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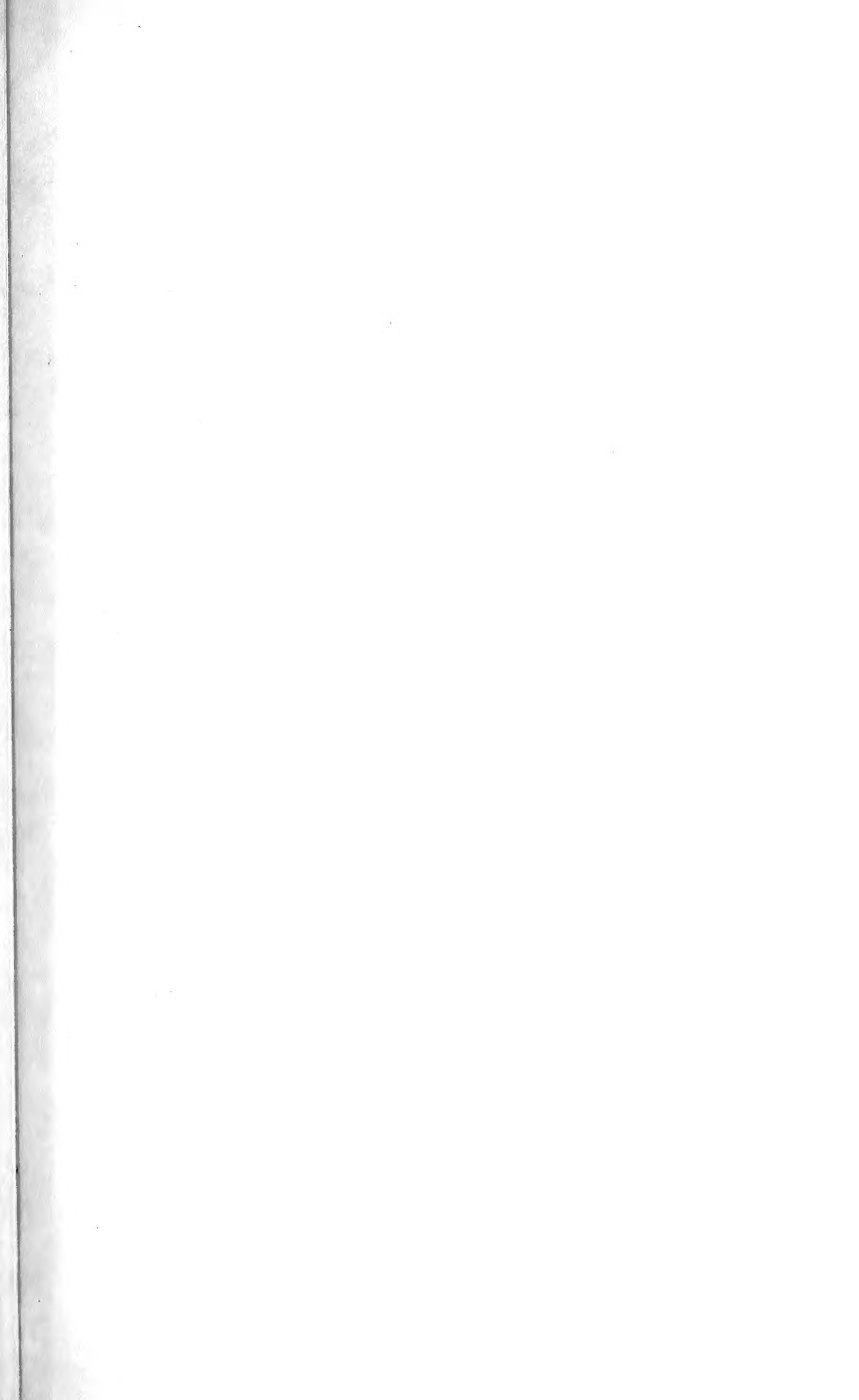
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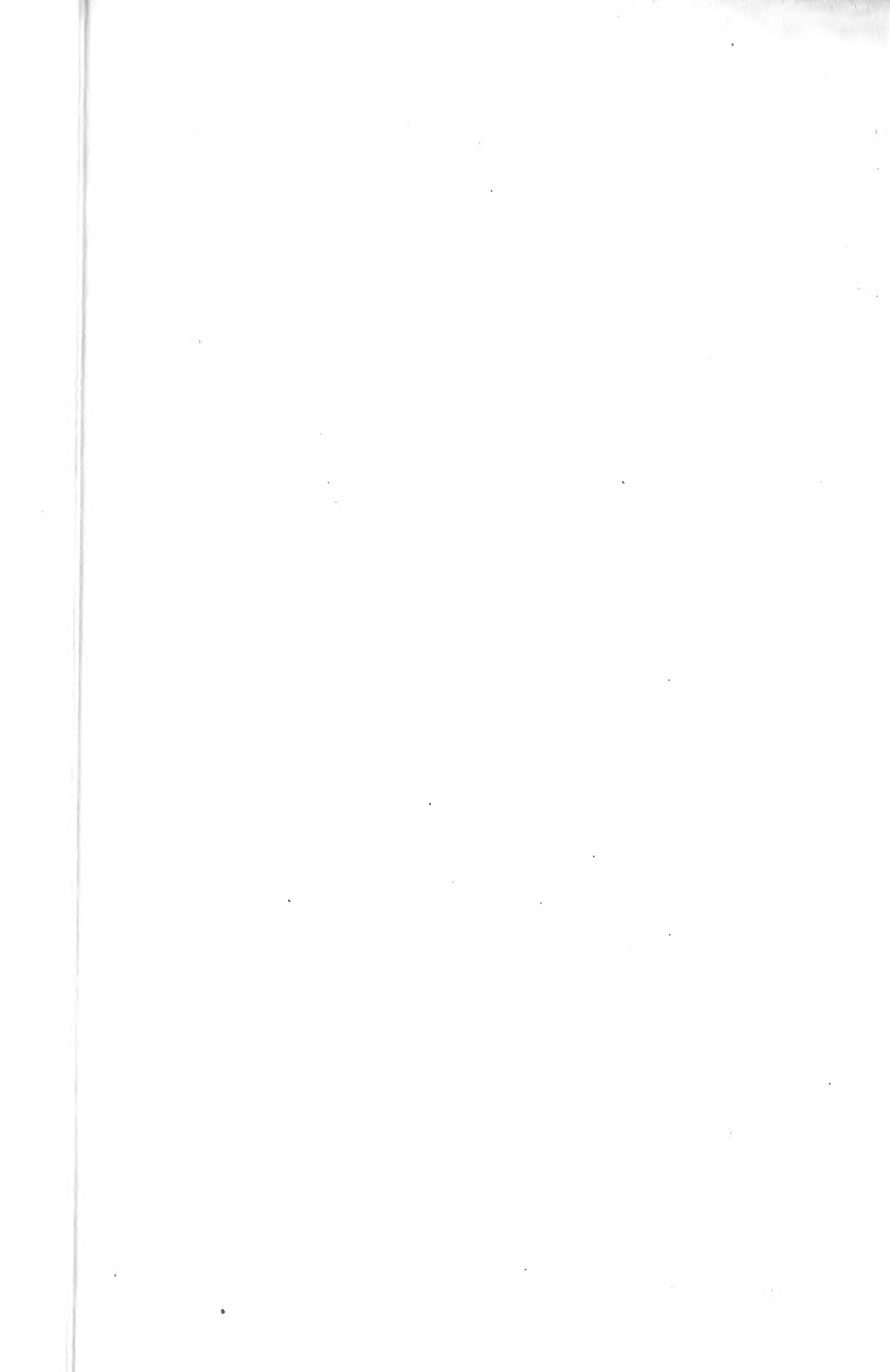


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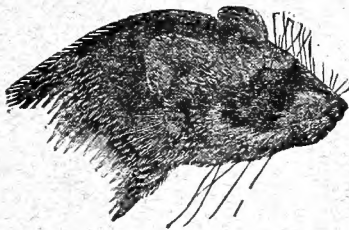
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HENRY W. HENSHAW, *Chief*

NORTH AMERICAN FAUNA

No. 35

[Actual date of publication, September 5, 1913]

