'arroyos' in the sun-baked sand and clay. Sometimes cloud-bursts deluge large areas, flooding the valleys and destroying multitudes of the smaller mammals. Three storms of this character were witnessed, two of moderate size, the third of great dimensions, and striking evidences of a fourth were everywhere noticeable when we reached the region. This latter almost inundated the town of Flagstaff and several other places along the line of the Atlantic and Pacific Railway, and left unmistakable evidences of its volume and force in various directions, the most impressive, perhaps, being the overflow of a crater lake and adjoining craterlet just east of Kendrick Peak. The track of the torrent that rushed down the sides of this crater, and for a distance through the pine forest beyond, suggested a veritable volcanic eruption.

While following the course of Tenebito Wash across the Painted Desert we saw a heavy rain-storm raging over the high mesas to the

north and east during the entire afternoon of August 14, though not a cloud came between us and the parching sun. Before dark a furious wind—the vehicle of a sand-blast—swept down the wash between the rows of cliffs which mark its course, abating as night came on. About 10 o'clock we were startled by a loud roaring in the north, which at first gave the impression that a severe storm was advancing upon us, but not a cloud could be seen, and the stars shone brightly in every direction. The roaring increased and came nearer until it was evident that something was coming down the bed of the wash; and in a moment a great wave of thick mud rushed past with a tremendous roar, accompanied by a fetid stench. The first wave was about $1\frac{1}{2}$ meters (5 feet) high, but it soon rose to $2\frac{1}{2}$ meters (8 feet), where it remained for an hour, and then slowly subsided. After $3\frac{1}{2}$ hours it was still about $1\frac{1}{2}$ meters (5 feet) deep and running swiftly, and it had not entirely ceased three days later.

Two days afterward (August 16), when at the Moki Pueblo of Oraibi, a furious rain set in about 4 p. m., and lasted more than an hour, flooding the house tops and streets, and parts of the valley below. And yet the desert was as parched next day as if it had never been wet.

The heaviest and most extended rain-fall observed by us occurred September 20, on which date Mr. Bailey and I set out from Little Spring for Moencopie. Heavy leaden clouds began scurrying over the mountain toward the northeast early in the morning, and by noon the entire sky was overcast and had a most ominous appearance. Soon the rain began falling in torrents, and the storm moved steadily eastward from the edge of the lava beds to the Little Colorado, and thence across the desert to the high mesas beyond. Such a deluge I never saw, and we afterwards learned that it extended 160 kilometers (nearly 100 miles) to the south. The gulch in the edge of the lava beds, about $2\frac{1}{2}$ kilometers ($1\frac{1}{2}$ miles) east of Black Tank, was full to overflowing; the flat upon which it empties was $1\frac{1}{2}$ meters (5 feet) under water; great lakes appeared in various parts of the desert, and the Little Colorado bottom was completely flooded. And yet all this vast volume of water disappeared in a few hours. A red, sirupy, alkaline mud filled the bed of the Little Colorado for a few days, and pools of similar mud were occasionally found in depressions in the sand-rock all the way to Moencopie. The whole desert, from the San Francisco lava beds on the west to Echo Cliffs on the east, showed that it had been recently deluged, as if by the breakage of some mighty dam, but the water had disappeared.

From the scanty data available, and from the experience of residents of the region, it is safe to infer that the rain-fall was unusually heavy in the Plateau region during the summer of 1889.

PART II.—GRAND CAÑON OF THE COLORADO, BETWEEN THE KAIBAB AND COCANINI PLATEAUS.

No attempt will be made to define or describe the faunas and floras of the stupendous chasm of the Colorado. Our stay of five days permitted only a hurried reconnoissance, which serves to indicate merely in a general way the more conspicuous features of the region.

The lowest point between San Francisco Mountain and the Grand Cañon is at the end of a narrow arm of the desert near Hull Spring, where the junipers and piñon which border this tongue of desert unite and extend westward in a broad belt, completely separating the pine forest of the mountain plateau from that of the Cocanini Plateau (as shown by the areas colored yellow and green on Map 1). While the San Francisco Mountain Plateau is composed of lava, the Cocanini Plateau is carboniferous limestone. The resulting difference in soil affects the vegetation, and many plants grow in the piñon belt at the cañon which are not found in the same belt on the lava. Among such plants are *Cowania mexicana*, *Berberis fendleri*, *Spiraea millefolium*, *Robinia neomexicana*, and *Yucca baccata*. *Juniperus californicus utahensis* grows there also, but the relation of its presence to the soil is uncertain. The true sage-brush (*Artemisia tridentata*) of the Great Basin here finds its extreme southeastern limit. Large patches of it occur on the south side of the cañon, opposite Point Sublime, but it disappears altogether a few miles away.

At the brink of the cañon opposite Point Sublime, about 2 miles east of the pool or tank known as Cañon Spring, is a dwarf forest of peculiar aspect, and having a uniform height of about 5 meters. It consists of piñon (*Pinus edulis*), cedar (*Juniperus californicus utahensis*), and mountain mahogany (*Cercocarpus ledifolius**), which here equals the juniper and piñon in height and measures 100 to 200 millimeters (approximately 4 to 8 inches) in diameter. Mingled with it are numerous tall bushes of *Berberis fremonti* and the beautiful *Spiraea millefolium*. In places this Lilliputian forest merges into extensive fields of the true sage-brush (*Artemisia tridentata*) and yucca (*Yucca baccata*, which at the time of our visit was ripening its sweet, banana-like fruit), with several kinds of cactuses; while in other directions it gives place to thickets of scrub

* This identification was made in the field. No specimens of the large form were brought back, but specimens of a smaller bush from the Cañon prove to be *Cowania mexicana*.

oak (*Quercus gambeli*), with here and there a small patch of dwarf locust (*Robinia neo-mexicana*).

The Cocanini Plateau is highest on the north and rises abruptly at the very rim of the cañon. The resulting southern slope is enough warmer than the pine-covered plateau to permit the growth of juniper and piñon, which besides forming a strip along the edge of the cañon, mingle with the pines below to a limited extent. The descent into the cañon is precipitous, the walls being vertical or even overhanging for the first 300 meters (1,000 feet), so that tree growth is impossible except in favored spots. In places where the cliff is broken down or cut into by side cañons a sparse forest of conifers maintains a precarious foothold.

The Grand Cañon is about 354 kilometers (220 miles) in length, and its proportions are on too vast a scale to be comprehended by those who have not seen it. At the point visited, it is about 1,800 meters (6,000 feet) in depth and 25 kilometers (15 miles) wide at the top. It is intersected by gulches and side cañons of gigantic dimensions. It has ledges, terraces, and mesas, barren crags and grassy slopes, lofty mountains and deep valleys, cool hillsides clad in forests of balsam firs, and hot bottoms filled with sub-tropical thickets; it has arid stretches of sand bearing a scattered growth of cactus and yucca, and marshes and springs that never become dry and are hidden by the verdure of a multitude of plants requiring a moisture-laden atmosphere for their existence. Its animal life is as sharply varied and as strangely contrasted.

In descending from the plateau level to the bottom of the cañon a succession of temperature zones is encountered equivalent to those stretching from the coniferous forests of northern Canada to the cactus plains of Mexico.* They result from the combined effects of altitude and slope-exposure, the effects of the latter being here manifested in an unusual degree. Where the walls of the cañon face north or north-east the uppermost tree-zone consists of Douglas and balsam firs (*Pseudotsuga douglasii* and *Abies concolor*)—northern species which do not occur elsewhere in the cañon. Below this is a belt of pines (*Pinus ponderosa*), succeeded in turn by a belt of junipers and piñon, usually more or less mingled with pines. Immediately below the piñon belt is a zone which corresponds in the main to the Desert of the Little Colorado; but since it has humid as well as arid areas, forms of vegetation unknown on the desert interrupt its stretches of cactuses, yuccas, and greasewoods. Still lower down another zone is encountered which may be recognized by the presence of huge cactuses, arborescent opuntias, agaves whose tall stems are conspicuous land-marks, and many other plants characteristic of the Lower Colorado and Gila regions, together

* The extremes of temperature are well illustrated by the fact that the lowest temperature of the twenty-four hours at the bottom of the cañon was 80° Fahr. at 4 a. m., September 13, while at the same time thick ice formed on a bucket of water at the top of the cañon.

with sub-tropical humid forms and a certain percentage of species not found elsewhere. The complex and interacting effects of radiation and refraction, of aridity and humidity, of marked differences in temperature at places of equal altitude on opposite sides of the cañon, of every possible angle of slope exposure, and of exposure to and protection from winds and storms, produce a diversity of climatic conditions the effect of which on the animal and vegetable life of the cañon has been to bring into close proximity species characteristic of widely separated regions, and to crowd the several life zones into narrow parallel bands along the sides of the cañon—bands which expand and contract in conforming to the ever-changing surface. The same conditions modify and alter the species there present in the manner in which the evolution of new species is brought about. In short, the Grand Cañon of the Colorado is a world in itself, and a great fund of knowledge is in store for the philosophic biologist whose privilege it is to study exhaustively the problems there presented.

LIST OF MAMMALS NOTED AT THE GRAND CAÑON OF THE COLORADO,
ARIZONA, SEPTEMBER 10 TO 15, 1889.

[The new species here mentioned are described in Part III.]

Vesperugo fuscus. Large Brown Bat.

Tolerably common; a few were seen nearly every evening.

Vesperugo hesperus. Pigmy Bat.

Abundant. These bats inhabit crevices in the cliffs and begin to fly before dark in the evening, at which time swarms of them come up over the brink of the cañon and flit about among the pines and piñon.

Sciurus aberti. Abert's Squirrel.

Tolerably common in the pines; a few were found feeding on piñon nuts along the brink of the cañon.

Tamias dorsalis. Gila Chipmunk.

Common among the cliffs along the top of the cañon, but excessively shy and difficult to procure.

Spermophilus grammurus. Rock Squirrel.

Abundant among the piñon along the brink of the cañon, living in holes in the rocks.

Hesperomys leucopus sonoriensis. White-footed Mouse.

Not common; two specimens provisionally referred to this form were caught along the top of the cañon, and one was killed in the day-time in a field of sage brush (*Artemisia tridentata*).

Hesperomys eremicus. Silky Cliff Mouse.

Abundant both along the cliffs at the top of the cañon and thence down to the river below. This is the most abundant mammal of the cañon.

Hesperomys megalotis sp. nov. Leaf-eared Cliff Mouse.

A single specimen was caught in the cliffs at the brink of the cañon.

Neotoma mexicana. Wood Rat.

Common both in the cañon and along the cliffs at the top.

Thomomys fulvus. Pocket Gopher.

Tolerably common wherever there is enough suitable soil on the plateau at the top of the cañon.

Perognathus (Chætodipus) intermedius. Pocket Mouse.

Common in small colonies down in the cañon.

Lepus texianus. Jack Rabbit.

This species inhabits fields of sage-brush near the cañon, coming up from the desert of the Little Colorado.

Lepus arizonæ. Arizona Cotton-tail.

Tolerably common in the juniper and chaparral.

Cariacus macrotis. Black-tailed Deer.

Three were killed by a sheep herder near the cañon during our stay.

Antilocapra americana. Antelope.

Said to be not rare near the cañon.

Ovis canadensis. Mountain Sheep.

Tolerably common; we saw fresh signs nearly every day, and started a small herd opposite Point Sublime.

Felis concolor. Mountain Lion.

Said to be tolerably common and destructive to sheep.

Lynx baileyi sp. nov. Plateau Wildcat.

Tolerably common.

Canis latrans. Coyote,

Common; many tracks seen. The sheep herders say that they lose many lambs through the depredations of Coyotes.

Spilogale gracilis sp. nov. Little Striped Skunk.

Common both in the cañon and among the cliffs at the top.

Bassaris astuta. Ring-tailed Bassaris.

Said to be abundant in Cataract Cañon and at places in the Grand Cañon.

LIST OF BIRDS NOTED AT THE GRAND CAÑON OF THE COLORADO, ARIZONA, SEPTEMBER 10 TO 15, 1889.

Zenaidura macroura. Mourning Dove.

A few were seen in the pines and piñon.

Cathartes aura. Turkey Vulture.

Common; as many as fifteen were seen at one time sailing over the cañon, and a number were observed circling over a flock of sheep near Hull's Ranch.

Accipiter velox. Sharp-shinned Hawk.

Common; one shot.

Accipiter cooperi. Cooper's Hawk.

Common; these hawks came to the spring every morning during our stay to prey upon the small birds which came there to drink.

Buteo borealis calurus. Western Red-tail.

Common.

Aquila chrysaëtus. Golden Eagle.

One seen.

Falco sparverius. Sparrow Hawk.

Tolerably common; a male was shot whose stomach was full of grasshoppers.

Pandion haliaëtus carolinensis. Osprey; Fish Hawk.

Seen twice.

Bubo virginianus saturatus. Dusky Great Horned Owl.

Tolerably common; two came to the spring to drink about 10 o'clock the night of September 14, and after satisfying their thirst began hooting in the tall pines. One was shot as he started to fly away.

Megascops flammeolus. Flammulated Screech Owl.

I shot a single specimen of this exceedingly rare owl while climbing out of the cañon about 3 o'clock in the morning of September 13. Its stomach contained a scorpion and the remains of insects.

Dryobates villosus hyloscopus. Cabanis's Woodpecker.

A few were seen in the pines.

Sphyrapicus thyroideus. Williamson's Sapsucker.

Tolerably common; adults of both sexes were shot.

Melanerpes formicivorus bairdi. California Woodpecker.

One was shot and several others were seen in the oaks half a mile from the cañon.

Melanerpes torquatus. Lewis's Woodpecker.

Tolerably common; flocks of half a dozen to a dozen came to the spring to drink every day.

Colaptes cafer. Red-shafted Flicker.

Tolerably common.

Micropus melanoleucus. White-throated Swift.

Several were seen in the cañon, but most of them had migrated before the date of our arrival (September 10).

Trochilus platycercus. Broad-tailed Hummingbird.

Tolerably common; shot down in the cañon and seen also at the top.

Tyrannus vociferans. Cassin's King-bird.

Two were seen in the sage-brush and chaparral near the cañon, and a few in the cedars.

Sayornis saya. Say's Phoebe.

Seen in the chaparral and cedars near the cañon.

Contopus richardsonii. Western Wood Pewee.

Tolerably common.

Cyanocitta stelleri macrolopha. Long-crested Jay.

Common; feeding on piñon nuts in company with Woodhouse's and Piñon Jays.

Aphelocoma woodhousei. Woodhouse's Jay.

A few were seen in the piñon near the brink of the cañon.

Corvus corax sinuatus. Raven.

Several were seen along the cliffs at the brink of the cañon.

Cyanocephalus cyanocephalus. Piñon Jay.

Abundant in the piñon near the brink of the cañon and also in the cedar belt; generally seen in flocks of from thirty to eighty.

Carpodacus mexicanus frontalis. House Finch.

Common in small flocks, coming to the tank to drink every day.

Loxia curvirostra stricklandi. Mexican Crossbill.

Common; both sexes were shot at the tank, where they came to drink.

Spinus psaltria. Arkansas Goldfinch.

Small flocks visited the tank to drink every day.

Pooecætes gramineus confinis. Western Vesper Sparrow.

Common in all grassy places and in the sage-brush.

Zonotrichia leucophrys. White-crowned Sparrow.

Two were shot.

Spizella socialis arizonæ. Western Chipping Sparrow.

Tolerably common.

Junco cinereus dorsalis. Red-backed Junco.

Tolerably common.

Peucaea ruficeps boucardi. Boucard's Sparrow.

Common in the cañon from an altitude of 4,000 feet downward. Adults and young were shot.

Melospiza lincolni. Lincoln's Sparrow.

Two were shot, and others seen near the brink of the cañon.

Pipilo maculatus megalonyx. Spurred Towhee.

Several were seen in the scrub oak.

Pipilo chlorurus. Green-tailed Towhee.

Abundant along the brink of the cañon.

Habia melanocephala. Black-headed Grosbeak.

Tolerably common.

Piranga ludoviciana. Louisiana Tanager.

An immature bird of this species was shot in the cañon.

Tachycineta thalassina. Violet-green Swallow.

A few only were seen, most of the species having gone south.

Ampelis cedrorum. Cedar Waxwing.

A few were seen and one shot at the tank.

Lanius ludovicianus excubitorides. White-rumped Shrike.

Two were seen in the sage and chaparral near the cañon.

Vireo solitarius cassinii. Cassin's Vireo.

Two were shot.

Vireo vicinior. Gray Vireo.

One was shot in a piñon at the brink of the cañon.

Dendroica auduboni. Audubon's Warbler.

Common.

Dendroica nigrescens. Black-throated Gray Warbler.

One was shot.

Dendroica townsendi. Townsend's Warbler.

One was shot.

Geothlypis macgillivrayi. Macgillivray's Warbler.

Common in thickets down in the cañon, where two were shot. A few were seen also along the brink of the cañon.

Geothlypis trichas occidentalis. Western Yellow-throat.

One was shot low down in the cañon.

Salpinctes obsoletus. Rock Wren.

Common along the edge of the cañon.

Catherpes mexicanus conspersus. Cañon Wren.

Common in the cañon.

Sitta carolinensis aculeata. Slender-billed Nuthatch.

Tolerably common.

Sitta pygmæa. Pygmy Nuthatch.

Abundant in the pines.

Parus inornatus griseus. Gray Titmouse.

Not uncommon in the cedars and piñon.

Parus gambeli. Mountain Chickadee.

Tolerably common.

Regulus calendula. Ruby-crowned Kinglet.

Several were seen and one shot.

Polioptila cærulea. Blue-gray Gnatcatcher.

Seen in small flocks near the top of the cañon.

Merula migratoria propinqua. Western Robin.

Tolerably common.

Sialia mexicana. Western Bluebird.

Abundant at the cañon.

PART III.—ANNOTATED LIST OF MAMMALS OF THE SAN FRANCISCO MOUNTAIN PLATEAU AND DESERT OF THE LITTLE COLORADO IN ARIZONA, WITH NOTES ON THEIR VERTICAL DISTRIBUTION, AND DESCRIPTIONS OF NEW SPECIES.

By Dr. C. HART MERRIAM.

Sorex monticolus sp. nov. Mountain Shrew.

This new Shrew is common throughout the Boreal zones of San Francisco Mountain. Specimens were secured at various altitudes from the lower edge of the Douglas fir belt (altitude 2,500 meters=8,200 feet) to the upper limit of the Subalpine or timber-line zone (altitude 3,500 meters=11,500 feet), but no traces of it were found in the pines. Its nearest relative seems to be *Sorex vagrans* of the Pacific coast. It may be known from the following description:

SOREX MONTICOLUS sp. nov.

Type No. $\frac{17599}{24535}$ ♂ ad. U. S. National Museum (Department of Agriculture collection). From San Francisco Mountain, Arizona, August 28, 1889. Collected by C. Hart Merriam and Vernon Bailey. Altitude 3,500 meters (11,500 feet). (Original number, 406.)

Measurements.—Total length, 107; tail vertebrae, 45; hairs, 2; hind foot, 12.5 (measured in the flesh); ear from crown 3 (measured from the dry skin).

General characters.—This is one of the smaller Shrews. In size, length of tail, external appearance, and coloration it closely resembles *Sorex vagrans* of the Pacific coast. The tail is about as long as the body without the head.

Color.—Upper parts uniform dull sepia brown, becoming paler on the sides; under parts much lighter but without sharp line of demarcation. Tail bicolor, concolor with the body.

Cranial and dental characters.—The skull resembles closely that of *S. vagrans*, from which it differs in having the brain-case broader and more inflated. The front upper incisor has a small but distinct internal basal lobe connivent with its fellow. The first lateral unicuspid is slightly smaller than the second. The third is less than half the size of

the fourth and nearly as small as the fifth, which latter is minute but distinctly visible from the outside. (See accompanying figure.)

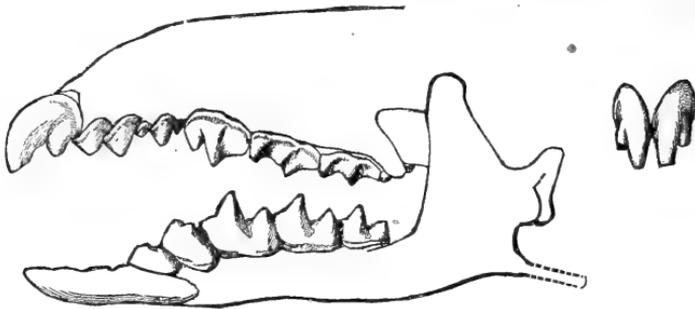


FIG. 1.—Jaws with teeth of *Sorex monticolus*.

Record of specimens collected of Sorex monticolus.

U. S. National Museum No.	Original No.	Locality.	Date.	Sex.	Total length.	Tail vertebrae.	Hind foot.	Remarks.
17999 17438	397	San Francisco Mountain, Arizona.	Aug. 22, 1889	♂ ad.	109	43 13		9,000 feet.
17999 17438	398	.....do .....	.....do	♂ ad.	109	44 13		Do.
17999 17438	406	.....do	Aug. 28, 1889	♂ ad.	107	45 12.5		11,500 feet. Type.
17999 17438	494	.....do	Sept. 19, 1889	♂ ad.	107	45 13		8,300 feet.

Vesperugo fuscus Palisot de Beauvois. Large Brown Bat.

This is the commonest Bat of the pine plateau about the base of San Francisco Mountain, where numbers were seen every evening. Six specimens were shot.

Record of specimens collected of Vesperugo fuscus.

U. S. National Museum No.	Original No.	Locality.	Date.	Sex.	Head and body.	Tail.	Head.	Ear from internal basal angle.	Tragus from inner base.	Humerus.	Fore-arm.	Thumb.	Third finger.	Fifth finger.	Tibia.	Hind foot.
18697	235	San Francisco Mountain, Ariz.	July 30, 1889	♂	60	48 21	13	5.5	29	44	8	77	57	19	11	
18698	236	.....do .....	.....do	♀	65	48 23	13.5	5.5	30	...	8.5	83	60	19	11	
18699	237	.....do .....	.....do	♂	58	51 21	14	5.5	...	48	9	83	60	...	11.5	
18700	256	.....do	Aug. 1, 1889	♂	63	48 22	13	5.5	31	48	8	79	58	19	11	
18701	257	.....do .....	.....do	♂	63	48 21.5	12.5	5	28	44	8	74	58	18	10	
18702	258	.....do .....	.....do	♂	58	42 21	12.5	5.5	...	...	8	77	...	18.5	10.5	

Vesperugo hesperus H. Allen. Pigmy Bat.

This tiny Bat is the smallest species known to inhabit the United States and is one of the most beautiful, its soft whitish fur contrasting handsomely with its black ears, lips, and wings. It was found in large numbers at Grand Falls on the Little Colorado River, and at the Grand Cañon of the Colorado along the Cocanini Plateau, and also about a small spring at the eastern foot of the great lava flow which ends about 5 miles west of Grand Falls on the desert. It spends the day hiding in crevices in the cliffs, emerging at night-fall to drink and hunt its insect prey. Its flight is so swift and zigzag that it is a very difficult species to shoot in the rapidly fading light. The young, as usual among bats, fly more slowly and steadily and are easily killed.

Record of specimens collected of Vesperugo hesperus.

U.S. National Museum No.	Locality.	Date.	Sex.	Head and body.		Tail.	Head.	Ear from internal basal angle.	Tragus from inner base.	Humerus.	Fore-arm.	Thumb.	Third finger.	Fifth finger.	Tibia.	Hind foot.
18685	Little Colorado River, Arizona.	Aug. 19, 1889	♂ ad.	36	29	14	9.5	3	19	30.5	3.5	49	35	10	6.5	
18686	do	do	♀ ad.	36	31	14	9.5	3	18.5	30	4	50	36		6.5	
18687	Grand Cañon of the Colorado, Arizona.	Sept. 10, 1889	♂	33	30	13	9	3	17.5	29	4	47	34	10	5.5	
18688	do	do	♂	33	28	13			17	27.5	3.5	43	33	10	5.5	
18689	do	do	♂	36	30	14	9	3.2	18.5	29	3.5	47.5	34	10	5	
18690	do	do	♀	40	33.5	14	9.5	3	19	30.5	3.5	50	37.5	11.5	5	
18691	do	Sept. 13, 1889	♂	35.5	29	13.5	8.75	3.2	18		3.5	47	34	10.5	5	
18692	do	do	♀	35	30	14	10	3.5	19		3.5	51	38	11.5	5.5	
18693	do	do	♂	35	31.5	14	9	3	17.5		4	50	35.5	11.5	5.5	

Vespertilio lucifugus LeConte. Common Brown Bat.

Three specimens of a small brown bat, provisionally referred to this species, were secured at Little Spring, at the north foot of San Francisco Mountain.

Record of specimens collected of Vespertilio lucifugus

U.S. National Museum No.	Original No.	Locality.	Date.	Sex.	Head and body.		Tail.	Head.	Ear from internal basal angle.	Tragus from inner base.	Humerus.	Fore-arm.	Thumb.	Third finger.	Fifth finger.	Tibia.	Hind foot.
18694	254	San Francisco Mountain, Ariz.	Aug. 1, 1889	♀	48	48	16	12	5.5	26	39	6.5	66	52	18	8	
18695	255	do	do	♂	45	41	18	12.5	5.5	25	38	8.5	63	50	16	8.5	
18696	299	do	Aug. 7, 1889	♀	49	50	16	12	5.2	25	38	6.5	63	50	18	8.5	

Vespertilio evotis H. Allen. Long-eared Bat.

A single specimen of this species was found dead near the water at Little Spring, at the north foot of San Francisco Mountain, on the morning of August 15.

Record of specimen collected of Vespertilio evotis.

U. S. National Museum No.	Original No.	Locality.	Date.	Sex.	Head and body.	Tail.	Head.	Ear from internal basal angle.	Tragus from inner base.	Humerus.	Fore-arm.	Thumb.	Third finger.	Fifth finger.	Tibia.	Hind foot.
18683	363	San Francisco Mountain, Ariz.	Aug. 15, 1889	♂	48	44	18.5	19	9.5	24.5	39	7	63	50	19	9

Vespertilio melanorhinus sp. nov. Black-nosed Bat.

While encamped at Little Spring, at the north base of San Francisco Mountain, I found a small golden-brown bat hanging head down from the inside of a trough made of a large pine log. It hung so low that its sharp, black nose almost touched the water. It proved to be an adult male of an undescribed species belonging to an unnamed section of the genus *Vespertilio*, characterized by having the upper incisors parallel as in *Kerivoula*, instead of divergent as in *Vespertilio* proper. The only other *Vespertilio* known to possess this peculiarity is *V. ciliolabrum*, a species recently described by the writer from Kansas and New Mexico.

VESPERTILIO MELANORHINUS sp. nov.

Type No. 18684, ♂ ad. (in alcohol). U. S. National Museum. (Department of Agriculture collection.) From San Francisco Mountain, Arizona, August 4, 1889. Collected by C. Hart Merriam. (Original number, 275.)

Measurements.—Head and body, 40; tail vertebræ, 43; head, 16; ear from internal basal angle, 13; tragus, from inner base, 6; humerus, 22; fore-arm, 32; thumb, 3.5; third finger, 57; fifth finger, 44; tibia, 14.5; hind foot, 7.

General characters.—Upper incisors parallel, directed inward; inner incisor slightly larger than outer, its crown bifid. First upper premolar small but with well-developed conical cusp, situated on inner side of tooth-row in contact with base of canine; second upper premolar minute, without well-developed cusp, situated on inner side of pm. 1, with which it is in contact; third premolar nearly as large as canine, molariform.

Crown of head but slightly elevated above plane of face; muzzle, narrow; naked area over nostrils small; glandular prominences between eyes and nose small and inconspicuous; sides of upper lip clothed with a dense fringe of long, straight, and rather stiff hairs, as in *V. ciliolabrum*.

Size rather small, about equaling *V. nigricans*; tail a little longer than head and body, the extreme tip projecting. Ears shorter than head, rather narrow, the tips not reaching end of nose when laid forward; anterior basal lobe angular, the horizontal and vertical borders meeting at a right angle; anterior (or inner) border of ear strongly convex on lower two-thirds, becoming straight on upper third; tip evenly rounded, with a slight posterior projection resulting from a shallow emargination, which occupies the upper half of the posterior (or outer) border; lower half of posterior border convex, with a thick lobule near the point of insertion, which is on a line with the anterior border of the tragus; tragus long and slender, directed forward and outward; upper third narrow; anterior border straight in lower two-thirds, upper third convex, tip evenly rounded; outer border with a distinct rounded lobule at base, above which it is convex on the lower two-thirds, and then rapidly becomes narrower and is sinuate and slightly concave on the upper third. Thumb very short, only about half as long as foot, and armed with a sharp and strongly curved nail. Foot of medium size; wing membranes from metatarsus at base of toes; upper surface furred only as far as a line drawn from the middle of the humerus to the knee; under surface furred to a line joining the knee and elbow. Interfemoral membrane furred above to a little beyond middle of tibia; calcaneum reaching about half way from foot to tip of tail; postcalcaneal lobule small but distinct.

Color.—Upper parts uniform dull golden-brown, except the lips and face below and in front of the eyes, which parts are abruptly black; under parts paler, palest posteriorly. Ears, face, and membranes black. Under fur everywhere blackish.

General remarks.—*Vespertilio melanorhinus* requires comparison with but one species, namely, *V. ciliolabrum*, from which it differs in having shorter ears and longer legs and tail, as well as in color and minor details of form and proportions.

Record of specimen collected of Vespertilio melanorhinus.

U. S. National Museum No.	Original No.	Locality.	Date.	Sex.	Head and body.		Ear from internal basal angle.	Tragus from inner base.	Humerus.	Fore-arm.	Thumb.	Third finger.	Fifth finger.	Tibia.	Hind foot.	Remarks.	
					Head.	Tail.											
18684	275	San Francisco Mountain, Ariz.	Aug. 4, 1889	♂ ad.	40	43	16	13	6	22	32	3.5	57	44	14.5	7	Type.

Nyctinomus brasiliensis Is. Geoff. St. Hilaire. Brazilian Free-tailed Bat.

A Free-tailed Bat which is provisionally referred to this species is very abundant along the Little Colorado River near Grand Falls, where it inhabits crevices in the sandstone cliffs. It was not observed elsewhere. Seven specimens were secured.

Record of specimens collected of Nyctinomus brasiliensis.

U. S. National Museum Number.	Original No.	Locality.	Date.	Sex.	Head and body.			Head.	Ear from base of tragus.	Tragus from inner base.	Humerus.	Forearm.	Thumb.	Third finger.			Fifth finger.	Tibia.	Foot.
					Head.	Tail.	Exserted part of tail.							Metacarpal.	First phalanx.	Second phalanx.			
18715	377	Grand Falls of Little Colorado River, Arizona.	Aug. 14, 1889	♀	58	34	15	21	14	2	43	8	41	16	15 ⁵	43	12 ⁵	10 ⁵	
18716	378	do	do	♀	59	34	11	21 ⁵	13	2 ⁵	24	44	8	43	16 ⁵	15 ¹	43	12	10 ⁵
18717	379	do	do	♀	59	36	19	21	13 ⁵	2	25	45	7 ⁵	43 ⁵	17	15 ⁵	44	12 ⁵	10 ⁵
18718	380	do	do	♀	54	...	...	20 ⁵	13 ⁵	2	24	43	7	40	15	14	37	...	10 ⁵
18719	381	do	do	♀	53	36	16	20 ⁵	14	2	23 ⁵	42 ⁵	7 ⁵	41	16 ⁵	14	42	12	11
18720	382	do	do	♂	54	33	18	20 ⁵	13 ⁵	2 ⁵	24	41	7	40	15	14	39 ⁵	12	10 ⁵
18721	383	do	do	♂	56	31	16	20 ⁵	14	2	22 ⁵	40	7	38	15	14	37	11 ⁵	10 ⁵

Sciurus fremonti mogollonensis Mearns. Red Squirrel; Chickaree.

The Red Squirrel of San Francisco Mountain inhabits the Boreal zones and is equally common, according to my observation, from the bottom of the Douglas fir belt to timber line. It is not nearly so noisy as its eastern congener, which its note suggests, though differing considerably from it. It feeds on seeds from the cones of the spruce and fir trees, and heaps containing many bushels of the scales of these cones may be found beneath the trees where it lives. Full-grown young were taken during the latter part of August. It is doubtful if the San Francisco Mountain Chickaree ever descends so low as the Piñon belt, though it may do so in winter. At all events it was not seen in the Pine belt, which separates the Douglas fir from the Piñon. The difference in altitude between the lower border of the Douglas fir, where this squirrel is common, and the upper border of the Piñon belt, is only a little more than 300 meters (about 1,000 feet), and the distance between the two zones, at the point where they come nearest together, is only about a mile (on the northeast side of the mountain—in other directions it is much greater), and yet the faunal boundaries are so sharply defined that this seemingly insignificant difference constitutes a barrier as impassable as an arm of the ocean.

Dr. E. A. Mearns has recently separated subspecifically the San Francisco Mountain Chickaree from the form inhabiting the Rocky Mountains.* The principal difference is that the former is slightly larger than the latter, with larger ears and hind feet.

* Bulletin American Museum of Natural History, Vol. II, No. 4, pp. 277-280. Separates issued February 21, 1890.

Record of specimens collected of Sciurus fremonti mogollonicus.

U. S. National Museum No.	Original No.	Locality.	Date.	Sex.	Total length.	Tail vertebrae.	Hind foot.	Remarks.
17513 17514	231	San Francisco Mountain, Arizona.	July 30, 1889	♀ ad..	345	142	54	Nursing; teats $\frac{1}{2}$.
17515 17516	248	.....do.....	July 31, 1889	♂ ad..	320	121	55	End of tail gone.
17517 17518	266	.....do.....	Aug. 2, 1889	♂ ad..	335	130	52	Do.
17519 17520	270	.....do.....	Aug. 3, 1889	♂ ad..	320	120	55	Do.
17521 17522	271	.....do.....	.....do.....	♀ ad..	340	140	54	Nursing; teats $\frac{1}{2}$.
17523 17524	272	.....do.....	.....do.....	♂ im..	304	127	52	Do.
17525 17526	359	.....do.....	Aug. 14, 1889	♀ im..	320	137	51	Do.
17527 17528	371	.....do.....	Aug. 17, 1889	♂ im..	293	129	51	Young; milk in stomach.
17529 17530	391	.....do.....	Aug. 21, 1889	♂ ad..	365	156	54	Do.
17531 17532	393	.....do.....	.....do.....	♀ im..	325	141	49	Do.
17533 17534	400	.....do.....	Aug. 22, 1889	♀ ad..	350	148	54	Lately nursing; teats $\frac{1}{2}$.
17535 17536	418	.....do.....	Aug. 28, 1889	♀ ad..	340	143	54	Do.
17537 17538	419	.....do.....	Aug. 29, 1889	♂ ad..	330	138	51	Do.
17539 17540	552	.....do.....	Sept. 29, 1889	♂ ad..	340	135	53	Do.
17541 17542	553	.....do.....	.....do.....	♀ ad..	333	142	52	Teats $\frac{1}{2}$.
17543 17544	554	.....do.....	.....do.....	♀ ad..	323	134	50	Do.
17545 17546	555	.....do.....	.....do.....	♀ ad..	335	143	52	Do.
17547 17548	564	.....do.....	Oct. 5, 1889	♀ ad..	335	137	54	Do.

Sciurus aberti Woodhouse. Abert's Squirrel.

This large and handsome Squirrel is restricted to the pine area and was not detected in a single instance either in the Douglas fir belt above, or in the piñon and cedar belt below. At the same time it undoubtedly does invade the upper part of the piñon zone when the piñon nuts are ripe. It is common everywhere in the pines, and is particularly fond of the large seeds of *Pinus flexilis*, though the smaller ones of *Pinus ponderosa* constitute the greater part of its food because of the much greater abundance of the latter tree.

It builds large covered nests of green pine branches, lined with soft grass, among the limbs of the trees, but also avails itself of holes in the trunks when suitable openings can be found. As a rule it is unwarlike and may be easily approached within short gunshot range; but when really frightened it runs swiftly over the lava rocks for a long distance before taking to a tree, often passing over the roots of many large pines in its flight. On reaching the tree of its choice, it climbs to the very top, and then, unlike any other squirrel with which I am familiar, crawls out to the small end of a branch about which it curls and remains motionless. When in this position it is exceedingly difficult to see, though considerably larger than our eastern Gray Squirrel; and even the conspicuous white under side of the bushy tail is so coiled about the body as to aid in deceiving the observer.

The long and handsome ear-tufts are shed in the spring, and the new

ones do not attain their full growth until the early part of winter; hence specimens taken in summer have naked or nearly naked ears. The young begin to appear about the middle of September and are very tame and unsuspecting. Their ear-tufts grow much more rapidly than those of the adults, or at least begin to grow earlier in the season, so that in September and October the young have much longer tufts than their parents.

Whether the species raises two litters in a season I was not able to determine, but females with udders full of milk were shot as late as the middle of September.

Abert's Squirrel was first described by Dr. S. W. Woodhouse from specimens collected by himself at San Francisco Mountain in October, 1851, when attached to the Sitgreaves Expedition.

Record of specimens collected of Sciurus aberti.

U. S. National Museum No.	Original No.	Locality.	Date.	Sex.	Total length.	Tail vertebrae.	Hind foot.
17591 14437	267	San Francisco Mountain, Arizona	Aug. 2, 1889	♀ ad..	515	230	74
17437	273	.....do	Aug. 4, 1889	♂ ad..	500	225	76
17438 14438	274	.....do .....	.....do	♂ ad..	505	224	77
17439 14439	323	.....do	Aug. 9, 1889	♀ ad..	510	230	75
17593 14439	404	.....do	Aug. 25, 1889	♂ ad..	520	240	76
17592 14438	405	.....do	Aug. 29, 1889	♂ ad..	500	220	74
17439 14438	428	.....do	Sept. 2, 1889	♂ ad..	495	238	73
17436 14436	429	.....do .....	.....do	♂ ad..	495	230	75
17437 14436	430	.....do .....	.....do	♀ ad..	500	235	77
17437 14433	439	.....do	Sept. 6, 1889	♂ ad..	445	195	73
17590 14430	462	.....do	Sept. 16, 1889	♀ im..	455	219	72
17438 14434	463	.....do .....	.....do	♂ im..	470	227	70
17436 14431	499	.....do	Sept. 19, 1889	♀ ad..	510	238	75

Tamias cinereicollis J. A. Allen. San Francisco Mountain Chipmunk.

Type No. $\frac{17597}{24533}$ ♀ ad. U. S. National Museum (Department of Agriculture collection). From San Francisco Mountain, Arizona, August 1, 1889. Collected by C. Hart Merriam and Vernon Bailey. Original number, 260.

This new species of Chipmunk, which has just been described by Dr. J. A. Allen from specimens obtained at San Francisco Mountain,* is abundant throughout the pine plateau and the Douglas fir zone, and reaches up the mountain as high as timber line. It is most common where the Douglas fir and pine overlap. Unlike many of its congeners it is a good climber and is often found hidden among the dense foliage of the balsams. It is a lively and rather noisy species, feeding chiefly on seeds of small plants, and hibernating late or not at all.

* Bull. Am. Mus. Nat. Hist., N. Y., III, No. 1, 94-96. Separates issued July, 1890.

Record of specimens collected of Tamias cinereicollis.

U. S. National Museum No.	Original No.	Locality.	Date.	Sex.	Total length.	Tail vertebrae.	Hind foot.	Remarks.
17596 24535	234	San Francisco Mountain, Arizona	July 30, 1889	♂	212	100	35	
17593 24532	246	do	July 31, 1889	♀ ad.	228	106	34	
17588 24524	247	do	do	♀ ad.	228	102	34	
17594 24530	259	do	Aug. 1, 1889	♀ ad.	242	109	36	Lately nursing; teats $\frac{1}{4}$.
17597 24533	260	do	do	♀ ad.	235	104	35	Do.
17595 24531	269	do	Aug. 3, 1889	♀ ad.	222	95	35	Nursing; teats $\frac{1}{4}$.
17589 24525	309	do	Aug. 8, 1889	♂	231	101	36	
17701 24637	346	do	Aug. 12, 1889	♀	225	105	35	
17592 24528	347	do	do	♀	218	96	35	
17585 24521	348	do	do	♂	225	101	34	
17582 24518	352	do	do	♀	213	99	35	
17591 24527	357	do	Aug. 13, 1889	♀	221	100	34	
17587 24523	358	do	Aug. 14, 1889	♂	230	106	35	
17584 24520	365	do	Aug. 16, 1889	♂ ad.	230	105	35	
17581 24517	411	do	Aug. 28, 1889	♀	220	101	35	
17590 24526	412	do	do	♀	225	101	33	
17578 24514	413	do	do	♀	230	105	34	
17580 24516	414	do	Aug. 29, 1889	♂	225	106	35	
17579 24515	415	do	Aug. 26, 1889	♀	223	101	34	
17700 24636	416	do	Aug. 28, 1889	♀	220	101	35	
17583 24513	565	do	Oct. 5, 1889	♂	215	97	33	

Tamias dorsalis Baird. Gila Chipmunk.

The Gila Chipmunk is tolerably common among the cliffs along the brink of the Grand Cañon of the Colorado on the Cocanini Plateau, but is shy and difficult to obtain. Chipmunks believed to be this species were seen at Walnut Cañon and at Turkey Tanks, but were not secured.

Record of specimens collected of Tamias dorsalis.

U. S. National Museum No.	Original No.	Locality.	Date.	Sex.	Total length.	Tail vertebrae.	Hind foot.
17871 24882	445	Grand Cañon, Arizona	Sept. 14, 1889	♀ ad.	220	100	33
17872 24883	456	do	do	♂	218	100	34

Tamias leucurus cinnamomeus subsp. nov. White-tailed Chipmunk.

This new subspecies of the Antelope Squirrel or White-tailed Chipmunk is tolerably common in suitable places throughout the Desert of the Little Colorado and the piñon belt, and is found also in the Grand Cañon of the Colorado. It was observed in greatest abundance near Moa Ave, at the south end of Echo Cliffs, and along the upper part of

Moencopie Wash. It is a rock-loving species, and was seldom seen far from cliffs or lava beds, though in a few instances it was found on the open desert. At Echo Cliffs it was feeding largely on the seeds of *Rhus aromatica trilobata*; in the piñon belt it was feeding on piñon nuts (*Pinus edulis*); and one killed on the desert had its cheek pouches filled with cactus seeds (*Opuntia* sp.?).

This form of Antelope Squirrel may be distinguished from true *Tamias leucurus* by the following description:

TAMIAS LEUCURUS CINNAMOMEUS subsp. nov.

Type No. $\frac{17987}{24898}$ ♀ ad. U. S. National Museum (Department of Agriculture collection). Echo Cliffs, Painted Desert, Arizona, September 22, 1889. Collected by C. Hart Merriam and Vernon Bailey. (Original number 510.)

Measurements.—Total length, 220; tail vertebræ, 76; hind foot, 40 (taken in flesh). Ear from crown 6 (from dry skin).

General characters.—Differs from *Tamias leucurus* in the greater length of the ears, tail, and hind feet, and in the ground color of the upper parts, which are uniform pale cinnamon, inconspicuously lined with black-tipped hairs, and slightly paler on the sides of the shoulders, rump, and legs than on the back. There is no trace of the grizzled-gray color which characterizes *T. leucurus*, particularly in winter pelage. Almost the only difference in color between the summer and winter coat is that the latter is darker and more vinaceous cinnamon. The summer pelage is short and coarse; the winter pelage long and silky. The fall moult takes place in September and October and progresses from behind forwards. Several specimens procured during the latter part of September are in the change, the new coat covering the back and rump while the old remains on the head and shoulders.

Specimens from the cedar belt are slightly darker than those from the desert.

The Antelope Squirrel and its geographic races afford striking illustrations of the exhibition of two principles of color adaptation combined in the same individual. When at rest, the animal is seldom seen, its color and markings being in complete harmony with its surroundings, in obedience to the law of *protective* coloration. But the instant it starts to run, the tail is elevated and its conspicuous white under-side is turned toward the observer, forcing itself upon the eye whether on the lookout for it or not. This is an example of what Professor Todd has termed *directive* coloration, under which head are classed colors and markings which promote mutual recognition at a distance.*

* J. E. Todd in *American Naturalist*, xxii, 1888, 201-207.

Record of specimens collected of Tamias leucurus cinnamomeus.

U. S. National Museum No.	Original No.	Locality.	Date.	Sex.	Total length.	Tail vertebre.	Hind foot.
17297 17298	510	Moa Ave, Painted Desert, Arizona.....	Sept. 22, 1889	♀	220	76	40
17298 17299	511	.....do.....	.....do.....	♂	223	71	40
17299 17300	517	.....do.....	.....do.....	♀	200	58	38
17300 17301	518	.....do.....	.....do.....	♀	208	69	39
17301 17302	519	.....do.....	.....do.....	♀	220	72	39
17302 17303	525	Moencopie, Painted Desert, Arizona.....	Sept. 24, 1889	♂	231	70	43
17303 17304	539	Little Colorado River, Arizona.....	Sept. 26, 1889	♂	210	73	38
17304 17305	540	.....do.....	.....do.....	♀	200	62	39
17305 17306	431	Piñon belt east of O'Leary Peak.....	Sept. 4, 1889	♂	220	78	39

Tamias lateralis Say. Say's Ground Squirrel.

Say's Ground Squirrel in the San Francisco Mountain country is pre-eminently characteristic of the pine belt, where it is the most abundant mammal. It extends up into the Douglas fir zone, and stragglers climb even higher on the mountain, a single individual having been found at timber line. It inhabits burrows in the ground, usually in rocky places, and does not climb trees. It has neither the grace nor agility of the arboreal squirrels (*Sciurus*) or the true Chipmunks (*Tamias* proper) but its motions, habits, and voice more nearly resemble those of the Spermophiles (*Spermophilus*) and Prairie Dogs (*Cynomys*).

Its principal food plant in August is *Frasera speciosa*, a rank herb which in general habit resembles our eastern mullein, having a large stalk 4 or 5 feet in height. The Chipmunks were often seen climbing these stalks for the purpose of feeding on the seeds. A little later they turned their attention to the ripening seed-pods of *Pentstemon barbatus torreyi*. Their manner of procedure when feeding on the seeds of this plant is peculiar and interesting. They stand erect on their hind feet, clasp the stem between their fore paws, and bite it off as high up as they can reach. Then they draw the stem past their faces, biting off each pod as it is reached, until their cheek-pouches are enormously distended. One individual which I shot in the act had thirty-nine unbroken seed-pods in its pouches. They feed also upon the seeds of many other plants, and on green herbage.

We had not been in camp a week when Say's Chipmunks began to come to pick up the crumbs that were left after each meal. Familiarity bred boldness, and we soon found them in the cook tent carrying off our meager stock of provisions. These inroads became so serious that we were obliged to kill the culprits, in spite of our admiration of their audacity, beauty, and entertaining manners. They were so numerous that several dozen had to be destroyed before the depredations ceased.

They became very fat during the latter part of August and the first

half of September, at which time they began to go into winter quarters. During hot days a few appeared until the time of our departure, the first week in October, but they were silent and did not run about much.

Record of specimens collected of Tamias lateralis.

U. S. National Museum No.	Original No.	Locality.	Date.	Sex.	Total length.	Tail vertebrae.	Hind foot.
17554 24459	232	San Francisco Mountain, Arizona	July 30, 1889	♀ ad..	267	101	40
17555 24460	233	.....do.....	.....do.....	♀ ad..	250	97	40
17557 24455	238	.....do.....	.....do.....	♀ ad..	247	65	42
17558 24456	239	.....do.....	.....do.....	♂ im..	240	90	40
17559 24457	252	.....do.....	Aug. 1, 1889	♀ ad..	280	94	42
17538 24474	253	.....do.....	.....do.....	♀ ad..	280	104	42
17522 24462	261	.....do.....	Aug. 2, 1889	♀ im..	263	102	43
17523 24463	268	.....do.....	.....do.....	♂ im..	261	97	42
17540 24470	288	.....do.....	Aug. 5, 1889	♂ im..	267	103	41
17543 24473	298	.....do.....	Aug. 7, 1889	♂ im..	260	100	43
17545 24481	306	.....do.....	Aug. 8, 1889	♂ im..	255	93	42
17528 24483	307	.....do.....	.....do.....	♂ ad..	275	97	41
17535 24485	308	.....do.....	.....do.....	♂ ad..	292	102	44
17536 24473	317	.....do.....	.....do.....	♀ im..	260	97	43
17554 24480	319	.....do.....	.....do.....	♀ im..	250	64	43
17551 24487	320	.....do.....	.....do.....	♂	270	90	43
17544 24486	321	.....do.....	.....do.....	♀	255	88	43
17537 24482	331	.....do.....	Aug. 10, 1889	♂	284	98	42
17553 24469	332	.....do.....	.....do.....	♀ ad..	300	100	43
17529 24488	333	.....do.....	.....do.....	♂ im..	270	96	42
17549 24493	334	.....do.....	.....do.....	♂ im..	242	86	38
17540 24468	335	.....do.....	.....do.....	♂ im..	270	98	43
17546 24483	336	.....do.....	.....do.....	♀ ad..	280	93	42
17547 24477	337	.....do.....	.....do.....	♀ ad..	265	88	37
17527 24473	341	.....do.....	Aug. 11, 1889	♂ ad..	285	98	41
17552 24484	342	.....do.....	.....do.....	♀ im..	262	92	42
17552 24488	343	.....do.....	Aug. 12, 1889	♂	276	86	42
17525 24481	344	.....do.....	.....do.....	♂ im..	272	76	43
17532 24489	345	.....do.....	.....do.....	♂ im..	246	89	41
17556 24492	353	.....do.....	Aug. 13, 1889	♀ ad..	273	95	41
17549 24484	354	.....do.....	.....do.....	♂ ad..	282	106	43
17550 24486	355	.....do.....	.....do.....	♂ ad..	280	106	42
17526 24482	356	.....do.....	.....do.....	♂	270	96	40
17554 24491	364	.....do.....	Aug. 16, 1889	♀ ad..	290	102	35
17522 24483	417	.....do.....	Aug. 29, 1889	♀ im..	250	100	40
17547 24483	427	.....do.....	Aug. 31, 1889	♂ ad..	266	95	43
17533 24490	562	.....do.....	Oct. 4, 1889	♂	280	96	42
17533 24470	563	.....do.....	.....do.....	♀	265	93	41

Spermophilus spilosoma pratensis subsp. nov. Park Spermophile.

The Park Spermophile inhabits the grassy openings or parks of the pine belt, where its faint chirp is often mistaken for the note of a bird. It lives in holes among the tufts of bunch-grass and iris, on whose seeds it largely subsists, in common with *Arvicola mogollonensis*, with which it is often associated. It feeds also on green herbage, various small seeds, and grasshoppers, the latter forming an important part of the contents of the stomachs examined.

The form inhabiting the north park on the main mountain-side is typical of the new subspecies, its general color being dark russet-hazel, and its spots clearly defined. Specimens from the black lava beds along the lower edge of the pine zone are still darker, exhibiting the darkest phase of coloration yet observed in the species, and are here named *Spermophilus s. obsidianus*. The form inhabiting the desert is very pale, and is here separated specifically under the name *Spermophilus cryptospilolus*, no intermediate forms having been discovered in the intervening region. In fact, the transition from the nearly black soil resulting from the decomposition of the trachyte and basalt of the lava beds to the light soil of the desert is so abrupt that there is no suitable place for intergrades to occur. Protective coloration is almost as marked in this group as in the Horned Toads (*Phrynosoma*) of the same region.

The form of Spotted Spermophile inhabiting the parks of the pine plateau region may be known from the following description :

SPERMOPHILUS SPILOSOMA PRATENSIS subsp. nov.

Type No. $\frac{17659}{24595}$ ♀ ad. U. S. National Museum (Department of Agriculture collection). Pine plateau at north foot of San Francisco Mountain, Arizona, August 5, 1889. Collected by C. Hart Merriam and Vernon Bailey. (Original number 285. Teats $\frac{5}{5}$.)

Measurements.—Total length, 197; tail vertebræ, 60; hind foot, 28 (taken in flesh). Ear from crown 2.5 (from dry skin).

Spermophilus spilosoma pratensis is somewhat larger and considerably darker than *S. spilosoma* proper. The upper parts are uniform russet-hazel, marked with numerous whitish spots from the shoulder to the base of the tail. These spots are bordered posteriorly with blackish, but are not clearly defined anteriorly or laterally. They show a tendency to arrange themselves in transverse rows. The under parts, both eyelids, and sides of the neck are soiled white. The proximal half of the tail above is colored like the back, but is mixed with yellowish and black hairs; the distal half of the tail above is black, bordered with yellowish-brown. The under surface of the tail is yellowish, with a partly concealed sub-apical border of black, and a basal band of rufous.

Record of specimens collected of *Spermophilus spilosoma pratensis*.

U. S. National Museum No.	Original No.	Locality.	Date.	Sex.	Total length.	Tail vertebræ.	Hind foot.
17661 24697	276	San Francisco Mountain, Arizona	Aug. 4, 1889	♀ im..	163	52	28
17663 24699	277	.....do.....	Aug. 5, 1889	♀ yg..	149	47	26
17671 24707	278	.....do.....	.....do.....	♀ yg..	158	52	26
17670 24696	279	.....do.....	.....do.....	♂ yg..	150	49	26
17662 24698	281	.....do.....	.....do.....	♀ yg..	171	58	27
17657 24694	282	.....do.....	.....do.....	♀ ad..	195	61	30
17695 24695	*285	.....do.....	.....do.....	♀ ad..	197	60	28
17665 24691	286	.....do.....	.....do.....	♀ yg..	166	55	26
17687 24693	287	.....do.....	.....do.....	♂ yg..	.....	55	27
17675 24611	295	.....do.....	Aug. 6, 1889	♂ im..	177	58	29
17673 24699	296	.....do.....	Aug. 7, 1889	♀ im..	170	53	26
17659 24694	300	.....do.....	.....do.....	♀ ad..	201	61	31
17666 24692	301	.....do.....	.....do.....	♀ im..	176	58	29
17669 24695	322	.....do.....	Aug. 8, 1889	♀ im..	180	60	28
	330	.....do.....	Aug. 10, 1889	♀ yg..	175	55	29
17660 24696	339	.....do.....	.....do.....	♀ yg..	171	56	26
17664 24694	340	.....do.....	.....do.....	♀ yg..	173	58	27
17664 24695	384	.....do.....	Aug. 20, 1889	♀ yg..	170	62	28
	516	.....do.....	Sept. 23, 1889	♂	195	62	31

* Type.

***Spermophilus spilosoma obsidianus* subsp. nov.** Dusky Spotted Spermophile.

The Dusky Spermophile is a dark form of the Spotted Spermophile group. It inhabits the disintegrated lava soil of the cedar belt, and its relation to *S. cryptospilotus* of the Painted Desert is precisely the same as that of *Onychomys fuliginosus* to *Onychomys pallescens*, both being striking illustrations of the law of color adaptation. Its relation to *Spermophilus spilosoma pratensis* of the parks in the pine belt is very close, and it may be regarded as a dark form of that animal. It is highly probable that the specimens here described do not represent the darkest phase of the subspecies, as they were taken in the upper edge of the cedar belt where the soil is not nearly so black as in many other places.

SPERMOPHILUS SPILOSOMA OBSIDIANUS subsp. nov.

Type No. $\frac{17674}{24610}$ ♂ ad. U. S. National Museum (Department of Agriculture collection). Cedar belt, northeast of San Francisco Mountain, October 1, 1889. Collected by Vernon Bailey. (Original number 557.)

Measurements (taken in flesh by collector).—Total length, 190; tail vertebræ, 65; hind foot, 33. External ears represented by a mere thickened rim above.

Spermophilus spilosoma obsidianus closely resembles *S. s. pratensis*, but has longer hind feet and tail, and is uniformly darker, the ground color above being dull sepia-brown instead of russet-hazel. The whitish

dorsal spots are about as distinct as in *pratensis*, and reach further forward on the nape, but their black edgings are lost in the dark ground color.

Record of specimens collected of Spermophilus spilosoma obsidianus.

U. S. National Museum No.	Original No.	Locality.	Date.	Sex.	Total length.	Tail vertebræ.	Hind foot.	Remarks.
17672 24608	326	Cedar belt, northeast of San Francisco Mountain.	Aug. 9, 1889	♂ ad..	210	68	33	
17674 24610	557	.....do.....	Oct. 1, 1889	♂ ad..	190	65	33	Type.

***Spermophilus cryptospilotus* sp. nov.** Desert Spermophile.

This new species is one of the few diurnal mammals which inhabit the hot and arid wastes of the Painted Desert, where it lives in burrows in the sand among the scattered bushes of the spiny grease wood (*Atriplex canescens*). I shot the type specimen near Tenebito Wash, about 40 kilometers (25 miles) east of the Little Colorado, August 17, 1889; and trapped several others at the foot of Echo Cliffs, in the northern part of the Desert, September 23.

It is the palest representative of the group of which *Spermophilus spilosoma* may be regarded as the central form, and its bleached, yellowish pelage is in perfect harmony with its desert surroundings. It may be known from the following description:

SPERMOPHILUS CRYPTOSPILOTUS sp. nov.

[Plate ix, figs. 1, 2, and 3: skull.]

Type No. ¹⁷⁶⁷⁶/₂₄₆₁₂ ♂ ad. U. S. National Museum (Department of Agriculture collection.) From Tenebito Wash, Painted Desert, Arizona, August 17, 1889. Collected by C. Hart Merriam.

Measurements (taken in flesh by collector).—Total length, 190; tail vertebræ, 60; hind foot, 32. Ear from crown 2 (taken from dry skin).

Spermophilus cryptospilotus is the palest known form of the *S. spilosoma* group. In the type, which is an adult male in worn summer pelage, the ground color above is uniform buffy-clay-color, without spots. When held in certain lights, faint traces of the obsolete spots may be detected. Patches of the fresh fall coat are coming in behind the ears and on the sides of the neck. The tail is colored like the back, but is more yellowish below, and has a partially concealed subterminal black band.

Another adult (No. 17678, from the foot of Echo Cliffs), a recently nursing female (with pectoral teats $\frac{1}{2}$; inguinal $\frac{2}{3}$), is in the same worn breeding pelage though killed as late as September 23. The color above is tinged with vinaceous cinnamon, and there are no traces of spots. Two others taken at the same place the same day (Nos. 17677 and 17679), and probably young of the year, though full grown, are in the

new unworn pelage and are distinctly marked with whitish spots on the rump and posterior part of the back, and the rest of the back is mixed with hoary.

Record of specimens collected of Spermophilus cryptospilotus.

U. S. National Museum No.	Original No.	Locality.	Date.	Sex.	Total length.	Tail vertebrae.	Hind foot.	Remarks.
346136 346136	374	Painted Desert, Arizona.	Aug. 17, 1889	♂ ad..	190	60	32	Type, from Tenebito Wash.
346139 346139	513	.....do	Sept. 23, 1889	♀	206	72	31.5	
346140 346140	514	.....do .....	.....do	♀	194	66	33	
346141 346141	515	.....do .....	.....do	♀ ad..	210	72	32	Teats ♀.
346142 346142	516	.....do .....	.....do	♂	195	62	31	

Spermophilus grammurus Say. Ground Squirrel or Spermophile.

The home of this Spermophile is in the piñon and cedar belt. It rarely occurs so high up as the lower edge of the pines, and still more rarely in the desert below the edge of the cedars. It is particularly abundant along the brink of the Grand Cañon of the Colorado, living in ledges and crevices among the rocks, and feeding chiefly on piñon nuts when they are to be had. Unlike Abert's Squirrel, which it nearly equals in size, it is very wary and difficult of approach. Young about two-thirds grown were found near the mouth of their holes early in September.

Record of specimens collected of Spermophilus grammurus.

U. S. National Museum No.	Original No.	Locality.	Date.	Sex.	Total length.	Tail vertebrae.	Hind foot.
346137 346137	436	San Francisco Mountain, Arizona	Sept. 5, 1889	♀ ad..	440	183	56
346138 346138	437	.....do .....	.....do	♂ ad..	478	208	59
346139 346139	457	Grand Cañon (7,500 feet), Arizona.....	.....do	♂ ad..	460	194	57
346140 346140	453	.....do .....	.....do	♀ ad..	460	198	58
346141 346141	438	San Francisco Mountain, Arizona .....	.....do	♂ im..	425	190	58
346142 346142	454	Grand Cañon (7,500 feet), Arizona.....	Sept. 14, 1889	♂ im..	405	182	59
346143 346143	455	.....do	Sept. 13, 1889	* ♂ im..	400	146	60

* Tail short.

Cynomys gunnisoni Baird. Prairie Dog. [Plate IX, figs. 5, 6, and 7: skull.]

Prairie Dogs abound throughout the Sonoran region, occurring in scattered colonies on the Little Colorado Desert and in nearly all the parks in the cedar and pine belts. A few are found as high up as the parks that penetrate the Douglas fir zone. They are abundant in the large meadow in which Fort Moroni is situated, at the west foot of San

Francisco Mountain, and are common within 2 miles from the town of Flagstaff, where I have seen dozens of them feeding in a field of ripening oats which had been ruined by their depredations. Their boldness in permitting me to approach within a stone's throw before diving into their burrows shows that no effort had been made to destroy them. As a rule they are not easily trapped, but under ordinary circumstances ranches of reasonable size may be kept clear of them by the use of bisulphide of carbon.

The San Francisco Mountain Prairie Dog is typical *gunnisoni* of Baird, and differs from the white-tailed animal from Wyoming, the latter being as yet unnamed.*

Record of specimens collected of Cynomys gunnisoni.

U. S. National Museum No.	Original No.	Locality.	Date.	Sex.	Total length.	Tail vertebrae.	Hind foot.
17688 17689 17690	324	San Francisco Mountain, Arizona.....	Aug. 9, 1889	♀ ad..	330	60	55
17691 17692	464	.....do	Sept. 16, 1889	♂ ad..	330	59	59
17693 17694	556	.....do	Oct. 1, 1889	♀ ad..	323	53	53
17695 17696	325	.....do	Aug. 9, 1889	♂ im..	320	70	58

Castor canadensis Kuhl. Beaver.

Beavers still inhabit the lower part of the Little Colorado, at least at certain times of the year, but what becomes of them when the river dries up I am unable to say. Perhaps they move down into the Grand Cañon of the Colorado, where water is always plentiful. We found Beaver cuttings at Tanner's Crossing. Woodhouse states that he found lodges on the Little Colorado, near the mouth of the Zuñi, in October, 1851; Kennerly says that in December, 1853, Beavers were "very common in many places" along the Little Colorado; and Möllhausen speaks of finding their dams on the same stream.

Onychomys fuliginosus sp. nov. Dusky Scorpion Mouse. •

This new species of Scorpion Mouse inhabits the piñon and cedar belt and the lava beds between San Francisco Mountain and the Desert of the Little Colorado, where its dark, almost blackish coloration, unique in the genus, is in as complete accord with the prevailing color of the decomposed lava and 'malpais' soil on which it lives as the pallid-cinnamon tints of its congener of the Painted Desert are with its environment. The two forms, though inhabiting adjoining areas, exhibit the extremes of color variation at present known in the genus; yet it is clear that both sprang from a common ancestor in very recent times, for the region which they inhabit was only recently (geologically speaking) rendered habitable for any member of the group. The high

* It will be described in *Fauna* No. 4, under the name *Cynomys leucurus*.

plateau on which the Desert of the Little Colorado is situated, and below the general level of which it has been excavated to the depth of 1,000 meters (about 3,000 feet) by the drainage system of the now evanescent stream whose name it bears, was formerly clad in a forest of spruce and fir, the remnants of which still cling to the mountains and buttes that rise above its level, and was too cold and moist to suit the requirements of this type, whose center of distribution is in the semi-tropical arid lands of the Sonoran fauna. Therefore the differentiation must have taken place subsequent to the invasion of the region by the parent form, the well-known laws of protective coloration operating to clothe the colonies which made their homes respectively on the light sandy desert, and in the black lava beds, with garbs which harmonize best with their distinctive surroundings. Nearly parallel cases occur in the *Spermophilus spilosoma* group, the *Perognathus flavus* group, and the *Thomomys* group inhabiting the same region. Better examples of color adaptation to environment would be hard to find.

A complete series of intergrades between *Onychomys fuliginosus* and *O. melanophrys pallescens* (the pale form inhabiting the Painted Desert) might be expected were it not for the abrupt transition from the dark lava beds to the light-colored soil of the desert. Two somewhat intermediate specimens (Nos. 17,995 and 17,996) were in fact obtained just below the edge of the lava flow a few miles east of Black Tank. Still others may be discovered, in localities not yet explored, which will connect the Scorpion Mouse of the lava beds with that of the desert. But for the present it must be accorded full specific rank.

The stomachs of the specimens collected contained scorpions and insects.

The species may be known from the following diagnosis:

ONYCHOMYS FULIGINOSUS sp. nov.

Type ¹⁷⁹⁹⁷/₂₄₉₀₈ ♀ ad. U. S. National Museum (Department of Agriculture collection.) From Black Tank lava beds, northeast of San Francisco Mountain, September 27, 1889. Collected by C. Hart Merriam and Vernon Bailey. (Original No. 547. This specimen is a very old female with the teeth worn down flat. She contained two large embryos.)

Measurements.—Total length, 160; tail vertebrae, 47; hind foot, 21.5 (taken in flesh). Ear from crown, 12.5; ear from anterior root, 16 (taken from dry skin).

General characters.—Size rather large; tail and hind feet short; ears rather large, with lanuginous tufts at base scantily developed; pelage coarser than in the *melanophrys* group.

Color.—Above, blackish slate, darkest along the middle of the back, faintly tinged with fulvous on the sides; under parts white, the hairs of the belly plumbeous at base. Tail dusky above, except the terminal fourth which is whitish like the under side; a ring of dusky surrounds the base of the tail. The color of the upper parts is more extended

than in any of the known forms. It completely covers the sides, coming down to the belly, from which it is separated by a very sharp line of demarkation; it also completely covers the posterior and outer aspects of the hind legs to the ankles, where it ends abruptly.

General remarks.—The general color of *Onychomys fuliginosus* suggests the immature pelage of *O. leucogaster*, but comparison of specimens soon dispels the illusion. The type of the present species is one of the oldest specimens of the genus that has fallen under my observation.

Record of specimens collected of Onychomys fuliginosus.

U. S. National Museum No.	Original No.	Locality.	Date.	Sex.	Total length.	Tail vertebrae.	Hind foot.	Ear from crown.	Ear from anterior base.	Remarks.
47297 47298	547	Black Tank, lava beds northeast of San Francisco Mountain, Arizona.	Sept. 27, 1889	♀ ad..	160	47	21.5	12.5	16	Type; contained two large embryos.
47292 47293	432	Cedar belt east of San Francisco Mountain, Arizona.	Sept. 5, 1889	♂ im..	152	45	21	12	16	
47293 47294	560	.....do	Oct. 4, 1889	♂ im..	145	45	21.5	12	16	
47296 47297	501	Black Tank, lava beds northeast of San Francisco Mountain, Arizona.	Sept. 21, 1889	♀ ad..	160	53	22.5	12	15.5	
47295 47296	500	.....do .....	.....do	♂ im..	135	42	22	11.5	15.5	

Onychomys melanophrys pallescens subsp. nov. Desert Scorpion Mouse.

This form of *Onychomys* inhabits the Painted Desert and the high mesa on which the Moki pueblos stand.

Like its congeners it is carnivorous, feeding principally on insects and scorpions. The stomachs of all of the specimens procured contained scorpions, and many were distended with them to the exclusion of other food. One contained the hair and flesh of a mouse. The species was very troublesome because of its habit of preying upon the small mammals found in our traps. It may be known by the following diagnosis:

ONYCHOMYS MELANOPHRYS PALLESCENS subsp. nov.

Type No. $\frac{4252}{4983}$ ♂ ad. Merriam Collection. Moki Pueblos, Apache County, Arizona, May 18, 1888.

Measurements of type (from dry skin, apparently somewhat over-stuffed).—Total length, 168; head and body, 125; tail, 45; hind foot, 22; ear from crown, 12; from anterior root, 16.5.

General characters.—Size large, exceeded only by *O. longipes* of Concho County, Texas; ears, feet, and tail much as in *O. melanophrys*; fur

full, long, and soft; orbital ring absent or inconspicuous; lanuginous tuft at base of ear well developed.

Color.—Above, pale tawny-cinnamon, palest anteriorly, and brightest on the flanks and rump; not noticeably mixed with black-tipped hairs. Below, pure white to roots of hairs.

General remarks.—*Onychomys melanophrys pallescens* differs from *O. melanophrys* in its somewhat larger size and decidedly paler coloration. An adult female from the Moki villages agrees in all respects with the type. An adult female (No. 17998) from Echo Cliffs, near the north end of the desert, is somewhat smaller and the colors are slightly deeper. A young adult male (No. 18002) from a gulch a few miles north of Moencopie, has a longer hind foot (measuring 24 millimeters), and the upper parts are clay-colored, faintly washed with tawny, particularly on the flanks. Three young from Echo Cliffs have the upper parts clear gray, slightly mixed with black-tipped hairs, and in one of them (No. 17999) the fur of the belly is plumbeous at base.

Record of specimens collected of Onychomys melanophrys pallescens.

U. S. National Museum No.	Original No.	Locality.	Date.	Sex.	Total length.	Tail vertebrae.	Hind foot.	Ear from crown.	Ear from anterior base.
24999	528	Painted Desert, Arizona	Sept. 25, 1889	♀ ad..	150	46	21.5	12	15.5
24998	520	.....do	Sept. 24, 1889	♂ ad..	160	49	24	12	16
24997	530	.....do	Sept. 25, 1889	♂ im..	142	47	23	12	15
24996	531	.....do .....	.....do	♀ juv.	123	38	21	12	15.5
24995	532	.....do .....	.....do	♂ juv.	123	38	20.5	12	15.5

Hesperomys eremicus Baird. Silky Cliff Mouse.

Hesperomys eremicus was described by Baird in 1857 from specimens collected at Fort Yuma on the Lower Colorado. It is a rock-loving species and usually makes its home in cliffs or ledges in the desert. Following up the Colorado River it passes through the Grand Cañon and enters the Desert of the Little Colorado. Specimens were secured along the sandstone cliffs that border the latter stream, and also at Echo Cliffs. In the Grand Cañon it is excessively abundant, outnumbering all the other mammals collectively, and proving a nuisance to the trapper by constantly getting into traps set for Pocket Mice and other more desirable species.

During the two nights spent in the cañon these mice came about my blankets in great numbers and I was forced to place my scanty stock of provisions in a small tree for protection; but even there it was not safe, for the mice are excellent climbers, and I shot one by moonlight as it peered down at me from a low branch,

Record of specimens collected of Hesperomys eremicus.