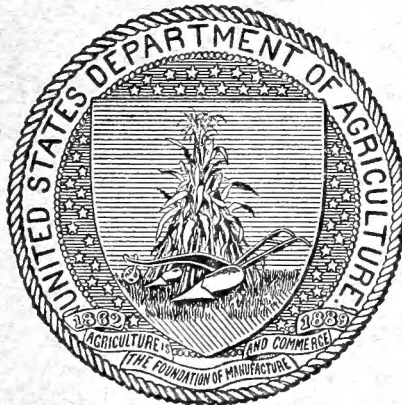


LIFE ZONES AND CROP ZONES OF NEW MEXICO

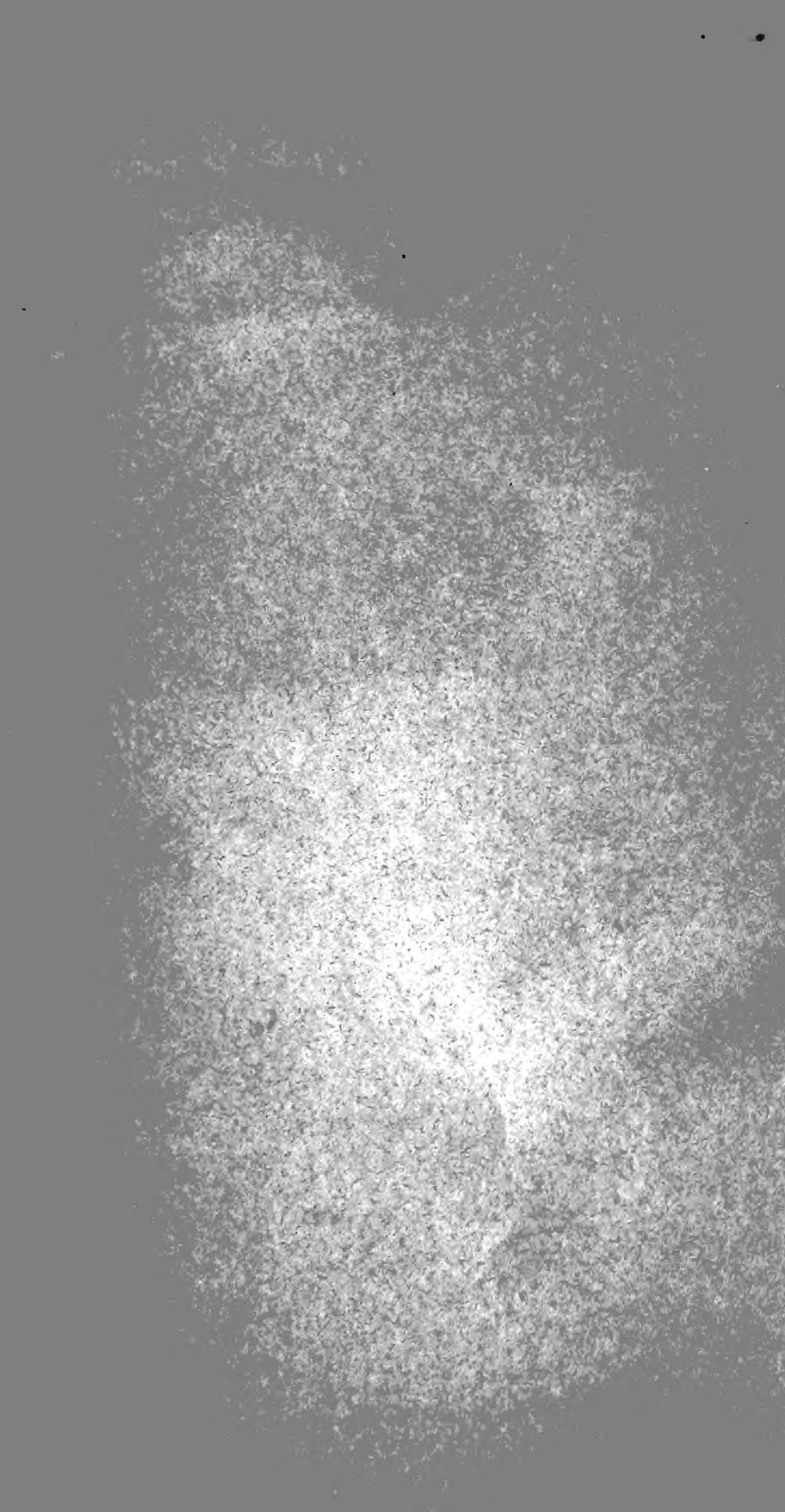
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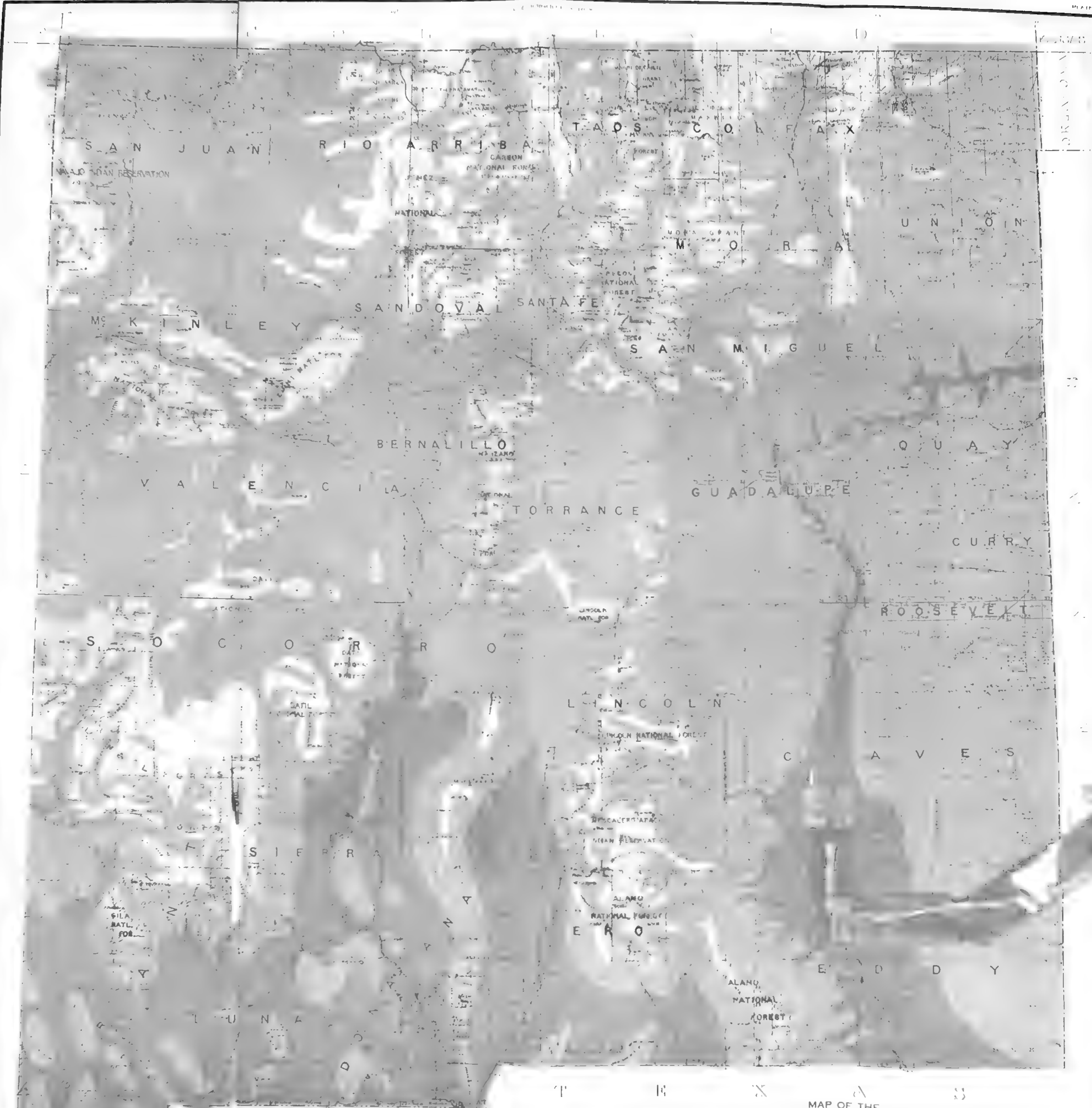
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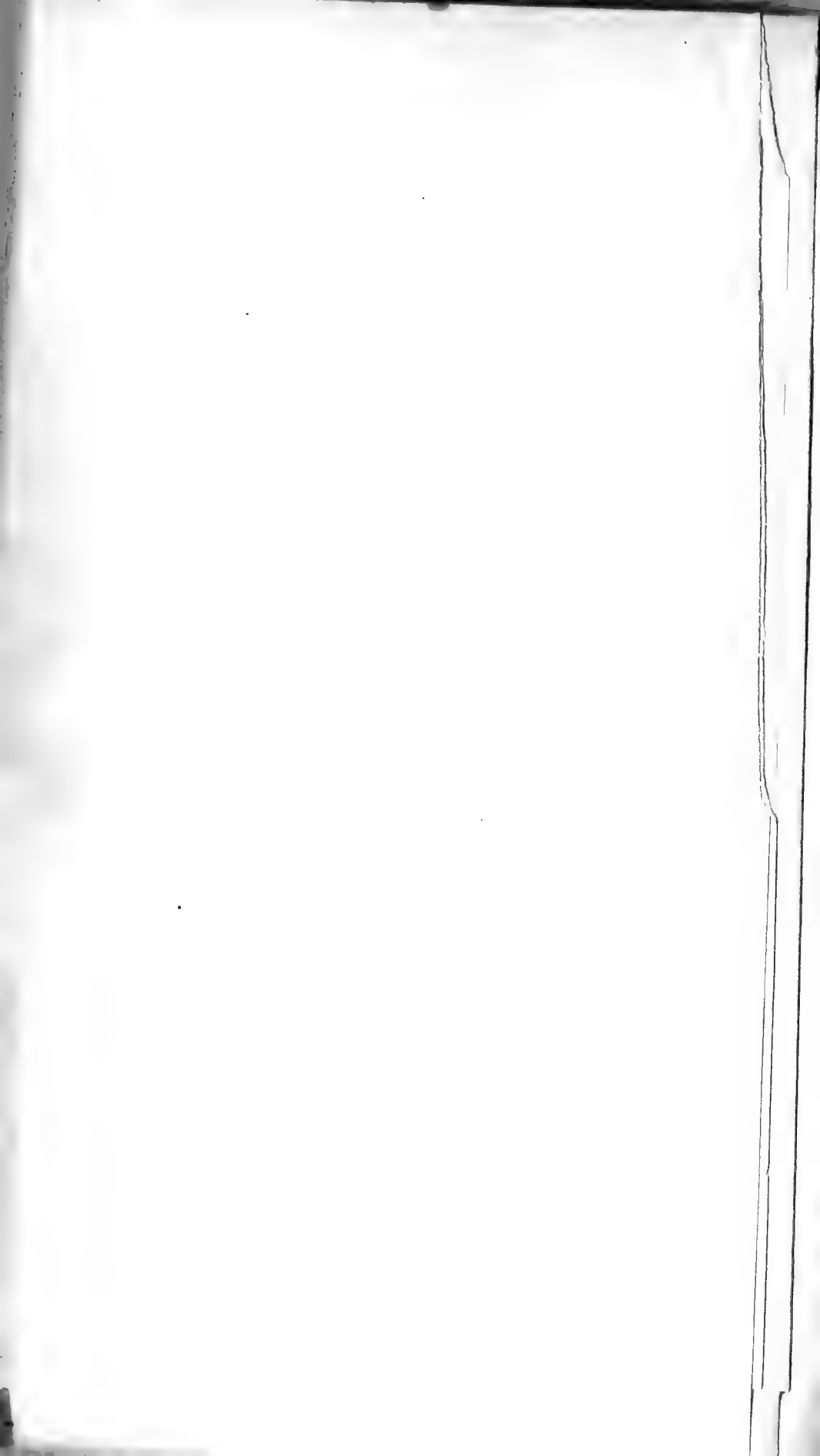




- HUDSONIAN AND ARCTIC ZONE
- CANADIAN
- TRANSITION
- UPPER SONORAN
- LOWER SONORAN

MAP OF THE
LIFE ZONES
 OF
NEW MEXICO

BY VERNON BAILEY
 U. S. BIOLOGICAL SURVEY, DEPARTMENT OF AGRICULTURE
 TO ACCOMPANY REPORT ON LIFE ZONES AND CROP ZONES OF NEW MEXICO
 1913



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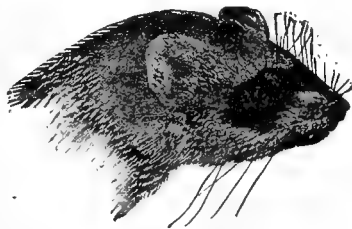
BUREAU OF BIOLOGICAL SURVEY

HENRY W. HENSHAW, *Chief*

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LIFE ZONES AND CROP ZONES OF NEW MEXICO

BY

VERNON BAILEY

IN CHARGE OF BIOLOGICAL INVESTIGATIONS, BIOLOGICAL SURVEY



WASHINGTON
GOVERNMENT PRINTING OFFICE

1913

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF BIOLOGICAL SURVEY,
Washington, D. C., March 15, 1913.

SIR: I have the honor to transmit herewith, for publication as North American Fauna No. 35, a report on the Life Zones and Crop Zones of New Mexico, by Vernon Bailey, in charge of Biological Investigations, Biological Survey. During recent years New Mexico has made rapid strides in modern agriculture, for which dry farming and irrigation projects are chiefly responsible. The present report is devoted mainly to a consideration of the life and crop zones of the State with a view to affording practical information as to the areas in which certain specified crops will best thrive. The accompanying map is intended to facilitate reference to the zones.

Respectfully,

HENRY W. HENSHAW,
Chief, Biological Survey.

Hon. DAVID F. HOUSTON,
Secretary of Agriculture.



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LIFE ZONES AND CROP ZONES OF NEW MEXICO.

By VERNON BAILEY.

INTRODUCTION.

The Biological Survey has carried on field work in every important valley and mountain range in New Mexico, and has gathered material for a fairly detailed map of the life zones of the State, which accompanies the present report, and for reports on the birds and mammals to be published later. The practical purpose of mapping life zones and their subdivisions is to show the extent and location of areas in the several States in which certain farm products thrive and outside of which they can not be made to thrive. In traversing the country even the most casual observer is often struck by the contrast in the plant and animal life of different regions. These differences sometimes conform to natural geographic areas, but upon close investigation are almost invariably found to correspond to changes of climatic conditions. By careful study of the distribution of native species of mammals, birds, reptiles, and plants,¹ which have reproduced for ages in their respective regions until they have become thoroughly adapted to them, it is possible to plot with considerable accuracy the areas which are marked by groups of species with similar ranges. In this way the climatic belts or life zones which cross the continent have been traced out and mapped with some detail. The temperature during the season of growth and reproduction controls the ranges of animals and plants, and therefore determines the extent and limits of the several zones.

While the climate may vary slightly in different parts of a distribution area, and always varies more or less in different years, the total range of variation does not exceed the power of adaptation possessed by the species living within the area. Beyond its borders, however, many or most of the species which characterize it give way

¹ Many species in other groups, notably of insects and mollusks, could be used to advantage in determining the limits of distribution areas, but unfortunately their ranges have not been mapped with sufficient accuracy for the purpose.

to others that in turn have become adapted to their own climatic conditions. It should be remembered, however, that zone boundaries are never sharply marked in nature except on steep slopes, but change gradually as one set of average climatic conditions is succeeded by another. They are here mapped to conform as nearly as possible to the mean limits as indicated by the ranges of species of plants and animals.

Not all distribution areas, however, are of equal rank. Some are so strongly characterized that comparatively few species overlap the boundaries, while others limit the ranges of a smaller percentage of species. Some are of great extent, while others are very restricted, and all are of irregular outline in conformity to the climatic barriers by which they are bounded. The broad and strongly marked life zones are made up of minor units, or subdivisions, some of which are so well marked as to have widely different crop adaptations. In New Mexico, however, the main life zones are comparatively uniform except the Upper Sonoran, in which the subdivisions are sufficiently well marked to show important differences in agricultural possibilities. In the other zones the crops that are found to flourish in one section can be safely introduced into other sections of the same zone without the necessity of slow and costly experimentation.