U. S. National Museum No.	Original No.	Locality.	Date.	Sex.	Total length.	Tail vertebrae.	Hind foot.
17224 24334	443	Grand Cañon, Arizona	Sept. 15, 1889	♂ ad..	200	109	23
17226 24336	470	.....do.....	Sept. 11, 1889	♂ ad..	166	72	22
17228 24338	472	.....do.....	.....do.....	* ♀ ad..	195	100	23
17232 24342	477	.....do.....	Sept. 12, 1889	♀ ad..	178	98	22.5
17234 24344	479	.....do.....	.....do.....	♀ ad..	190	103	20.5
17236 24346	482	.....do.....	.....do.....	♂ ad..	174	91	20
17238 24348	485	.....do.....	.....do.....	♂ ad..	185	101	20.5
17240 24350	486	.....do.....	.....do.....	♀ ad..	182	100	20.5
17258 24368	487	.....do.....	.....do.....	♂ ad..	176	95	
17262 24372	488	.....do.....	.....do.....	♀ ad..	185	105	20
18058	489	.....do.....	.....do.....	♀ ad..	175	97	20
17260 24370	490	.....do.....	Sept. 14, 1889	♂ ad..	194	106	24
17264 24374	444	.....do.....	Sept. 15, 1889	♂ ad..	172	96	21
17266 24376	445	.....do.....	Sept. 15, 1889	♀ im..	185	103	22
17267 24377	471	.....do.....	Sept. 11, 1889	♂ im..	172	99	22
17268 24378	473	.....do.....	.....do.....	♀ im..	172	96	22
17229 24337	478	.....do.....	Sept. 12, 1889	♀ im..	182	100	20
17265 24375	480	.....do.....	.....do.....	♀ im..	180	98	21
17270 24380	481	.....do.....	.....do.....	♀ im..	190	106	22
17277 24387	483	.....do.....	.....do.....	♂ im..	173	98	21
17235 24345	491	.....do.....	Sept. 14, 1889	♀ im..	178	100	21.5
17252 24362	492	.....do.....	.....do.....	♀ im..	171	96	21
17269 24379	441	.....do.....	Sept. 15, 1889	♀ im..	167	85	22
17265 24375	474	.....do.....	Sept. 11, 1889	♀ im..	162	91	21
17266 24377	475	.....do.....	.....do.....	♂ im..	170	95	21
17268 24379	476	.....do.....	.....do.....	♂ im..	167	92	21
17266 24377	484	.....do.....	Sept. 12, 1889	♂ im..	160	93	19
17237 24347	507	Painted Desert, Arizona	Sept. 22, 1889	♂ ad..	178	98	22
17238 24348	533	.....do.....	Sept. 26, 1889	♂ ad..	196	106	23
17239 24349	534	.....do.....	.....do.....	♂ ad..	175	95	21.5
17240 24350	536	.....do.....	.....do.....	♂ ad..	181	103	21
17239 24349	535	.....do.....	.....do.....	♀ ad..	195	103	22
17233 24343	508	.....do.....	Sept. 22, 1889	♀ juv.	168	82	22
17234 24344	537	.....do.....	Sept. 26, 1889	♀ im..	160	87	21.5

* Teats 3.

Hesperomys megalotis sp. nov. Leaf-eared Cliff-Mouse.

This huge-eared Mouse was found at two places only: the Grand Cañon of the Colorado and the Desert of the Little Colorado. In the latter locality it inhabits the ruins of ancient cave dwellings in the side of a lava flow about a mile east of Black Tank. Specimens of the same or a closely related form were collected by Mr. Bailey at Moccasin Spring, Arizona, near the boundary line between Arizona and Utah, in December, 1888.

HESPEROMYS MEGALOTIS sp. nov.

[Skull, plate IV; teeth, plate III, figs 1, 2, 3, and 4.]

Type No. $\frac{17943}{24854}$ ♂ ad. U. S. National Museum (Department of Agriculture collection). From Black Tank, Desert of the Little Colorado, Arizona, September 21, 1889. Collected by C. Hart Merriam (original number 502).

Measurements.—Total length 200; tail vertebrae 108; pencil 10; hind foot 24 (taken in flesh). Ear from crown 21; ear from anterior notch 25 (taken from dry skin).

General characters.—Size large; ears enormous; tail long and sharply bicolor, with a long pencil.

Color.—Upper parts yellowish-brown, strongly suffused with reddish-brown [other specimens lack this suffusion], sides washed with tawny-salmon; ears, narrow ring round eye, and upper surface of tail dusky. Under parts including feet, white; a salmon suffusion across breast.

General remarks.—*Hesperomys megalotis* requires comparison with but one species, namely, *H. truei* from Fort Wingate, N. Mex. Through the kindness of Mr. F. W. True, Curator of Mammals in the National Museum, I have the type of *H. truei* before me. Its ears, hind feet, and tail are shorter than those of *H. megalotis*; its skull is broader and flatter, and the notch between the condyle and angle of the jaw is much deeper. Unfortunately the teeth of *H. truei* are worn down to the gums and show no characters. The hind foot of *H. truei* measures 21^{mm}, while in the smallest of four specimens of *H. megalotis* it measures 23^{mm}. Shufeldt records the length of the tail vertebrae as 82^{mm}. in *H. truei*; the shortest perfect tail in four specimens of *H. megalotis* measured 103^{mm}, a difference of 21^{mm}., or a little more than 20 per cent.

Record of specimens collected of Hesperomys megalotis.

U. S. National Museum No.	Original No.	Locality.	Date.	Sex.	Total length.	Tail vertebrae.	Hind foot.
$\frac{17943}{24854}$	469	Grand Cañon, Arizona.....	Sept. 11, 1889	♀ ad..	195	103	24
$\frac{17943}{24854}$	*502	Black Tank, in Desert northeast of San Francisco Mountain, Arizona.	Sept. 21, 1889	♂ ad..	200	108	24
$\frac{17943}{24854}$	541	.....do.....	Sept. 27, 1889	♀	210	112	23
$\frac{17943}{24854}$	545	.....do.....	.....do.....	♂.....	178	†83	23

*Type.

† Tail broken.

Hesperomys leucopus rufinus subsp. nov. White-footed Mouse.

The White-footed Mouse of San Francisco Mountain abounds in the open parks as well as in the forests, and extends up the mountain to or beyond the upper limit of tree growth. As in most other parts of

North America it is a constant annoyance to the trapper, getting into all kinds of traps set for other small animals, particularly Arvicolas, Shrews, and Spotted Spermophiles. As a rule, traps must be kept in one place long enough to catch most of the White-footed Mice of the immediate vicinity before much success can be expected with other species. This is due in part to the abundance of these Mice, and in part to the fact that they take all kinds of bait—bread, cheese, corn-meal, oatmeal, and flesh, particularly birds' heads, a favorite bait for Shrews. They are chiefly nocturnal, but are sometimes caught in the day-time. Seeds of small plants and remains of grasshoppers were found in most of the stomachs examined.

The new form may be known from the following description :

HESPEROMYS LEUCOPUS RUFINUS subsp. nov.

[Teeth, plate III, figs. 5, 6, 7, and 8.]

Type No. $\frac{17646}{24582}$ ♀ ad. U. S. National Museum. From San Francisco Mountain, Arizona (altitude 9,000 feet), August 22, 1889. Collected by C. Hart Merriam and Vernon Bailey (original No. 401; contained 7 embryos; teats, $\frac{3}{3}$.)

Measurements.—Total length, 168; tail vertebræ, 69; pencil, 5; hind foot, 19 (taken in the flesh); ear from crown, 13; ear from anterior notch, 18 (taken from dry skin.)

General characters.—Similar to *H. leucopus*, but with somewhat larger and broader ears and much shorter tail. There is a lanuginous tuft at anterior base of ears, of which hardly a trace exists in *H. leucopus*. The hallux ends opposite the base of the second toe, while in *H. leucopus* it passes beyond this point.

Color.—Upper parts, deep tawny brown, darkest along the middle of the back, and brightest along the sides, the body color reaching to the elbows and heels; under parts, including feet, white; tail, sharply bi-color, dusky above, whitish below; ears, dark.

Cranial characters.—The zygomatic arches are much broader anteriorly than in *H. leucopus*, and the incisive foramina extend further backward, reaching the plane of the first molar. The most marked cranial character is the shape of the zygomatic arches; anteriorly they stand out from the skull with a distinct 'elbow' at the bend, and in some specimens are actually broader in front than behind, while in *H. leucopus* they are very much narrower anteriorly than posteriorly.

General remarks.—I have compared the San Francisco Mountain White-footed Mouse with nearly a thousand specimens from various parts of North America, and find that it most closely resembles the form inhabiting the Adirondack region in northern New York. The difference in length of tail, however, is great, and the cranial differences are those above mentioned.

Record of specimens collected of Hesperomys leucopus rufinus.

U. S. National Museum No.	Original No.	Locality.	Date.	Sex.	Total length.	Tail vertebrae.	Hind foot.
176033 176034	240	San Francisco Mountain, Arizona.....	July 31, 1889	♂ ad..	157	67	21
176041 176040	241	.....do.....	.....do.....	♂ ad..	160	71	21
176044 176043	249	.....do.....	Aug. 1, 1889	♀ ad..	167	70	20
176033 176032	250	.....do.....	.....do.....	♂ ad..	161	74	19
176041 176037	262	.....do.....	Aug. 2, 1889	♂ ad..	168	75	21
176039 176038	289	.....do.....	Aug. 6, 1889	♀ ad..	155	66	19
18057	290	.....do.....	.....do.....	♀ ad..	163	70	20
176040 176036	291	.....do.....	.....do.....	♂ ad..	150	61	19+
176038 176037	297	.....do.....	Aug. 7, 1889	♂ ad..	170	75	21
176043 176042	310	.....do.....	Aug. 8, 1889	♂ ad..	160	66	21
176040 176035	314	.....do.....	.....do.....	♂ ad..	153	64	20
176039 176038	315	.....do.....	.....do.....	♂ ad..	159	69	20
176052 176051	329	.....do.....	Aug. 10, 1889	♂ ad..	151	56	19
176046 176045	*401	.....do.....	Aug. 22, 1889	♀ ad..	168	69	19
176050 176049	425	.....do.....	Aug. 30, 1889	♀ ad..	168	66	20
176047 176046	426	.....do.....	.....do.....	♂ ad..	152	65	20
176050 176049	242	.....do.....	July 31, 1889	♂ im..	125	58	20
176053 176052	263	.....do.....	Aug. 2, 1889	♂ im..	152	65	20
176051 176050	265	.....do.....	.....do.....	♂ im..	150	68	20
176049 176048	292	.....do.....	Aug. 6, 1889	♂ im..	142	61	20
176051 176050	293	.....do.....	.....do.....	♀ im..	140	58	20
176050 176049	316	.....do.....	Aug. 8, 1889	♂ im..	121	44	19
176053 176052	410	.....do.....	Aug. 27, 1889	♂ im..	112	47	19
176054 176053	420	.....do.....	Aug. 29, 1889	♂ im..	155	66	20

*Type.

Hesperomys leucopus sonoriensis Le Conte. Desert White-footed Mouse.

This subspecies inhabits the Painted Desert. Several immature specimens from the edge of the lava beds near Black Tank, and one from the Grand Cañon of the Colorado, are here provisionally catalogued under this name though too young to show positive characters. These are Nos. 17926, 17932, 17942, 17945, 17946, 17947, 17948.

Record of specimens collected of Hesperomys leucopus sonoriensis.

U. S. National Museum No.	Original No.	Locality.	Date.	Sex.	Total length.	Tail vertebrae.	Hind foot.
18054	521	Painted Desert, Arizona.....	Sept. 24, 1889	♂ im..	160	70	20
17931 17930	529	.....do.....	Sept. 25, 1889	♀ ad..	156	67	20
17945 17944	542	.....do.....	.....do.....	♂	160	75	20
17933 17932	543	.....do.....	Sept. 27, 1889	♂	156	68	20
17943 17942	546	.....do.....	.....do.....	♂	152	61	20
17929 17928	526	.....do.....	Sept. 25, 1889	♂	146	61	19.5
17931 17930	527	.....do.....	.....do.....	♀	136	56	18
17948 17947	544	.....do.....	Sept. 27, 1889	♂	136	56	19
17947 17946	548	.....do.....	.....do.....	♂	148	62	20.5
17948 17947	549	.....do.....	.....do.....	♀	144	60	19.5
17929 17928	442	Grand Cañon, Arizona.....	Sept. 15, 1889	♂	146	63	19.5

Neotoma mexicana Baird. Round-tailed Wood Rat. [Skull, plate X, figs. 5, 6, 7, and 8.]

This Wood Rat is abundant throughout the pine area, where it makes its nests in the crevices of rocky ledges. Bulky nests of sticks were found on the ground in the cedar and piñon zone, and also in the ancient cave dwellings of the Indians in the volcanic craters and lava flows below the mountain and in the desert. Cactus spines in large quantities form an important element in and about these nests, and doubtless serve as a protection against Coyotes and Skunks. Whether or not the different kinds of nests are made by the same species I am unable to say. Wood Rats are abundant in the Grand Cañon of the Colorado, where specimens were captured along the cliff at the top of the cañon and also near the bottom.

Record of specimens collected of Neotoma mexicana.

U. S. National Museum No.	Original No.	Locality.	Date.	Sex.	Total length.	Tail vertebrae.	Hand foot.
17692	366	San Francisco, Mountain, Arizona.....	Aug. 16, 1889	♀ ad..	355	163	37
17693	367	.....do.....	.....do.....	♀ ad..	347	161	37
17697	372	.....do.....	Aug. 17, 1889	♂ ad..	383	176	37
17698	373	.....do.....	.....do.....	♂ ad..	363	164	36
17699	561	.....do.....	Oct. 4, 1889	♂ ad..	345	160	37
17700	361	.....do.....	Aug. 15, 1889	♀ im..	265	125	34
17701	440	.....do.....	Sept. 16, 1889	*♂ im..	130	48	215
17702	558	.....do.....	Oct. 2, 1889	♀ im..	305	146	36
17703	447	Grand Cañon, Arizona.....	Sept. 15, 1889	♀ ad..	340	157	36
17704	449	.....do.....	.....do.....	♀ ad..	340	162	36
17705	450	.....do.....	.....do.....	♀ ad..	330	154	35
17706	453	.....do.....	Sept. 14, 1889	♀ ad..	325	152	36
17707	448	.....do.....	Sept. 15, 1889	♀ im..	320	150	34

* Very young.

Arvicola alticolus sp. nov. Mountain Vole.

This new species occupies higher altitudes and moister situations than *A. mogollonensis*, the only other Vole known to inhabit the region. It is common along the borders of the higher parks, and in the moist meadows at and just above timber line on San Francisco Mountain, and ranges down to the lower part of the Douglas fir zone, where several specimens were caught at the point where Little Spring comes out of the ground. Thus its vertical range is from 2,500 to 3,500 meters (8,200 to 11,500 feet). Its runways were noticed in great abundance in a moist park on the summit of Kendrick Peak. At timber line, on San Francisco Mountain, it feeds extensively on seeds of *Primula parryi*.

The species may be known from the following description:

ARVICOLA (MYNOMES) ALTICOLUS sp. nov.

[Skull, plate V, figs. 1 and 2; teeth, plate VI, figs. 1, 2, 3, and 4.]

Type No. ¹⁷⁶¹⁵/₂₄₅₅₁ ♀ ad. U. S. National Museum (Department of Agriculture collection). From Little Spring (altitude 2,500 meters = 8,200 feet), San Francisco Mountain, Arizona, July 31, 1889. Contained 6

embryos; teats $\frac{4}{4}$. Collected by C. Hart Merriam and Vernon Bailey. (Original number 243.)

Measurements.—Total length, 170; tail vertebræ, 56; hairs, 8; hind foot, 20 (taken in flesh). Ear from crown, 8; from anterior root, 14 (taken from dry skin).

General characters.—Size medium or rather large; ears large, projecting nearly 4 millimeters above the fur; antitragus small, hardly half as large as in *A. longicaudus*; hind feet of medium length; tail long but shorter than in *A. longicaudus*.

Color.—Upper parts dark bister, suffused with pale reddish-brown, and conspicuously lined with black; under parts hoary plumbeous, the line of demarkation distinct but not sharp. Tail bicolor; dark brown above, darkest near the tip; grayish brown below.

Cranial characters.—Skull large and rather narrow across the zygomatic arches; rostral portion long; incisive foramina about twice as long as premaxillary symphysis; nasals ending posteriorly nearly on a line with the ends of premaxillaries and terminating in a rounded or pointed extremity [this character does not hold in the young]; nasals not strongly decurved; jugals not expanding into a vertical plate or lamella; zygomatic arches spreading posteriorly; outer border of parietals convergent anteriorly.

Dental characters.—The dental characters of this species are those of the western division of the section or subgenus *Mynomes* of Rafinesque—the western species, as a rule, lacking the postero-internal loop or triangle of the middle upper molar, which is a conspicuous character in the eastern *A. riparius*.

General remarks.—*Arvicola alticolus* is nearly related to *A. longicaudus* from the Black Hills of Dakota. It differs from *A. mogollonensis*, the only other species known to inhabit the mountains of northern Arizona, in many particulars, which for convenience of reference have been arranged antithetically in tabular form as follows:

Distinctive diagnoses of Arvicola alticolus and A. mogollonensis.

	<i>A. mogollonensis.</i>	<i>A. alticolus.</i>
Total length.....	Less than 140 ^{mm}	More than 170 ^{mm} .
Tail vertebræ.....	Less than 32 ^{mm} *.....	More than 50 ^{mm} .
Hind foot.....	18 ^{mm}	20 ^{mm} .
Ratio of zygomatic breadth to basilar length of skull.....	About 68.....	About 62.
Incisive foramina.....	But little longer than premaxillary symphysis.	About twice as long as premaxillary symphysis.
Jugal bone.....	Expanding into a vertical plate or lamella.	Not expanding into a vertical plate or lamella.
Zygomatic arches.....	Widest anteriorly.....	Widest posteriorly.
Nasals ending posteriorly.....	Far short of premaxillaries..	Nearly on a line with premaxillaries.
Posterior ends of nasals.....	Emarginate.....	Rounded or pointed.
Nasals.....	Strongly deflexed.....	Not strongly deflexed.
Outer borders of parietals.....	Parallel anteriorly.....	Convergent anteriorly.

* Thirty-two millimeters is the maximum measurement of tail in fifteen specimens of *A. mogollonensis*.

Record of specimens collected of Arvicola alticolus.

U. S. National Museum No.	Original No.	Locality.	Date.	Sex.	Total length.	Tail vertebrae.	Hind foot.	Remarks.
34835	243	San Francisco Mountain, Arizona.	July 31, 1889	♀	170	56	20	Type. Contained six embryos.
34813	251	.....do	Aug. 1, 1889	♀	170	55	20	Adult.
34816	409	.....do	Aug. 29, 1889	♀	193	53	20	Contained five embryos.
34803	422	.....do	Aug. 30, 1889	♂	182	55	20	Adult.
34814	495	.....do	Sept. 19, 1889	♂	175	62	20	Do.
34819	403	.....do	Aug. 23, 1889	♀	148	47	20	Immature.
34819	407	.....do	Aug. 29, 1889	♂	123	36	19	Do.
34817	408	.....do	Aug. 28, 1889	♂	157	52	21	Do.
34813	423	.....do	Aug. 30, 1889	♀	123	39	19	Do.
34818	424	.....do .....	.....do	♀	120	38	19	Do.
34823	496	.....do	Sept. 19, 1889	♂	122	41	19	Do.
34823	497	.....do .....	.....do	♂	121	37	19	Do.
34826	498	.....do .....	.....do	♂	123	39	19	Do.

Arvicola mogollonensis Mearns. Mogollon Vole.

This species, which has been recently named by Dr. Mearns* from an immature specimen collected at Baker Butte, on the Mogollon Mesa in central Arizona, inhabits the parks in the pine belt of San Francisco Mountain, but was not found at a greater altitude than 2,500 meters (8,200 feet). It lives in small colonies, with well-beaten paths or runways between the various burrows, and feeds principally on the seeds of *Artemisia wrightii* and related species, and also upon those of the blue iris (*Iris missouriensis*), and the stems of various grasses.

Dr. Mearns named the species from a young individual with a broken skull, but did not point out any characters by which it can be distinguished from other members of the genus. Through the courtesy of Dr. J. A. Allen, Curator of Mammals in the American Museum of Natural History, New York, I have had the opportunity of examining the type and comparing it with my series of the same species from San Francisco Mountain.† In order that the species may be recognized by future students of the group, I have prepared the following description, based on fifteen specimens collected at San Francisco Mountain, Arizona:

Arvicola mogollonensis Mearns.

[Skull, plate V, figs. 3 and 4; teeth, plate VI, figs. 5, 6, 7, and 8.]

(This species belongs to the western division of the subgenus *Myonomes*.)

Measurements.—Total length, 125 to 140; tail vertebrae, 24 to 32; hairs, 5; hind foot, 18 (taken in flesh). Ear from crown, 5.5; from anterior base, 11 (taken from dry skin).

*Bull. Am. Mus. Nat. Hist. New York, II, 4, 283. Author's separates published February 21, 1890.

†San Francisco Mountain is about 96 kilometers (60 miles) north of Baker Butte.

General characters.—Size small; tail and hind feet very short; hind feet broad and hairy; ears moderate, not concealed by fur; antitragus of medium or rather large size; pelage long and soft, not “short and hispid” as stated by Dr. Mearns.

Color.—Upper parts uniform light bister, strongly and uniformly suffused with pale reddish-brown, with no tendency to become darker along the middle of the back, and not conspicuously mixed with black tipped hairs; under parts uniform dark plumbeous overlaid with hoary, due to the whitish tips of the hairs. Tail indistinctly bicolor: above, concolor with the back; below somewhat lighter.

Cranial characters.—Skull short and broad; zygomatic arches widest anteriorly or with sides parallel; rostrum short; incisive foramina not more than one-half longer than premaxillary symphysis; nasals abruptly deflexed, emarginate posteriorly, and falling far short of premaxillaries; jugals expanding anteriorly into a vertical plate or lamella the lower part of which embraces the end of the zygomatic process of the maxillary; outer borders of parietals parallel anteriorly.

Dental characters.—The dental characters of *Arvicola mogollonensis* are those of the subgenus *Mynomes*. The postero-internal loop of the middle upper molar is generally wanting, as usual in western *Arvicolæ*, but in one specimen it is present (No. 24563). The last upper molar commonly has three re-entrant angles on its inner face, but sometimes has four owing to an extra fold on the posterior crescent. The front lower molar usually has two and sometimes three closed triangles on the inner side. The range of variation is well shown in the accompanying figures (see pl. VI, figs. 5–8).

An antithetical diagnosis of *A. mogollonensis* as compared with *A. alticolus* has been given under the head of the latter species.

Record of specimens collected of Arvicola mogollonensis.

U. S. National Museum No.	Original No.	Locality.	Date.	Sex.	Total length.	Tail vertebrae.	Hind foot.	Remarks.
34622 24622	283	San Francisco Mountain, Arizona.	Aug. 5, 1889	♀	139	32	18	Contained three embryos.
34623	284	.....do.....	.....do.....	♀	127	28	17	Nearly full grown.
34624 24624	294	.....do.....	Aug. 6, 1889	♂	130	27	18	Old.
34627 24627	302	.....do.....	Aug. 7, 1889	♂	130	30	18	Do.
34628 24628	303	.....do.....	.....do.....	♀	136	29	18	Contained three embryos.
34631 24631	304	.....do.....	.....do.....	♂	126	28	17	bryos.
34635 24635	305	.....do.....	.....do.....	♂	133	30	18	Adult.
34629 24629	311	.....do.....	Aug. 8, 1889	♂	127	24	18	Do.
34630 24630	312	.....do.....	.....do.....	♂	128	26	16	
34633 24633	313	.....do.....	.....do.....	♀	128	27	16	
34625 24625	327	.....do.....	Aug. 10, 1889	♀	120	26	18	
34625 24625	328	.....do.....	.....do.....	♀	135	28	18	
34619 24619	392	.....do.....	Aug. 21, 1889	♂	123	26	18	Do.
34612 24612	399	.....do.....	Aug. 22, 1889	♂	128	26	18	
34624 24624	338	.....do.....	Aug. 10, 1889	♂	135	31	18	Do.

Thomomys fulvus Woodhouse. Woodhouse's Pocket Gopher.

This species was first described by Woodhouse from specimens procured at San Francisco Mountain in October, 1851. It is very abundant throughout the pine belt, and occurs also in suitable places all the way up the side of the mountain to timber line.

Record of specimens collected of Thomomys fulvus.

U. S. National Museum No.	Original No.	Locality.	Date.	Sex.	Total length.	Tail vertebrae.	Hind foot.
347554	245	San Francisco Mountain, Arizona	July 31, 1889	♂ ad..	222	70	30
347555	349	.....do.....	Aug. 12, 1889	♂ ad..	203	64	28
347556	350	.....do.....	.....do.....	♀ ad..	210	73	29
347557	351	.....do.....	Aug. 13, 1889	♂ ad..	215	71	30
347558	362	.....do.....	Aug. 15, 1889	♂ ad..	231	74	30
347559	385	.....do.....	Aug. 21, 1889	♀ ad..	220	75	34
347560	386	.....do.....	.....do.....	♂ ad..	210	70	30
347561	387	.....do.....	.....do.....	♀ ad..	210	65	30
347562	395	.....do.....	Aug. 22, 1889	♀ ad..	205	60	28
347563	402	.....do.....	Aug. 23, 1889	♂ ad..	217	64	30
347564	421	.....do.....	Aug. 29, 1889	♂ ad..	187	62	27
347565	244	.....do.....	July 31, 1889	♀ im..	216	65	29
347566	318	.....do.....	Aug. 8, 1889	im..	178	59	29
347567	388	.....do.....	Aug. 21, 1889	♀ im..	194	65	28
347568	389	.....do.....	.....do.....	♀ im..	178	57	27
347569	390	.....do.....	.....do.....	♀ im..	190	56	26
347570	394	.....do.....	Aug. 22, 1889	♀ im..	205	67	30
347571	396	.....do.....	.....do.....	♀ im..	193	64	28
347572	493	Grand Cañon, Arizona	Sept. 14, 1889	♂ im..	170	52	25

Thomomys perpallidus Merriam. Desert Pocket Gopher.

This pallid form of Pocket Gopher occurs in isolated colonies in the Painted Desert. Specimens collected in the sand flats bordering the Little Colorado are almost as pale as the type, which came from the Colorado Desert in southern California, except that the tips of the hairs of the back, occiput, and sides of the face are strongly marked with tawny clay-color.

Record of specimen collected of Thomomys perpallidus.

U. S. National Museum No.	Original No.	Locality.	Date.	Sex.	Total length.	Tail vertebrae.	Hind foot.
34993	504	Painted Desert, Arizona	Sept. 22, 1889	♂	232	79	33

Dipodops longipes gen. et sp. nov. Moki Kangaroo Rat.

This new Kangaroo Rat is common throughout the Desert of the Little Colorado, but was not found elsewhere. Like its relatives, it lives

in burrows in the sand, which are usually closed in the day-time. Mr. Bailey long ago made the discovery that the holes of most species of this group may be recognized at a glance from the fact that they are never dug straight down on a level plain, but are made in a side hill or sand bank so that the entrance is nearly horizontal, and as a rule there is a little mound of sand at the mouth of the burrow, which the animal throws out for the purpose of closing the hole for the day.

The American Kangaroo Rats fall naturally into two groups of generic value, one possessing four toes on the hind foot, the other five. The type of the genus *Dipodomys* (*D. phillipsi*, from Real del Monte, Mexico, described by Gray in 1841) has four hind toes; hence the generic name *Dipodomys* must be restricted to the four-toed species. The first five-toed species described is *D. agilis* (from Los Angeles, California, named by Gambel in 1848), which therefore becomes the type of the new genus, *Dipodops*. The genus *Dipodops* is based on the possession of five complete toes on the hind foot (each toe consisting of metatarsal, phalanges, and claw), without regard to any other character whatsoever. Discussion of the cranial characters of the species of both genera may be found in a special paper soon to be published by the writer.

The species inhabiting the Desert of the Little Colorado may be known from the following description :

DIPODOPS LONGIPES sp. nov.

Type No. $\frac{17703}{24639}$ ♂ yg. ad. U. S. National Museum (Department of Agriculture collection). Foot of Echo Cliffs, Painted Desert, Arizona, September 22, 1889. Collected by C. Hart Merriam. (Original number, 512.)

Measurements.—Total length, 275; tail vertebræ, 165; pencil, 25; hind foot, 42 (taken in flesh). Ear from crown, 8 (taken from dry skin).

General characters.—Similar to *Dipodops agilis*, but with longer hind feet, shorter tail, and much paler coloration.

Color.—Above, uniform ochraceous-buff, finely lined with black-tipped hairs, the latter being most noticeable on the rump; a large pure white spot over each eye and another behind each ear. Cheeks between whiskers and ears, mostly white, slightly mixed with ochraceous. Under parts pure white to base of hairs, including fore legs and feet, band across thighs, and hind feet (except soles, which are dusky). Upper tail stripe dusky, continuous to end of tail, but paler on the crested penicillate portion, where it involves the terminal half of each hair only; under tail stripe very narrow posteriorly and indistinctly continuous with the dark tip of the pencil; lateral white stripes broad and distinct from basal white ring to white basal portion of pencil.

Cranial characters.—The skull of *Dipodops longipes* differs from that of *D. agilis* in the following particulars: The vault of the cranium is

more highly arched; the parietals (viewed from above) do not send off a long and slender postero-lateral process; the zygomatic bridge of the maxillary is evenly rounded off below, instead of sending off a postero-external lobule; the distance across the posterior border of the frontals equals that from the front of the nasals to the posterior end of the nasal branches of the premaxillaries, and also that from the anterior point of the frontal to the mastoid inflation; and the pit in the horizontal ramus of the mandible, behind the last molar, is very much larger than in *D. agilis*.

It should be mentioned that the present species needs no comparison with *D. chapmani*, recently described by Dr. Mearns from Fort Verde.

Record of specimens collected of Dipodops longipes.

U. S. National Museum No.	Original No.	Locality.	Date.	Sex.	Total length.	Tail vert.	Hind foot.
47633	505	Painted Desert, Arizona	Sept. 22, 1889	♂	255	137	43
47633	*512	.....do.....	Sept. 23, 1889	♂	275	165	42
		.....do.....	Sept. 24, 1889	♂	255	150	41

* Type.

Perognathus apache Merriam. Apache Pocket Mouse.

This Pocket Mouse is probably common in suitable localities throughout the Little Colorado Desert. The type specimen of the species came from the high mesa on the east side of the Painted Desert. I caught an immature individual near Moa Ave at the foot of Echo Cliffs, September 25. Its hole was under a greasewood bush on a sand plain.

Record of specimen collected of Perognathus apache.

U. S. National Museum No.	Original No.	Locality.	Date.	Sex.	Tail length.	Tail vertebrae.	Hind foot.	Remarks.
47623	524	Painted Desert, Arizona.	Sept. 25, 1889	♂ im.	139	72	18.5	Foot of Echo Cliffs.

Perognathus flavus subsp. Baird's Pocket Mouse.

An undescribed form of *Perognathus flavus* inhabits the Desert of the Little Colorado. An immature specimen was caught in Tanner's Gulch, a few miles north of Moencopie, September 24, but it is too young to admit of satisfactory description.

Record of specimen collected of Perognathus flavus subsp.

U. S. National Museum No.	Original No.	Locality.	Date.	Sex.	Total length.	Tail vertebræ.	Hind foot.	Remarks.
17708 24644	522	Painted Desert, Arizona.	Sept. 24, 1889	♂ im ..	125	60	19	Near Moencopie.

Perognathus fuliginosus sp. nov. Dusky Pocket Mouse.

The Dusky Pocket Mouse is a dark form of *Perognathus flavus*, inhabiting the lava beds. It is modified in the same manner and for the same reason as *Onychomys fuliginosus*, and the remarks under the head of the latter species apply equally well to the present. An immature specimen was captured in the cedar and piñon zone on the black lava or 'malpais' northeast of the mountain, October 4. It may be known from the following diagnosis:

PEROGNATHUS FULIGINOSUS sp. nov.

Type $\frac{17708}{24644}$ ♂ im. U. S. National Museum (Department of Agriculture collection). From Cedar belt, northeast of San Francisco Mountain, altitude 7,000 feet, October 4, 1889. Collected by Vernon Bailey. Original number, 559.

Measurements.—Total length, 116; tail vertebræ, 58; hind foot, 18 (taken in flesh by collector); ear from crown, 4 (taken from the dry skin).

Characters.—Similar to *Perognathus flavus*, but with the upper parts uniform sooty brown, faintly tinged with yellowish-brown; post-auricular spots and backs of ears yellowish; a fulvous lateral stripe, ill-defined below, merges into the color of the belly, which is strongly suffused with fulvous. In coloration this species is unique in the genus.

Perognathus (Chætodipus) penicillatus Woodhouse. Woodhouse's Pocket Mouse.

San Francisco Mountain is the type locality of this species, but I did not succeed in finding it. Woodhouse, who discovered it when attached to the Sitgreaves Expedition, captured his specimen in October, 1851, at San Francisco Mountain, but does not state the exact spot. His journal, however, shows that it was not far from their camp No. 17, which seems to have been at Hart Spring at the west base of the mountain.

Perognathus (Chætodipus) intermedius Merriam. Intermediate Pocket Mouse.

[Skull, plate V, figs. 5, 6, and 7.]

Five specimens of this species were collected by Vernon Bailey and myself in the Grand Cañon of the Colorado directly below the tank known as 'Cañon Spring,' on the Cocanini Plateau, north of San Francisco Mountain. They were found living in small colonies among rocks and cactus in the Agave zone, which is below the level of the Painted Desert. Like other members of the genus they are strictly nocturnal

and feed chiefly on seeds. Two additional specimens were caught in the cliffs of red sandstone at Tanner's Crossing on the Little Colorado River in September.

The specimens here mentioned differ from the type (which came from Mud Spring in northwestern Arizona) in having the rump spines more numerous and of larger size. They vary considerably in lengths of tail and hind feet, as shown by the following table of measurements. One individual in particular (No. $\frac{17976}{24887}$ ♀ from the Grand Cañon) departs more than usual from the type and resembles in some respects *P. spinatus*. Thus the interparietal might almost be described as broadly pentagonal, and the posterior border of the parietals is about as long as the anterior. The front lower molar, however, is that of *intermedius*, and the evident immaturity of the specimen may account for its peculiarities.

Record of specimens collected of *Perognathus (Chaetodipus) intermedius*.

U. S. National Museum No.	Original No.	Locality.	Date.	Sex.	Total length.	Tail vertebrae	Hind foot.
$\frac{24793}{24804}$	465	Grand Cañon, Arizona	Sept. 12, 1889	♂ ad.	183	101	23
$\frac{24807}{24813}$	466	.....do.....	.....do.....	♀ ad.	175	105	23
$\frac{24827}{24836}$	467	.....do.....	.....do.....	♀	175	100	22
$\frac{24837}{24850}$	468	.....do.....	.....do.....	♂	185	105	23
$\frac{24704}{24854}$	506	Painted Desert, Arizona	Sept. 22, 1889	♀	172	100	23
$\frac{24705}{24861}$	538	.....do.....	Sept. 26, 1889	♀	166	93	21

Erethizon epixanthus Brandt. Yellow-Haired Porcupine.

Porcupines inhabit the spruce belt and the sub-alpine or timber-line zone of San Francisco Mountain. No specimens were secured, but numerous gnawings were observed. Their favorite food-tree is the fox-tail pine (*Pinus aristata*). Hundreds of stunted trees of this species growing near timber line show ugly scars where the bark has been eaten. The gnawings which I examined are on the west side of the mountain. Most of them are on the east side (the up-hill side) of the trees, and their height above the ground varies from one to three or four meters. Their average size is hardly greater than a man's hand, though some of them are much larger.