New Mexico, while rich in prehistoric ruins and containing some of the oldest Caucasian settlements in the United States, has only recently begun to make rapid strides in modern agriculture. "Dry farming" is now encroaching upon much of the best stock range, while irrigation is reclaiming many of the desert valleys. The Reclamation Service and private irrigation companies are building numerous reservoirs, canals, and ditches to conserve and utilize the water, and eventually much more of the desert will be brought under cultivation.

Stock raising, forestry, and mining are being put on a scientific basis. Graded cattle have almost entirely taken the place of the Texas longhorn; valuable horses are superseding the cayuse; the grade of sheep in many places is being greatly improved; lumbering is coming under Government control that, while utilizing the forests, will perpetuate them; and mining methods are being improved so that low-grade ores are worked at a profit.

Certain sections are becoming famous for the flavor and quality of fruits, which develop and mature to their greatest perfection under the combined influence of an arid atmosphere and the proper control of moisture in the soil. Various forage crops, grains, and vegetables have proved signally successful in restricted areas, and if the best results of a steadily developing agriculture are to be obtained the boundaries of the areas of approximately uniform agricultural character should be mapped and be made known.

Anyone familiar with the local flora and fauna can determine by reference to a list of the plants, birds, and mammals living in each zone the zonal position of any locality in New Mexico even without referring to the zone map, while the map will usually enable one not familiar with the native plants and animals to learn in which zone he resides. The map should also aid those desiring to take up any specific line of agriculture to locate where the conditions are most favorable.

GENERAL PHYSICAL FEATURES.

New Mexico is diversified by numerous mountain ranges, open plains, and extensive valleys. Its higher mountain ranges stand out in bold relief, usually belted or capped with dark forests, but there are also many half barren, jagged little peaks and ridges, rich in desert colors, quaint vegetation, and interesting forms of animal life, and often rich in minerals. The various mountain ranges are described in detail elsewhere in this report. But by far the greater part of its area is composed of grassy plains and arid valleys, lying between the levels of 4,000 and 7,000 feet. These also are described in some detail under their respective zones.

While some wide areas are approximately level and treeless, there are over most of the plains frequent canyons, gulches, "dry washes" (temporary watercourses), and occasional streams. The canyons, stream courses, and rough country generally are more or less wooded, and even the most arid valleys supply considerable fuel from their scrubby growth of mesquite with its greatly developed root system.

The lowest part of the State is in the south, where the Pecos River crosses the line at about 2,800 and the Rio Grande at about 3,700 feet, while the highest part is in the north, where Wheeler Peak reaches an altitude of 13,600 feet.¹

This great range of altitude, together with an extent of nearly 6° of latitude, gives extremes of climate sufficient to include all of the life zones of North America above the Tropical and the lower division of Lower Sonoran, and to give a correspondingly wide range of agricultural possibilities.

The climate² of New Mexico is mainly arid, varying from semi-arid on the eastern plains, with an average annual rainfall of 15 to 20 inches, to extreme arid in the western valleys, with an average annual rainfall generally given as varying from 10 to 15 inches. There are very few data as to the amount of precipitation in the mountains either in summer rains or winter snowfall, but to anyone who has been in the higher ranges at either season it is evident that

¹ Wheeler Peak is the highest point in the Taos Mountains, or the part of the Sangre de Cristo Range northeast of the Pueblo of Taos. Repeated aneroid readings from the railroad as a known base make it 13,600 feet, the highest peak in New Mexico.

² See Tinsley, T. D., Forty Years of New Mexico Climate, Bull. 59, New Mex. Agric. Exp. Sta., 1906.

they are far from arid. Summer rains are frequent; while in winter the snow often lies 6 to 10 feet deep in the woods and in summer rarely if ever entirely leaves the highest peaks. Thus the mountains feed the streams that water the valleys and while mainly above the zones of agriculture they are the real source of agricultural wealth. Not only the water but the rich alluvial soil of the valleys is brought down from the mountain slopes along the numerous watercourses.

Three important rivers (the Pecos, the Canadian, and the Gila) have their sources in the mountains of New Mexico, while the Rio Grande traverses its entire length and the San Juan makes a wide circuit through its northwestern corner. These with their branches supply far more water than is at present used, and enough when fully utilized to reclaim a large part of the desert. Still there are areas to which water can not be brought and which will long continue as open range. Much remains to be done in the improvement of grazing lands and the conversion of barren desert into productive grazing land. The resources of the State are now in various stages of development, some well advanced and others only beginning.

The best of these short-grass plains are in the eastern part of the State, where they comprise a wide area north of the Canadian River and nearly half of the Llano Estacado lying south of that river. These treeless, wind-swept plains, once a terror to travelers, are now dotted with ranches and windmills, marked by good roads and fences, and enlivened by countless herds of cattle. Between the Pecos and the Rio Grande lies another wide area of plains slightly more arid, while west of the Rio Grande are extensive but much broken and generally still more arid plains. These grassy plains furnish most of the range for vast numbers of stock produced in New Mexico, but much of the best stock range is now being used for "dry farming," and homes are being established in the semiarid regions, where there is no possibility of irrigation.

The principal valleys of the State are the Rio Grande, Pecos, and Gila in the south, the Canadian in the northeast, and the San Juan in the northwest. These, while comprising the hottest and most arid parts of the State, are of the greatest agricultural importance, as they contain extensive areas of rich alluvial soil and an ample supply of water for irrigating a large part of it.¹ The native vegetation of the lowest and hottest of these valleys is sparse and scattered, so that their value as stock range is comparatively slight, but under irrigation they are extremely productive.

PERSONNEL AND ACKNOWLEDGMENTS.

The field work on which the present report is mainly based was carried on by the author under the direction of Dr. C. Hart Merriam,

¹ See Sullivan, Vernon L., *Irrigation in New Mexico*, Bull. 215, Office Exp. Sta., U. S. Dept. Agric., 1909.

with the assistance at different times of B. H. Dutcher, Arthur H. Howell, E. A. Goldman, N. Hollister, J. Alden Loring, James A. Gaut, E. A. Weller, and Clarence Birdseye. Additional field notes have been contributed by Dr. C. Hart Merriam, H. W. Henshaw, Dr. A. K. Fisher, and E. W. Nelson. Other assistance and information will be credited as far as possible under the separate notes. The various published local lists of birds, mammals, and plants have been of much assistance.

For the identification of plants turned in to the United States National Herbarium, I am especially indebted to F. V. Coville, J. N. Rose, E. L. Greene, Paul C. Standley, and E. O. Wooton, and for specimens of trees turned in to the Forest Service, to George B. Sudworth. From both Prof. Wooton and Mr. Standley I have received much assistance in preparing the zone lists of plants, and the names of grasses, cactuses, and *Eriogonum* were supplied in large part by Prof. Wooton.

From Prof. Fabian Garcia, horticulturist of the New Mexico Agricultural Experiment Station, I have received many practical suggestions, and through the numerous publications of the experiment station, by Garcia and others, I have drawn freely on the fund of information collected by the various members of the staff.

LIFE ZONES AND CROP ZONES OF NEW MEXICO.

Six of the transcontinental life zones are represented in New Mexico (see frontispiece) as broad bands sweeping across the State, as tongues reaching in from farther south, or as encircling rings or caps on the elevated peaks and mountain ranges. *Lower Sonoran*, the zone of mesquite, comes into the southern valleys along the Pecos, Rio Grande, and Gila Rivers, and over the low plains of the southwestern corner of the State; *Upper Sonoran*, the zone of nut pine and juniper, covers most of the plains and foothill country; *Transition*, the zone of yellow pine, covers generally the middle mountain slopes of the high ranges; *Canadian*, the zone of spruce and fir, covers the higher mountain slopes; *Hudsonian*, the zone of dwarf spruces, occurs as a narrow belt of scrubby timberline trees around the high peaks; and the treeless *Arctic-Alpine Zone* caps many of the higher peaks in the Sangre de Cristo Range.

LOWER SONORAN ZONE.¹

(*The zone of mesquite and creosote bush.*)

While only the upper or cooler part of this arid division of the Lower Austral Zone comes into southern New Mexico, it covers an area

¹ Lower and Upper Sonoran are here spoken of as zones, while they are in reality only the arid subdivisions of the Lower and Upper Austral Zones. The humid divisions of these, the Austroriparian and Carolinian, are not represented in New Mexico. For full classification and nomenclature of life zones of North America see *Life Zones and Crop Zones of the United States*, by C. Hart Merriam (Bull. 10, Biological Survey, 1898), and the *Fourth Provisional Zone Map of North America*, prepared by the Biological Survey, 1910.

of approximately 18,000 square miles, some of which is of great agricultural value. It extends up the Pecos Valley to Roswell and in dilute form beyond; covers most of the Tularosa Valley; and extends up the Rio Grande Valley to Socorro and in narrow strips beyond; and west from the Rio Grande Valley in dilute form over the Deming Plains to the Upper Gila and San Francisco River Valleys. The Playas, Animas, and Hachita Valleys are also mainly Lower Sonoran. The zone has no important subdivisions in New Mexico and is as uniform in climate as in the assemblage of species which mark its boundaries. The greatest difference lies between its east and west extremes, the Pecos and Gila Valleys, each of which draws some of its species from adjoining areas—a few plains species entering the Pecos Valley and a few species extending up the Gila Valley from Arizona.

It is the region of mesquite and creosote bush, striking shrubs which most conspicuously mark the zone, the mesquite marking a liberal and the creosote a more conservative boundary. Along the upper edge of the zone there is the usual overlapping of Upper and Lower Sonoran species, often resulting on gradual slopes in a complete mixture of the two zones for a considerable distance, but the dominant species at any point usually show to which zone that point really belongs.

The great advantages of the Lower Sonoran Zone for agricultural purposes are its high temperature and long growing period. Many crops mature that will not succeed in a cooler zone, and several successive crops are often raised on the same ground during one season. The abundance of water and the rich soil of its principal valleys make it, despite its limited area of arable land, the most important agricultural zone in the State. With the extension of irrigation its importance will be greatly increased, for at present agriculture is confined mainly to the lowest valley bottoms, which owing to the settling of cold air currents are more subject to spring and fall frosts than the adjoining bench lands. It is a well-known fact that frost often occurs on bottom lands when surrounding areas 50 or 100 feet higher escape, and these so-called "thermal belts" should be taken advantage of, especially in fruit raising.

The slight differences in the native species in each of the Lower Sonoran valleys may indicate slight variations in climatic or physiographic conditions, but there are also in each valley local conditions of soil and moisture that determine the limits of certain species, especially of plants. Most of these local peculiarities can be taken advantage of in some line of agriculture and all should be studied until thoroughly understood.

PECOS VALLEY.

This is the least arid of the Lower Sonoran valleys in New Mexico, and while characterized in the main by the same species which occur

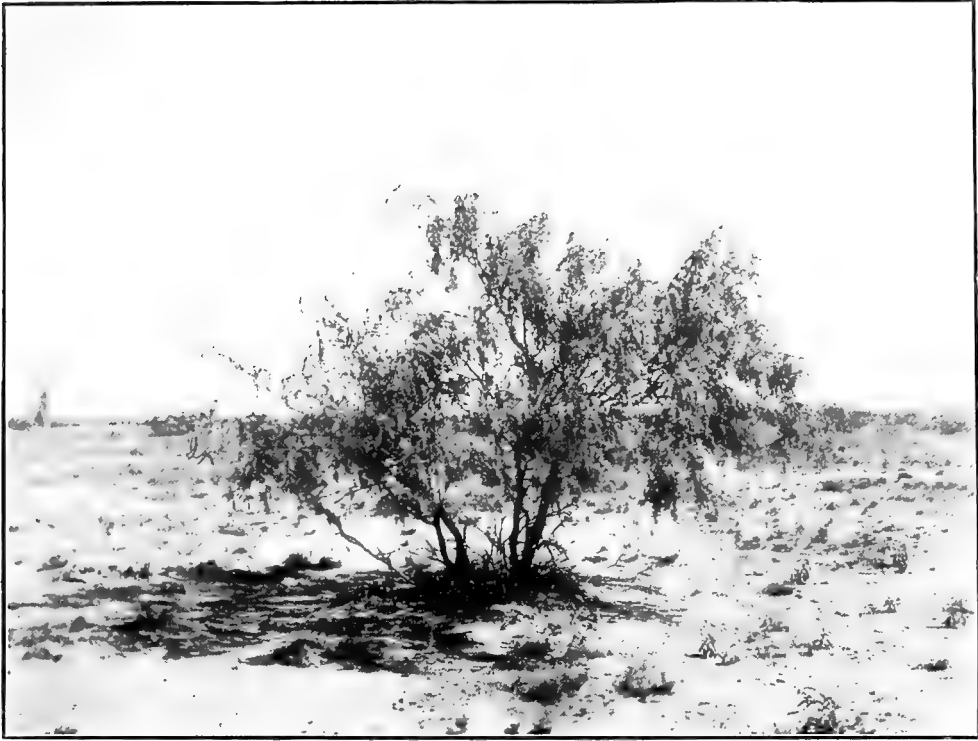


FIG. 1.—MESQUITE (*PROSOPIS GLANDULOSA*) IN LOWER SONORAN VALLEY WEST OF DEMING.