During the fall and winter the Porcupines sometimes descend from the mountain to lower levels, and on several occasions they have been found along the Little Colorado. Sirgreaves and Kennerly mention instances of this kind, and a cattleman told me of a similar case that fell under his observation. Kennerly states that in December, 1853, Porcupines were common along the Little Colorado, where "they find a bountiful subsistence in the bark and tender twigs and buds of the young

cottonwood trees;" and Möllhausen, who was with Kennerly, says in his 'Diary,' "from time to time we saw porcupines, *Cercolabes nova*, lazily climbing the trees."

Lepus texianus Waterhouse. Jack Rabbit. [Skull, plate VII.]

Jack Rabbits are common throughout the upper levels of the Little Colorado Desert and in the piñon and cedar belt, and sometimes enter the parks of the pine belt. During the intense heat of the day we frequently started them from their hiding places under the low branches of junipers or in tufts of greasewood. At such times they remain absolutely motionless, squatting close to the ground with their long ears laid flat upon their backs. When in this position their colors harmonize so well with their surroundings that they are rarely seen until they start with a great bound and gallop swiftly away.

Record of specimens collected of Lepus texianus. •

U. S. National Museum No.	Original No.	Locality.	Date.	Sex.	Total length.	Tail vertebrae.	Hind foot.	Remarks.
47713	435	San Francisco Mountain, Arizona.	Sept. 5, 1889	♀ ad..	610	95	142	Killed in cedar belt; nursing.
47714	503	Painted Desert, Arizona.	Sept. 21, 1889	♀ ad..	630	100	145	
47715	550	San Francisco Mountain, Arizona.	Sept. 27, 1889	♀ ad..	610	92	140	Killed in cedar belt.

Lepus arizonæ J. A. Allen. Arizona Cotton-tail; Jack Cotton-tail.
[Skull, plate VIII.]

When overtaken by night in the lava beds of the cedar belt east of O'Leary peak, and many miles from water, I first made the acquaintance of the Jack Cotton-tail, a species which differs strikingly from the other American 'Cotton-tails,' in the great length of its ears. Just at dusk a family of them came out of their hiding-places in the chaparral to feed upon the scattered tufts of bunch-grass which exist even on this porous, arid soil. We found them again, and at the same hour, in the broad strip of piñon and cedars which separates the tall pine forest of the San Francisco Mountain Plateau from that of the Cocanini Plateau bordering the Grand Cañon of the Colorado. Afterward they were found to be tolerably common throughout the piñon and cedar zone, and were sometimes encountered in the Desert, where I shot one in the daytime in one of the small red sand-stone cañons of the Little Colorado River near the point known as Tanner's Crossing.

The great length of the external ears in this species (fig. 2) is correlated with a corresponding increase in the size of the bony parts which incase the organs of hearing, the audital bullæ being fully double the size of those of *Lepus sylvaticus* (see pl. VIII, figs. 1 and 3). The tail also is much longer than in the other members of the *sylvaticus* group.

The flesh of the Arizona Cotton-tail is white and tender, but rather dry.



Fig 2.—Head of *Lepus arizonae*, natural size.

It is possible that this species may prove to be the same as *Lepus bachmani*, described by Waterhouse in 1838, from a specimen collected by Douglas during his overland journey from Texas to California, in which case, of course, Waterhouse's name will have precedence.

Record of specimens collected of Lepus arizonæ.

U. S. National Museum No.	Original No.	Locality.	Date.	Sex.	Total length.	Tail vertebrae.	Hind foot.
344823 344823	433	San Francisco Mountain, Arizona	Sept. 4, 1889	♀ ad*	393	57	97
344825 344825	434	.....do .....	.....do	♂ im	368	38	90
344826 344826	460	.....do	Sept. 15, 1889	♂ im	360	48	94
344827 344827	459	.....do	Sept. 16, 1889	♂ im	325	48	84
344828 344828	461	.....do	Sept. 15, 1889	♀ im	330	46	86

* Ear 85mm.

Cariacus macrotis Say. Black-tailed Deer.

The Black-tailed Deer is abundant on San Francisco Mountain and neighboring peaks and buttes, where it inhabits the boreal zones, coming down into the pines in fall and winter. A fawn in the spotted coat was captured August 5.

Record of specimen collected of Cariacus macrotis.

U. S. National Museum No.	Original No.	Locality.	Date.	Sex.	Total length.	Tail vertebrae.	Hind foot.	Remarks.
347204 347204	280	San Francisco Mountain, Arizona.	Aug. 5, 1889	♂ juv.	730	94	280	Fawn in spotted coat.

Antilocapra americana Ord. Antelope.

The Antelope is still common in the San Francisco Mountain region, where it ranges from the upper levels of the Little Colorado Desert to the upper part of the pine zone. Its center of abundance seems to be in the piñon belt. It does not inhabit the Painted Desert proper, nor the Douglas fir zone. Small herds, composed of two or three to a dozen individuals, were seen frequently in the parks throughout the pine belt, and occasionally in the pine forests away from any openings. They were seen near Partridge Spring and within a mile of Little Spring. A few years ago Antelopes were very abundant throughout this region, but they have been killed off by both Indians and white men. The Indians hunt them on horseback among the lava beds just below the piñon belt, east and northeast of O'Leary Peak.

Ovis canadensis Shaw. Mountain Sheep.

A small herd of Mountain Sheep inhabits the main peak of San Francisco Mountain, where I saw eight or nine individuals together on one occasion (August 23). They are said to leave San Francisco Mountain in early winter, and to cross over to Kendrick Peak where they remain

until spring, the reason being that there is better feed and protection on Kendrick than on San Francisco Mountain. The two peaks are only 12 miles apart. Sheep are common at the Grand Cañon, where I surprised a small herd September 14.

Felis concolor Linnæus. Mountain Lion; Panther; Cougar.

The Mountain Lion occurs throughout the San Francisco Mountain region, but is not abundant. It is found chiefly in the piñon and pine areas, though it descends at times into the desert. During our stay at the Grand Cañon of the Colorado, about the middle of September, a Mountain Lion carried off a Deer shot by a sheep-herder and left out over night. It is much dreaded by the herders, who lose many sheep and lambs from its depredations.

Two Navajo Indians whom we met at Red Horse Tank, September 10, had quivers made of skins of the Mountain Lion with the tails left on. The tails were much shorter and the color of the pelage darker than in the eastern animal.

Lynx baileyi sp. nov. Plateau Wild-Cat.

Wild Cats are common throughout the region, but whether or not more than one species is represented is an open question. Their tracks were often seen at Little Spring, where they came to drink at night. The only specimen secured was an old female which I shot September 28, in the spruce belt near the upper border of the park that extends far up the mountain above Hart Spring. Although killed as early as 4 o'clock in the afternoon on a clear day, its stomach was distended with small mammals, proving that it sometimes hunts in broad daylight. It contained one Red Squirrel or Chickaree (*Sciurus fremonti mogollonensis*), one Mountain Chipmunk (*Tamias cinereicollis*), two Pocket Gophers (*Thomomys fulvus*), and one Mountain Vole (*Arvicola alticolus*).

The Wild Cat of San Francisco Mountain belongs to an undescribed species, of which I have specimens from various parts of the great Colorado Plateau in Colorado, Utah, and Arizona. It may be known from the following description:

LYNX BAILEYI * sp. nov.

[Skull, plate XI.]

Type No. ⁵²¹⁴/₅₉₀₉ ♀ ad. Merriam Collection. Moccasin Spring, Arizona, December 28, 1888. Collected by Vernon Bailey. (Original number, 466.)

Measurements.—Total length, 745; tail vertebrae, 132; hind foot, 165 (measured in flesh by collector). Ear from crown, 60 (from dry skin).

General characters.—*Lynx baileyi* differs from *Lynx rufus* of the eastern United States in being uniformly paler above and in having a shorter tail and softer fur. The upper parts are everywhere suffused with a

* Named in honor of my assistant, Mr. Vernon Bailey, who has collected more new species of North American mammals than any other person.

buffy tint, and the dark markings are decreased in area or altogether suppressed. Thus, the blackish marblings of the face and forehead are obsolete, and the black half ring at the tip of the tail is not more than half the width of that of *L. rufus*. On the other hand, the anterior border of the ear is distinctly whitish, in marked contrast to the black immediately behind it, while in *L. rufus* the same border is dark tawny-brown. The white hind toes of *L. rufus* are absent.

Cranial characters.—The vault of the cranium is greatly inflated compared with that of *L. rufus*, and the constriction behind the supraorbital processes is much less pronounced. The distance from the foramen magnum to the post-palatal notch equals that from the front of the nasals (in median line) to the plane of the supraorbital processes, while in *L. rufus* the former measurement greatly exceeds the latter. The tympanic portion of the audital bulla is inflated and projects anteriorly slightly beyond the inflated capsular portion, making the bulla as a whole wider anteriorly than posteriorly. The reverse is true of *L. rufus*. In *Lynx baileyi* a distinct sulcus marks the line of attachment of the septum which separates the tympanic chamber from the inner chamber. This sulcus is not evident in *L. rufus* except in the young.

I am indebted to Mr. John H. Sage, of Portland, Connecticut, for the loan of two Connecticut specimens of *Lynx rufus*. One of these is a very old male of great size killed at Chester, Connecticut, December 1, 1887. It measured 959^{mm} and weighed 14½ kilograms (32¼ pounds). The other is a half-grown female kitten, killed at the same locality December 19, 1887. It measured 658^{mm} and weighed 4 kilograms (8 pounds 10 ounces).

Record of specimen collected of Lynx baileyi.

U. S. National Museum No.	Original No.	Locality.	Date.	Sex.	Total length.	Tail vertebrae.	Hind foot.
34775 34881	551	San Francisco Mountain, Arizona	Sept. 28, 1889	♀ ad.	780	130	170

Canis latrans Say. Coyote.

The Coyote is common in the Sonoran fauna, and is very destructive to young lambs and to fruit. Several were seen on the Painted Desert, one in the act of feeding on a watermelon at the Moki pueblo of Moencopie.

In common with most carnivorous mammals the Coyote can not go many days without water. Woodhouse states that one was killed with a club at a small spring on the desert in western Arizona, where his party remained for two days. He says the Coyotes "became desperate, and would come to drink whilst the men and their mules were standing there." Dr. Kennerly states that specimens of this Wolf col-

lected at San Francisco Mountain had softer fur and broader skulls than those from the Missouri. (Pacific R. R. Repts. x, d, 11.)

Putorius sp. ———? Weasel.

Unmistakable signs of a Weasel were found on the summit of the mountain, just above timber line, but as no specimen was secured the species is uncertain.

Mephitis estor sp. nov. Skunk.

This Skunk is common about San Francisco Mountain, where a number of specimens were trapped in a ledge of rocks near Little Spring, on the line where the pine and Douglas fir zones meet (at an altitude of 8,200 feet). The limits of its vertical range were not ascertained, and I am unable to say whether or not it inhabits the Desert proper.

The North American Skunks are greatly in need of revision, the species being undefined and the synonymy hopelessly involved. I should not venture to add a new name to the list except for the fact that the present species can not be assigned to any already described. It may be known from the following description :

MEPHITIS ESTOR sp. nov.

[Skull, plate x, figs. 1, 2, 3, and 4.]

Type No. $\frac{17709}{24645}$ ♂ ad. U. S. National Museum (Department of Agriculture collection). From San Francisco Mountain, Arizona, August 17, 1889. Collected by Vernon Bailey (Original number, 369.)

Measurements (taken in flesh by collector).—Total length, 640; tail vertebrae, 256; pencil, 140; hind foot, 67. Ear from anterior base, 18; from crown, 8 (measured from dry skin).

General characters.—Size, small; tail, short, considerably shorter than head and body, and made up of hair of two lengths; ears, small; soles naked throughout, though the heel has the appearance of being haired because it is overlapped by the long hairs of its sides.

Color.—There is the usual white frontal stripe, narrow and barely reaching the nuchal patch, which latter begins in a straight line stretching completely across from ear to ear, occupying the whole occipital region and extending posteriorly in a broad white band, narrowing slightly over the shoulders and immediately expanding so as to cover the whole dorsal surface of the posterior half of the back and rump, inclosing a small, narrow streak of black along the middle of the rump (and this is wanting in some specimens, leaving the posterior back solid white), and thence passing continuously out over the tail, which it covers as a thin veil, allowing the black to show through, and projecting 90^{mm} beyond at the tip. The under parts are black, with irregular white patches on the throat [and breast in other specimens] and a white central area in the tail, which is produced by the fact that the basal half of each of the black hairs is white.

Cranial and dental characters.—Compared with a series of fifty skulls

of *Mephitis mephitis* from northern New York, that of *M. estor* is narrower, the nasal portion of the face is less abruptly deflected, and the 'step' in the under jaw less sharply defined. The second and third upper molars are smaller, and the first lower molar larger. The post-palatal notch is anterior to the plane of the posterior edge of the alveolus of the last molar; there is no distinct pit between the audital bulla and post-glenoid process; the greatest breadth across mastoids is less than the distance from the foramen magnum to post-palatal notch; the greatest breadth across the supraorbital processes exceeds the interorbital breadth; the distance from the foramen lacerum posticum to the tip of the mastoid is not greater than the distance between canines; and the distance from the last lower molar to the condyle (in median line) is less than the length of the lower molar series.

In skunks, as usual in the *Mustelidæ*, the sutures disappear so early in life that the excellent characters which they afford are lost if adult skulls only are studied. Therefore, when seeking distinctive cranial characters, it is desirable to compare skulls of immature as well as adult animals.

In a young specimen of *Mephitis estor* (No. 25485) the nasals end in a narrow point exactly on the plane of the posterior borders of the maxillaries, and equal the parietals in length. The shorter, lateral portion of the nasals is less than half the length of the frontals. The basioccipital is unusually broad and short, its breadth between the carotid foramina equaling its length. In both *M. mephitis* and *M. occidentalis* the basioccipital is very much narrower. In both of these species, also, the audital bullæ are larger and less compressed laterally. In *M. estor* the post-palatal notch is truncated anteriorly, ending in a straight line; in *M. mephitis* it bears a blunt median spine, while in *M. occidentalis* it is narrowly notched in the median line. The great size of the molars in *M. occidentalis* is strikingly apparent in comparing young skulls with those of *M. estor* and *M. mephitis* of approximately the same age.

Mephitis estor may be distinguished at a glance from *M. macroura* by the shortness of its tail.

Record of specimens collected of *Mephitis estor*.

U. S. National Museum No.	Original No.	Locality.	Date.	Sex.	Total length.	Tail vertebrae.	Hind foot.
27292	*369	San Francisco Mountain, Arizona	Aug. 17, 1889	♂ ad.	640	256	67
27211	368	.....do	Aug. 16, 1889	♀ im.	520	255	65
27210	370	.....do	Aug. 17, 1889	♀ im.	580	288	64

* Type.

Spilogale gracilis sp. nov. Little Striped Skunk.

The Little Striped Skunks are characteristic members of the Sonoran fauna, and do not occur at higher altitudes than this fauna or its offshoots attain. They are rarely found far from water, and most of the species prefer rocky situations, often making their homes in crevices in cliffs.

While asleep near a small spring in the Grand Cañon of the Colorado, September 12, 1889, I was awakened at midnight by a sniffling noise about my head. Rising suddenly on my elbow, a small animal scampered hurriedly away over the rocks. His form was only dimly outlined in the dark, but a hasty shot left no doubt as to his identity, and a moment later I held in my hand the type of a new species of Little Striped Skunk. A day or two afterward a younger individual was captured among the cliffs at the top of the Cañon. The stomachs of both contained remains of the cliff mouse (*Hesperomys eremicus*). The new species may be known from the following description:

SPILOGALE GRACILIS sp. nov.

Type No. $\frac{17986}{24807}$ ♂ ad. U. S. National Museum (Department of Agriculture collection). From Grand Cañon of the Colorado (altitude 3,500 feet), Arizona, north of San Francisco Mountain, September 12, 1889. Collected by C. Hart Merriam (Original number 451).

Measurements (taken in the flesh).—Total length 400; tail vertebrae 142*; hairs 100; hind foot 46.

General characters.—Longer and more slender than the eastern *S. putorius*, with a much longer tail. Frontal white patch much longer than broad, and rounded off both above and below; dorsal and lateral markings essentially as in *S. putorius*. Terminal part of tail white; the white occupying a little more than a third of the upper surface and two-thirds of the under surface.

Cranial and dental characters.—The skull of *Spilogale gracilis* differs widely from that of *S. putorius*. It is much flatter; the zygomatic arches are broader, and the fronto-parietal region is depressed to the general plane of the top of the cranium. The horizontal ramus of the under jaw is straight, while in *S. putorius* it is strongly convex below. The front of the upper sectorial tooth between the anterior and inner lobes is concave; while in *S. putorius* it is straight.

* The tail of this specimen has been injured in early life and the terminal portion is absent. The tail vertebrae of a young individual caught at the Cañon measure 160^{mm}.

Comparative measurements of *Spilogale putorius*, and *S. gracilis*, taken in the flesh.

	S. putorius.	S. gracilis.	
	17185♂ old	17986♂ old.	18568♂ im.
Total length	372	400	390
Tail vertebræ	129	142*	160
Tail pencil	60	100	105
Hind foot	39	46	46

* Tail short; tip gone.

Cranial measurements and ratios.

Measurements.	S. gracilis ♂ ad. type Grand Cañon, Ariz., No. 24897.	S. putorius ♂ ad. Lake Worth, Fla., No. 24117.
Greatest length of skull (from occipital condyle)	53.8	52.3
Basilar length of Hensel	47.0	46.5
Occipito-nasal length	50.5	48.5
Greatest zygomatic breadth	34.0	33.0
Greatest mastoid breadth	29.8	29.5
Breadth across postorbital processes	16.8	18.0
Least postorbital breadth	12.2	14.5
Greatest height of cranium from basisphenoid	16.5	17.8
Greatest height of cranium from palate	12.5	15.0
Greatest breadth across molars	18.4	18.5
Length of pterygoid fossa	10.8	11.0
RATIOS.		
Ratios to basilar length of Hensel:		
Zygomatic breadth	72.3	70.9
Palatal length	40.8	38.7
Height of cranium from basisphenoid	35.1	38.2
Height of cranium from palate	26.5	32.2
Length of pterygoid fossa	22.9	23.6
Breadth across postorbital processes	35.7	38.7
Breadth of postorbital constriction	25.9	31.1
Ratios to palatal length:		
Distance from foramen magnum to postpalatal notch	144.7	155.5
Distance across upper molars	95.8	102.7
Ratio of breadth to length of upper molar	131.9	139.1

Record of specimens collected of *Spilogale gracilis*.

U. S. National Museum No.	Original No.	Locality.	Date.	Sex.	Total length.	Tail vertebræ.	Hind foot.	Remarks.
17986 24897	451	Grand Cañon, Arizona.	Sept. 12, 1889	♂ ad.	400	142	46	Type: Tail vertebræ injured and short.
18568 25368	452	.....do	Sept. 14, 1889	♂ im.	390	160	46	

Taxidea americana Boddaert. Badger.

The Badger is a common inhabitant of the Sonoran fauna, but does not extend up into the balsam zone. A single individual was observed in the pines about the middle of September.

Lutra hudsonica Lacépède. Otter.

Mr. Bailey found tracks of an Otter along the Colorado River at the bottom of the Grand Cañon in September.

Bassaris astuta Lichtenstein. Ring-tailed Cat.

This animal, to which the misleading name 'American Civet' has been applied, is common in places in the Grand Cañon, particularly near the mouth of Cataract Cañon. It is found also in the cañon of the Little Colorado, just below Grand Falls, as I was informed by a man who killed one there.

Ursus horribilis Ord. Grizzly Bear.

The Grizzly Bear has been reported by early writers from San Francisco Mountain, where both Woodhouse and Kennerly speak of it as abundant. Coues and Yarrow state that several were killed on the north slope of Bill Williams Mountain; and Mr. G. K. Gilbert tells me that his party killed one on the same mountain October 28, 1871.

Möllhausen, in his 'Diary,' says that when he passed New Year's Spring, at the south foot of Mount Sitgreaves, January 2, 1854, it was "covered with thick ice." He says further:

The numerous footprints of the grey bear which traversed the forest in all directions, tempted us to follow them. We examined the forest that lay to the south of us as well as that at the foot of Mount Sitgreaves and the neighboring hills, and we found dens in such numbers that if they had been tenanted we should have had a bear to every acre of land. The declivities and ravines of Mount Sitgreaves are, it seems, a particularly favorite residence with them, and even Leroux, old trapper and hunter as he was, did not remember to have ever met with signs of such numbers living together on so small a space; but, unfortunately, the whole company had emigrated but a few days before our arrival. Probably the freezing of the water had occasioned this move, for we found on the ice marks of their having tried to break it. They seemed to have made their journey to the south in troops of eight or more, and their path was plainly recognisable on the glittering snow. (Vol II, pp. 164-165).

Ursus americanus Pallas. Black Bear.

The Black Bear is common throughout the Boreal zones of the San Francisco Mountain region, and is particularly abundant on Kendrick Peak and some of the neighboring buttes. It is said to be common also in Oak Creek Cañon, where the effects of slope-exposure make up for the low altitude.

MAMMALS OF THE SEVERAL ZONES.

Arctic-Alpine Zone.—The Rocky Mountain Sheep (*Ovis canadensis*) and a species of Weasel (*Putorius* sp. —?) are the only mammals known to inhabit the bare rocky summit of the mountain, and it is probable that they belong more properly to the subalpine or timber-line

zone. Other species occasionally straggle up there; thus a single Say's Squirrel (*Tamias lateralis*), a Mountain Chipmunk (*Tamias cinereicollis*), and a Shrew (*Sorex monticolus*) were found just above timber line.

Boreal Zones (comprising the timber-line, spruce, and Douglas fir belts).—The characteristic mammals of these zones are the Porcupine (*Erethizon epixanthus*), Black Bear (*Ursus americanus*), Black-tailed Deer (*Cariacus macrotis*), Red Squirrel (*Sciurus fremonti mogollonensis*), Voles (*Arvicola mogollonensis* and *A. alticolus*), and Shrew (*Sorex monticolus*). All except the *Arvicolas* range from the top of the timber-line zone to the bottom of the Douglas fir zone. *Arvicola alticolus* inhabits the subarctic and Hudsonian (or spruce) zones, while *Arvicola mogollonensis* does not occur above the parks of the Canadian (or fir) zone.

In addition to the above-mentioned species, which so far as known are restricted to the Boreal Province during the breeding season, several others occur there which inhabit also one or more of the zones below. These are the Mountain Chipmunk (*Tamias cinereicollis*) which really belongs to the Boreal Province, though it ranges throughout the upper levels of the pine plateau area; Say's Chipmunk (*Tamias lateralis*), which extends up from the pines; Pocket Gopher (*Thomomys fulvus*); White-footed Mouse (*Hesperomys leucopus rufinus*); Wildcat (*Lynx baileyi*); Mountain Lion (*Felis concolor*), Skunk (*Mephitis estor*).

Pine Zone.—In the area next below the fir—the Pine Plateau area—there is but one distinctive mammal, and it, singularly enough, is a Squirrel—Abert's Squirrel (*Sciurus aberti*). Though this is the only mammal restricted to the Pine area, many others occur there. Say's Chipmunk (*Tamias lateralis*) here finds its center of abundance, though in common with the Mountain Chipmunk (*T. cinereicollis*), it ranges up through the Boreal zones. The following are common to the Pine and Sonoran regions: Antelope, Badger, Coyote, Round-tailed Wood-Rat, Rock Spermophile, Spotted Spermophile, and Prairie Dog. The two latter are found only in the openings or parks.

Piñon Zone.—The most characteristic mammal of the piñon belt is the Rock Squirrel or Spermophile (*Spermophilus grammurus*.) The Antelope also seems to find its center of abundance in this zone. Another characteristic species is the White-tailed Chipmunk (*Tamias leucurus cinnamomeus*), which comes up from the desert along with the Scorpion Mouse (*Onychomys fuliginosus*), Pocket Mouse (*Perognathus fuliginosus*), and Rabbits (*Lepus texianus* and *Lepus arizonæ*.)

Desert Area.—The most characteristic mammals of the desert region are Kangaroo Rats (*Dipodops*) and Pocket Mice (*Perognathus*), both of which are long-legged, long-tailed, jumping animals, provided with external cheek-pouches, and strictly nocturnal in habits. Other desert animals are the Big-eared Mice (*Hesperomys eremicus* and *H. megalotis*), Free-tailed Bats (*Nyctinomus*), and the Pigmy Bat (*Vesperugo hesperus*).

PART IV.—ANNOTATED LIST OF BIRDS OF THE SAN FRANCISCO
MOUNTAIN PLATEAU AND THE DESERT OF THE LITTLE COL-
ORADO RIVER, ARIZONA.

By Dr. C. HART MERRIAM.

Colymbus nigricollis californicus. Eared Grebe.

A Grebe, probably of this species, was seen in a small pond in Tanner's Gulch, a few miles north of Moencopie, during the latter part of September. Recently it has been recorded from Mormon Lake and "a small lake near Flagstaff" by Dr. E. A. Mearns (Auk. VII, Jan. 1890, 50.)

Anas boschas. Mallard.

A large number of Mallards were seen, and several shot, on a small pond in Tanner's Gulch, north of Moencopie, September 23.

Anas americana. Baldpate.

Recorded by Dr. Mearns as common at Mormon Lake, about 20 miles south of San Francisco Mountain.

Anas discors. Blue-winged Teal.

Six were seen at a small pool in a park in the balsam belt August 30. At Hull Spring, September 9, a large flock (fifty or more) was found squatting in the mud below the spring, and seven were killed at one shot by Vernon Bailey. I killed one and saw several others in a small pond north of Moencopie, September 23.

Spatula clypeata. Shoveller.

During the evening of September 23, when camped in Tanner's Gulch, north of Moencopie, I shot a Great Horned Owl, which had just alighted on a rocky pinnacle overlooking the pond, where he had doubtless come to feed on coots (*Fulica americana*). At the discharge of the gun a flock of ducks rose from the pond and circled over our small camp-fire. Dimly discerning them in the darkness I fired and a Shoveller fell dead at my feet.

Dafila acuta. Pintail.

Recorded from Mormon Lake by Dr. Mearns.

Erismatura rubida. Ruddy Duck.

Recorded by Dr. Mearns from both Mormon Lake and Duck Lake, near Flagstaff.

Plegadis guarauna. White-faced Glossy Ibis.

Breeds abundantly on Mormon Lake, about 20 miles south of San Francisco Mountain, as I was informed by several persons. Recorded also by Dr. Mearns. Woodhouse states that he obtained two specimens on the Little Colorado.

Botaurus lentiginosus. American Bittern.

"Especially abundant at Mormon Lake, where it finds a most congenial home."—Mearns.

Nycticorax nycticorax nævius. Black-crowned Night Heron.

Recorded by Dr. Mearns from Mormon Lake.

Grus mexicana. Sandhill Crane.

Recorded by Dr. Mearns from Mormon Lake.

Porzana carolina. Sora.

Found in the rushes in Tanner's Gulch, a few miles north of Moencopie, during the last week of September. Recorded by Dr. Mearns as abundant at Mormon Lake.

Fulica americana. American Coot.

Enormously abundant amongst the rushes in a small pond in Tanner's Gulch, a few miles north of Moencopie. There must have been thousands of them in this place at the time of our visit, September 23, 24. A dozen or more could be killed at a single shot at almost any time. Their flesh is excellent. Dr. Mearns records the species as breeding abundantly at Mormon Lake.

Phalaropus lobatus. Northern Phalarope.

A flock of eight, six of which were killed, was found in a little crater lake ('Walker Lake'), August 19.

Recurvirostra americana. American Avocet.

A flock of about twenty was seen August 13 near the Little Colorado River, in a small alkali pool, the result of a heavy shower. No others were observed.

Tringa bairdii. Baird's Sandpiper.

Five were shot August 27 in a small crater lake (Walker Lake), and two more at the same place September 1.

Tringa minutilla. Least Sandpiper.

Shot at a small crater lake August 27 and September 1 in company with *Tringa bairdii* and *Actitis macularia*.

Ereunetes pusillus. Semipalmated Sandpiper.

Shot September 1 at Walker Lake.

Totanus solitarius. Solitary Sandpiper.

One was shot August 26 at a little pool in a park in the balsam belt, and another at Walker Lake, September 1. No others were seen.

Actitis macularia. Spotted Sandpiper.

Shot August 27 and September 1 at a small crater lake (Walker Lake).

Ægialitis vocifera. Killdeer.

A single individual was found in a park in the pines near Flagstaff, July 28, and a few were seen about the scattered pools in the bed of the Little Colorado River, August 13 and 14. One was shot at a small crater lake (Walker Lake), August 27.

Callipepla gambeli. Gambel's Partridge.

Gambel's Partridge does not inhabit the summit of the Great Plateau though it reaches its edge from the south and west. It is found a short distance west of Bill Williams Mountain, and is common in Cataract Cañon. The only evidence of its presence in the region of the Little Colorado is Möllhausen's statement that "small partridges hopped about among the thick shrubs" bordering this stream when he crossed it in December, 1854 (Möllhausen's Diary, II, 1858, 143).

Dendragapus obscurus. Dusky Grouse.

Mr. John Swinburne, of Shona Ranch, St. John's, Arizona, visited our camp early in September, and climbed San Francisco Mountain September 3. He informs me that he saw a Dusky Grouse in the spruce belt on the mountain. He is perfectly familiar with the species, and I think there can be no doubt as to the correctness of the identification.

Meleagris gallopavo mexicana. Mexican Turkey.

Common. In August they were feeding on gooseberries in the balsam belt; in September they were feeding on piñon nuts in the cedar belt.

The northward distribution of the Turkey is said to be limited by the Grand Cañon of the Colorado. This may be due to the greater elevation of the Kaibab Plateau which is in the Canadian fauna, its prevailing forest being Douglas fir instead of pine.

Columba fasciata. Band-tailed Pigeon.

There is something remarkable about the occurrence of this species in the San Francisco Mountain region. It was recorded as common by Woodhouse, who found it in small flocks in October, 1851; and Dr. Mearns states that he found it common about the base of San Francisco Mountain in May and June. It was not seen at all by our party.

Zenaidura macroura. Mourning Dove.

Common from the Desert of the Little Colorado to the upper limit of the pine belt. Every evening they assemble at the springs and water holes, coming in greatest numbers just at dark, particularly about the borders of the Desert where water is very scarce. On the evening of August 20 we camped for the night at a small spring about 5 miles west of Grand Falls. At dusk hundreds of Doves came to drink, and continued coming until it was so dark that they could not be seen.

Cathartes aura. Turkey Vulture.

Tolerably common, particularly about Flagstaff and at the Grand Cañon; seldom seen at San Francisco Mountain.

Circus hudsonius. Marsh Hawk.

Several were seen circling about some grass and bushes near a spring

at Echo Cliffs September 22-24. One was seen at Tenebito Wash, about the middle of August, and another at Black Tank September 20.

Accipiter velox. Sharp-shinned Hawk.

Tolerably common about San Francisco Mountain, and at the Grand Cañon.

Accipiter cooperi. Cooper's Hawk.

Tolerably common, particularly at the Grand Cañon of the Colorado, where they used to watch a water hole, perched motionless on a neighboring pine, and pounce on the birds that came to drink. Shot an old female at Little Spring August 4, another August 6 at Kendrick Peak, and saw several others about the mountains.

Accipiter atricapillus. Goshawk.

Several seen on the mountain. One was shot and another seen in the act of drinking at Little Spring, at the lower edge of the Douglas fir belt. Dr. Mearns states that he saw an immature Goshawk near timber line on San Francisco Mountain, June 7, 1887.

Buteo borealis calurus. Western Red-tail.

A few probably breed, but none were observed until August 6, when they suddenly became abundant, remaining so until the latter part of September. I have never seen these hawks so unwary. They were easily approached either on horseback or afoot, and many were shot in the pines. They fed principally on Chipmunks (*Tamias cinereicollis* and *Tamias lateralis*), and occasionally captured the large Abert's Squirrel (*Sciurus aberti*).

Buteo lineatus elegans. Red-bellied Hawk.

A specimen of this Hawk was collected on the Little Colorado by Kennerly and Möllhausen in November, 1853.

Buteo swainsoni. Swainson's Hawk.

Rare; only two were seen during the season. One of these was shot August 30.

Aquila chrysaëtos. Golden Eagle.

The Golden Eagle breeds on San Francisco Mountain, where it was often seen. An adult was shot by Vernon Bailey, August 28, at a small pool of very cold water at timber line. Its stomach contained the remains of an Abert's Squirrel (*Sciurus aberti*). On the morning of August 7, a little after daylight, I saw two Golden Eagles perched in tall pines near Le Roux Spring, watching for Prairie Dogs. They allowed me to ride under the trees on which they were perched.

Falco mexicanus. Prairie Falcon.

A pair of these Falcons had their nest on a high cliff in the crater of the main peak of San Francisco Mountain, and another pair had possession of a similar ledge on Kendrick Peak. Their loud cries may be heard a long distance. A specimen of this species was secured by Kennerly and Möllhausen on the Little Colorado in November, 1853.

Falco columbarius. Pigeon Hawk.

Mr. F. Stephens writes me that he saw this Hawk at San Francisco Mountain, near Le Roux Spring, about the middle of July, 1887.

Falco sparverius. Sparrow Hawk.

Abundant throughout the piñon, pine, and spruce zones, and common in parts of the Desert where there were bushes for it to perch on. Feeds principally on insects.

Pandion haliaëtus carolinensis. Osprey; Fish Hawk.

Seen twice at the Grand Cañon about the middle of September.

Asio wilsonianus. Long-eared Owl.

Mr. F. Stephens writes me that he shot a specimen of this species at San Francisco Mountain, near Le Roux Spring, about the middle of July, 1887.

Megascops flammeolus. Flammulated Screech Owl.

At 3 o'clock in the morning of September 13, while climbing out of the Grand Cañon of the Colorado by moonlight, I shot one of these Owls. Its stomach contained a scorpion and some beetles and other insects. It was an immature female.

Nyctala acadica. Saw-whet Owl.

Dr. Mearns found a nest of this owl near Little Spring and secured the female parent. The nest contained one egg and three young, but the date is not given.

Bubo virginianus saturatus. Dusky Great Horned Owl.

This dark form of the Great Horned Owl has been heretofore regarded as limited in its range to the humid spruce forests of the northwest coast region from Oregon to Alaska, and thence easterly through the great northern spruce forests of Canada to Labrador; but no one seems to have suspected its existence in the Rocky Mountains. Comparison of San Francisco Mountain specimens with the U. S. National Museum series shows that they pertain to this form and differ widely from either *B. virginianus* of the East, or *B. subarcticus* of the Plains and arid lands of the West.

This Owl is common in the spruce and balsam belts of San Francisco Mountain. A specimen shot at the brink of the Grand Cañon of the Colorado differs from the mountain specimens in having considerable white on the feet.

A Great Horned Owl was shot at Tanner's Gulch, near Echo Cliffs, on the desert of the Little Colorado, September 23, but was not preserved.

Speotyto cunicularia hypogæa. Burrowing Owl.

Found on the higher mesas of the Desert of the Little Colorado, occupying deserted burrows of Prairie Dogs (*Cynomys gunnisoni*).

Glaucidium gnoma. Pygmy Owl.

Not obtained by our party. Dr. Mearns records it from San Francisco Mountain.

Geococcyx californianus. Road-runner.

Not observed by our party. Recorded by Dr. Kennerly, who states that it was "seen occasionally during the winter along the Little Colorado River."

Ceryle alcyon. Belted Kingfisher.

A single Kingfisher was seen at Tanner's Gulch, a few miles north of Moencopie, September 23.

Dryobates villosus hyloscopus. Cabanis's Woodpecker.

Common in the pine belt.

Picoides americanus dorsalis. Alpine Three-toed Woodpecker.

Common in the spruce and balsam belts. A female was shot high up on the mountain August 23, feeding a full-grown young. A few were killed as low as the upper edge of the pine belt.

Sphyrapicus varius nuchalis. Red-naped Sapsucker.

Occurs during fall migration. First observed September 19, when Professor Knowlton shot an adult male near Little Spring. The next day, September 20, I shot an immature bird in the cedars, and September 23, saw another at Moa Ave. September 30, Professor Knowlton shot another male at Little Spring. No others were seen.

Sphyrapicus thyroideus. Williamson's Sapsucker.

Common in the Douglas fir belt and the upper part of the pines; probably breeds in the aspens. Both young and old were shot. Common in the pines at the Grand Cañon the middle of September.

Melanerpes torquatus. Lewis's Woodpecker.

Breeds in the piñon and cedar belt, where it is tolerably common; may breed in the lower part of the pine area also. Rather common at Cañon Spring on the south side of the Grand Cañon, where small flocks came to drink every day during our stay, about the middle of September. Young were shot at Turkey Tanks the middle of August.

Melanerpes formicivorus bairdi. Californian Woodpecker.

Found among the oaks near the Grand Cañon of the Colorado. Not seen elsewhere.

Colaptes cafer. Red-shafted Flicker.

Common in the pines.

Phalacroptilus nuttalli. Poor-will.

A colony of Poor-wills inhabited a ledge of rocks at the lower edge of the balsam belt, near Little Spring. They began calling just at dusk every evening. A young was shot August 1, and several adults afterward. A single Poor-will was seen at Tanner's Crossing on the Little Colorado, but whether it was the present form or the Frosted Poor-will (*Phalacroptilus nuttalli nitidus*) is uncertain. The same doubt pertains to specimens from the Moki villages recorded in the Report of the Ives Expedition.

Chordeiles virginianus henryi. Western Nighthawk.

Common about the mountain in summer, and on the Desert of the Little Colorado in August; not seen after the middle of September.

Micropus melanoleucus. White-throated Swift.

Flocks of White-throated Swifts were seen high up on the mountain and circling over the higher buttes in August and the early part of September. One was seen at the Grand Cañon September 10.

Trochilus platycercus. Broad-tailed Hummingbird.

Very abundant in the balsam belt and the upper part of the pine belt. A nest containing two nearly fledged young was found on the limb of a Douglas fir, about four feet from the ground, July 31. The principal food plant of this Hummingbird is the beautiful scarlet trumpet flower of *Pentstemon barbatus torreyi*. During the latter part of August and early September, after it had ceased flowering, these birds were most often seen in the beds of the large blue larkspur (*Delphinium scopulorum*). They wake up very early in the morning and go to water at daylight no matter how cold the weather is. During the month of August, and particularly the first half of the month, when the mornings were often frosty, hundreds of them came to the spring to drink and bathe at break of day. They were like a swarm of bees, buzzing about one's head and darting to and fro in every direction. The air was full of them. They would drop down to the water, dip their feet and bellies, and rise and shoot away as if propelled by an unseen power. They would often dart at the face of an intruder as if bent on piercing the eye with their needle-like bill, and then poise for a moment almost within reach before turning, when they were again lost in the busy throng. Whether this act was prompted by curiosity or resentment I was not able to ascertain. Several were seen at the summit of the mountain during the latter part of August. They were found also at the Grand Cañon of the Colorado, September 12-15. They began to leave the mountain during the first week in September, and none were seen after the middle of the month.

Trochilus rufus. Rufous Hummingbird.

Common in the pines, feeding principally on *Pentstemon barbatus torreyi*. Rarely seen as far up as the balsam belt. A few were usually seen among the multitude of Broad-tailed Hummers at Little Spring every morning in August, but they were more abundant lower down.

Dr. Mearns records *Trochilus alexandri* as "a summer resident in the zone of *Pinus ponderosa*" (Auk, July, 1890), but does not mention the present species.

Tyrannus vociferans. Cassin's Kingbird.

Rather scarce. A few pairs breed in the parks in the pine belt, but the species is much more common in the cedar belt and upper levels of the Desert. A few were seen at the Grand Cañon of the Colorado about the middle of September.

Sayornis saya. Say's Phoebe.

Found in the Desert of the Little Colorado and at the Grand Cañon in September, frequenting patches of greasewood (*Atriplex canescens*) in the former locality, and sage-brush (*Artemisia tridentata*) in the latter. Also common in the bushes bordering the Little Colorado at Tanner's Crossing, September 21.

Contopus borealis. Olive-sided Flycatcher.

Common in the balsam belt. Several broods of young were found early in August.

It is noteworthy that *Contopus pertinax*, which is common on the Santa Catalina and White Mountains, was not found anywhere in the San Francisco Mountain region.

Contopus richardsonii. Western Wood Pewee.

Abundant throughout the pines.

Empidonax difficilis. Western Flycatcher.

Common in the pines and in the lower part of the balsam belt.

Empidonax hammondi. Hammond's Flycatcher.

A few specimens were taken during the latter part of August.

Otocoris alpestris arenicola. Desert Horned Lark.

Common in flocks in the parks of the cedar belt, and tolerably common in the upper part of the desert, particularly in September.

Pica pica hudsonica. Magpie.

Not observed by our party but recorded from the Little Colorado by Kennerly, who procured a specimen there December 8, 1853.

Cyanocitta stelleri maculophya. Long-crested Jay.

Abundant during August in the balsam and pine belts, and in September found everywhere from timber line to the lower part of the cedar belt.

Aphelocoma woodhousei. Woodhouse's Jay.

Common in the cedars and piñon, where it was seen at Turkey Tanks, at a crater east of O'Leary peak, and at the Grand Cañon of the Colorado. It is shy and difficult to procure.

Corvus corax sinuatus. Raven.

Common on the Desert of the Little Colorado, but not found about the mountain. Seen along the Rio Puerco, the Colorado Chiquito, Tenebito Wash, and Moencopie Wash. Found also at the Grand Cañon. A flock of about fifty individuals was seen near Hull Spring on a narrow tongue of the desert which projects far into the cedar belt between San Francisco Mountain and the Grand Cañon.

Corvus americanus. Crow.

Not common. A flock was usually found in the neighborhood of Fort Moroni, the headquarters of the cattle ranch.

Picicorvus columbianus. Clarke's Nutcracker.

Breeds commonly in the spruce belt, occasionally descending to the pines in summer. In September, when the piñon nuts were ripening, it came down from the mountain in flocks and was often seen in the piñon belt with the Piñon and Woodhouse's Jays. At the same time it was common at the uppermost limit of the dwarf spruce of the sub-alpine zone.

Cyanocephalus cyanocephalus. Piñon Jay.

Breeds abundantly throughout the piñon belt, of which it is one of the most characteristic species. Always seen in flocks; very noisy.

Agelaius phoeniceus. Red-winged Blackbird.

Recorded by Woodhouse, who says of it: "I found them also in the San Francisco Mountain, near the Laguna Enematio."

Sturnella neglecta. Western Meadowlark.

A few pairs breed in the parks of the lower part of the pine zone. In the latter part of September it was tolerably common in the neighborhood of Moa Ave, near the north end of the Desert of the Little Colorado, and also between Black Tank and the cedar belt on the west side of the desert. None were seen in the desert proper.

Icterus bullocki. Bullock's Oriole.

Shot an immature bird in some tall bushes bordering the Little Colorado at Grand Falls, August 14.

Scolecophagus cyanocephalus. Brewer's Blackbird.

Tolerably common about Flagstaff, and seen occasionally in the cedar belt and in some of the parks in the pine belt. Several were seen in a bushy place near a spring at the south end of Echo Cliffs, September 22, and the species was common in the rushes in Tanner's Gulch, north of Moencopie, the last week in September.

Coccothraustes vespertina. Evening Grosbeak.

Breeds in the spruce. An adult female was killed at Le Roux Spring, July 29. The skin of her belly was thick and gelatinous, showing that she had only recently left the nest. Another was seen near Le Roux Spring, August 7, and an adult male was seen at Little Spring September 7.

Carpodacus mexicanus frontalis. House Finch.

Occasionally seen in small flocks in the pines. When camped at the Grand Cañon of the Colorado during the middle of September, small flocks of this species came to a pool to drink every day.

Loxia curvirostra stricklandi. Mexican Crossbill.

Tolerably common in the balsam belt, coming down into the pines in the latter part of summer. They may breed in the pines in early spring when the mountain is covered with snow. During our stay at the Grand Cañon, about the middle of September, they used to come every day to a small pool to drink.

Spinus psaltria. Arkansas Goldfinch.

Not common; a few were seen from time to time in the pines and at the Grand Cañon.

Spinus psaltria arizonæ. Arizona Goldfinch.

A few were seen at Flagstaff in September.

Spinus pinus. Pine Siskin.

Common in the balsam belt, where it breeds; common in the pines during the latter part of summer.

Pooecetes gramineus confinis. Western Vesper Sparrow.

Common in the parks in the pine belt and thence down to the upper levels of the desert. Common at the Grand Cañon September 10-16. Several were seen along the upper part of Moencopie Wash during the latter part of September.

Ammodramus sandwichensis alaudinus. Western Savanna Sparrow.

Found near Echo Cliffs late in September. Not noted elsewhere.

Chondestes grammacus strigatus. Western Lark Sparrow.

Common in the open parks in the cedar belt and occasionally found in the parks in the pines.

Zonotrichia leucophrys. White-crowned Sparrow.

Shot at the Grand Cañon the middle of September. First shot at the mountain September 19; afterwards tolerably common.

Zonotrichia intermedia. Intermediate Sparrow.

Common during migration. The first was shot in the pine belt, near Little Spring, August 31; afterward it was tolerable common until the end of September.

Spizella socialis arizonæ. Western Chipping Sparrow.

Abundant throughout the pines and cedars.

Spizella monticola. Tree Sparrow.

This species is a winter visitant from the far north and had not arrived at the time of my departure. Dr. Kennerly found it in December on the Little Colorado, "feeding upon the seeds of the grapes and weeds that grow along the valley."

Spizella breweri. Brewer's Sparrow.

Common on the Desert of the Little Colorado in summer, and found also in the cedar belt in early autumn. This species and *Amphispiza bilineata* were almost the only birds found on the Painted Desert proper in August.

Junco hyemalis oregonus. Oregon Junco.

A fall migrant, not seen until September 22, after which a few were seen.

Junco caniceps. Gray-headed Junco.

Woodhouse described *Junco caniceps* in 1852 from several specimens taken at different localities as wide apart as Mexico, Texas, and San Francisco Mountain. The bird from the latter locality is an immature female in fall plumage (collected October 14, 1851). It is not the same species as the males described on the same page. The latter come first in the description and I believe them to be *Junco cinereus* Swainson or *Junco cinereus palliatus* Ridgway.

Junco cinereus dorsalis. Red-backed Junco.

Breeds abundantly throughout the upper levels of the pine plateau region and in the balsam and spruce belts. At San Francisco Mountain in summer it is the commonest species of bird after *Sitta pygmaea*, and it was still abundant when we left the mountain, October 1. Spotted young were taken throughout August.

Amphispiza bilineata. Black-throated Desert Sparrow.

Tolerably common on the Desert of the Little Colorado; not seen elsewhere.

Amphispiza belli nevadensis. Sage Sparrow.

A spotted young was shot on the edge of a field near Flagstaff July 28. Others were seen along the Desert of the Little Colorado and at the Grand Cañon. It probably spends the whole year on the desert,

for Dr. Kennerly states that he found it "in the month of December along the Little Colorado River, wherever the weeds and bushes were thick."

Peuceæa ruficeps boucardi. Boucard's Sparrow.

Common in the Grand Cañon, where several were shot; found also on the Desert of the Little Colorado.

Melospiza fasciata fallax. Desert Song Sparrow.

This subspecies was shot at the Grand Cañon of the Colorado and along Echo Cliffs, near Moencopie.

Melospiza fasciata montana. Mountain Song Sparrow.

Two specimens of this subspecies were shot at Little Spring September 6, and another September 27. Others were seen near the same locality during the latter part of August.

Melospiza lincolni. Lincoln's Sparrow.

Tolerably common in weeds in the pine belt early in September; first shot September 7. Two were shot and others seen at the Grand Cañon about the middle of September.

Passerella iliaca schistacea. Slate-colored Sparrow.

Dr. Leonhard Stejneger shot one at the north foot of San Francisco Mountain September 29. No others were seen.

Pipilo maculatus megalonyx? Spurred Towhee.

Several were seen in the scrub-oak at the Grand Cañon of the Colorado about the middle of September.

Pipilo chlorurus. Green-tailed Towhee.

Common in the pines during migration, and also in the bushes along the Little Colorado. It probably breeds near the mountain, where an immature bird was shot in the pines August 5.

This species was very abundant at the Grand Cañon of the Colorado during the middle of September, and its habit of searching for food on the ground led to the death of several individuals which got into our traps set for Mice and other small mammals. It was seen at Echo Cliffs late in September.

Habia melanocephala. Black-headed Grosbeak.

Several were shot in the pines. It was rather common at the Grand Cañon of the Colorado about the middle of September.

Piranga ludoviciana. Louisiana Tanager.

Breeds commonly in the balsam belt, where both young and old were taken in early August. They were in the habit of coming to Little Spring to drink every morning during the early part of our stay. A young of the year was shot in the Grand Cañon, September 13.

Piranga hepatica. Hepatic Tanager.

Probably breeds in the lower levels of the pine belt east of O'Leary Peak, where an adult male was shot and others seen September 4 and 5. An immature male was shot in the pines near Little Spring August 31, and an adult female September 7.

The first specimen of the Hepatic Tanager secured within the United

States was killed at San Francisco Mountain by Dr. S. W. Woodhouse, naturalist of the Sitgreaves Expedition, in October, 1851. Dr. C. B. R. Kennerly states that he saw it at San Francisco Mountain in December, 1853.

Progne subis. Martin.

Dr. Mearns records this species as common in the pine plateau region. We did not find it.

Petrochelidon lunifrons. Cliff Swallow.

Several were seen at Grand Falls, on the Little Colorado, August 14, and a number of deserted nests were found on the sandstone cliffs on the east bank of the river. Not seen elsewhere.

Chelidon erythrogaster. Barn Swallow.

Several were seen at Tanner's Gulch, north of Moencopie, September 24.

Tachycineta thalassina. Violet-green Swallow.

Common, particularly in the parks of the pine plateau.

Ampelis cedrorum. Cedar Waxwing.

One was shot, and several were seen at different times near a pool on the edge of the Grand Cañon about the middle of September.

Lanius ludovicianus excubitorides. White-rumped Shrike.

Common on the greasewood plains of the desert of the Little Colorado. Two were seen in the sage-brush and chaparral at the Grand Cañon, and one in a park in the pine belt.

Vireo gilvus swainsoni. Western Warbling Vireo.

Common in the pines.

Vireo solitarius cassinii. Cassin's Vireo.

Common in the pines during fall migration; first shot August 21. Two were shot at the Grand Cañon the middle of September.

Vireo solitarius plumbeus. Plumbeous Vireo.

Tolerably common; first shot August 31. Mr. F. Stephens writes me that he shot a specimen of this species and saw others near Le Roux Spring about the middle of July, 1887.

Vireo vicinior. Gray Vireo.

This species was not found except at the Grand Cañon of the Colorado, where a male was shot in a piñon September 14.

Helminthophila virginiae. Virginia's Warbler.

Specimens were shot in the pines July 28 and August 17.

Helminthophila ruficapilla gutturalis. Calaveras Warbler.

Abundant during the latter part of August, particularly in the aspens; found also as high up on the mountain as the timber-line zone.

Helminthophila celata lutescens. Lutescent Warbler.

A few were shot from August 29 to September 18, mostly in the tall pines and aspens.

Dendroica aestiva. Yellow Warbler.

Shot near Little Spring August 12, August 29, and September 3. Tolerably common in the cottonwoods along the Little Colorado River

in August. Several were seen in a patch of reeds along Tenebito Wash in the desert, far from any trees, August 17; and in a thicket of bushes near a spring at the foot of Echo Cliffs late in September.

Dendroica auduboni. Audubon's Warbler.

Breeds abundantly in the balsam belt; common in migration throughout the timber-covered portions of the region.

Dendroica graciae. Grace's Warbler.

First shot at the mountain August 12, and in the cedar belt August 13; afterward a few were taken in the pines; not seen after the last week in August.

Dendroica nigrescens. Black-throated Gray Warbler.

First shot August 12 in the pines; common until the middle of September. Found on the mountain as high as timber line, and also at the Grand Cañon of the Colorado.

Dendroica townsendi. Townsend's Warbler.

First shot on the mountain August 21; became common about August 28, and disappeared early in September. Found from the pines to the upper part of the timber-line zone. Shot at the Grand Cañon September 14.

Dendroica occidentalis. Hermit Warbler.

Common during fall migration, particularly from August 23 to September 1 in the timber-line zone. A few were killed as low down as the pines.

Geothlypis macgillivrayi. Macgillivray's Warbler.

One was seen at the base of Mount Kendrick August 6, and a female was shot near Little Spring August 14. No others were observed until August 22, when the species was tolerably common for a few days in some undergrowth along the edge of one of the parks in the pine belt. Three were shot and others seen in the Grand Cañon September 12 and 13.

Geothlypis trichas occidentalis. Western Yellow-throat.

One was shot and several seen in some thick weeds in the pine belt August 31, and others were shot in the Grand Cañon of the Colorado September 12 and 14.

Sylvania pusilla. Wilson's Warbler.

Abundant on the mountain during migration; first taken August 14; soon became abundant, outnumbering all the other Warblers; became scarce about the end of August; last seen early in September.

Anthus pensilvanicus. American Pipit; Titlark.

Probably breeds in the neighborhood of timber line on San Francisco Mountain, where it was shot by Mr. Bailey August 23. During migration it was seen at other places, and came to water at the little crater lake called Walker Lake, September 18, 22, and 25. Several were seen at Moa Ave, near the south end of Echo Cliffs, the last week in September.

Oroscoptes montanus. Sage Thrasher.

Occurs sparingly on the Desert of the Little Colorado; hardly more than half a dozen individuals were seen altogether.

Mimus polyglottos. Mockingbird.

Common at Grand Falls, on the Little Colorado.

Harpophynchus sp.—?

Two Thrashers were seen in the upper part of the Desert of the Little Colorado about the middle of August, but they were so shy that I was unable to approach within shooting distance, and consequently could not determine the species.

Salpinctes obsoletus. Rock Wren.

Common about rocky exposures everywhere from the Desert of the Little Colorado up to the top of San Francisco Mountain, and also at the Grand Cañon of the Colorado.

Catherpes mexicanus conspersus. Cañon Wren.

Tolerably common in the Grand Cañon and in the Cañon of the Little Colorado, where its marvelous song echoes and re-echoes until the towering cliffs fairly ring. One was shot on a ledge on the north side of San Francisco Mountain August 22, and several were seen among the lava rocks on the west side of the desert September 21 and 26.

Troglodytes aëdon aztecus. Western House Wren.

Tolerably common about the bottom of the Douglas fir belt in summer. Common in bushes bordering the Little Colorado during the latter part of September.

Cistothorus palustris. Long-billed Marsh Wren.

Common in the tall rushes in Tanner's pond, a few miles north of Moencopie.

Certhia familiaris montana. Rocky Mountain Creeper.

Tolerably common in the Douglas fir belt and the upper part of the pine belt.

Sitta carolinensis aculeata. Slender-billed Nuthatch.

Tolerably common in the tall pines and balsams; found also at the Grand Cañon during the middle of September.

Sitta canadensis. Red-bellied Nuthatch.

Recorded by Dr. Mearns from San Francisco Mountain; not secured by us.

Sitta pygmæa. Pygmy Nuthatch.

The most abundant and characteristic bird of the pine belt, to which it is probably restricted during the breeding season. In the fall it ranges up through the Douglas fir zone. It commonly moves in small flocks, and is one of the most familiar and affectionate of birds.

Parus inornatus griseus. Gray Titmouse.

Breeds commonly in the piñon belt, to which it seems to be restricted and in which it was encountered at various points from Turkey Tanks to the Grand Cañon.

Parus gambeli. Mountain Chickadee.

Breeds abundantly in the spruce and fir zones, and is tolerably common in the pines during the latter part of August and September.

Psaltriparus plumbeus. Lead-colored Bush-tit.

Tolerably common in the piñon belt; not seen elsewhere.

This species was described by Baird from specimens collected along the Little Colorado by Kennerly and Möllhausen in November, 1853. Dr. Kennerly states that it was found in large flocks among the scattered bushes along the river.

Regulus satrapa. Golden-crowned Kinglet.

Not observed by us, but recorded by Woodhouse from San Francisco Mountain, where he found it in October, 1851, associated with *R. calendula* and *Parus gambeli*.

Regulus calendula. Ruby-crowned Kinglet.

Common on the mountain, where it breeds in the spruce belt. It was tolerably common at the Grand Cañon the middle of September.

Poliophtila cærulea. Blue-gray Gnatcatcher.

Common in the cedar belt and at the Grand Cañon of the Colorado. Two were seen in the greasewood along Moencopie Wash, late in September.

Myadestes townsendii. Townsend's Solitaire.

Breeds in the Boreal zones of San Francisco Mountain and Kendrick Peak. A spotted young was shot on Kendrick Peak, August 25. During migration it was seen as low as the cedar belt (September 16).

Turdus aonalaschkæ auduboni. Audubon's Hermit Thrush.

Breeds abundantly throughout the spruce and Douglas fir zones. Spotted young were shot August 1.

Merula migratoria propinqua. Western Robin.

Occasionally seen in the pines and along the lower part of the fir belt. A few were seen at Grand Falls on the Little Colorado the middle of August, and it was tolerably common at the Grand Cañon of the Colorado the middle of September.

Sialia mexicana. Western Bluebird.

Breeds abundantly in the pines, and was common in the cedars and piñon in early autumn.

Sialia arctica. Mountain Bluebird.

Breeds sparingly; rare until September 5, when it suddenly became abundant; afterward seen at frequent intervals until the end of the month, principally in the cedars.

PART V.—ANNOTATED LIST OF REPTILES AND BATRACHIANS COLLECTED BY DR. C. HART MERRIAM AND VERNON BAILEY ON THE SAN FRANCISCO MOUNTAIN PLATEAU AND DESERT OF THE LITTLE COLORADO, ARIZONA, WITH DESCRIPTIONS OF NEW SPECIES.

By LEONHARD STEJNEGER.

A.—REPTILIA.

Crotaphytus baileyi sp. nov. Plate XII, fig. 1.

Diagnosis.—Similar to *C. collaris* in coloration, but with at least two rows of interorbital scutellæ; supraoculars smaller; head narrower, and snout longer.

Habitat.—Western New Mexico, Arizona, Utah, Nevada, and northern Mexico.

Type.—U. S. National Museum No. 15821; Painted Desert, Little Colorado River, Arizona; September 26, 1889; Dr. C. Hart Merriam and V. Bailey, coll.

Synonymy.—*Crotaphytus collaris* Auct. part nec Say.

Crotaphytus collaris var. Bocourt, Miss. Scientif. Mexique, Zool., Rept., 3 livr., p. 155, pl. xvii bis, figs. 6, 6a (1874).

Bocourt seems to have been the first to notice the difference in the scutellation and proportions of the heads of the typical *Crotaphytus collaris* and the form here named *C. baileyi*, but owing to the fact that he only possessed a single specimen of the latter, with somewhat uncertain locality ("Mexico") he failed to recognize the full significance of the characters he so admirably describes and figures. The general similarity in the very striking coloration which in both forms is equally variable seems to have overshadowed the structural distinction between them.

The type of Say's *Agama collaris* came from the Verdigris River, near its junction with the Neosho River, Creek Nation, Indian Territory. I have therefore selected a specimen collected at the Verdigris River (U. S. National Museum, No. 9368) for comparison and illustration as typical of the species. (See pl. XII, fig. 2.)

The differences between the two forms are so well expressed in the figures accompanying this paper that a detailed description is quite unnecessary. Suffice it to say that I have found these characters to hold good in a collection of over seventy specimens from nearly thirty dif-

ferent localities in the West, due consideration being given to individual variation.

If we plot on a map the exact localities from which we have undoubted specimens (see map, pl. XIII) we shall find that our specimens of *C. collaris* hail from Kansas, Indian Territory, Arkansas, Texas, and eastern New Mexico, while specimens of *C. baileyi*, with definite localities, are at home in the western portion of the latter territory, in Arizona, Nevada, and northern Mexico. It will be seen that the two forms come very close together in New Mexico, but they belong to two different drainage systems, at least in the northern portion of the territory, and I do not believe that both will be found anywhere in the same locality.

There can consequently be no doubt that both forms are subspecies of the same species, but whether the form now named for the first time should receive a trinomial appellation or not is quite another thing, depending, according to the code of zoological nomenclature adopted by the American Ornithologists' Union,* which I adhere to in all my writings, upon the question whether the two forms are "now known to intergrade" or not.

In the collection before me there are a few specimens which present features which at first sight might seem to indicate intergradation. Thus No. 2725, collected by Dr. Kennerly "between Los Angeles and Rio Grande," and one of the specimens of No. 4958, Pecos River, Texas, Captain Pope, are quite alike as far as the interorbital scutellation is concerned, and neither are typical in this respect, inasmuch as both have a large interorbital, with a minute scale on the edge of it instead of either a large single one, or two smaller of equal size; but a comparison of the two specimens shows at once that the first mentioned one with the elongated snout belongs to *C. baileyi*, while the latter does not materially differ from the two typical *C. collaris* in the same bottle.

A specimen of No. 2715 is in every way similar to Dr. Kennerly's *C. baileyi* just referred to; two others in the same bottle seem to be typical of this form, while the remaining two are typical *C. collaris*. These specimens were collected by Möllhausen, under Lieutenant Whipple, "near Canadian," but it is quite significant that he crossed from the Canadian River into the territory exclusively inhabited by our new form, consequently across the boundary between the two.

It is quite possible that intergradation takes place, especially in southern New Mexico east of the Rio Grande, but until the fact shall have been proved conclusively I refuse to adopt a clumsy trinomial.

So far I have been unable to establish any difference in color between the two forms, though at one time I thought that *C. baileyi* had a better developed black collar usually connected on the neck, but the exceptions are too many to make this tendency available as a character.

* Canon xi, The Code of Nomenclature, etc., adopted by the American Ornithologists' Union. New York, 1886.

During the second trip across the Painted Desert (September 21 to 26), Dr. Merriam collected seven specimens (Nos. 15821 to 15827) of various sizes near the Little Colorado River. Several of them were quite fresh when brought to camp, and I had the opportunity to make a color sketch and the following description from a young individual (No. 15824), the color designations referring to Ridgway's "Nomenclature:"

Head above pale sepia, inclining to clay color; anterior portion of upper neck in front of the first black collar pale blue, with several longitudinal marks of 'coral red;' space between the two black collars pale 'oil green,' with a narrow transverse collar of coral red; ground color of back dull oil green, fading posteriorly on hind legs and tail to a grayish 'pea green,' the back densely covered with rather large dark grayish olive blotches, which only allow the ground color to show through as a fine reticulation; the second black collar bordered posteriorly with a wide line of 'lemon-yellow,' the back being crossed by five similar lines, fading posteriorly and more or less alternating on the lateral halves of the body; tail with transverse bars of dark grayish brown; fore legs above 'apple green,' nearly yellow on the hand and faintly barred with the latter color; under surface pale greenish-white, palms slightly pinkish, tail nearly white. Tongue deep pink; pharynx blackish carmine; palate ultramarine blue. Iris brassy greenish-yellow.

Crotaphytus wislizenii B. & G.

The only specimen was collected near the Great Falls of Little Colorado River, August 18 (U. S. Nat. Mus., No. 15820.) It is a full-grown female of the typical form.*

* A comparison of Dr. Merriam's specimen with the material in the National Museum, more than seventy specimens, led to the discovery that those of the Pacific province from central California northwards belong to a separate form which I propose to characterize as

Crotaphytus silus sp. nov.

Diagn.—Similar to *C. wislizenii*, but with the snout much shorter and more truncate in profile; greatest width of head equal to or greater than distance from nostril to ear opening; distance between nostril and inner anterior orbital angle considerably less than vertical diameter of ear opening.

Hab.—San Joaquin Valley, California, to the State of Washington.

Type.—U. S. National Museum No. 11790 A; Fresno, Cal.; Gustav Eisen, coll.

This form is not *C. gambeli* B. & G., the type of which (U. S. Nat. Mus., No. 2722) is before me, showing all the typical features of *C. wislizenii*. As stated in the original description (Proc. Phila. Acad., VI, 1852-'53, p. 126) the exact locality of Gambel's specimens is not known, but as they were collected by him during his trip to California it has been surmised that they were from the latter State. Though this is by no means certain, it is quite possible, for I suspect that the form occurring in the desert region of southern California will be found to agree with that of Arizona and New Mexico, *i. e.* the true *C. wislizenii*. Nor is it the same as *C. copeii* Yarrow, from which the new form differs in the same manner as it does from *C. wislizenii*.

Uta stansburiana B. & G.

Three specimens in excellent condition (U. S. Nat. Mus., Nos. 15842-15844) were collected in the Painted Desert, near the Little Colorado River, September 21. These are in every way typical.

Four young specimens (Nos. 15845-15848) were secured in the Grand Cañon of the Colorado on September 12, about 500 feet above the bottom. These seem to have longer arms than typical examples, resembling in that respect *U. palmeri*,* but owing to their bad state of preservation it is impossible to come to any conclusion, though it is certain that they do not belong to the latter form. I made the following notes on their color while yet tolerably fresh :

Nos. 15846 and 15847: Above coppery drab with three longitudinal series of indistinct brown spots along the back, which is speckled all over with numerous bluish white dots one to three scales large; tail somewhat grayer with faint cross-bars of a slightly darker color, and a longitudinal dusky spot along the median line of each of the darker cross-bars on the anterior half of the tail; legs with faint dusky cross-bars; head more rusty on the crown inclining to greenish bronze on supraorbitals and the region between them; snout, dusky; under side whitish, flanks inclining to greenish; chin and throat sky blue with faint dusky marblings. No. 15845 is similar, but with fewer light specks on the back, and with numerous dusky dots particularly noticeable on the upper neck; whole head uniform coppery drab; cross-bars on tail more distinct; chin and throat whitish, slightly suffused with

I have *C. silus* from the following localities :

U. S. Nat. Mus. No.	Locality.	Collector.	No. of specimens.
11790	Fresno, Cal.....	G. Eisen	8
11757	.....do	do	3
9581	Fort Tejon, Cal	W. M. Gabb.....	2
12771	Des Chutes River, Oregon.....	Captain Bendire	1

* **U. palmeri** sp. nov.

Diagn.—Similar to typical *U. stansburiana* and with the same dorsal lepidosis, the scales being small, tuberculate, and not carinated for their entire length, but much larger and with longer fore legs, the tips of which, when adpressed, reach to or beyond the insertion of the thigh; scales on edge of collar much smaller; large prefrontals about twice as large as the largest supraoculars; number of femoral pores about 17; about 30 dorsals in a head length; color (in alcohol) above uniform bluish drab, with numerous small whitish dots, two to three scales large, sprinkled over the body, and no dusky markings whatever; dark blue blotch behind axilla present, though rather indistinct.

Hab.—San Pietro Martir Island, Gulf of California.

Type.—U. S. National Museum, No. 16002; Dr. Edw. Palmer, coll.

Dimensions of largest specimen (♀): Total length (tail reproduced) 158^{mm}; head 15^{mm}, width of head 14^{mm}; snout to posterior gular fold 25^{mm}; gular fold to vent 48^{mm}; fore limb 33^{mm}; hind limb 52^{mm}.

bluish and marbled with purplish gray; upper and lower mandibles suffused with 'salmon color.'

Uta ornata B. & G.

After a careful examination of the material at hand I have come to the conclusion that there exists a well-marked difference between *Uta ornata* of Baird and Girard and *U. symmetrica*.

This difference, however, is not the one which would suggest itself upon a comparison of the original descriptions (for instance, as contrasted by Boulenger, Cat. Liz. Br. Mus., II, pp. 210-211, and quite naturally so) inasmuch as both forms have the median dorsal series much smaller than those immediately adjoining it on both sides. Judging from the original description of *U. ornata* one would imagine the dorsal lepidosis to be similar to that of *U. graciosa* (Hallowell), but I have Baird and Girard's types before me (U. S. Nat. Mus., No. 2750,* Rio San Pedro, Texas, J. H. Clark, coll.), which show conclusively that both forms in this respect are essentially on the same plan. That the original describers failed to point out this character was undoubtedly due to the fact that at that time they had only to compare their new species with *U. stansburiana* from which the characters given were quite sufficient to separate it.

The chief difference between the two forms seems to be one of proportions *U. symmetrica* being more slender and elongated, with much longer hind limbs, particularly tibiæ and toes. The males in both forms are slenderer than the females, but the difference is well marked if specimens of the corresponding sex are compared. As a rule the difference may be expressed thus: In *U. ornata* the hind leg is shorter than distance from posterior gular fold to vent; while in *U. symmetrica* the hind leg equals or exceeds the same distance.

Though arranged on the same plan with a series of smaller dorsals in the middle, there is, nevertheless, a well marked distinction between the dorsal lepidosis of the two forms; for in *U. symmetrica* the difference between the two kinds of rows is greater, and their arrangement more symmetrical and orderly, the keels of the larger ones forming four nearly continuous parallel lines, while in *U. ornata* the rows are not so perfect, the outer one being often very irregular, both in size and number, more or less interrupted, or in some places divided into two smaller rows. In one of the types, the male, there can hardly be said to be more than one row of large scales on each side of the smaller middle one.

U. ornata and *U. symmetrica* seem to affect different altitudes, the latter occurring in the lower arid and desert regions, while the former is found chiefly in the cedar belt† and above.

* In the Mex. Bound. Surv. Rept., p. 7, the number is erroneously given as 2700, which belongs to a *Crotaphytus*.

† The horizontal distribution of *U. ornata* is as yet uncertain. In addition to the San Francisco Mountain specimens I have seen others collected near Fort Whipple,

Dr. Merriam collected one specimen (No. 15841) of typical *U. ornata* in the cedar belt of San Francisco Mountain (altitude about 6,800 feet) on September 5. There are two more specimens in the National Museum from the same mountain (No. 4275) collected by H. B. Möllhausen, under Lieutenant Ives.

Uta symmetrica Baird.

As already pointed out under the foregoing species, this one is quite distinct from *U. ornata*, and in its distribution is a lowland and desert form. Professor Baird's type (No. 2760) from Fort Yuma, seems to be lost, but I have an excellent series of sixteen specimens (No. 2744) from the same locality, ample material for establishing the characters of the species. The three specimens (Nos. 15838-15840) all males, collected by Mr. Bailey near the bottom of the Great Cañon of the Colorado River, altitude about 2,500 feet, agree very well with these and are undoubtedly true *Uta symmetrica* as distinguished from *U. ornata*.