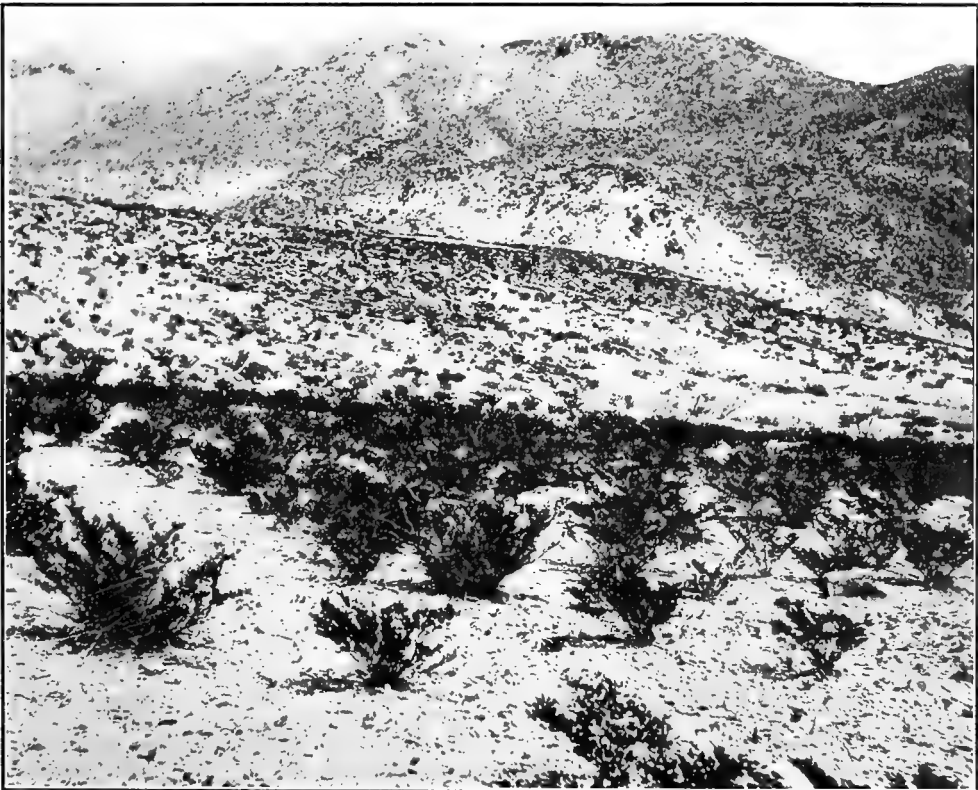


FIG. 2.—CREOSOTE BUSH (*COVILLEA GLUTINOSA*) ON LOWER SONORAN MESA ABOVE EL PASO.



in the others it has a more vigorous plant growth, better grazing on the uplands, and in places may allow some successful agriculture by "dry-farming" methods. The bottom lands and adjacent valley slopes which have received first attention in farm development are characterized by a vigorous growth of cottonwood, willows, baccharis, chrysothamnus, atriplex, dondia, heliotrope, salt grass, and other saline and alkaline plants, none of which are very strongly characteristic of the Lower Sonoran Zone. It is even questionable whether these cool bottoms should be classed as pure Lower Sonoran. The slightly elevated bench lands along the sides of the stream valleys, however, carry full sets of the most characteristic zone plants, mesquite, creosote bush, *Acacia constricta*, *Flourensia cernua*, allthorn (*Koeberlinia spinosa*), ocotillo (*Fouquieria splendens*), *Berberis trifoliolata*, sotol (*Dasyllirion texanum*), lechuguilla (*Agave lechuguilla*), *Yucca macrocarpa*, and many others that definitely fix the zonal position of these parts of the valley.

In the Pecos Valley, as elsewhere near the border of a zone, these plants give place to Upper Sonoran species on north slopes or along cold bottoms, a fact that should be taken advantage of in diversified farming or horticulture. Until very recently little of the unmistakably Lower Sonoran area of this valley has been under cultivation, because it is easier to carry water over the lower levels. It seems a safe prediction, however, that the greater part of Pecos Valley will eventually be brought under cultivation through the extension of irrigation systems, the storage of flood and rain water along the side streams, and a partial use of dry-farming methods. Even the slopes that can never be irrigated can be greatly improved for grazing by a system of contour furrows that will catch and hold the rain where it falls. After a heavy rain in this valley the water is said to rise sometimes 50 feet in an hour in Pecos Canyon lower down, so quickly does it run off the open surface.

The Lower Sonoran Zone in the Pecos Valley, as indicated on the map (frontispiece) includes some mixed areas, especially along the edges and in the narrow northern strip extending along the river between Roswell and Santa Rosa, where only traces of the zone are found on hot slopes in the form of dwarf mesquite and occasional bushes of small-leaved sumac (*Schmaltzia microphylla*), *Zizyphus obtusifolia*, *Parosela formosa*, *Opuntia leptocaulis*, and *O. cyclodes*, together with some of the less closely restricted species of birds, mammals, and reptiles. So narrow a strip as this northern extension would hardly be indicated on the map except for its importance as a highway for the distribution of Lower Sonoran species between the Pecos and Canadian River Valleys through the narrow gap around the northern end of the Staked Plains, and the consequent intrusion of a dilute Lower Sonoran element in the New Mexico part of the Canadian River Valley north of Tucumcari.

CANADIAN RIVER VALLEY.

The Lower Sonoran element in the Canadian River Valley on warm slopes and open plains reaches from the Texas line up the valley above Tucumcari, with scattered traces across the low pass to Santa Rosa on the Pecos. It is marked by such characteristic species as mesquite, small-leaved sumac (*Schmaltzia microphylla*), soapberry tree (*Sapindus marginatus*), *Parosela formosa*, *Krameria secundiflora*, and *Opuntia leptocaulis*, and by the scaled quail, road-runner, Texas woodpecker, Scott's oriole, desert and Cassin's sparrows, and the western mockingbird.

While a great number of species in this valley are Upper Sonoran, the strong admixture of Lower Sonoran species indicates a modified climate, in which some Lower Sonoran crops would doubtless thrive.

TULAROSA VALLEY.

The great valley lying between the Sacramento and San Andres Mountain ranges is almost entirely Lower Sonoran, but so extremely arid and so unlikely to be adequately irrigated, unless from subterranean sources, that at present it is agriculturally unimportant. Over great stretches the land is level and the soil of excellent quality, but the few marginal streams barely reach the edges of the valley and furnish a very limited supply of water.

The striking features of the valley are its diminutive forests of tree-like yuccas (*Yucca radiosa*), its scattered growth of low desert shrubs and cactuses, its dunes of white gypsum sand, extensive playas with incrustations of salt and alkali, salt marshes, and wide flows or jagged outcroppings of black lava rock. In climate and in plant and animal life it is practically identical with the Rio Grande Valley above El Paso, with which it connects through low gaps in the mountain.

RIO GRANDE VALLEY.

The Rio Grande Valley from the Texas line north to Socorro is mainly Lower Sonoran, and traces of the zone extend north to Las Lunas and into the lower Puerco Valley. The lateral boundaries are more irregular than the zone map indicates, just as the details of valley surface and slope are more intricate than any map can show. In general, the Lower Sonoran Zone extends from the western foothills of the San Andres Mountains to the eastern base of the Mimbres and Magdalena Mountains and out to the southwest over the Deming plain. On east and west slopes the upper edge of this zone in the Rio Grande Valley conforms closely to the 5,000-foot contour, but on northeast slopes usually runs 500 feet lower and on southwest slopes 500 feet higher. On very steep slopes the variation is even greater, while on very gentle slopes it is proportionately less. Many low

mountain ranges, high hills, or ridges stand out as Upper Sonoran islands in this area, while slopes dipping northward are generally Upper Sonoran down to about 4,500 feet.

The lowest part of the immediate river valley, where most of the farming has been carried on, is evidently not the warmest part of the Rio Grande Valley. While most of its vegetation is of Lower Sonoran species, such as mesquite, screw bean, acacia, atriplex, dondia, zizyphus, baccharis, pluchea, lycium, chilopsis, willows, and cottonwoods, some of these also run into or through the Upper Sonoran Zone. The side slopes of the valley are more purely Lower Sonoran,

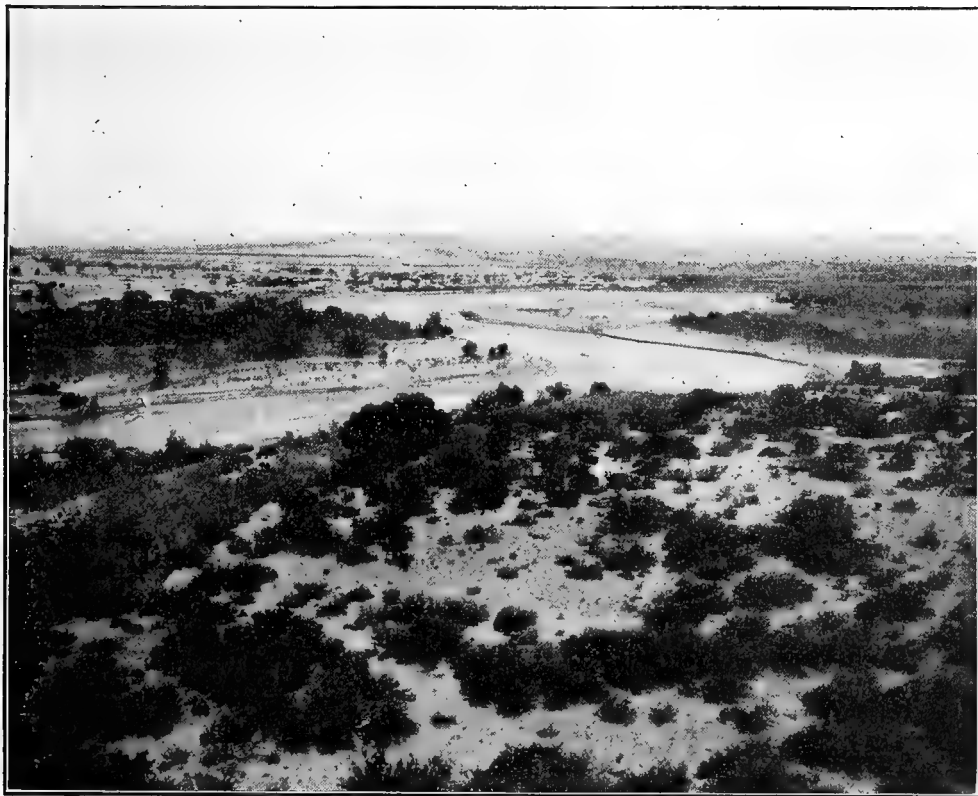


FIG. 1.—Rio Grande Valley at Las Palomas, below the Elephant Butte Reservoir.

as shown by their flora and fauna. The characteristic plants of these middle slopes are mesquite, acacia, creosote bush, ocotillo (*Fouquieria splendens*), allthorn (*Koeberlinia spinosa*), small-leaved sumac (*Schmaltzia microphylla*), tree yuccas (*Yucca radiosa* and *Y. macrocarpa*), cactuses (*Echinocactus wislizeni*, *Opuntia leptocaulis*, and *O. engelmanni*), *Flourensia cernua*, *Coleosanthus laciniatus*, *Krameria canescens*, *Parosela frutescens*, *Ephedra trifurca*, and *Thamnosma texanum*.

The distribution of mammal, bird, and reptile life is less influenced than that of plant life by slight local changes of climate, but in determining the zones over the valley at large is of equal, if not

greater importance. The great advantage of plants is that they are always conspicuous, while the ranges of animals must be worked out slowly by collecting or identifying many individuals of each species.

North over the great dry Jornada Valley,¹ which is part of the Rio Grande Valley, the general level rises to nearly 5,000 feet, and the long undulations alternate in Lower Sonoran Zone on south slopes and Upper Sonoran on north slopes. Such details can not be shown on a small scale zone map, but are counted as a part of the overlapping always found along the junction of two zones. Farther north, from San Marcial to Socorro, there is considerable overlapping, while north of Socorro are only scattered traces of Lower Sonoran species, some of which reach nearly to Albuquerque.

THE DEMING PLAIN.

The broad arid plain lying between the Rio Grande and Gila Valleys, with Deming as its center, is mainly below 4,500 feet. Numerous sharp and rugged little peaks, craters, and mountain ranges rise from its general level, and basin valleys drop a little below. The level plain is dominated by Lower Sonoran species, which run up to a little above 5,000 feet on warm slopes and down to about 4,500 feet on cold slopes. The Hachita, Playas, and San Luis Valleys form part of this Lower Sonoran plain, which opens out broadly to the valley of the Gila and other Lower Sonoran valleys of southern Arizona.

The plants and animals of these plains are mainly the same as in the Rio Grande Valley, with a few Arizona species coming in on the west. In fact, this plain is the great highway through which the Gila River Valley and Rio Grande Valley species characteristic of the upper division of the zone have freely intermingled. The lower or subtropical division of Lower Sonoran, as represented in the Rio Grande Valley of Texas and the Gila Valley of Arizona, are, however, separated by this upper division of the zone, and their characteristic plants, mammals, and reptiles are widely different. The characteristic birds of the two regions are for obvious reasons more nearly the same.

There are practically no permanent streams over these dry plains, but in many places good water lies near the surface, and some agriculture is carried on by pumping or by storing flood water.

Grazing is generally sparse and poor, but it could be greatly improved by a system of cross furrowing to hold the rain where it falls on the sloping surfaces and by closing the arroyos so as to turn the water out over dry mesas. This would also prevent the formation of

¹ Valle Jornada del Muerto, the "valley of the journey of death," was so named from the death of the Spanish refugees who perished there of thirst in 1680 on their flight down its waterless stretch of 90 miles to Old Mexico. In 1867 Gen. H. C. Merriam marched his infantry down this valley with the water each man could carry in his canteen, covering the distance in three night marches, with no great suffering or danger. Now stock ranches dot the valley here and there, and windmills and water tanks may be seen from the train.

great shallow lakes in the valley bottoms which in drying up leave miles of worthless mud flats or "playas." Because of the mild winters and the fact that the grasses cure well and retain their nutriment, the grazing would be especially valuable if the grass were more abundant.

GILA VALLEY.

The Lower Sonoran Zone extends up the Gila Valley into New Mexico for about 50 miles, or a little beyond Cliff, and strong traces of it reach up the Valley of the San Francisco, a northern branch of the Gila, well within the State. These valleys are narrow, but both contain rich agricultural land with abundance of pure water for irrigation.

The characteristic Lower Sonoran plants of the Gila Valley are creosote bush, mesquite, acacia, mimosa, chilopsis, fouquieria, zizyphus, sapindus, atriplex, *Yucca radiosa*, and several species of cactus. Its birds are Gambel's and scaled quail, road-runner, Gila woodpecker, Texas woodpecker, vermilion flycatcher, black phoebe, Abert's towhee, cactus wren, and crissal thrasher.

Its mammals are the large and small kangaroo rats (*Dipodomys spectabilis* and *D. merriami*), Ord kangaroo rat (*Perodipus ordi*), Baird pocket mouse (*Perognathus flavus*), Arizona grasshopper mouse (*Onychomys torridus*), Anthony white-footed mouse (*Peromyscus anthonyi*), Arizona pocket gopher (*Thomomys cervinus*), little canyon bat (*Pipistrellus hesperus*), New Mexico desert fox (*Vulpes macrotis neomexicana*), and probably the gray-tailed antelope squirrel (*Ammospermophilus harrisi*), which at least comes near the line and which enters the Animas Valley farther south.

CHARACTERISTIC LOWER SONORAN SPECIES IN NEW MEXICO.

The following list of mammals, birds, reptiles, and plants includes the species that best mark the limits of the Lower Sonoran Zone in New Mexico. Comparatively few of these occur throughout the zone and some reach only into a corner or inhabit a very restricted area in the State.

Only breeding birds are given in the zone lists, as the greater number of migrants passing through on their way north and south occur in practically the whole of the State at one time or another with little regard to zonal limits. Also some of the birds that breed in the higher zones of the State spend the winters in the lower zones, while others breeding in the low hot zones hurry into the mountains or a higher zone when the breeding season is over and remain there during the driest and hottest part of summer. Some of the birds breed as early as February and March, while others breed in mid-summer, and many breed more than once in a season, so that the

mere presence of a bird at a given locality in summer is not always sufficient evidence of its breeding there. The actual breeding ranges of many species are not well determined. In some cases the records are few and some of these may be erroneous, so that the present lists are only provisional.

Mammals are generally more stable in their range, but some are more or less migratory or nomadic, and others are adapted to a wide range of climatic and environmental conditions. Some of the common species are therefore not included in the zone lists, being found in so many zones that their distribution has little zonal significance. Most of the species, however, are very constant in their range.

MAMMALS OF THE LOWER SONORAN ZONE IN NEW MEXICO.

[Species marked *U.* occur also in Upper Sonoran Zone.]

- | | |
|--|---|
| <i>Didelphis mexicanus texensis</i> , Texas Opossum. | <i>Castor canadensis frondator</i> , Broad-tailed Beaver. |
| <i>Tatu noremecinctum texanum</i> , Texas Armadillo. | <i>Geomys arenarius</i> , Desert Pocket Gopher. |
| <i>Tayassu angulatum</i> , Texas Peccary. | <i>Thomomys aureus lachuguilla</i> , Lechuguilla Pocket Gopher. |
| <i>Ammospermophilus interpres</i> , Texas Antelope Squirrel. | <i>Thomomys cervinus</i> , Arizona Pocket Gopher. |
| <i>Ammospermophilus harrisi</i> , Gray-tailed Antelope Squirrel. | <i>Perognathus penicillatus eremicus</i> , Desert Pocket Mouse. |
| <i>Citellus mexicanus parvidens</i> , Rio Grande Ground Squirrel. | <i>Perognathus penicillatus pricei</i> , Price Pocket Mouse. |
| <i>Citellus spilosoma macropsilotus</i> , Spotted Ground Squirrel. | <i>Perognathus intermedius</i> , Intermediate Pocket Mouse. |
| <i>Citellus spilosoma arens</i> , Spotted Sand Squirrel. | <i>Perognathus flavus</i> , Baird Pocket Mouse. |
| <i>Onychomys torridus</i> , Arizona Grasshopper Mouse. | <i>Perognathus merriami gilvus</i> , Dutcher Pocket Mouse. |
| <i>Peromyscus eremicus</i> , Desert White-footed Mouse. | <i>Perodipus ordi</i> , Ord Kangaroo Rat. |
| <i>Peromyscus eremicus anthonyi</i> , Anthony White-footed Mouse. | <i>Dipodomys merriami</i> , Merriam Kangaroo Rat. |
| <i>Peromyscus leucopus tornillo</i> , Tornillo White-footed Mouse | <i>Dipodomys merriami ambiguus</i> , El Paso Kangaroo Rat. |
| <i>Peromyscus leucopus arizonae</i> , Arizona White-footed Mouse. | <i>Dipodomys spectabilis</i> , Large Kangaroo Rat. <i>U.</i> |
| <i>Reithrodontomys megalotis</i> , Large-eared Harvest Mouse. | <i>Lepus californicus texianus</i> , Texas Jack Rabbit. <i>U.</i> |
| <i>Neotoma micropus canescens</i> , Gray Wood Rat. | <i>Lepus californicus eremicus</i> , Desert Jack Rabbit. |
| <i>Sigmodon hispidus berlandieri</i> , Berlandier Cotton Rat. | <i>Sylvilagus auduboni minor</i> , Desert Cottontail. |
| <i>Sigmodon minimus goldmani</i> , Goldman Cotton Rat. | <i>Felis onca hernandezi</i> , Jaguar. |
| <i>Fiber zibethicus ripensis</i> , Pecos River Muskrat. | <i>Vulpes macrotis neomexicana</i> , New Mexico Desert Fox. |
| <i>Fiber zibethicus pallidus</i> , Pale Muskrat. | <i>Canis mearnsi</i> , Mearns Coyote. <i>U.</i> |
| | <i>Procyon lotor mexicanus</i> , Mexican Raccoon. |
| | <i>Nasua narica pallida</i> , Nasua. |
| | <i>Taxidea taxus berlandieri</i> , Mexican Badger. <i>U.</i> |

MAMMALS OF THE LOWER SONORAN ZONE IN NEW MEXICO—continued.

<i>Mustela frenatus neomexicanus</i> , New Mexico Weasel.	<i>Notiosorex crawfordi</i> , Eared Shrew.
<i>Spilogale leucoparia</i> , Rio Grande Spotted Skunk.	<i>Myotis yumanensis</i> , Yuma Bat. U.
<i>Spilogale ambigua</i> , Chihuahua Spotted Skunk.	<i>Myotis velifer</i> , Cave Bat. U.
<i>Spilogale arizonae</i> , Arizona Spotted Skunk.	<i>Myotis californicus</i> , Little California Bat. U.
<i>Mephitis leucomitra</i> , Hooded Skunk.	<i>Myotis thysanodes</i> , Fringed Bat. U.
<i>Mephitis mesomelas varians</i> , Texas Skunk.	<i>Myotis incautus</i> , House Bat.
<i>Conepatus mesoleucus mearnsi</i> , Mearns White-backed Skunk.	<i>Pipistrellus hesperus</i> , Little Canyon Bat.
	<i>Antrozous pallidus</i> , Large Pale Bat. U.
	<i>Nyctinomus mexicanus</i> , Free-tailed Bat.

BREEDING BIRDS OF LOWER SONORAN ZONE IN NEW MEXICO.

[Species marked U. occur also in Upper Sonoran Zone.]

<i>Colinus virginianus texanus</i> , Texas Bobwhite.	<i>Sturnella magna hoopesi</i> , Rio Grande Meadowlark.
<i>Callipepla squamata</i> , Scaled Quail. U.	<i>Icterus parisorum</i> , Scott's Oriole.
<i>Lophortyx gambeli</i> , Gambel's Quail.	<i>Icterus cucullatus nelsoni</i> , Arizona Hooded Oriole.
<i>Melopelia asiatica trudeaui</i> , White-winged Dove.	<i>Amphispiza bilineata deserticola</i> , Desert Sparrow.
<i>Parabuteo unicinctus harrisi</i> , Harris's Hawk.	<i>Peucaea cassini</i> , Cassin's Sparrow.
<i>Buteo abbreviatus</i> , Zone-tailed Hawk.	<i>Pipilo aberti</i> , Abert's Towhee.
<i>Falco fusco-caerulescens</i> , Aplomado Falcon.	<i>Cardinalis cardinalis canicaudus</i> , Gray-tailed Cardinal.
<i>Polyborus cheriway</i> , ¹ Audubon's Caracara.	<i>Pyrrhuloxia sinuata</i> , Arizona Pyrrhuloxia.
<i>Aluco pratincola</i> , ¹ Barn Owl.	<i>Guiraca caerulea lazula</i> , Western Blue Grosbeak. U.
<i>Speotyto cunicularia hypugaea</i> , Burrowing Owl. U.	<i>Passerina ciris</i> , Painted Bunting.
<i>Micropallas whitneyi</i> , ¹ Elf Owl.	<i>Phainopepla nitens</i> , Phainopepla.
<i>Geococcyx californianus</i> , Road-runner.	<i>Mimus polyglottos leucopterus</i> , Western Mockingbird. U.
<i>Dryobates scalaris cactophilus</i> , Cactus Woodpecker.	<i>Toxostoma curvirostre</i> , Curve-billed Thrasher. U.
<i>Centurus uropygialis</i> , Gila Woodpecker.	<i>Toxostoma curvirostre palmeri</i> , Palmer's Thrasher.
<i>Chordeiles acutipennis texensis</i> , Texas Nighthawk.	<i>Toxostoma crissale</i> , Crissal Thrasher.
<i>Calypte costae</i> , Costa's Hummingbird.	<i>Heleodytes brunneicapillus couesi</i> , Cactus Wren.
<i>Tyrannus vociferans</i> , Cassin's Kingbird. U.	<i>Catherpes mexicanus conspersus</i> , Cañon Wren. U.
<i>Sayornis nigricans</i> , Black Phoebe.	<i>Auriparus flaviceps</i> , Verdin.
<i>Pyrocephalus rubinus mexicanus</i> , Vermilion Flycatcher.	<i>Polioptila plumbea</i> , Plumbeous Gnatcatcher.
<i>Otocoris alpestris adusta</i> , Scorched Horned Lark.	
<i>Corvus cryptoleucus</i> , White-necked Raven.	