Two of the specimens were in good condition when brought into camp, and afforded me an opportunity to make the following notes on the fresh colors:

No. 15838. Ground color above grayish-drab, more pinkish on tail and along the middle line, with a series of eight 'herring-bone' cross-bars of dusky, growing pale posteriorly and including a light spot on the

Arizona (Dr. Coles, No. 11881, seven specimens; Captain Carpenter, No. 15693). I refer to this form with some doubt a specimen (U. S. Nat. Mus., No. 15729) which I collected last year on the rim of Walnut Cañon near Flagstaff, Arizona (about 7,000 feet altitude). It is very peculiar in having the scales bordering the posterior gular fold considerably larger than any *Uta* I have seen, but as it agrees in proportions with *Uta ornata* from the same altitude and neighborhood, I refuse to regard it otherwise than an individual variation until other specimens shall have been obtained.

Two specimens from a widely distant locality, however, agreeing completely among themselves and differing from all the rest before me, though evidently belonging to the same group as *U. ornata*, will have to be diagnosed under a separate name as—

Uta levis sp. nov.

Diagn.—A band of about six longitudinal, somewhat irregular rows of enlarged and only slightly carinated scales along the middle of the back from the shoulders backwards; the two median rows smaller; no lateral line of enlarged scales or tubercles on body or neck; frontal divided transversely; tail much less than twice the length of head and body; length of hind leg considerably less than distance from posterior gular fold to vent; no dark spot behind axilla.

Hab.—Tierra Amarilla, New Mexico.

Type.—U. S. National Museum, No. 11474; Prof. E. D. Cope, coll.

This form, of which both male and female (Nos. 11474, 8554) were collected by Professor Cope at Tierra Amarilla, about 110 miles northwest of Santa Fé, New Mexico, at an altitude of about 7,800 feet, is easily distinguished from *U. ornata*, its nearest ally, by the absence of the lateral enlarged scales or tubercles, those on the dorso-lateral fold being scarcely perceptibly larger than the other dorsal granules; nor are there any pointed tubercles or cluster of tubercles on the neck. In addition to these characters the carination of the enlarged dorsals is rather feeble. As in typical *U. ornata* the hind legs are short and the dorsal scale rows very irregular. The color of both specimens above is uniform pale without the slightest trace of markings; the male has flank patches of a pale sky-blue (in alcohol).

middle line; the six anterior cross-bars are bordered behind by a narrow black line, and all, both in front and behind, by a whitish line which is broader behind than in front; on the sides several rows of indistinct pale spots, many of them bordered anteriorly by dusky; a narrow dusky line across the head between the eyes; an indistinct dusky line from nostrils through eyes to above ear; legs and tail with indistinct and irregular cross-bands of a lighter shade than the ground color; underside whitish, with an elongated patch of emerald green on the flanks and a more yellowish one on the middle of the throat. (Now, after having been in alcohol for more than half a year, the green of the flanks has changed to a faint sky-blue, and the yellowish throat patch has disappeared.)

The other specimen (No. 15840) is considerably smaller. It resembles the above, though a little darker and with the pattern more distinct; no green on flanks, and the throat patch pinkish-yellow (now disappeared).

Holbrookia maculata flavilenta Cope.

By this name Professor Cope recently designated some specimens from Lake Valley, New Mexico, and as I find all the western specimens differing from true *H. maculata* in much the same manner as described by him and being in need of a name for this western (west of the Rio Grande) subspecies, I adopt the above appellation, at least provisionally.

This is the form which Professor Cope formerly called *H. propinqua* (for instance: Proc. Phila. Acad. 1866, p. 303; Expl. W. 100 Merid, v. p. 601), a species which he has later restricted—and most properly so—to southwestern Texas. The New Mexican and Arizona specimens were left with *H. maculata* “subspecies *maculata*.” Yet the differences between these specimens and typical *H. maculata* which originally led to their identification with *H. propinqua* do in reality exist, though they are difficult to express in words, but they do also intergrade, to some extent, necessitating the use of trinomials.

In order to properly identify the specimens brought home by Dr. Merriam, I was obliged to review the whole question of *H. maculata* and its various races, and I came to the conclusion that there are two main races, each with a special geographic color variety. I may tabulate them as follows, indicating at the same time their geographic distribution *in so far as I have been able to examine specimens* from undoubted localities.

A. Pointed snout and narrow anterior supralabials.

1. *Holbrookia maculata*, typical: Northern Texas, Indian Territory, Kansas, Nebraska, eastern Colorado.
2. *H. m. lacerata*: Central Texas.

B. Truncate snout and broad prominent anterior supralabials.

3. *H. m. flavilenta*: Western New Mexico, Arizona, except extreme southern portion.
4. *H. m. approximans*: Southern Arizona, parts of Sonora, Chihuahua and Coahuila.

H. lacerata I take to be only a color race of typical *H. maculata*. In outline of head, shape of labials, and proportions I can find no difference between the ♂ *H. lacerata* (No. 10160 Helotes, Texas; W. G. Marnock, coll.) and various males of the typical form. So far as coloration of the upper parts are concerned, *H. lacerata* is closely approached by three specimens from Neosho, Kansas (No. 4693), and in regard to the lateral spots it may be stated that they are present in all three examples belonging to the National Museum, though the original description expressly says: "No blue spots on the sides."

Both *H. approximans* and *H. flavilenta*, as here understood, differ from true *H. maculata* as exemplified by numerous specimens from the typical locality, the Platte River, in the more truncated outline of the snout, as seen from above, the greater width, height, and obliqueness of the supralabials, and generally, in the reduced number, consequently greater size and greater flatness of the scales on top of the snout. As a rule the hind feet of these western forms are longer, but proportions of feet and tail as compared with length of body vary to such an extent individually all over the range of the species that they are hardly available for purposes of identification.

H. approximans seems to differ from *H. flavilenta* chiefly, if not exclusively, in having the lateral dark spots placed a little further back and surrounded by more blue.

Dr. Merriam's specimens (U. S. National Museum, Nos. 15828-15837) were collected in the Painted Desert, some at Moencopie, but the majority near the Little Colorado River, between September 21 and 26. One is quite young, the others full grown, or nearly so.

Sceloporus clarkii B. & G.

Originally described from southern Arizona, and by subsequent collectors ascertained to inhabit the drainage basin of the Gila River as well as the lower Colorado valley. Dr. Merriam's discovery of its occurrence in the Grand Cañon of the Colorado River north of San Francisco Mountain materially extends the range of the species northward and adds another to the many southern forms which push their northern outposts up through this wonderful cañon. As one of the specimens was caught about 1,000 feet above the bottom of the cañon, it is quite possible that this species may extend at least as far as the mouth of the San Juan River, or across the border into Utah.

Of the two specimens collected (Nos. 15849, 15850) one is very young—head and body 38^{mm} long. Its coloration is very pronounced and differs considerably from that of the adults, except the head and upper neck. The rest of the upper surface is of a pale bluish drab, with very distinct blackish-brown cross-bars, those on one side of the back alternating with those on the other side; across the neck just in front of the shoulders there is a nearly complete brownish black collar, laterally bordered with pale yellow both in front and behind. In the other specimen, which is more than half grown, only a trace is left of the

collar, consisting of a blackish spot on each shoulder bordered behind with pale yellowish.

Sceloporus consobrinus B. & G.

Like *Uta ornata*, the present species is confined to the Cedar belt of the plateau, where it is not uncommon. Four specimens were collected: No. 15854, San Francisco Mountain, August 25, 1889; No. 15853, in the Cedar belt north of the mountain, at an altitude of about 6,500 feet, September 9; and two (Nos. 15851-'2) near Cañon Spring, at the rim of the Grand Cañon, September 13 and 15. It is not found either in the cañon or in the desert.

Sceloporus graciosus B. & G.

A very young specimen (No. 15855), which was collected at Tanner's Gulch, Painted Desert, on September 24, I refer to this species, although it differs considerably in coloration from the full-grown specimens which I have been able to compare it with. The dorsal spots are represented by two longitudinal brownish bands, narrowly margined with black, bordering a median band of nearly the same width but of a beautiful sky-blue color; laterally the dark bands are again bordered by a white one of equal width; beyond this there is a wider dusky band, followed again on the sides by a narrower and less well-defined white band which is set off from the light under surface by a shade of dusky.

Sceloporus elongatus, sp. nov.

Diagnosis.—Head shields smooth; occipital comparatively small, but broader than parietals; two or three parietals on each side; two scales on canthus rostralis; supraoculars, one large row and three small subequal ones, two outer and one inner; five free scales in front of ear opening; dorsal rows nearly parallel; lateral scales but little smaller, in oblique rows; scales on shoulders large, connecting dorsals with brachials; dorsal scales keeled, pointed, with a well-pronounced notch on each side of the point, 47 to 51 scales between occipital and tail, 9 to 11 in a head length; femoral pores 16 to 18 on each side, not meeting medially; tail about eight times the length of the head; distance between base of fifth toe and extremity of fourth, including claw, less than distance from nostril to arm, and much more than from snout to posterior margin of ear; no color band across nape; no longitudinal color bands; males with dark blue patches on flanks and one on each side of throat, females similarly marked, but colors less vivid and less extended.

Habitat.—Painted Desert, Arizona.

Type.—U. S. National Museum, No. 15858; Moa Ave, Painted Desert, Arizona; September 23, 1889; Dr. C. Hart Merriam, coll.

Unable to identify the specimens brought home by Dr. Merriam from the Painted Desert with any of the numerous forms described, I have been obliged to introduce them under a new name. Although nearly related to several of the species already known it is not an intermediate form

connecting any of them, as in slenderness it surpasses them all, the tail and hind legs being particularly elongated.

In the number of dorsal scales this form is intermediate between *S. consobrinus* and *S. graciosus*, though the number included in a head length is the same as in the former, but in the new form the scales are not so strongly carinated, the keel being lower and mostly confined to the terminal half of the scale. It also agrees with *S. consobrinus* in the distribution of the blue color on flanks and throat, but shares with *S. bocourtii* the peculiarity of exhibiting a similar coloration in the females and young, differing from the latter, however, in having a blue mark on each side of the throat instead of a single one on the middle of the throat. The coloration of the upper side, however, is more of the *S. undulatus* type; but it is much lighter, the dark undulating cross-lines are not so heavy, and there is no trace of longitudinal bands. Even in the very young specimen these color characters are well pronounced and identical with the adults.

Measurements (in millimeters).

U. S. National Museum No.	Collector.	Sex and age.	Locality.	Date.	Total length.	Snout to occiput.	Width of head.	Snout to vent.	Fore legs.	Hind legs.	Vent to tip of tail.	Remarks.
15858	Dr. C. Hart Merriam and V. Bailey.	♂ ad.	Moa Ave, Arizona.	Sept. 23, 1889	199	15	14	75	34	52	124	Type.
15859	.....do	♀ ad.	.....do .....	.....do	197	16	13	73	35	50	124	
15856	.....do	♀ ad.	Little Colorado River, Arizona.	Sept. 21, 1889	.....	14	12	70	32	49	*77	
15857	.....do	juv.	.....do	Sept. 26, 1889	104	10	8	40	.....	28	64	

* Tail reproduced.

Phrynosoma hernandesi (Gir.).

To avoid mistakes I may at once remark that this name is intended for the interior form usually designated as *Ph. douglassii*, or even *Ph. douglassii douglasii* (!), as distinguished from the northwest coast form known as *Ph. douglassii pygmaea*, for as it was upon the latter that Bell founded his *Agama douglassii*, it is plain that the dwarf species found in the territory drained by the Columbia River is entitled to the name *Ph. douglassii* without any further qualifying trinomial.

It is beyond the scope of the present paper to discuss in detail the status of all the forms which are more or less closely grouped around *Ph. douglassii*, but I may state in this connection that the examination of a very extensive material has convinced me of the necessity of recognizing at least four different forms, each with a definite and distinct geographical distribution, viz, the typical *Ph. douglassii* (= *pygmaea*)

from Oregon and Washington; *Ph. hernandesi* (= *douglassii* Auct. nec Bell) from the wooded plateau region of Colorado, Utah, New Mexico, and Arizona; *Ph. ornatissimum*, from the desert region of the latter territories; and *Ph. brevirostre* (Gir. nec Cope), a small edition of *Ph. ornatissimum* from Wyoming and, in general, the drainage basins of the Yellowstone and Platte Rivers.

Of these, only *Ph. hernandesi* and *Ph. ornatissimum* concern us in the present connection.

After having discovered that *Ph. pygmaea* is only a synonym of typical *Ph. douglassii*, it remained to ascertain which name in the long list of synonyms would be available for the form so long known as *Ph. douglassii*. It was then found that Girard's types of *Ph. hernandesi* in the U. S. National Museum (Nos. 107, 198) are still extant and that they are identical with the plateau form here in question.

Fortunately, Girard's type of *Ph. ornatissimum* is also preserved (U. S. National Museum, No. 204), so that we have authentic bases for both names. It remains now only to point out the differences between these species, differences which may be more easily appreciated by an inspection of plate XII, figs. 3 and 4, drawn from specimens collected by Dr. Merriam.

In *Ph. hernandesi* the head is more pointed, the lateral outline being straight or even concave, against convex in *Ph. ornatissimum*; the spines both on head and body are considerably larger and more numerous; the occipital spines are more horizontal, sloping backwards and parallel with the temporal spines, hence the outline of the occipital angle when viewed from above is subdivided into three angles by the points of the occipital spines, while in *Ph. ornatissimum* the occipital spines are more erect so that they do not protrude backwards into the occipital angle which, besides, is considerably more shallow. In *Ph. hernandesi* the occipital spines are also placed much nearer to the temporal spines, the interval being less between the occipital spines and the apex of the occipital angle, while in *Ph. ornatissimum* they are situated about midway, there being a large opening between the occipital spines and the temporal ones. The spines on the dorsal surface are larger in *Ph. hernandesi*, especially the row on the neck running backwards from the tip of the occipital spines. *Ph. hernandesi*, moreover, seems to have a considerably longer tail, it being quite as long in the females as in the males of *Ph. ornatissimum* (the males as is well known having considerably longer tails than the females). There are also decided differences in coloration, in spite of the great individual variation in both species. Quite characteristic of *Ph. hernandesi* is the red color of the cephalic spines, while the rest of the head is more or less of a greenish or bluish gray.

Phrynosoma hernandesi has a range corresponding to that of *Uta ornata* and *Sceloporus consobrinus*, being chiefly confined to the cedar belt and the lower pine belt. It was collected by Dr. Merriam at various

points on San Francisco Mountain at various altitudes from 7,000 to 8,500 feet, and I myself obtained specimens of the same form at Hull's Spring (6,000 feet alt.) and at the Cañon Spring. A melanistic form was found in the black lava beds east and northeast of the mountain. The following is a full list of the specimens brought home by Dr. Merriam :

U. S. Nat. Mus. No.	Sex and age.	Locality and altitude.	Date.
15799	♂ ad.	San Francisco Mountain, Arizona (7,000 feet).....	Sept. 8, 1889
15800	♂ ad.	.....do.....	Sept. 5, 1889
15801	♂ ad.	.....do.....	Do.
15802	♂ ad.	.....do.....	Do.
15803	♂ juv.	.....do.....	
15804	♂ juv.	.....do.....	Aug. 20, 1889
15805	♂ juv.	.....do.....	Aug. 7, 1889
15806	♀ ad.	.....do.....	Aug. 20, 1889
15807	♀ ad.	.....do.....	Aug. 5, 1889
15808	♀ ad.	.....do..... (7,000 feet).....	Sept. 5, 1889
15809	♀ ad.	.....do.....	Aug. 17, 1889
15810	♀ ad.	.....do..... (8,500 feet).....	Aug. 8, 1889
15811	♀ ad.	.....do..... (7,000 feet).....	Sept. 5, 1889
15812	juv.	.....do.....	Aug. 17, 1889
15813	juv.	.....do.....	Aug. 25, 1889
15814	♂ juv.	Black lava beds east of mountain.....	Aug. 19, 1889
15815	♂ juv.	Black lava beds northeast of mountain.....	Sept. 26, 1889

Much has been written in regard to the perfection with which these animals 'imitate' the color of the ground on which they live, and our own observations fully verified the statement that they afford one of the most striking examples of protective mimicry. In the cedar and pine belts of the San Francisco Mountain the dark brown color of the soil and stones covering the surface is closely matched by the ground color of the *Phrynosomas*, while the greenish gray and orange colored markings which somewhat irregularly adorn their backs are perfect imitations of the lichens covering the rocks and pebbles among which these odd-looking creatures live. Near the rim of the Grand Cañon of the Colorado, on the other hand, the ground is covered with small pebbles of variously colored sandstone, ranging from a clayey white to brick red and dark brown, and the specimen which I collected there (No. 15724) is such a faithful reproduction of the surroundings that it would undoubtedly have remained undetected had it not been moving. Even more remarkable are the specimens which Dr. Merriam collected in the black lava belt east and northeast of the mountain. One of these (No. 15815) was brought to camp alive, enabling me to make the following description of the fresh colors: "Ground color of upper side, including head, satiny black; light markings on median third of body

dull 'Naples yellow,' abruptly changing into the yellow ochre of those on the sides; tips of most lateral spines white; tips of largest cephalic spines marbled with ochre; under side yellowish white, densely marbled with blackish; collar, light ochre yellow." In these specimens even the gloss of the black lava was imitated.

Phrynosoma ornatissimum (Gir.).

The differences between this species and *Ph. hernandesi* have been pointed out under the head of the latter. They seem to be constant, they are well pronounced in the adults, and there seems to be no intergradation, so that I see no reason for adopting a trinomial appellation.

As already alluded to, this species is a true desert form, and it was consequently found by Dr. Merriam only on his trips through the Painted Desert. The following specimens were secured:

U. S. Nat. Mus. No.	Sex and age.	Locality.	Date.
15816	♂ ad.	Painted Desert, Arizona	Aug. 17, 1889
15817	♂ ad.	Little Colorado Desert, Arizona	Sept. 25, 1889
15818	♀ ad.	.....do	Sept. 24, 1889
15819	♀ ad.	Moencopie, Painted Desert, Arizona	Do.

Judging from these specimens the normal coloration of *Ph. ornatissimum* is a pale cinnamon rufous on the back, with large round black spots, surrounded by a pale yellow line; upper side of head including spines uniform cinnamon rufous of the same shade as the ground color of the back.

The relation between *Ph. hernandesi* and *Ph. ornatissimum* and their distribution offers a most interesting parallel to that observed between a number of species of rodents, as pointed out by Dr. Merriam on previous pages (see pp. 55, 56, 59, 60, 74).

Eutainia vagrans B. & G.

The only snake collected was found by Mr. Bailey in the crater of O'Leary Peak, 9,000 feet altitude, October 2. (No. 15798.) This was, moreover, the only snake seen during the entire stay of the party in the San Francisco Mountain * plateau, though a single rattlesnake was seen on the Painted Desert, near Tenebito Wash, by Dr. Merriam.

* This is a fact well worth recording, for it tends to corroborate the statement that snakes, especially rattlesnakes, are becoming rare in many western localities where they were quite abundant not long ago. During a short stay in July, 1864, Dr. E. Cones collected quite a number of rattlesnakes belonging to no less than four different species, on the same mountain, where not one was seen by Dr. Merriam's whole party during a stay of two months. The species collected by Dr. Cones have been determined as follows: *Crotalus confluentus*, *molossus*, *lucifer*, and *scutulatus*. (Wheeler's Expls. W. 100 Mer., v., pp. 604-608.)

B.—BATRACHIA.

Amblystoma tigrinum (Green).

While we were sitting around the camp-fire in the evening of September 19, a salamander (U. S. Nat. Mus., No. 16179) was suddenly seen writhing in the hot ashes, having probably dropped off one of the burning logs. I follow Cope's authority in adopting the above name. San Francisco Mountain is the locality whence came the type of Hallowell's *A. nebulosum*.

The fresh colors above were dark olive and "straw-yellow" in about equal proportions; a ring round the eyes and upper lips tinged with reddish; under side of head whitish; of body, pale yellowish-gray; free portions of digits tinged with pink; iris dark hazel.

Bufo lentiginosus woodhousei (Gir.).

Two medium-sized specimens (Nos. 16181, 16182) were collected on September 24 at Tanner's Gulch, 3 miles north of Tuba City, Painted Desert. They are normally colored though rather light, especially the smaller one. The following color notes were taken from the fresh specimens: "Above pale olive-green with a somewhat lighter stripe down the middle of the back; tip of tubercles pale red surrounded by black rings; lower surface olive-white."

Two other and much smaller specimens were obtained at Tanner's Crossing of the Little Colorado, September 22 (Nos. 16183, 16184). Although differing greatly from the former in coloration, I can find no other character to distinguish them. A colored sketch and description from the fresh specimens at the time are to the following effect: "No. 16183. Entire upper surface pale flesh color, suffused with buff on hands and feet; parotoids darker, nearly 'brick-red' except in the middle; all the tubercles of the same red color; each of the larger ones surrounded at the base by a circle of minute black specks; a narrow white stripe down the middle of the back; a few dusky annular marks on upper flanks and hind legs; under surface bluish-white; lower abdomen and inner side of hind limbs pale brownish-yellow; palms of the same color, but the inner surface of the fore limbs pinkish; iris brassy, densely clouded with dark mottlings, except a narrow inner ring which is bright metallic."

Professor Cope, in his elaborate work on the "Batrachia of North America" (Bull. U. S. Nat. Mus., No. 34, p. 282), as a reason for leaving Hallowell's *B. dorsalis* out of the synonymy, makes the following statement:

There is nothing in the description nor in the figure to enable us to ascertain what species or subspecies is represented. The evidence is as much in favor of the specimen having been a *B. l. americanus* as a *B. l. woodhousei*, and no locality is given to assist in reaching a conclusion. The type specimen can not be found.

This is not so, for in the first place Hallowell gives the locality of the only specimen expressly as "San Francisco Mountain, New Mexico" (*i. e.*,

Arizona), and in the second place mention is made of the shortness of the head ("Length of head, 8 lines; length of head and body, 3 inches," consequently "head 4.5 times in length"). Moreover, Girard, who afterwards examined and partly described the type specimen, simply changed the name because *B. dorsalis* was already preoccupied by Spix, and we are well warranted in regarding the only specimen brought home by Dr. Woodhouse as the type of *B. woodhousii*. Finally, Hallowell's type of *B. dorsalis*, so far from not being found, is one of the very specimens enumerated by Professor Cope, viz, No. 2531. The "Calif. Mts." in the original entry on the Museum record book is simply a slip for San Francisco Mountain, as is evidenced by the original parchment label still attached to the specimen, which reads:

"*Bufo dorsalis* Hallowell, San Francisco Mountain, New Mexico. S. W. Woodhouse, M. D."

This also disposes of another statement by the same author (*op. cit.*, pp. 282-284) that Möllhausen's specimen from Canadian River (U. S. Nat. Mus., No. 2632) is the type. Girard, at the time of publishing the name *B. woodhousii* had only the "Sonoran" specimens from the U. S. Mexican Boundary Survey and Hallowell's type of *B. dorsalis*. Those from the Pacific Railroad surveys under Whipple came in later.

Bufo punctatus B. & G.

Four specimens (U. S. National Museum, Nos. 16185-16188) of this species were collected by Mr. Bailey at the bottom of the Grand Cañon, September 13, 1889. I took the following color description from one of the fresh specimens (No. 16185): "Above 'malachite-green' densely speckled with small dots of bright vermilion; limbs paler, dotted with vermilion and also with minute black specks which likewise occur on the flanks; region surrounding nostrils black; upper lips and whole under surface bluish-white, irregularly speckled with black; posterior part of belly and underside of thighs dark brownish flesh-color; soles, dull orange.

This is a southern species which extends northward along the Colorado River. Möllhausen collected it in the "Upper Colorado Region," which apparently means the region about the Little Colorado River.

Specimens collected: U. S. National Museum, Nos. 16185-16188.

Spea hammondi (Baird).

A single specimen (No. 16180) was collected by Dr. Merriam in the Painted Desert, August 18, 1889. The label is inscribed as follows:

"Tenebitto Wash: found in a hole in wet mud; this wash is dry most of the year."

Hyla arenicolor Cope.

An interesting color variety of this species was collected by Dr. Merriam about 1,000 feet above the bottom of the Grand Cañon of the Colorado, September 13, 1889; and Mr. Bailey obtained similar specimens at the bottom. These specimens, which were found on a very light-colored rock, the exact shade of which they matched, are remarkable for

the nearly total absence of dark markings on the upper surface. They were brought to me fresh, so as to give me an opportunity to prepare the following description of the colors: No. 16189, 1,000 feet above bottom of Grand Cañon, Dr. Merriam, coll. "Iris pale brassy with black marblings. Above uniform frosted silvery, irregularly overlaid with a faint golden gloss which is more brassy on tympanum and sides of face; faint traces of dusky cross-bars on limbs, the light interspaces being pale golden; under side whitish, suffused with pinkish on fore neck, and with pale bluish-green on chin and (more intensely so) on middle of breast and belly; flanks posteriorly, as well as inner surface of limbs, bright and deep gamboge-yellow; under side of thighs and sides of belly more brownish-orange; digital discs pale orange-pink."

The specimens collected by Mr. Bailey were less metallic and more of a clayey color, except the tympanum, which was coppery; discs more purplish-pink; web of hind limbs bright gamboge-yellow. One of these (No. 16190) shows traces of the normal marblings of the species, the description from the fresh specimen being as follows: "Above clayey, with numerous slightly darker spots and well marked cross-bars of the same color on limbs; labial margins whitish; chin dark purplish-gray with whitish dots; breast whitish; belly bluish, gradually shading into yellowish behind; inner surface of limbs bright gamboge-yellow; thighs underneath more brown, speckled with whitish; digital discs pale flesh-color."

Specimens collected: U. S. National Museum, Nos. 16189-16194.

Rana virescens brachycephala. Cope.

Quite a number of these Frogs were obtained at Tuba City and Tanner's Gulch, Painted Desert, September 24, 1889, three of which were preserved (Nos. 16195, 16196, 16197). I have no doubt that this is the species which Hallowell records under the name of *Rana areolata*, as collected by Dr. Woodhouse in the San Francisco Mountain.

FOREST TREES OF THE SAN FRANCISCO MOUNTAIN REGION, ARIZONA.

By Dr. C. HART MERRIAM.

The lofty pine forest of the San Francisco Mountain Plateau has been famous since the days of the early explorers, Sitgreaves, Kennerly, and Ives, who passed through it on their journeys across the continent.

It is a noteworthy forest, not alone on account of the size and beauty of the single species of tree of which it is composed (*Pinus ponderosa*), but also because of its openness, freedom from undergrowth, and its grassy carpet—for the porous lava soil supports a sparse growth of bunch-grass which is high enough after the rainy season sets in to conceal the rocky surface, and, at a little distance, to present the appearance of a meadow. The pleasing effect is heightened by the circumstance that the region can not be reached from any direction without first passing over a long stretch of arid desert.

The pine forest is thoroughly mature, nearly all the trees being of large size, and rarely crowded. Toward the desert it gives place to the juniper and piñon of the 'Cedar belt;' while on the mountains which rise above the plateau level it is invaded and finally superseded by other species. Most of the kinds of trees growing on San Francisco Mountain have been enumerated under the zones in which they occur; hence a brief notice of each will suffice.

Quercus gambelii Nuttall. Oak.

This is the only Oak met with by the expedition. It was seen in the neighborhood of Red Horse Tank, and thence to the Grand Cañon of the Colorado, and in small quantities near Walnut Cañon, but was not found at the mountain. It occurs as a rule in the form of scrub thickets not more than two or three meters in height, but a few large trees were seen near the Grand Cañon.

There is something remarkable respecting the history of this tree in the San Francisco Mountain region. Sitgreaves and other early explorers speak of it as abundant about the mountain, while we did not find it at all in the very places where it was formerly common. Its absence explains the absence of several species of birds which might be expected at the mountain, but which are rarely found except in oak scrub.

Populus tremuloides Michaux. Aspen; Quaking Aspen.

The Aspen is a common tree on San Francisco Mountain, where its normal vertical range is from a little below 2,500 to 3,000 meters (about 8,200 to 9,800 feet), though it descends considerably lower on north-easterly exposures. It is abundant on the pinnacle which caps the summit of Kendrick Peak. It grows on drier soil than Douglas fir and usually occupies the places from which the latter has been burned off, often forming large groves whose tall white trunks, as straight as arrows, attain a height of 25 meters (about 80 feet). It is worthy of remark that the common brake (*Pteris aquilina*) is usually associated with the Aspen, wherever found.

Populus monilifera Aiton. Cotton-wood.

The Cotton-wood grows sparingly along the Little Colorado bottom, where it is the only tree. It occurs also in places in the Grand Cañon.

Juniperus occidentalis monosperma Engelm. Western Cedar; Juniper.

This is the tree from which the cedar belt takes its name. It is associated with the piñon, and is bounded by the desert below and by *Pinus ponderosa* above, ranging in altitude from 1,800 to 2,100 meters (6,000 to 7,000 feet).

Juniperus californica utahensis Engelm. Great Basin Cedar.

This species was found at the Grand Cañon of the Colorado.

Juniperus pachyphloea Torrey. Checker-bark Cedar; Alligator-bark Cedar.

This striking and handsome tree is rare in the San Francisco Mountain region, where it was observed in two places only, namely, at Walnut Cañon, and near the east base of Elden Mountain.

Abies concolor Lindley & Gordon. White Fir; Balsam Fir.

This fir is common in places at the Grand Cañon of the Colorado, where it occupies the uppermost zone on northerly exposures in company with *Pseudotsuga douglasii*. It was found by Mr. Bailey on the east side of Elden Mountain, but was not observed on San Francisco Mountain. The species is easily distinguished by the great length of its leaves, and by the balsam blisters on its bark, in this respect resembling the eastern *Abies balsamea*, and differing from all the other trees of the Plateau region.

Abies subalpina Engelm. White Cork-bark Fir.

This beautiful fir, unique in the color and character of its bark, is one of the most conspicuous trees on San Francisco Mountain between the altitudes of 2,725 and 2,900 meters (8,950 to 9,500 feet). On the north side of a large butte, just south of Walker Lake crater, it descends to 2,600 meters (8,500 feet). The bark is a fine elastic cork of uniform texture, and free from hard particles. It averages about 6 millimeters in thickness and is very durable, frequently remaining intact while the wood rots away. Large pieces of it, still retaining their elasticity, may be stripped from dead trees and from logs upon the ground. It is sculptured by irregularly interrupted longitudinal depressions or grooves, and is ornamented by fine, parallel, wavy lines. Its color varies from creamy white to gray, and the surface has a velvety texture.

The leaves are short; and the scales of the large cones are deciduous while still on the tree. In fact, it was almost impossible to secure a perfect cone as early as the latter part of September.

I believe this tree to be distinct from true *A. subalpina*, but in the absence of material for direct comparison, I am unwilling to separate it.

On Kendrick Peak it grows from the south rim of the crater (altitude about 2,800 meters, or 9,200 feet) to the summit (a little above 3,050 meters, or 10,000 feet).

***Pseudotsuga douglasii* Lindley.** Douglas Fir.

Douglas fir is the most characteristic tree of the Canadian zone of San Francisco Mountain, where it ranges from 2,500 to 2,800 meters (8,200 to 9,200 feet) in altitude. It is associated with *Pinus flexilis macrocarpa* and *Populus tremuloides*, though preferring moister situations. On the south side of both Agassiz and Kendrick Peaks the effects of slope-exposure carry it up nearly if not quite to 3,050 meters (10,000 feet). In a cold cañon on the northeast side of San Francisco Mountain, on the other hand, the effects of slope-exposure bring its lower limit down to 2,280 meters (7,500 feet); and it descends still lower in the crater on the northeast side of O'Leary Peak.

***Picea engelmanni* (Parry).** Engelmann's Spruce.

Engelmann's Spruce reaches the uppermost limit of tree growth in company with *Pinus aristata*, and comes down to the upper limit of the Douglas fir zone, thus ranging in altitude from 2,800 to 3,500 meters (9,200 to 11,500 feet). On the south side of Kendrick Peak it was not observed below 2,950 meters (9,700 feet). Perhaps *Picea pungens* occurs with it, in which case the latter has the lower range.

***Pinus flexilis macrocarpa* Engelmann.** White Pine.

This lofty pine, which equals or even exceeds *P. ponderosa* in size, occupies the lower zone of San Francisco Mountain, from about 2,500 to 2,775 meters (8,200 to 9,100 feet), occurring with Douglas fir and aspens. Along the upper part of the *Pinus ponderosa* belt it is mixed with that species. On the south side of Kendrick Peak it begins at about 2,680 meters (8,800 feet) and reaches the summit. Its nuts are much sought after, on account of their large size, by squirrels and chipmunks.

***Pinus ponderosa* Douglas.** Yellow Pine.

As already stated, this species may be properly spoken of as the only tree of the San Francisco Mountain plateau, where its normal vertical range is from 2,100 to 2,500 meters (7,000 to 8,200 feet), though it extends irregularly to 2,675 meters (8,800 feet), mixing with the firs, aspens, and white pines. On the south side of Kendrick Peak the effects of slope-exposure elevate its upper limit to an altitude of about 2,830 meters (9,300 feet); while on the south side of Agassiz Peak it reaches 2,775 meters (9,100 feet). It stretches southward from San Francisco Mountain to the plateau escarpment west of Baker Butte, and thence easterly along the crest of the plateau rim to the White Mountains, with no break of any considerable size, though near the White Mountains it is invaded by cedar and piñon.

Along the plateau escarpment *Pinus ponderosa* descends to a much lower altitude than elsewhere, being found as low as 1,370 meters (4,500 feet). This is due to the low altitude of base-level below the plateau.

The forest of *Pinus ponderosa* covering the Cocanini plateau, and commonly known as the 'Cocanini forest,' is separated from the San Francisco Mountain plateau forest by a wide belt of cedar and piñon (see Map 1). Another disconnected forest of the same kind occupies the high crest of the plateau west of Cataract Cañon. For this latter information I am indebted to Mr. John H. Renshawe, of the U. S. Geological Survey.

Pinus aristata Engelmann. Fox-tail Pine.

The Fox-tail Pine is a tree of high altitudes. On San Francisco Mountain it begins to appear at about 2,750 meters (9,000 feet), and ranges thence to timber line, vieing with *Picea engelmanni* to attain the greatest elevation on the rocky side of the peak, and thriving best in more open and slightly drier situations than its companion. It was not found on Kendrick or O'Leary Peaks. At the upper limit of its range (the timber-line zone), it is little more than a gnarled and prostrate bush, while lower down (in the Hudsonian zone), it is a large and handsome tree. Its large cones are usually dripping with clear, transparent resin.

Pinus edulis Engelmann. Piñon; Nut Pine.

The Piñon occurs in company with Junipers, the two together constituting the Piñon or cedar belt, which is the zone next below the pines. The altitude of the piñon belt is 1,800 to 2,100 meters (6,000 to 7,000 feet). The Piñon is more abundant in the upper than in the lower part of the cedar belt, and was common wherever we entered this belt from Walnut Cañon to the Grand Cañon of the Colorado, but the single-leaved form (*P. monophylla*) was nowhere met with, though it is accredited to the San Francisco Mountain region by Sargent in his volume on Forest Trees (Tenth Census, 1884, p. 190).

The Piñon is a prolific bearer, the quantity of nuts produced by the small and apparently distorted cones of a single tree being surprisingly large. They begin to ripen about the end of August, and constitute the most important indigenous food of the Indians as well as of many of the mammals and birds of the region.

TREES OF ESSENTIALLY COINCIDENT RANGE.

Between the summit of the mountain and the desert plain below, the following approximate coincidences in the vertical range of trees occur :

<i>Pinus aristata</i>	} Approximate altitude, 2,800-3,500 meters, or 9,200-11,500 feet.
<i>Picea engelmanni</i>	
<i>Pseudotsuga douglasii</i>	} Approximate altitude, 2,500-2,800 meters, or 8,200-9,200 feet.
<i>Pinus flexilis macrocarpa</i>	
<i>Populus tremuloides</i>	
<i>Pinus edulis</i>	} Approximate altitude, 1,800-2,100 meters, or 6,000-7,000 feet.
<i>Juniperus occidentalis monosperma</i> .	