REPTILES.

The following lists are mainly from New Mexico specimens in the United States National Museum collection, identified by Dr. Leonhard Stejneger, herpetologist and head curator of zoology. Some additional species are included from a report by Dr. Alexander G. Ruthven

¹ Record doubtful as to breeding.

on a collection of reptiles and amphibians from southern New Mexico and Arizona. The zonal position of some of the species is based on so few records as to be still somewhat in doubt, but is given as best indicated by the localities represented.

REPTILES OF LOWER SONORAN ZONE IN NEW MEXICO.

[Species marked *U.* occur also in Upper Sonoran Zone.]

Lizards.

<i>Crotaphytus wislizeni</i> , Leopard Lizard.	<i>Phrynosoma modestum</i> , Gray Horned Lizard. <i>U.</i>
<i>Holbrookia texana</i> , Texas Spotted-tailed Lizard.	<i>Cnemidophorus gularis</i> , Whip-tailed Lizard. <i>U.</i>
<i>Holbrookia propinqua</i> , Spotted-tailed Lizard.	<i>Cnemidophorus tigris</i> , Striped Whip-tailed Lizard. <i>U.</i>
<i>Uta stansburiana</i> , Stansbury Lizard. <i>U.</i>	<i>Cnemidophorus melanostethus</i> , Whip-tailed Lizard.
<i>Sceloporus magister</i> , Great Scaly Lizard.	<i>Cnemidophorus sexlineatus</i> , Six-lined Lizard.
<i>Sceloporus clarki</i> , Clark Scaly Lizard.	<i>Heloderma suspectum</i> ¹ , Gila Monster.
<i>Sceloporus consobrinus</i> , Fence Scaly Lizard. <i>U.</i>	<i>Coleonyx brevis</i> , Gecko.
<i>Phrynosoma cornutum</i> , Texas Horned Lizard.	

Snakes.

<i>Leptotyphlops dulcis</i> , Burrowing Snake.	<i>Rhinocheilus lecontei</i> , LeConte's Snake.
<i>Thamnophis marciana</i> , Marcy's Garter Snake.	<i>Lampropeltis getulus splendidus</i> , King Snake.
<i>Natrix transversa</i> , Water Snake.	<i>Lampropeltis pyrrhmelanus</i> . <i>U.</i>
<i>Salvadora hexalepis</i> , Flat-nosed Snake.	<i>Lampropeltis pyrrhmelanus celaeonops</i> .
<i>Salvadora grahamiae</i> , Graham Snake.	<i>Diadophis regalis</i> , Ring Snake.
<i>Elaphe emoryi</i> , Emory's Snake.	<i>Gyalopium canum</i> .
<i>Bascanion flagellum</i> , Coachwhip Snake.	<i>Tantilla planiceps</i> , Plain-headed Little Snake.
<i>Arizona elegans</i> , Arizona Snake.	<i>Sistrurus catenatus edwardsi</i> , Massasauga.
<i>Ophedryx aestivus</i> , Rough Green Snake. <i>U.</i>	<i>Crotalus atrox</i> , Western Diamond Rattlesnake.
<i>Hypsiglena ochrorhyncha</i> , Rock Snake.	

PLANTS OF LOWER SONORAN ZONE IN NEW MEXICO.

[Species marked *U.* occur also in the Upper Sonoran Zone.]

Trees, shrubs, and herbaceous plants.

<i>Covillea glutinosa</i> , Creosote Bush. ²	<i>Sophora secundiflora</i> , Coral Bean.
<i>Prosopis glandulosa</i> , Mesquite.	<i>Parosela frutescens</i> , Dalea.
<i>Prosopis pubescens</i> , Screw Bean, Tornillo.	<i>Parosela formosa</i> , Dalea.
<i>Acacia constricta</i> , Straight-spined Acacia.	<i>Parosela scoparia</i> , Dalea.
<i>Acacia greggi</i> , Devil's Claw.	<i>Parosela lachnostachys</i> , Dalea.
<i>Acacia filicioides</i> , Spineless Acacia.	<i>Lupinus micensis</i> , Lupine.
<i>Cassia wislizeni</i> , Senna.	<i>Astragalus wootoni</i> , Milk Vetch.
<i>Cassia lindheimeriana</i> , Senna.	<i>Populus wislizeni</i> , Rio Grande Cottonwood. <i>U.</i>
<i>Cassia roemeriana</i> , Senna.	<i>Juglans rupestris</i> , Dwarf Walnut.
<i>Cassia bahinioides</i> , Senna.	<i>Quercus havardi</i> , Havard Oak.
<i>Hoffmanseggia densiflora</i> .	

¹ Reported on Gila River by residents.

² The plants most important in marking the life zones have been given precedence in the lists as far as is possible without separating related species.

PLANTS OF LOWER SONORAN ZONE IN NEW MEXICO—continued.

Trees, shrubs, and herbaceous plants—Continued.

- Sambucus mexicanus*, Mexican Elderberry.
Fouquieria splendens, Ocotillo, Devil's-walking-stick.
Koerberlinia spinosa, Allthorn.
Condalia spathulata.
Zizyphus obtusifolia, Blue-thorn.
Zizyphus lycioides, Blue-thorn.
Rhoedium microphyllum.
Mortonia scabrella.
Schmaltzia microphylla, Small-leaved Sumac.
Schmaltzia virens, Green Sumac.
Sapindus drummondi, Soapberry Tree.
Chilopsis linearis, Desert Willow.
Berberis trifoliolata, Three-leaved Barberry.
Jamesia gracilis.
Ungnadia speciosa, Mexican Buckeye.
Krameria canescens, Gray Chacata.
Krameria parvifolia, Dotted Chacata.
Krameria glandusola, Glandular Chacata.
Lycium torreyi, Torrey Lycium.
Lycium parviflorum, Small-flowered Lycium.
Allenrolfea occidentalis, Western Glasswort.
Cladostrix suffruticosa.
Cladostrix lanuginosa.
Dondia suffrutescens.
Atriplex acanthocarpa, Rough Saltbush.
Atriplex canescens, Gray Saltbush. U.
Atriplex elegans.
Atriplex expansa.
Flourensia cernua, Varnish Bush.
Baccharis viminea, Green Baccharis.
Baccharis glutinosa, Sticky Baccharis.
Baccharis pteronoides, Winged Baccharis.
Pluchea sericea, Gray Arrowwood.
Hymenoclea monogyra.
Coleosanthus laciniatus.
Gutierrezia lucida.
Gutierrezia glomerella.
Crassina pumila, Zinnia.
Artemisia filifolia, Narrow-leaved Sagebrush.
Ephedra trifurca, Three-scale Joint Fir.
Ephedra torreyana, Torrey Joint Fir. U.
Thamnosma texanum, Stinkbush.
Phoradendron macrophyllum, Mistletoe.
Agave lechuguilla, Lechuguilla, Little Century Plant.
- Agave parryi*, Parry Century Plant.
Dasyliirion texanum, Texas Setol.
Dasyliirion wheeleri, Wheeler Sotol.
Dasyliirion leiophyllum.
Yucca macrocarpa, Large-fruited Yucca, Spanish Bayonet.
Yucca radiosa, Narrow-leaved Tree Yucca.
Opuntia leptocaulis, Slender Bush Cactus.
Opuntia kleiniae, Slender Bush Cactus.
Opuntia arenaria, Sand Cactus.
Opuntia emoryi, Emory Prickly Pear.
Opuntia chlorotica, Green Prickly Pear.
Opuntia macrocentra, Long-spined Prickly Pear.
Opuntia dulcis, Sweet Prickly Pear.
Opuntia filipendula, Prickly Pear.
Opuntia toumeyii, Toumey Prickly Pear.
Opuntia chihuahuaensis, Chihuahua Prickly Pear.
Mamillaria grahami, Graham Pincushion Cactus.
Mamillaria macromeris, Large-spined Pincushion Cactus.
Mamillaria scheeri, Scheer Pincushion Cactus.
Echinocactus wislizeni, Devil's-head Cactus, Visnaga.
Echinocactus horizonthalonius, Little Devil's-head.
Echinocereus chloranthus, Green-flowered Petaya.
Echinocereus dasyacanthus, Yellow-flowered Petaya.
Echinocereus stramineus, Purple-flowered Petaya.
Echinocereus neomexicanus, New Mexico Petaya.
Jatropha macrorhiza, Spurge.
Croton corymbulosus, Spurge.
Croton neomexicanus, Spurge.
Ditaxis laevis, Spurge.
Chamaesyce serrula, Spurge.
Chamaesyce revoluta, Spurge.
Chamaesyce flagelliformis, Spurge.
Chamaesyce chaetocalyx, Spurge.
Chamaesyce lata, Spurge. U.
Chamaesyce albomarginata, Spurge. U.
Chamaesyce serpens, Spurge. U.
Kallstroemia grandiflora, Caltrop.
Kallstroemia brachystylis, Caltrop.
Kallstroemia hirsutissima, Caltrop.

PLANTS OF LOWER SONORAN ZONE IN NEW MEXICO—continued.

Trees, shrubs, and herbaceous plants—Continued.

<i>Anemopsis californica</i> , Marsh Pepperroot.	<i>Rumex ellipticus</i> , Dock.
<i>Eriogonum abertianum</i> , Eriogonum.	<i>Frankenia jamesi</i> .
<i>Eriogonum trichopodium</i> , Eriogonum.	<i>Juncus mexicanus</i> , Rush.
<i>Rumex hymenosepalus</i> , Dock.	<i>Cyperus erythrorhizos</i> , Cyperus.

Grasses.

<i>Amphilophis saccharoides</i> .	<i>Sporobolus flexuosus</i> , Bunch Grass. U.
<i>Schizachyrium neomexicanum</i> , New Mexico Broom Grass.	<i>Agrostis stolonifera</i> , Redtop. U.
<i>Hilaria mutica</i> , Tabosa Grass, Galleta Grass.	<i>Chloris elegans</i> .
<i>Eriochloa punctata</i> .	<i>Chloris brevispica</i> .
<i>Panicum fasciculatum chartiginense</i> , Panic Grass.	<i>Chloris cucullata</i> .
<i>Chaetochloa composita</i> , Foxtail Grass.	<i>Muhlenbergia texana</i> , Texas Dropseed Grass.
<i>Paspalum distichum</i> , Joint Grass.	<i>Bouteloua vestita</i> , Grama.
<i>Aristida bromoides</i> , Poverty Grass, Needle Grass.	<i>Bouteloua aristidoides</i> , Six-weeks Grama.
<i>Aristida divaricata</i> , Poverty Grass.	<i>Bouteloua polystachya</i> , Six-weeks Grama. U.
<i>Aristida schiediana</i> , Poverty Grass.	<i>Bouteloua eripoda</i> , Black Grama. U.
<i>Aristida havardi</i> , Poverty Grass.	<i>Bouteloua breviseta</i> , Black Grama.
<i>Sporobolus giganteus</i> , Bunch Grass.	<i>Leptochloa fascicularis</i> .
<i>Sporobolus wrighti</i> , Bunch Grass.	<i>Papophorum wrighti</i> .
<i>Sporobolus auriculatus</i> , Bunch Grass.	<i>Schleropogon brevifolius</i> , Needle Grass. U.
<i>Sporobolus airoides</i> , Bunch Grass. U.	<i>Arundo donax</i> , Cane (introduced?).
<i>Sporobolus nealleyi</i> , Bunch Grass.	<i>Munroa squarrosa</i> , False Buffalo Grass. U.
<i>Sporobolus strictus</i> , Bunch Grass. U.	<i>Dasyochloa pulchella</i> . U.
<i>Sporobolus asperifolius</i> , Bunch Grass. U.	<i>Tridens muticus</i> . U.
	<i>Eragrostis obtusiflora</i> , Skunk Grass.
	<i>Distichlis spicata</i> , Salt Grass. U.

LOWER SONORAN ZONE CROPS.

The local adaptation of crops in the various States is being tested by experts at agricultural experiment stations and substations. In New Mexico the station which is connected with the College of Agriculture and Mechanic Arts is located at Mesilla Park in the Rio Grande Valley about 40 miles north of El Paso, Tex. Its altitude is 3,865 feet and its location could not be better chosen as a center for the Lower Sonoran Zone area of New Mexico. Fruits and crops which succeed there should under proper conditions do well in any part of the zone in the State. So far as possible I have made use of the published reports of this station,¹ supplemented by my own field notes and those of other members of the Biological Survey.

The recent report of a committee of the American Pomological Society, entitled *Fruits Recommended by the American Pomological Society for Cultivation in Various Sections of the United States and Canada*,² has proved a helpful guide to the nomenclature of fruits and has been followed as far as possible.

¹ The next available experiment stations in this zone are at Tucson, Ariz., and College Point, Tex., both in different subdivisions of the zone, where many of the tests are unsafe for application to the New Mexico conditions.

² Bull. 151, Bur. of Plant Industry, U. S. Dept. Agric., 1909.

PEACHES.

The upper division of the Lower Sonoran Zone produces peaches of excellent quality and flavor, but in the New Mexico section of this zone most varieties bloom in March or early April and the fruit buds are often killed by early April frosts. The early ripening varieties, however, are the latest to bloom, and many of these have withstood the frosts fairly well. The best of 147 varieties tested for four years of bearing by Prof. Fabian Garcia at Mesilla Park, N. Mex., are listed as follows:¹

Alexander.	S. G. French.	Family Favorite.	Sargent.
Arkansas Traveler.	Boyle's Early.	Muir.	Early Silver.
Waterloo.	Hynes's Surprise.	George IV.	Hoover's Heath.
Gov. Garland.			

The following were added to the list by Prof. Garcia in 1910:

Texas King.	Crothers.	Salway.
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APRICOTS.

In the Lower Sonoran Zone in New Mexico apricots usually bloom in March or February and the young fruit is consequently killed by spring frosts. Seedling trees bear some fruit at irregular intervals, but varieties of commercial value are not recommended.

PLUMS.

Many excellent varieties of European and American plums are reported a success in the Lower Sonoran Zone at the experiment station at Mesilla Park after a six-year test.² The most successful are:

Imperial Gage.	Italian Prune.	Clyman.	Golden Beauty.
Yellow Egg.	Tragedy.	French Prune.	Wayland.
German Prune.	Englebert (Prince).	Golden Prune.	Wild Goose.
Pond's Seedling.	Spaulding.	Jefferson.	Bulgarian.
Golden Drop (Coe's).	St. Catherine.	Royal Hative.	Fellenberg.

APPLES.

Few apples reach their highest development in the lower division of the Lower Sonoran Zone, but many varieties yield well and are valuable crops in the upper division of this zone. Along the Rio Grande Valley in Dona Ana County, where they have been thoroughly tested, the most satisfactory varieties are listed as follows:³

Ben Davis.	Missouri Pippin.	Yellow Transparent.
Gano.	Jonathan.	Arkansas Black.
Arkansas (Mammoth Black Twig).	White Pearmain.	

¹ Garcia, F., Effect of Spring Frosts on the Peach Crop, Bull. 30, New Mex. Agric. Exp. Sta., p. 252, 1899.

² Vestal, G., and Garcia, F., Report on Plums, Bull. 27, New Mex. Agric. Exp. Sta., p. 124, 1898. Also Garcia, F., Orchard Notes, Bull. 39, p. 116, 1901.

³ Garcia, F., Apple Culture and Irrigation, Bull. 75, New Mex. Agric. Exp. Sta., p. 28, 1910.

QUINCES.

The following have been reported as successful at the experiment station at Mesilla Park:¹

Champion.	Missouri Mammoth.	Orange.
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GRAPES.

Of a large number of varieties of grapes tested at Mesilla Park those recorded as most satisfactory are:²

Mission.	Chasselas de Fontainbleau.	Emperor.
Alexandria (Muscat of Alexandria).	Thompson's Seedless.	Black Cornichon.
	Purple Damascus.	Flame Tokay.

Other satisfactory varieties given are :

Chasselas Rose.	Early Madeleine.	Hausco.
Chasselas Croquant.	Cannonhall Muscat.	Rose of Peru.
Golden Chasselas.	Black Hamburg.	Malaga.
Muscat Proceco Du Puy de Dome.	Blue Spanish.	Gros Coleman.

WATERMELONS.

Among many varieties tested in the Lower Sonoran Zone at Mesilla Park, those recommended as most satisfactory are:³

Phinney's Early.	Mammoth Ironclad.	Florida Favorite.
Cuban Queen.	Gypsy (Rattlesnake).	

MUSKMELONS AND CANTALOUPE.

The Rocky Ford cantaloupe is given as the most satisfactory variety for general purposes. Those recommended are:³

Rocky Ford.	Osage.	Hackensack.
Netted Gem.	Netted Nutmeg.	

ONIONS.

The onions recommended by the experiment station at Mesilla Park are:⁴

Early White Queen.	Red Victoria.	Australian Brown.
Barletta.	Prize Taker.	Denia (the real Spanish Onion).
White Bermuda.	Gigantic Gibraltar.	
Extra Early White Pearl.		

SWEET POTATOES.

From many varieties tested at Mesilla Park the following were selected as the best:⁵

White Bermuda.	Yellow Nansemond.	Vineland Bunch.
Red Bermuda.	Cooney.	

¹ Garcia, F., Orchard Notes, Bull. 39, New Mex. Agric. Exp. Sta., p. 126, 1901.

² Garcia, F., European Grapes, Bull. 58, New Mex. Agric. Exp. Sta., pp. 18, 19, 1906.

³ Garcia, F., Melon Culture, Bull. 63, New Mex. Agric. Exp. Sta., p. 38, 1907.

⁴ Garcia, F., Onion Culture, Bull. 52, New Mex. Agric. Exp. Sta., p. 21, 1904; also Onion Tests, Bull. 74, 1910; and Growing Denia Onion Seed, Bull. 82, 1912.

⁵ Garcia, F., Sweet Potato Culture, Bull. 70, New Mex. Agric. Exp. Sta., 1909.

MISCELLANEOUS CROPS.

Almonds, figs, and some of the more delicate grapes and other Lower Sonoran fruits do not thrive without unusual care and protection.

I have seen fairly good cotton growing and matured in the Rio Grande and Pecos Valleys in New Mexico, but it can not be considered a safe or profitable crop, since the season without frost is normally too short for it to mature.

UPPER SONORAN ZONE.

(*The zone of juniper, nut pine, and blue grama grass.*)

Most of the plains and foothill country of New Mexico and the valleys lying above 5,000 feet are included in the Upper Sonoran, the arid division of the transcontinental Upper Austral Zone. Its lower border in the Pecos Valley is approximately 4,000 feet and in the Rio Grande and Gila Valleys 4,500, varying of course with slope exposure. The upper border of the zone varies from approximately 7,000 to 8,000 feet, on steep and barren southwest slopes sometimes reaching above 8,000, and on steep northeast slopes sometimes falling below 7,000. It comprises approximately 92,000 square miles, or two-thirds of the total area of New Mexico, and includes a large part of the grazing and agricultural land. Its climate is mild without great extremes of heat or cold. While the zone is mainly arid, there is sufficient rainfall over most of it for good grass, but not enough for ordinary agriculture. Under irrigation the rich soil produces well and the zone is peculiarly adapted to the perfection of many fruits and other farm crops.

The principal subdivisions of the Upper Sonoran Zone in New Mexico are based mainly on differences of humidity and are not very strongly marked. The most evident divisions are those of the *Great Plains* and *Great Basin*.

GREAT PLAINS DIVISION.

The Upper Sonoran plains of New Mexico east of the Rio Grande Valley include nearly half of the Llano Estacado, broad slopes east and west of the Pecos Valley, and the plains north of the Canadian River Valley. This area belongs to the Great Plains division of the zone and having an average rainfall of only about 15 inches may be classed as semiarid. It is mainly characterized by abundant grass, and has evidently been kept treeless by ages of sweeping winds and fires.¹ Originally it was choice buffalo

¹ To those who have tried in vain to protect young trees from the fierce winds of the plains and have seen the green leaves actually torn off, the bark cut through against protecting frames, or deep funnels bored in the ground by the whipping of the unprotected trunks, the lack of trees needs no further explanation. If additional reason were needed, the spectacle of a torrent of fire driven before the same winds over the dense carpet of grass would suffice.

range, as it is now largely choice cattle range, though parts of it are rapidly yielding to dry farming. Along the western edge of this area, where foothills and deep gulches join it to the mountains, and over the rough "breaks" north of the Staked Plains, scrubby orchardlike forests of junipers, nut pines, and oaks have withstood the fires and now lead up from grassy plain to mountain forest. Besides the numerous grasses, these plains are characterized by narrow-leaved yuccas (*Yucca glauca*), prickly pears (*Opuntia cymochila* and *O. camanichica*), milkweeds (*Asclepias latifolia* and *A. speciosa*), blazing star (*Laciniaria punctata*), *Polygala alba*, *Psoralea linearifolia*, *Astragalus caryocarpus*, and *A. molissimus*; by such breeding birds as mountain plover, long-billed curlew, western night-hawk, desert horned lark, and western meadowlark; and by such mammals as the black-tailed prairie dog, black-footed ferret, plains jack rabbit, pale 13-lined ground squirrel, pale grasshopper mouse, Nebraska white-footed mouse, Cope and Kansas pocket mice, and Richardson kangaroo rat; and by the collared lizard and hog-nosed snake.

The agricultural development of this region without irrigation is as yet in an experimental stage, depending on control of the moisture in the soil. Great progress has been made in "dry-farming" methods, but the danger from a series of dry years is not yet eliminated. The soil is rich, and with proper treatment often gives a good yield of many standard crops without irrigation. Along the upper Pecos and Canadian Rivers and many of their branches there is abundant water for irrigation if it can be properly conserved during the seasons of high water and floods. Throughout the Plains region many of the dry washes at times become raging torrents that go to waste and carry destruction before them.

The crops best adapted to this division of Upper Sonoran Zone, provided sufficient moisture is obtainable, were listed by Dr. C. Hart Merriam in 1898 on as full data as were available at that time.¹ The cereals and fruits listed, while of general application to the arid Upper Sonoran, are not all adapted to all of its local subdivisions. For instance, on the open plains very few fruits can be raised until substantial windbreaks are provided. On hot slopes many fruit trees blossom so early that the later frosts invariably kill the fruit. But the aridity of the Great Plains has proved the greatest barrier to fruit raising except where irrigation is possible.

At present the best available testing grounds for the crops of the Great Plains region of eastern New Mexico are the experiment station at Fort Collins, Colo., and its substations at Cheyenne Wells and Rocky Ford. The results of 23 years' experiments published in

¹ Life Zones and Crop Zones of the United States, Bull. 10, Biological Survey, U. S. Dept. Agric., pp. 37-40 and 56-73, 1898.

numerous reports of the station should be a fairly safe guide to crop adaptations in this region.

The United States Dry Land Experiment Station at Akron, Colo., is also in this division of Upper Sonoran Zone and has conditions of climate and aridity very similar to those of the eastern New Mexico plains. The reports of the superintendent of this station therefore apply to practically all of the "dry-farming region" of eastern New Mexico.

The Bureau of Plant Industry also has published provisional lists of fruits for the Central and Southern Great Plains, which are especially applicable to this part of the zone in New Mexico.¹

Lists of crops recommended in various reports are not given here, since without the accompanying notes on culture, relative value of the crops, and the probabilities of success, such a compilation would be in many cases misleading and a source of danger.

GREAT BASIN DIVISION.

The Colorado drainage includes the valleys of the Gila, the Zuni, and San Juan Rivers. These and the Rio Grande Valley Upper Sonoran are in fauna and flora essentially a part of the Great Basin division of the zone. Both upper and lower divisions of the zone may also be traced irregularly throughout the more arid parts of the State, and especially in the Rio Grande and San Juan Valleys. These subdivisions are likewise due mainly to greater or less aridity, the higher borders of the zone receiving more rainfall and the lower valleys less. The upper (nut pine and juniper) subdivision forms a wide or narrow border as restricted by soil, moisture, and fire. The lower, open, more arid valley bottoms and slopes, clothed with scattered grass, cactuses, yuccas, and low desert shrubs, are marked by the absence of trees except along streams.