NOTE.—The normal altitudes here given for the various trees of San Francisco Mountain are averages for the *west* side of the mountain. Favorable southern and southwestern exposures carry the zones up a hundred meters or more above these limits, while similar northern and northeastern exposures, particularly in gulches and cañons, deflect the zones as much as 200, or even 300 meters. The normal average difference in altitude of the same zone on the southwest and northeast sides of San Francisco Mountain is about 275 meters (900 feet).

RELATION OF A BIOLOGICAL SURVEY TO AGRICULTURE.

The primary object of mapping the geographic distribution of species is to ascertain the number, positions, and boundaries of the natural faunal and floral areas—areas which are fitted by nature for the existence of certain native animals and plants, and which consequently are adapted for the growth of certain agricultural products and for the support of certain kinds or breeds of stock. The obvious reason why certain animals and plants inhabit restricted parts of the earth's surface and do not occur in other parts, where there are no impassable barriers to prevent, is that such species have become adapted to the particular physical and climatic conditions there prevailing, and their sensitive organizations are not sufficiently plastic to enable them to live under other conditions.

The present biological survey of the San Francisco Mountain region has demonstrated that mammals, birds, reptiles, insects, and plants so coincide in distribution that a map showing the boundaries of an area inhabited by an association of species in one group serves equally well for other groups. The reason of this coincidence in distribution is that all terrestrial forms of life inhabiting the same area are exposed to the same surroundings and governed by the same general laws.

The point of greatest significance, so far as the practical agriculturist is concerned, is that what is true of animals and plants in a state of nature is true also of animals and plants as modified by the voluntary acts of man; for every race or breed of sheep, cattle, or swine, and every variety of grain or vegetable thrives best under particular conditions of temperature, moisture, exposure, and so on. It follows that a map of the natural life areas of a country will tell the farmer what he can expect to produce most profitably on his own farm, and also what crops will *not* thrive in his neighborhood, thus saving the time and cost of experimental farming, which, in the aggregate, amounts to hundreds of thousands of dollars every year.

Illustrations of the application of the principle here enunciated are not lacking, even in the arid region under consideration. Maps 1 and 2 are examples of the kind of biological maps here referred to, and may be used by the settler as guides in the selection of crops for particular localities. It is true that very little of the region embraced in the present report is under cultivation, partly because of its scanty water supply and partly because of its inaccessibility until opened up by the Atlantic

and Pacific Railway. Nevertheless, several crops and garden vegetables have been grown successfully without irrigation, even in the Little Colorado Desert, and the beginning thus made indicates a natural grouping of agricultural products according to the zones here defined. The Moki Indians cultivate successfully, in the arid valleys below the Pueblos, cotton, tobacco, peaches, melons, flax, gourds, and southern varieties of corn and beans; and alfalfa grows luxuriantly in the same zone. None of these do well in the cooler climates of the higher zones. Attempts at agriculture in the Pine belt have developed the additional fact that wheat, potatoes, a variety of corn different from that of the desert, and other garden products yield excellent results. The Canadian or fir zone, which is next above the Pine, is subject to early frosts, and hence unfitted for any but the hardier crops; but turnips, beets, and oats have been found to do well along its lower border, and wild raspberries, gooseberries, and strawberries abound in the Spruce belt.

If the area here mapped were extended so as to include the Giant-cactus belt of the Gila and Salt River valleys, the range in agricultural products would be far more striking, for then the orange, the date, and the fig of the lower desert could be contrasted with the hardy cereals and the potato of the mountain plateau. These tropical fruits are now grown near Phoenix, only 200 kilometers (125 miles) from San Francisco Mountain.

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KENNERLY, DR. C. B. R., 1850. Report on the Zoology of the Thirty-fifth Parallel.

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LOEW, DR. OSCAR, 1875. Agricultural Resources, Vegetation, etc., of Arizona. <Expls. West of 100th Meridian, 4°; Washington, III, Geology, pt. VI, 1875, 573-612.

This paper contains an important chapter on the Geographical Distribution of Plants, in which four Plant Zones are defined, as follows:

"(1) Zone of Cactus, Yucca, and Agave; altitude, 3,000 to 3,500 feet; grass is scanty. Where there is water, a most luxuriant vegetation springs up.

(2) Zone of *Opibone* and *Artemisia* (Greasewood and Sage-brush) altitude, 3,500 to 4,900 feet. Grass is poor with few exceptions, on granitic and volcanic soil. The Cactus species are diminishing in number.

(3) Zone of *Juniperus occidentalis* (Cedar); altitude 4,900 to 6,800 feet; Cactus species few.

(4) Zone of Pine and Fir, 6,800 to 10,800 feet (highest points)."

LOEW, DR. OSCAR—Continued.

Loew's first zone does not reach the plateau, but extends far up the Grand Cañon, nearly if not quite to the mouth of the Little Colorado. His second and third zones are comparable respectively with the *Desert area* and the *Piñon or Cedar belt* of the present paper. The fourth zone includes everything between the Cedar belt and timber line, thus embracing the *Pine plateau area*, the *Douglas fir zone*, the *Spruce zone*, and the *Subalpine or Timber-line zone*.

The altitudes given by Loew relate to Arizona as a whole and consequently are not strictly comparable with those of the present paper, which are restricted to the plateau. The apparent discrepancy is due to the difference in base-level.

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Consists of Sitgreaves's Narrative (pp. 4-21, with 24 plates of scenery and Indians); Tables of Distances, Geographical Positions, and Meteorological Observations (p. 23-29); Report on National History, by S. W. Woodhouse, M. D., (pp. 31-178), containing the following parts: Narrative (pp. 33-40); Mammals (pp. 43-57, pls. 6); Birds (pp. 58-105, pls. 6); Reptiles [and Batrachians], by Edward Hallowell, M. D. (pp. 106-147, pls. 21); Fishes, by Spencer F. Baird and Charles Girard (pp. 148-152, pls. 3); Botany, by John Torrey (pp. 155-178, pls. 21); Medical Report, by S. W. Woodhouse, M. D. (pp. 181-185).

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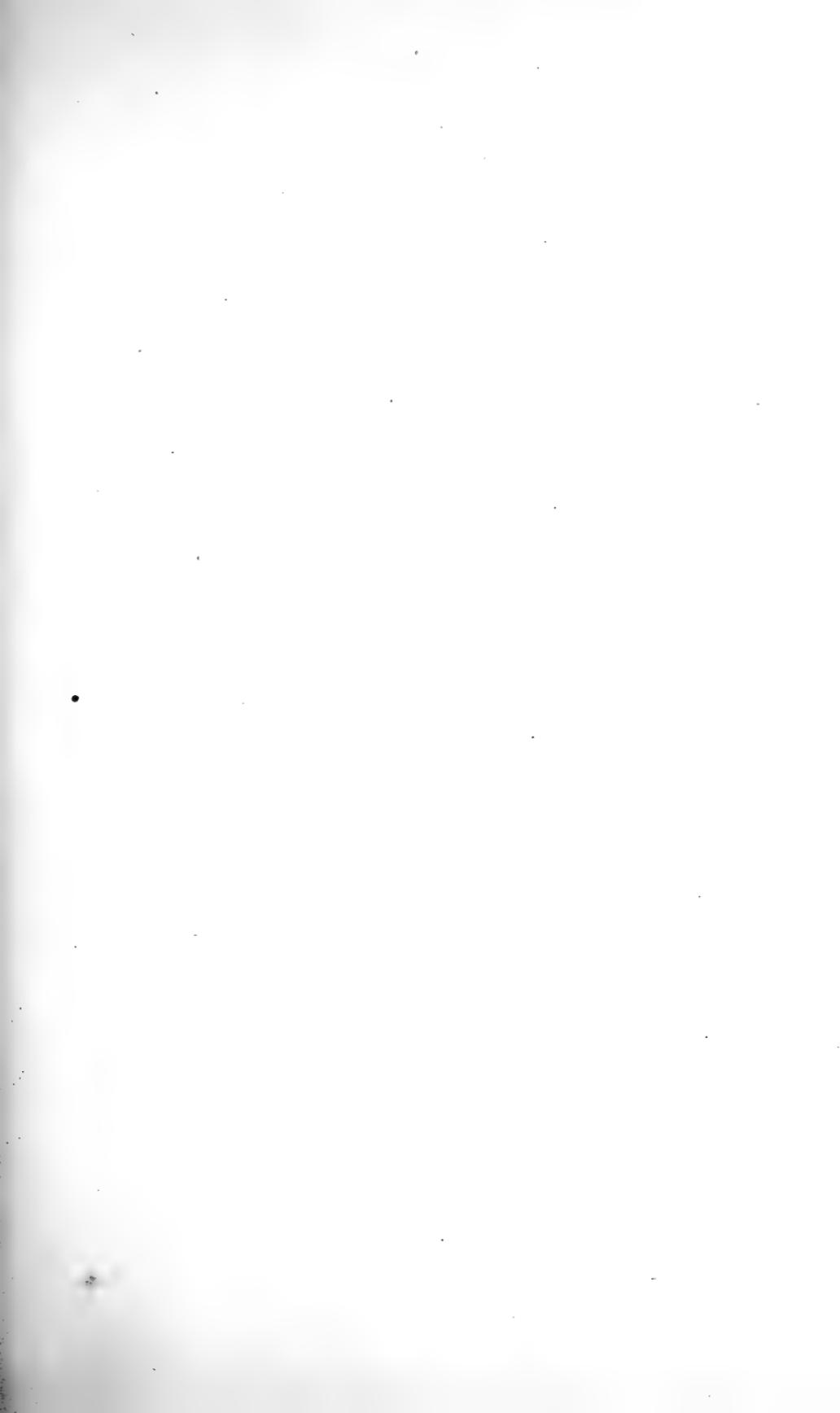
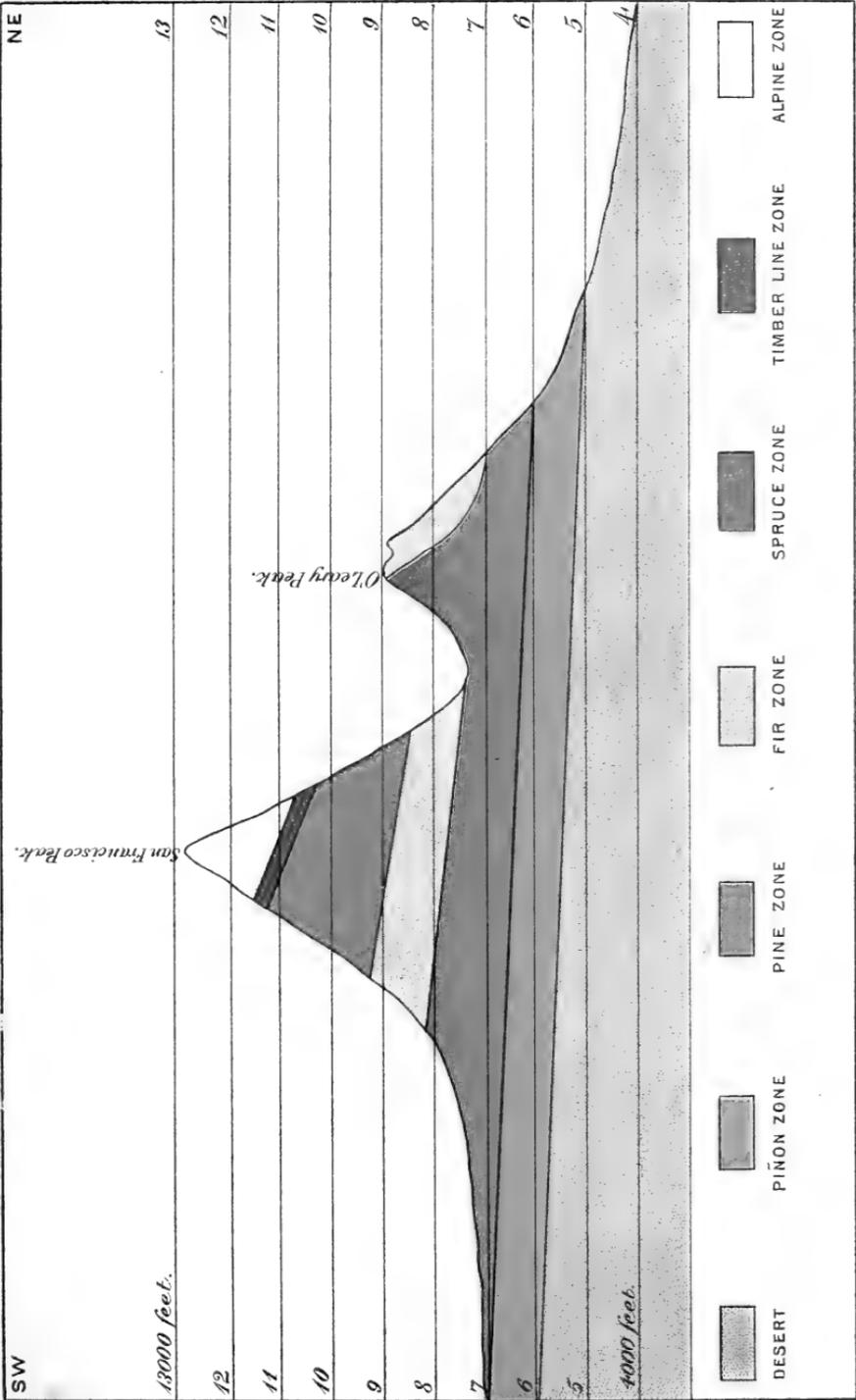


PLATE I.

Diagrammatic profile of San Francisco Mountain and O'Leary Peak from southwest to northeast, showing the several life-zones and effects of slope-exposure.

Slope exposure is the inclination of the surface of the earth in relation to the angle of reception of the sun's rays. The sun strikes the northeast and east sides of a hill or mountain early in the day, before the heat is very great; the south side at noon when the heat is greater; the southwest and west sides in the afternoon when the heat is greatest, and the northwest and north about sundown or not at all. It follows that the southwest side of a hill or mountain receives the sun's rays at nearly a right angle during the hottest part of the day, and consequently is the hottest side. The higher temperature on the southwest side causes the zones to rise, and conversely, the lower temperature on the north and northeast sides—the coldest exposures—causes them to dip down. The normal difference in altitude of the same zone on the southwest and northeast sides of San Francisco Mountain was found to be about 275 meters, or 900 feet.



DIAGRAMMATIC PROFILE OF SAN FRANCISCO AND O'LEARY PEAKS FROM S. W. TO N. E., SHOWING THE SEVERAL LIFE ZONES AND EFFECTS OF SLOPE EXPOSURE.



PLATE II.

Diagram showing effects of slope-exposure on a volcanic cone north of San Francisco Mountain.

This cone is in the pine belt, its base being above the level of the piñon or cedar belt; yet its south and west slopes are covered with piñon and cedars to the exclusion of the tall pines which cover its north and east slopes as well as the surrounding plain. This is the result of *slope-exposure*, the sun's rays striking the south and west sides at such a sharp angle as to increase the temperature sufficiently to permit the growth of trees normally restricted to lower levels.

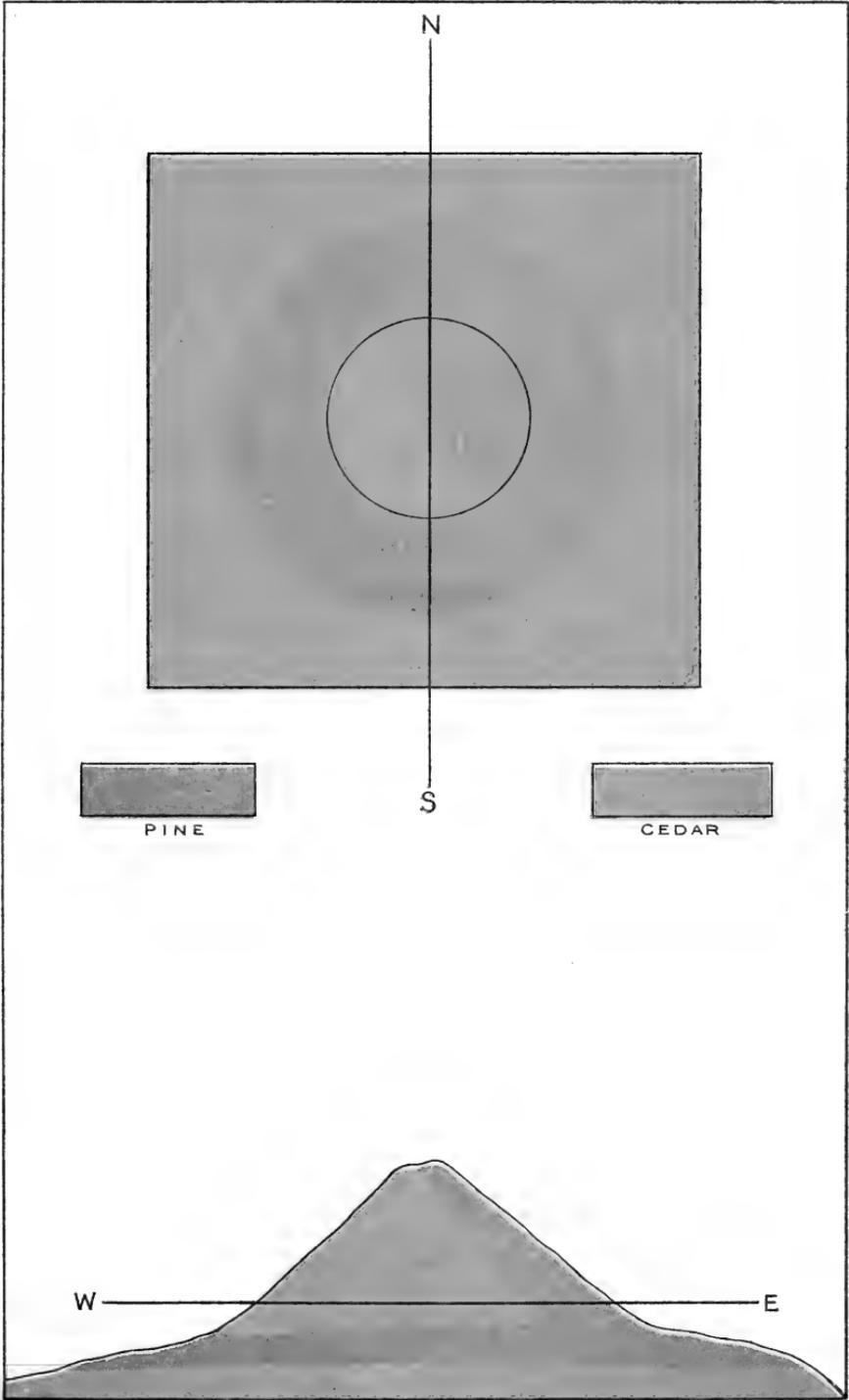


DIAGRAM SHOWING EFFECTS OF SLOPE EXPOSURE ON A VOLCANIC CONE NORTH OF SAN FRANCISCO MOUNTAIN.

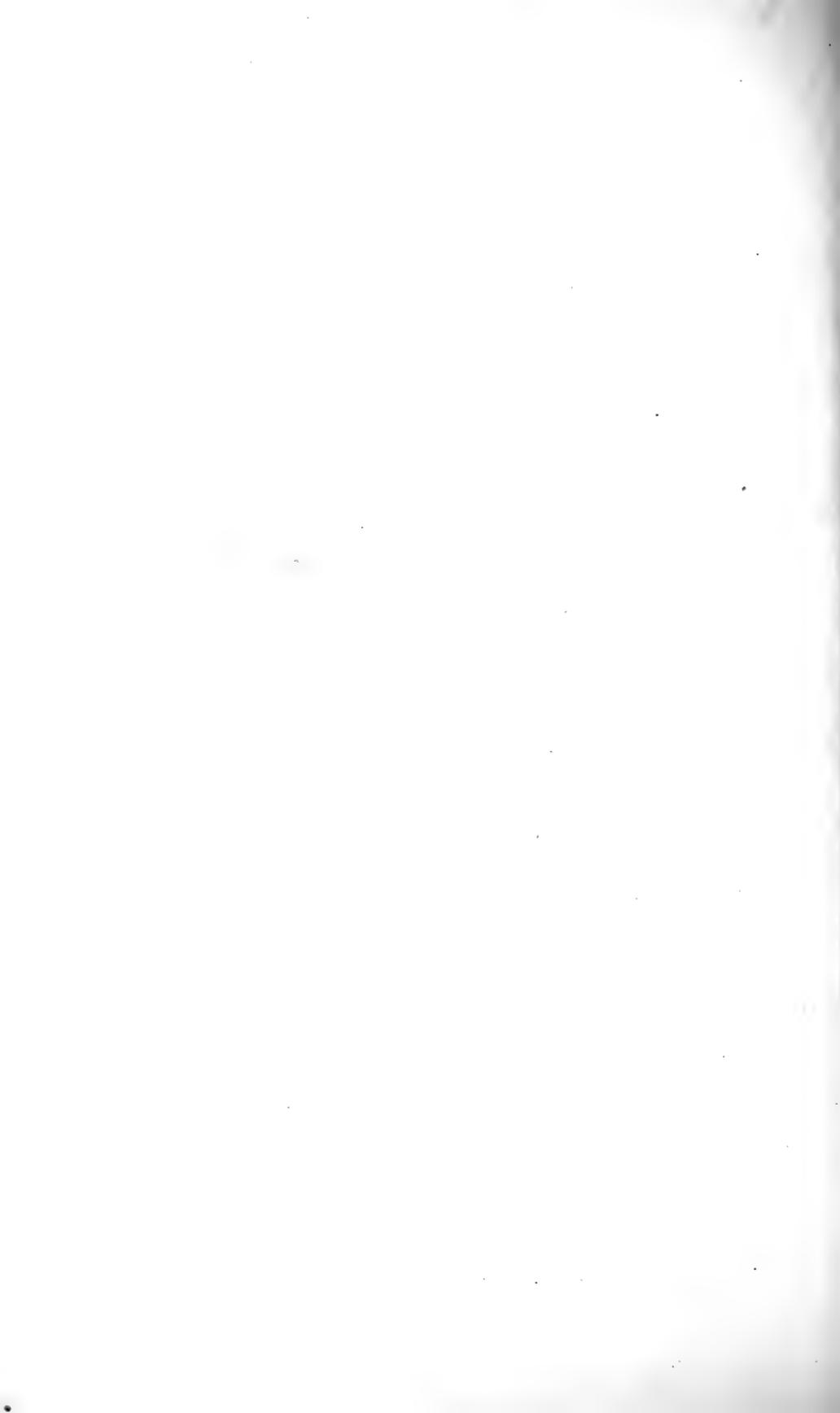




PLATE III.

Figs. 1, 2, 3, and 4, *Hesperomys megalotis* Merriam (No. $\frac{24354}{17943}$), ♂ ad. Painted Desert, Arizona. *Type*.

1. Crowns of left upper molars from below ($\times 10$).
2. Crowns of left lower molars from above ($\times 10$).
3. Crowns of left upper molars from the outside ($\times 10$).
4. Crowns of left lower molars from the outside ($\times 10$).

Figs. 5, 6, 7, and 8, *Hesperomys leucopus rufinus* subsp. nov. (No. $\frac{24584}{17618}$), ♀ ad. San Francisco Mountain, Arizona.

5. Crowns of left upper molars from below ($\times 10$).
6. Crowns of left lower molars from above ($\times 10$).
7. Crowns of left upper molars from the outside ($\times 10$).
8. Crowns of left lower molars from the outside ($\times 10$).

NOTE.—In this and the following plates the numbers in parentheses are those of the U. S. National Museum, unless the contrary is stated.



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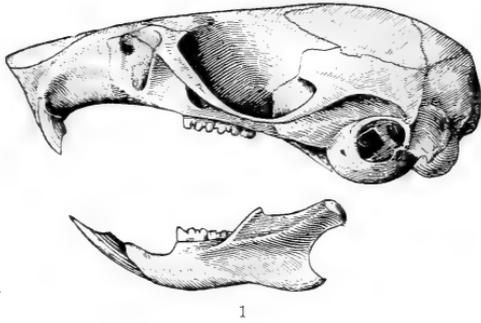
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1-4. *Hesperomys megalotis* sp. nov.

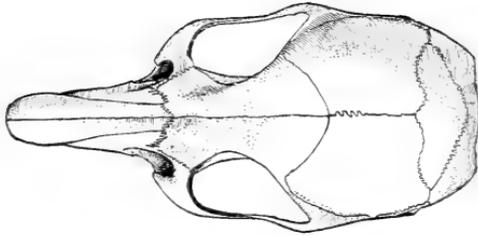
5-8. *Hesperomys leucopus rufinus*

PLATE IV.

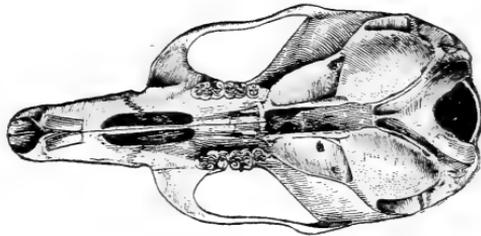
Figs. 1, 2, 3, and 4, skull of *Hesperomys megalotis* Merriam (No. $\frac{24854}{17943}$), ♂ ad.
Painted Desert, Arizona. *Type.*



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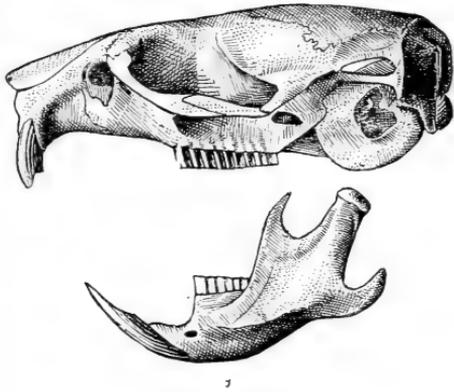
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PLATE V.

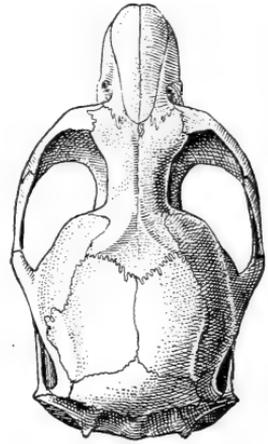
Figs. 1 and 2. Skull of *Arvicola alticolus* Merriam (No. $\frac{24551}{17615}$) ♀ ad. San Francisco Mountain, Arizona ($\times 2$).

Figs. 3 and 4. Skull of *Arvicola mogollonensis* Mearns (No. $\frac{24561}{17631}$) ♂ ad. San Francisco Mountain, Arizona ($\times 2$).

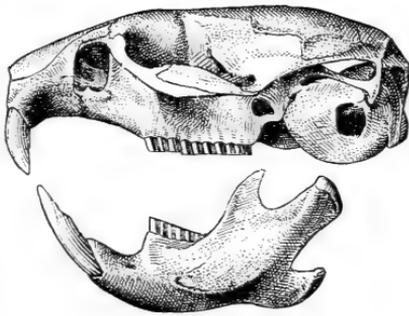
Figs. 5, 6, and 7. Skull of *Perognathus intermedius* Merriam (No. $\frac{24826}{19975}$) ♂ ad. Grand Cañon of the Colorado, Arizona ($\times 1\frac{1}{2}$).



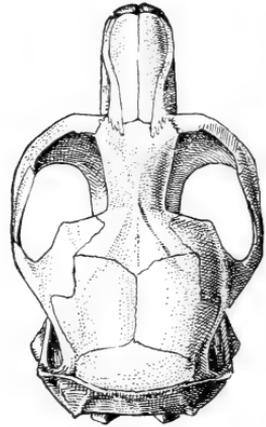
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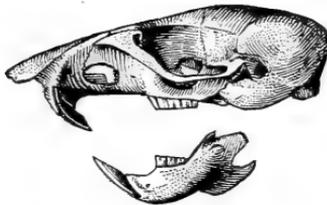
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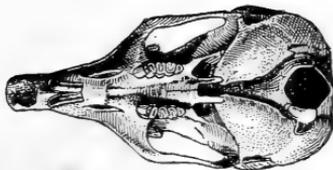
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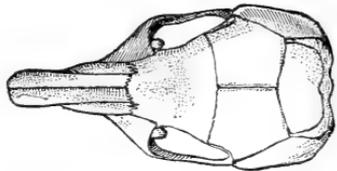
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1, 2. *Arricola alticolus* sp. nov.
3, 4. *A. mogollonensis*.

5, 6, 7. *Perognathus (Chaetodipus) intermedius*.

PLATE VI.

- 1, 2. *Arvicola alticolus* Merriam, ♀ ad. (No. $\frac{24551}{17615}$). San Francisco Mountain, Arizona.
Type.
1. Upper molar series.
 2. Lower molar series ($\times 10$).
- 3, 4. *Arvicola alticolus* Merriam, ♂ ad. (No. $\frac{24550}{17614}$). San Francisco Mountain, Arizona.
3. Upper molar series.
 4. Lower molar series ($\times 10$).
- 5, 6. *Arvicola mogollonensis* Mearns, ♂ im. (No. $\frac{1493}{2331}$ Am. Mus. Nat. Hist.). Baker Butte, Mogollon Mesa, Arizona. *Type.*
5. Upper molar series.
 6. Lower molar series ($\times 10$).
- 7, 8. *Arvicola mogollonensis* Mearns, ♂ (No. $\frac{24563}{17627}$). San Francisco Mountain, Arizona.
7. Upper molar series.
 8. Lower molar series ($\times 10$).



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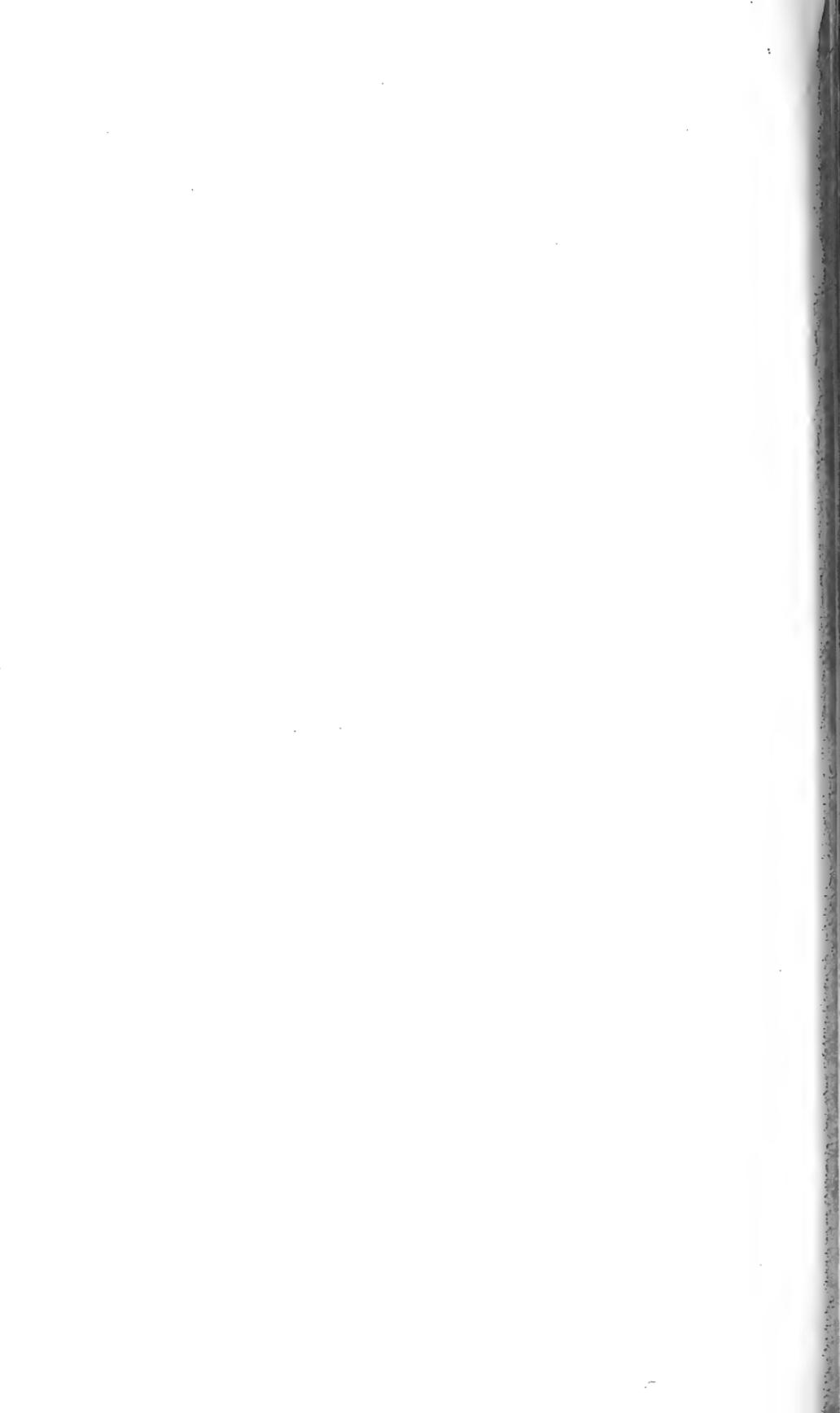
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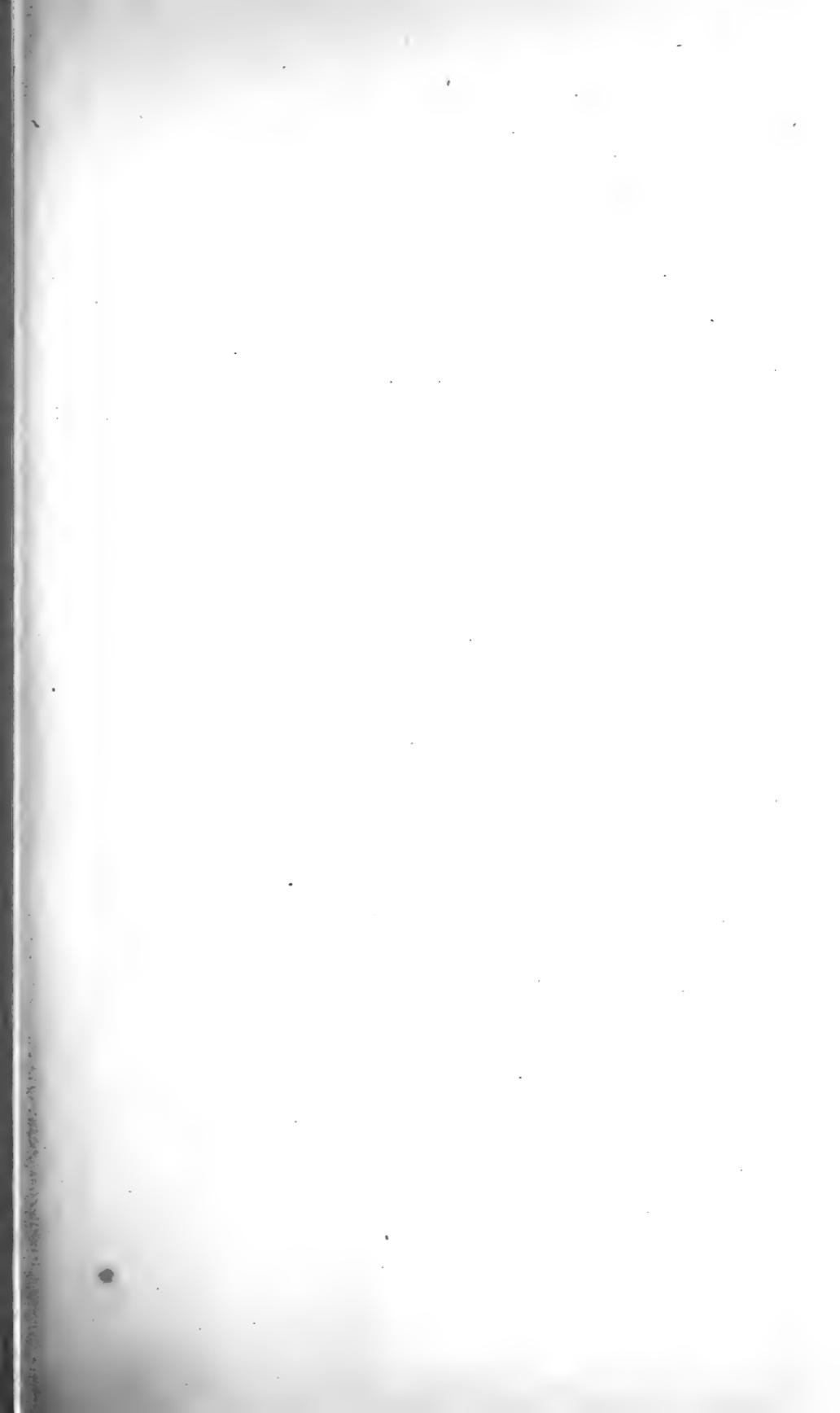
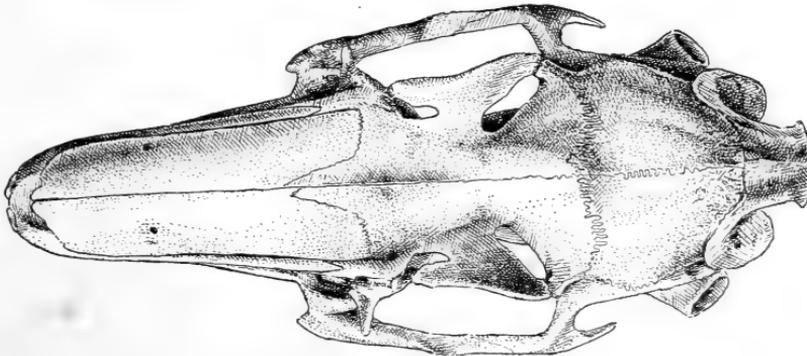
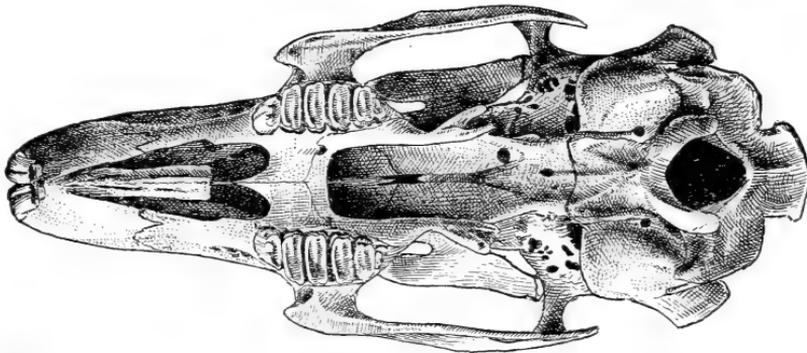
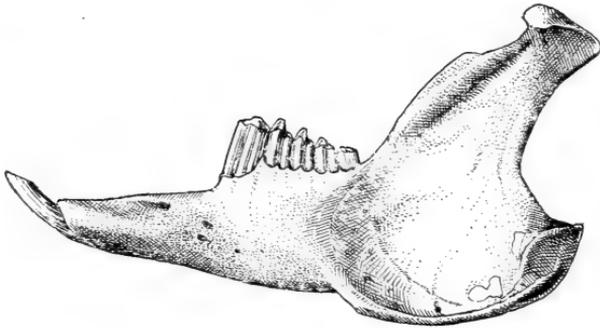
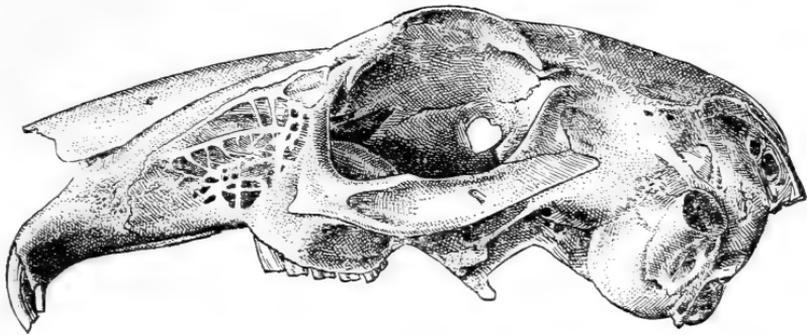


PLATE VII.

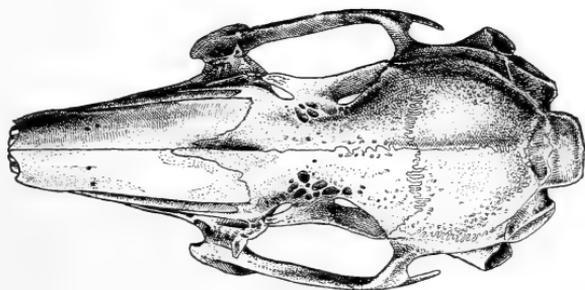
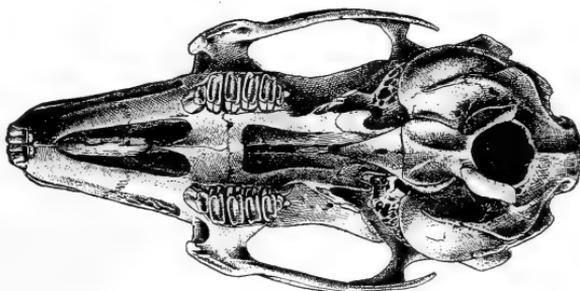
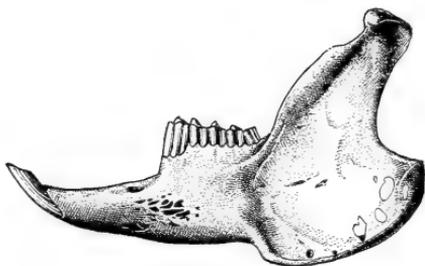
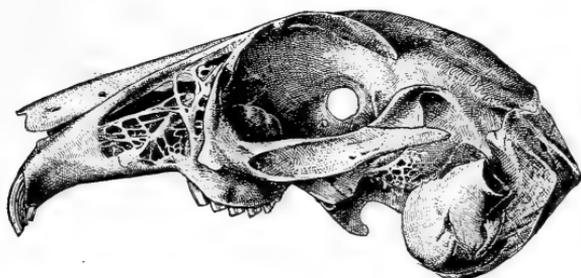
Skull of *Lepus texianus* Waterhouse (No. $\frac{24650}{17714}$), ♀ ad. San Francisco Mountain,
Arizona. (Natural size.)



Lepus texianus, ♀.

PLATE VIII.

Skull of *Lepus arizonæ* Allen (No. $\frac{24622}{17837}$), ♀ ad. San Francisco Mountain, Arizona.
(Natural size).

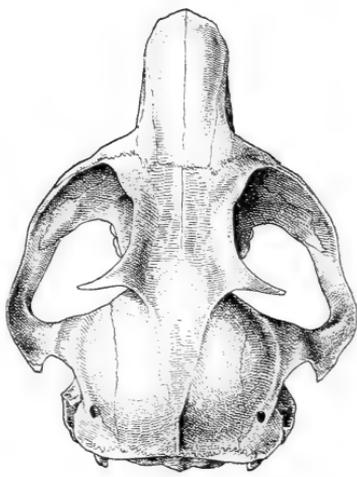
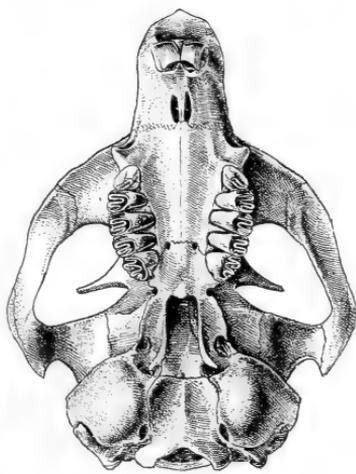
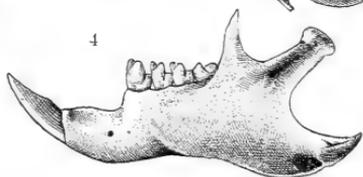
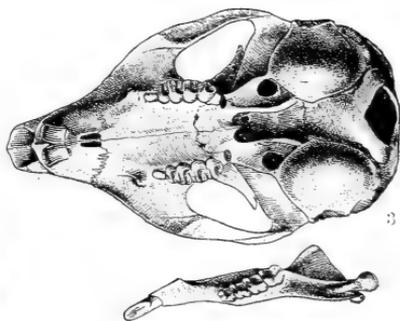
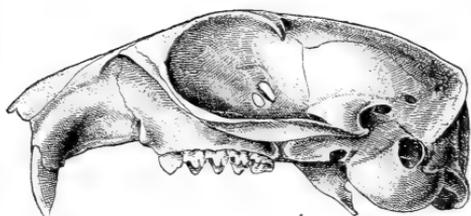
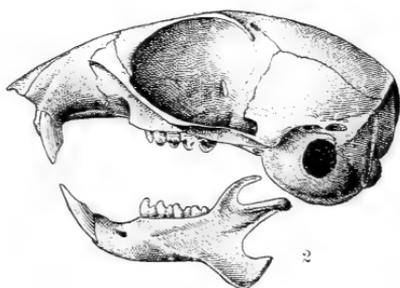
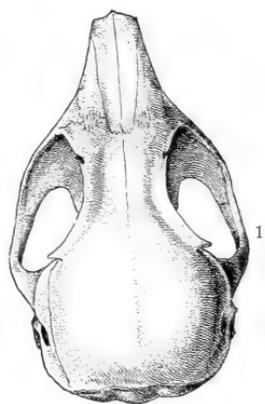


Lepus arizonæ, ♀.

PLATE IX.

Figs. 1, 2, and 3, skull of *Spermophilus cryptospilotus* Merriam (No. $\frac{24612}{17678}$), ♂ ad. Painted Desert, Arizona. *Type*. ($1\frac{1}{2}$ natural size.)

Figs. 4, 5, 6, and 7, skull of *Cynomys gunnisoni* Baird (No. $\frac{24625}{17639}$), ♀ ad. San Francisco Mountain, Arizona. (Natural size.)

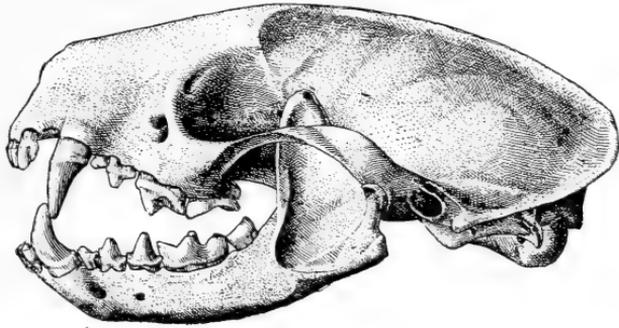


1-3. *Spermophilus cryptospilotus* sp. nov. ($\times 1\frac{1}{2}$).

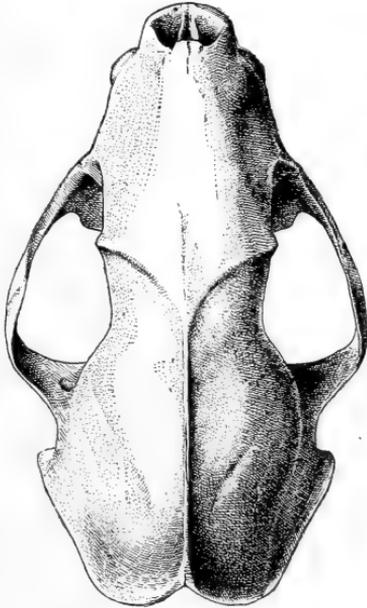
4-7. *Cynomys gunnisoni* (nat. size).

PLATE X.

- Figs. 1, 2, 3, and 4, skull of *Mephitis estor* Merriam (No. $\frac{24445}{17709}$), ♂ ad. San Francisco Mountain, Arizona. (Natural size.) *Type*.
- Figs. 5, 6, 7, and 8, skull of *Neotoma mexicana* Baird (No. $\frac{24633}{17697}$), ♂ ad. San Francisco Mountain, Arizona (natural size).



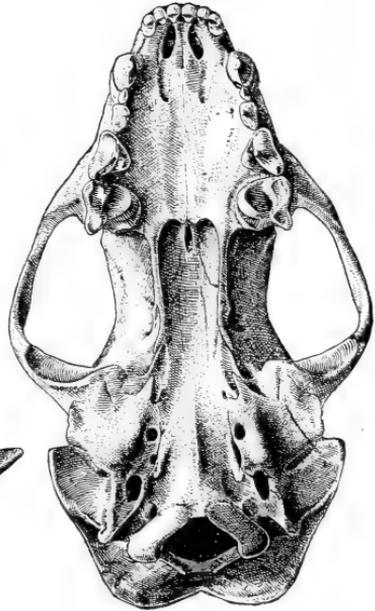
1



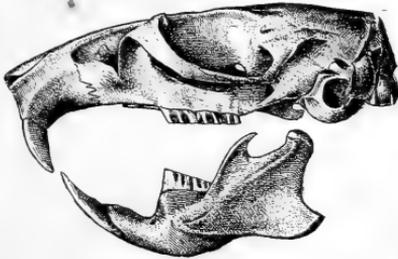
2



3



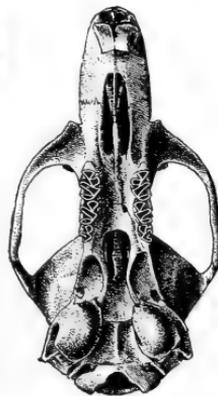
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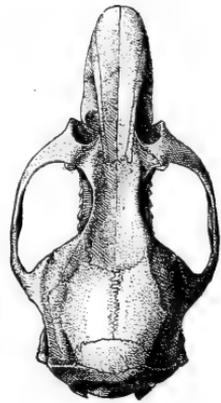
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6



7



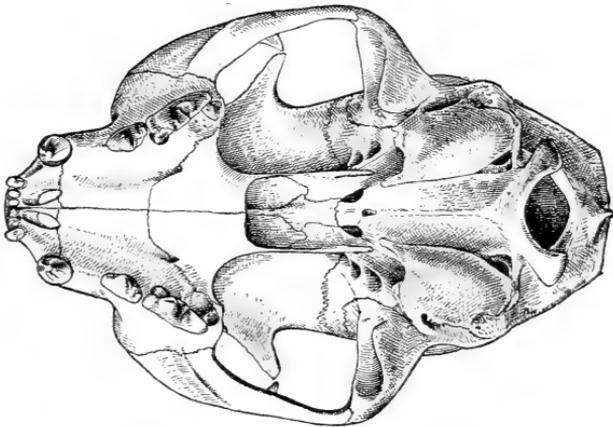
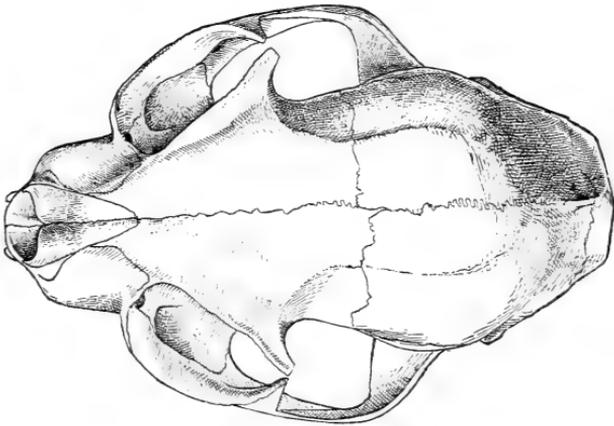
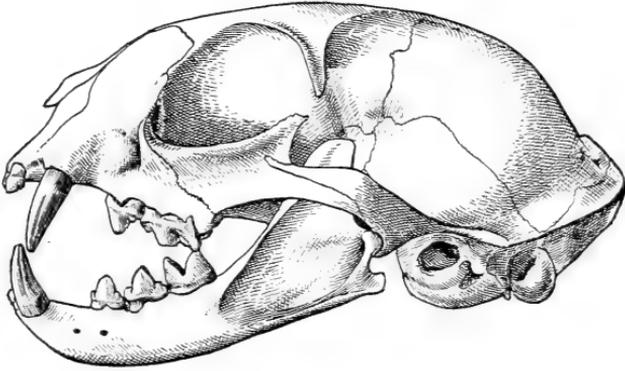
8

1-4. *Mephitis estor* sp. nov.

5-8. *Neotoma mexicana*.

PLATE XI.

Lynx baileyi Merriam (No. $\frac{24661}{17725}$), ♀ ad. San Francisco Mountain, Arizona. (Two thirds natural size.)

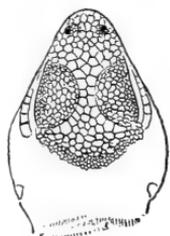


Lynx baileyi sp. nov., ♀, old ($\frac{1}{2}$ nat. size).

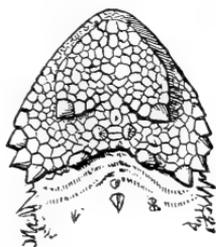
PLATE XII.

(All natural size.)

1. (15821) *Crotaphytus baileyi* Stejn. *Type.* Little Colorado Desert, Arizona.
2. (9368) *Crotaphytus collaris* (Say). Verdigris River, Arkansas.
3. (15818) *Phrynosoma ornatissimum* (Gir.). Little Colorado Desert, Arizona.
4. (15802) *Phrynosoma hernandesi* (Gir.). San Francisco Mountain, Arizona.



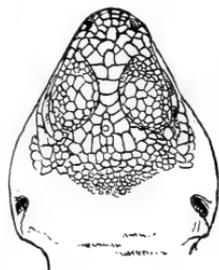
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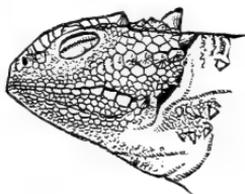
3a



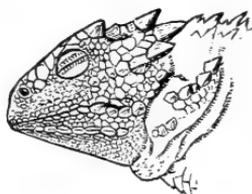
4a



2



3b



4b



3c



4c

PLATE XIII.

Map of the United States showing localities from which specimens of *Crotaphytus baileyi* and *C. collaris* have been examined.



* *Crotaphytus baileyi*.

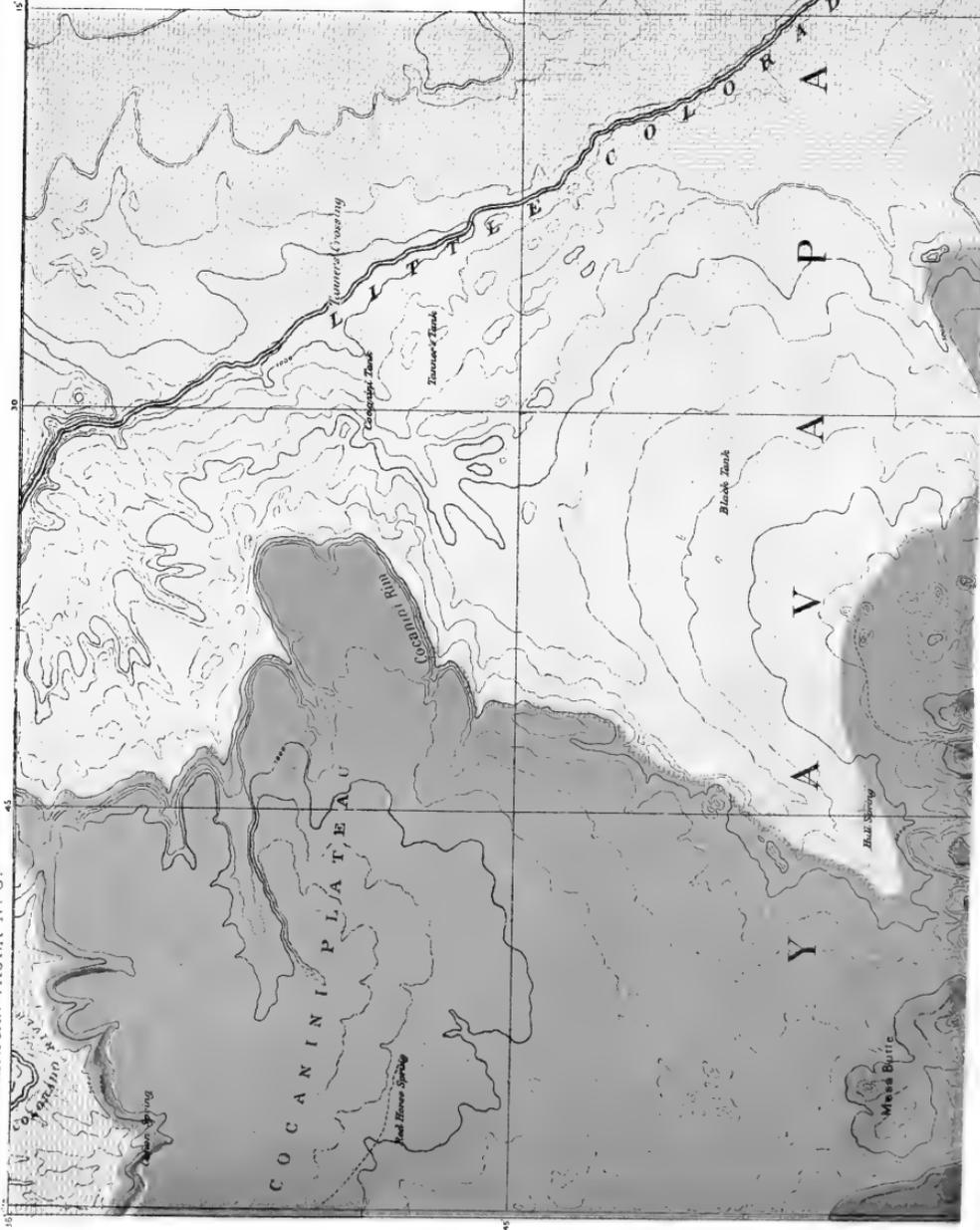
● *Crotaphytus collaris*.

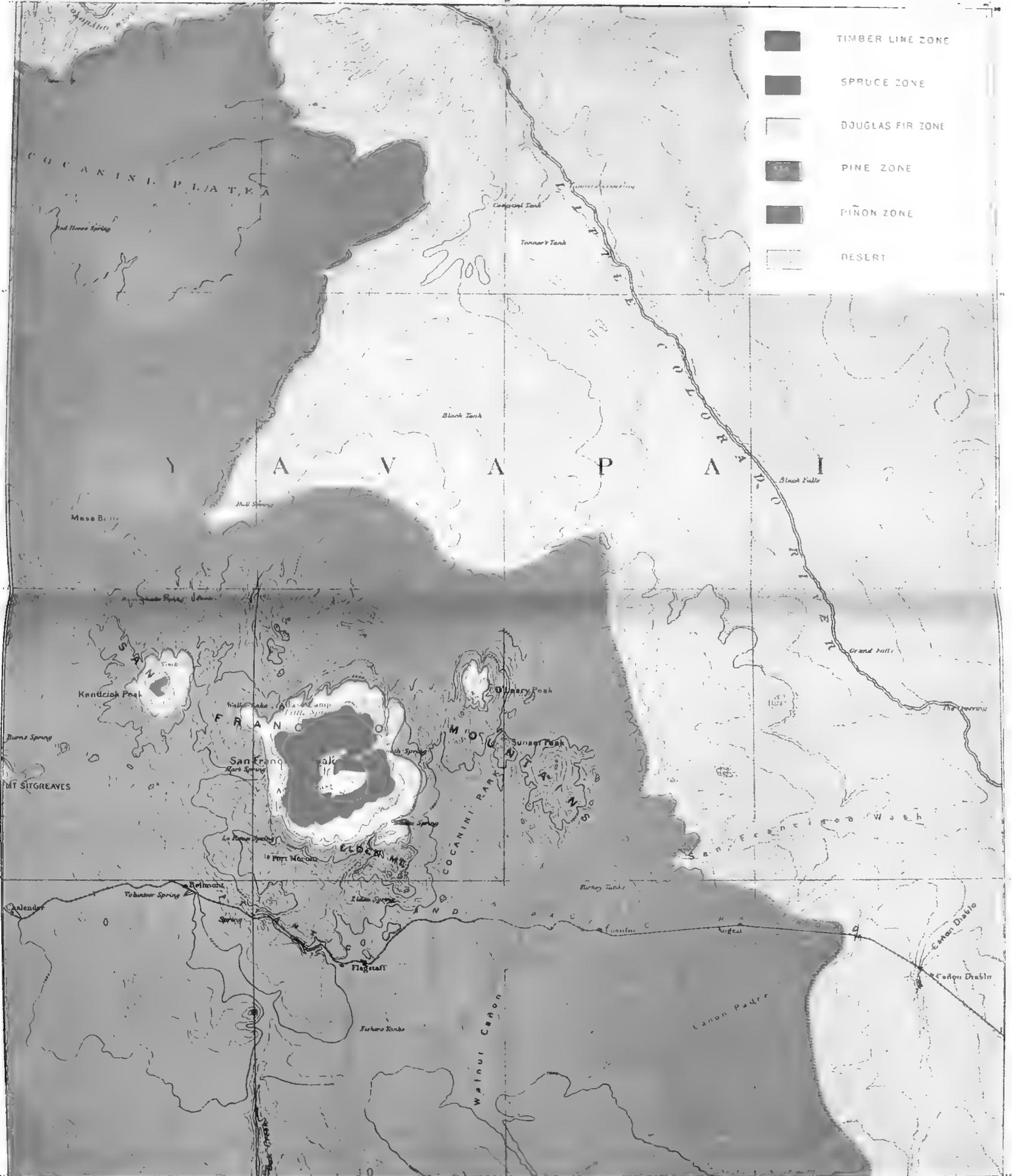
MAP SHOWING LOCALITIES FROM WHICH SPECIMENS OF CROTAPHYTUS BAILEYI AND CROTAPHYTUS COLLARIS HAVE BEEN EXAMINED.



Copyright 1890 by the American Geographical Society

- TIMBER LINE ZONE.
- SPRUCE ZONE.
- DOUGLAS FIR ZONE.
- PINE ZONE.
- PIÑON ZONE.
- DESERT.

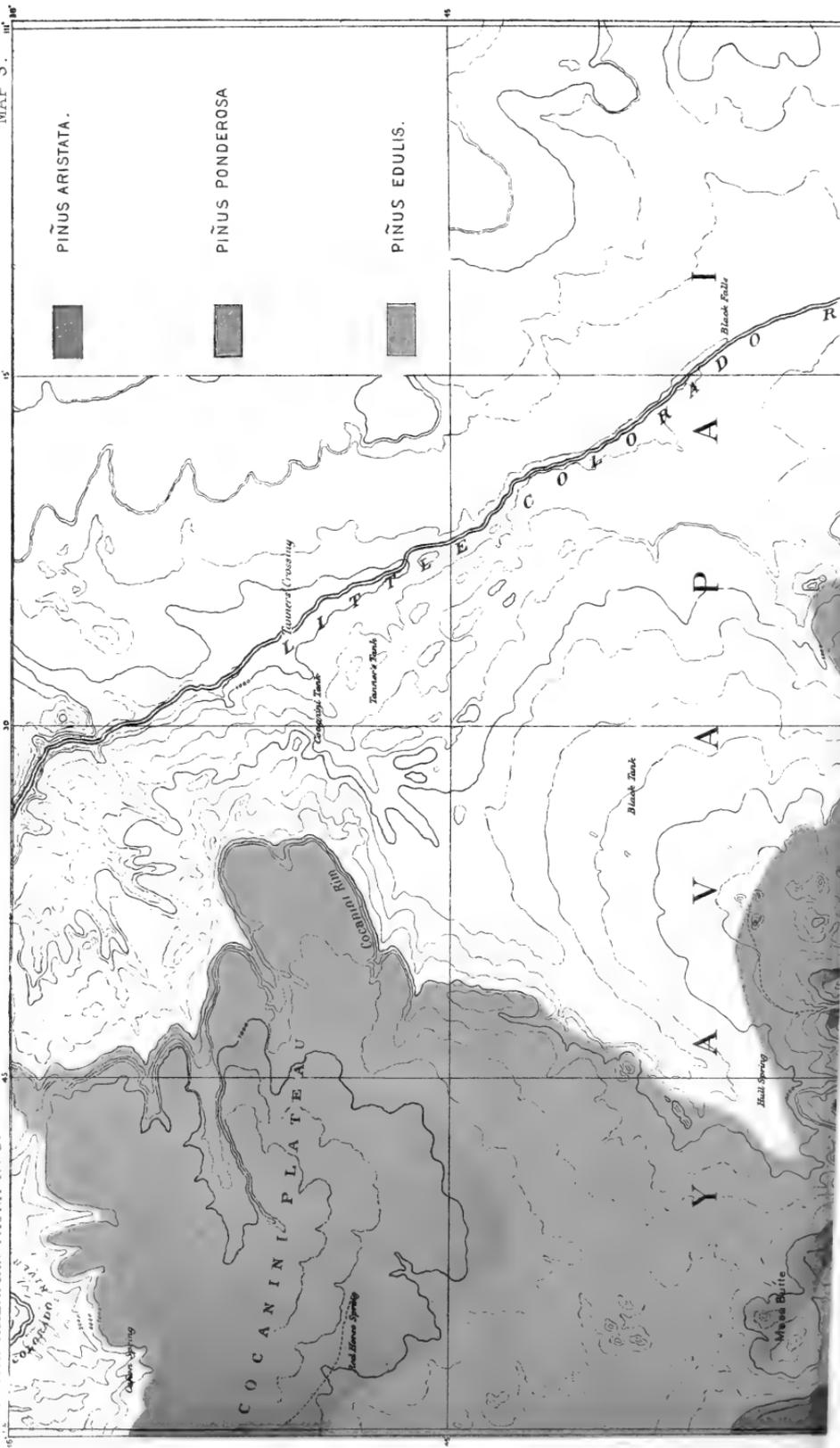




SAN FRANCISCO MT. AND VICINITY, ARIZONA.

0 1 2 3 4 5 6 7 8 9 10 11 12 Miles

Contour Interval 250 feet



PIÑUS ARISTATA.

PIÑUS PONDEROSA

PIÑUS EDULIS.

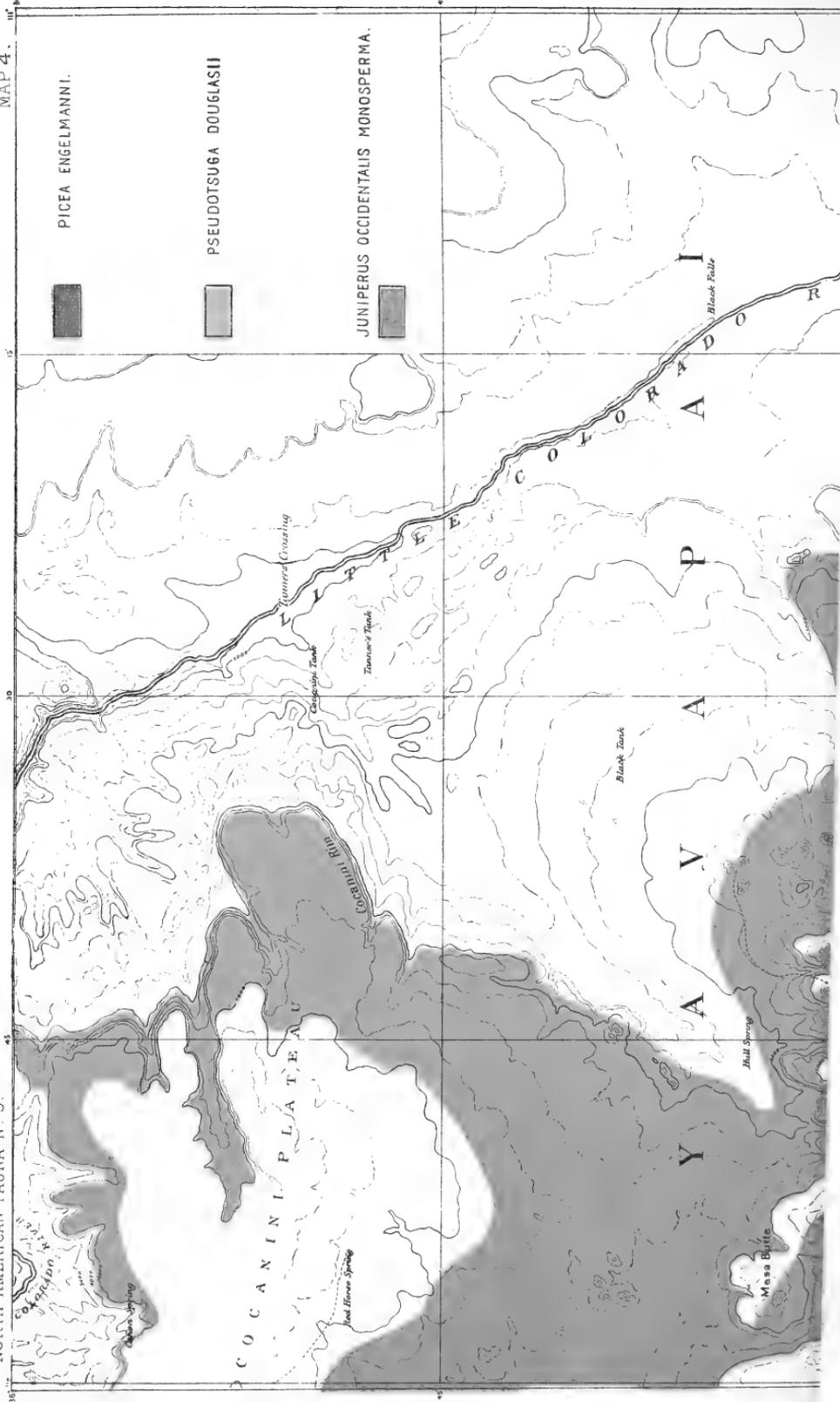
PICEA ENGELMANNI.



PSEUDOTSUGA DOUGLASSII



JUNIPERUS OCCIDENTALIS MONOSPERMA.



M A P 5 .

PROVISIONAL BIOLOGICAL MAP OF NORTH AMERICA, SHOWING PRINCIPAL LIFE AREAS. (PREPARED IN JANUARY, 1890.)

[See Pages 24-26.]

The areas indicated in different colors are not of equal value. The Boreal Province, as shown on the map in one color (green), is the equivalent of the Sonoran Province, which is shown in six colors, one for each of its principal divisions, as follows: The Sonoran proper, the Austroriparian, the Great Plains, the Great Basin, the Californian, and the Lower Californian. The Boreal Province comprises three zones—Subalpine or timber-line, Hudsonian, and Canadian—each of which undergoes certain changes in passing from the Atlantic to the Pacific, but our knowledge of the region is too vague to justify an attempt to show the resulting divisions.

The Carolinian Fauna is a northward extension of the Austroriparian, while the Alleghanian is neutral ground between the latter and the southernmost division of the Boreal Province (the Canadian Fauna). The data thus far accumulated do not admit of tracing the boundaries of these minor subdivisions or their equivalents in the West.