RIO GRANDE VALLEY.

A great part of the Upper Sonoran Zone in the Rio Grande Valley is extremely arid, having an average annual rainfall of only about 10 inches. It is generally characterized by sparse vegetation, consisting largely of desert shrubs, cactuses, yuccas, and short grasses. Over extensive areas of level land where the rainfall is all absorbed or where flood water spreads out, there is good grazing at certain seasons, but many of the steeper slopes from which the water runs quickly are very dry and barren. The higher edges of the zone are conspicuously less arid, and the rough broken mesas and foothill areas are generally covered with a scattered growth of juniper and nut pine and a better stand of grass.

Gould, H. P., Fruit Growing for Home Use in the Central and Southern Great Plains, Circ. 51, Bur. Plant Industry, U. S. Dept. Agric., 1910.

Excluding grasses, some of the most characteristic Upper Sonoran plants in open plains and valleys are cat's-claw (*Mimosa biuncifera*), saltbush (*Atriplex confertifolia* and *A. canescens*), white sage (*Eurotia lanata*), rabbit brush (*Chrysothamnus*, *Tetradymia*, *Chrysoma*, and *Gutierrezia*), sagebrush (*Artemisia*), *Ximenesia exauriculata*, Spanish bayonet (*Yucca baccata*), *Yucca glauca*, bear grass (*Nolina lindheimeriana*), and many species of cactus. In the foothills and rough borders of the valleys the conspicuous vegetation consists of nut pine (*Pinus edulis*), junipers (*Juniperus monosperma*, *J. pachyphloea*, and *J. scopulorum*), live oaks (*Quercus arizonica* and *Q. emoryi*), sumacs (*Schmaltzia trilobata* and *S. pumila*), mountain mahogany (*Cercocarpus parrifolius*), silk tassel (*Garrya goldmani* and *G. wrighti*), mesal (*Agave parryi*), and several species of cactus.

A few of the most characteristic Upper Sonoran birds of the Rio Grande Valley are Woodhouse's jay (*Aphelocoma woodhousei*), piñon jay (*Cyanocephalus cyanocephalus*), cañon towhee (*Pipilo fuscus mesoleucus*), lead-colored bush tit (*Psaltriparus plumbeus*), gray titmouse (*Bæolophus inornatus griseus*), and Montezuma horned lark (*Otocoris alpestris occidentalis*).

Its most characteristic mammals are kangaroo rats (*Perodipus montanus*, *P. longipes*, and *Dipodomys spectabilis*), Apache pocket mouse (*Perognathus apache*), white-throated wood rat (*Neotoma albigula*), gray-tailed prairie dog, large spotted ground squirrel (*Citellus spilosoma major*), pale grasshopper mouse (*Onychomys leucogaster melanophrys*), big-eared and Rowley white-footed mice (*Peromyscus truei* and *P. boylei rowleyi*), Texas jack rabbit (*Lepus californicus texianus*), and cedar belt cottontail (*Sylvilagus auduboni cedrophilus*).

Agriculture in the Rio Grande Valley is rarely attempted except where irrigation is possible, but in places where a good supply of water is available the extreme aridity is a distinct advantage, since it permits full control of soil moisture and thus makes possible the highest development of many farm crops.

COLORADO VALLEY.

In extreme western New Mexico considerable areas of Upper Sonoran Zone lie in the Colorado River drainage, as represented by the valleys of the Gila, the Little Colorado, and the San Juan. These valleys vary from 5,000 to 7,000 feet in altitude and show evidence of considerable variation in aridity. Each draws species both from the Arizona deserts and from the Rio Grande Valley, between which there is no barrier and no strong line of demarcation. Still a slight difference of climatic conditions is shown that probably can be taken advantage of in practical ways, and it is important to define these areas and determine their extent and local characteristics.

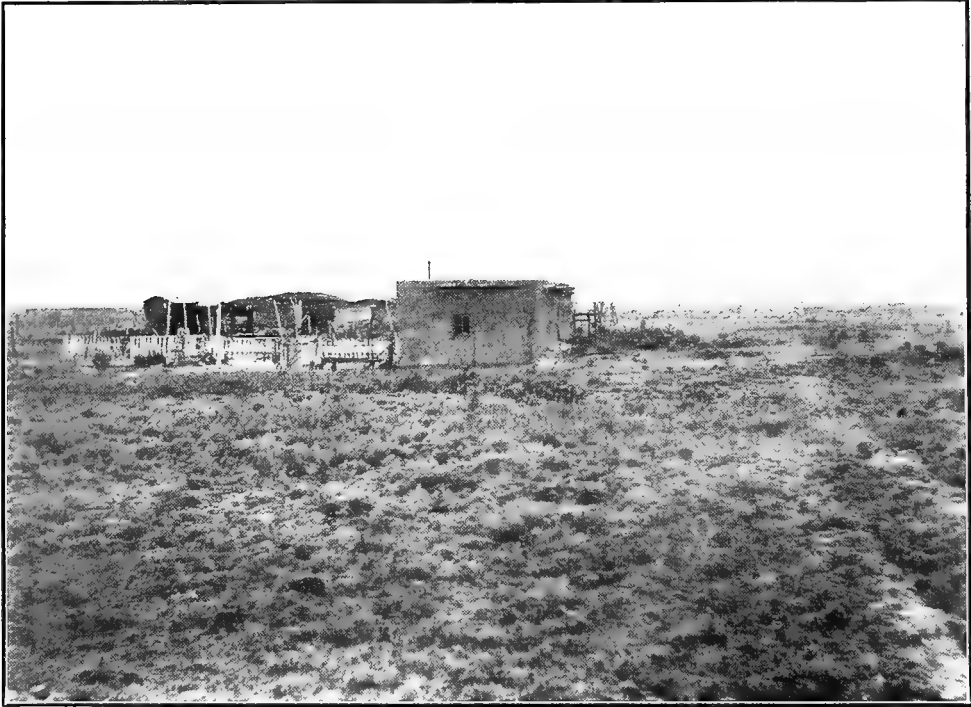


FIG. 1.—TYPICAL GREAT PLAINS COUNTRY NEAR CLAYTON IN NORTHEASTERN NEW MEXICO.

Low grasses are the principal vegetation. Photograph by A. H. Howell.



FIG. 2.—TYPICAL GREAT BASIN VEGETATION OF THE RIO GRANDE VALLEY NEAR TAOS, NEW MEXICO.

Sagebrush is the principal vegetation.



FIG. 1.—LANCE-LEAVED COTTONWOOD (*POPULUS ACUMINATA*) NEAR RESERVE IN THE VALLEY OF SAN FRANCISCO RIVER.

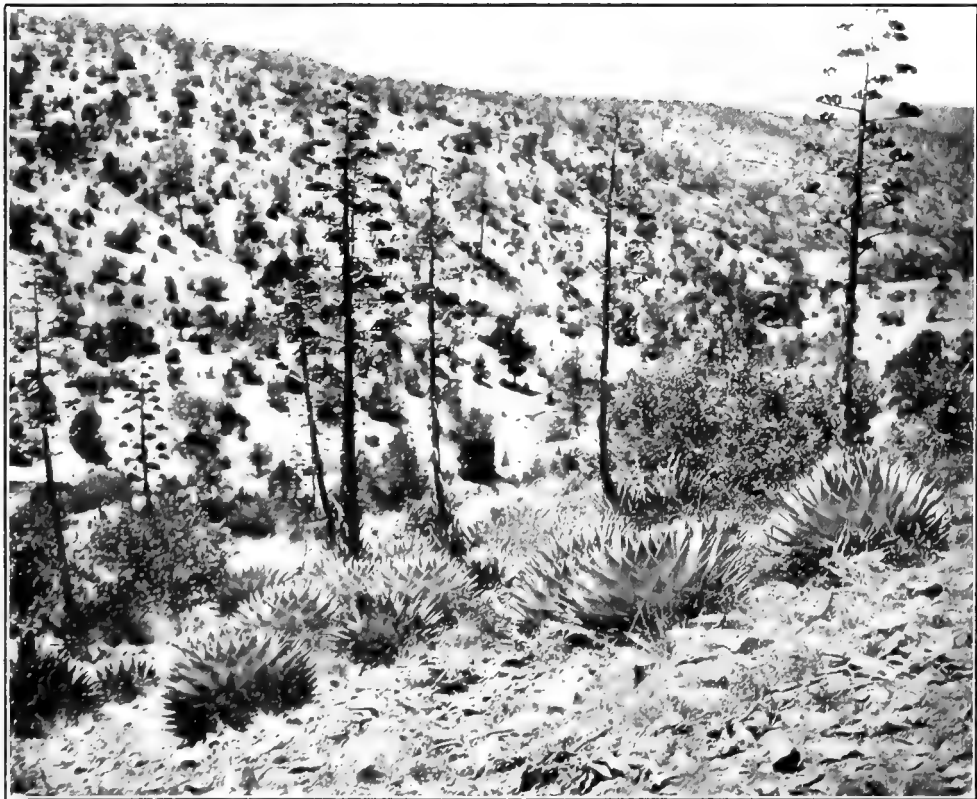


FIG. 2.—THE MESCAL PLANT (*AGAVE PARRYI*) NEAR THE HEAD OF THE RIO MIMBRES ON SLOPE COVERED WITH NUT PINE, JUNIPER, AND OTHER UPPER SONORAN VEGETATION.

GILA VALLEY.

The Upper Sonoran area of the Gila drainage is generally very rough, steep, and broken, and is largely occupied by a scattered growth of oaks, junipers, and nut pines. Along the upper valleys of the Gila and the San Francisco, including their side streams, are level areas of sufficient extent for a few good farms with plenty of pure water for irrigation. Owing to its proximity to the Mogollon and other mountain masses this area receives an unusual amount of rainfall and has in consequence a rich growth of the best forage grasses. In many ways it is an ideal stock country and the little agriculture is now mainly supplemental to stock raising and mining. It is a region of sheltered valleys under the shadow of big forested mountains, of warm winter canyons with numerous cave and cliff dwellings, and of abundant food-yielding plants and animals; a region which is full of wild charm and was defended long and savagely by its primitive occupants. In the canyons are a profusion of wild grapes, currants, wild cherries, hackberries, mulberries, walnuts, and black and blue live oaks, while on the ridges junipers, nut pines, and oaks abound. Fruit-bearing cactuses and yuccas are abundant, and the mescal agave grows in profusion on some of the slopes.

Some of the most characteristic plants of this area are the Arizona walnut, big-seeded juniper, boxelder, lance-leaved cottonwood, tree alder, wild grape, and velvet-leaved sumac. The bridled titmouse and Scott's sparrow are characteristic Upper Sonoran breeding birds. Among mammals the Sonora white-tailed deer, Arizona gray squirrel, rock squirrel, rock chipmunk, Stephens wood rat, and civet cat are characteristic

LITTLE COLORADO DRAINAGE.

The New Mexico tributaries of the Little Colorado River, the Zuni, Puerco, and Carrizo, with their branches, are at most times mere dry washes that head in a high plateau region of well-grassed valleys and well-wooded ridges and mesas. This drainage area lies close to the Continental Divide in west central New Mexico, mainly west and south of the Zuni Mountains, and would include the many basins and sinks west of the Datil Mountains if there were sufficient rainfall to overflow their rims. While there is enough rain to produce good forage grasses and much juniper and nut pine forest, there are few permanent streams and only occasional springs. Limited areas could be brought under cultivation by water storage, but at present the region is almost entirely devoted to stock raising, to which it is admirably adapted. It has few characteristic species except those belonging to the upper or nut pine division of the Upper Sonoran Zone.

The Zuni Indians of this region have long supported themselves in part by a primitive type of dry farming, planting little patches of

corn, squashes, and beans on spots that received an extra flow of rain water or on which in time of rain the flood water could be diverted to the crops. In 1853 Lieut. Whipple reported that without irrigation they produced abundant crops of grain and vegetables, and that after furnishing forage to Fort Defiance their supply of maize seemed inexhaustible.¹ They now have a good system of irrigation, but the people of the Ojo Caliente pueblo still have garden patches scattered over many little valleys where surprisingly good crops are often gathered with little or no cultivation or irrigation.

PLAIN OF SAN AUGUSTINE.

The San Augustine plain is 25 miles wide and extends 60 or 70 miles along the Continental Divide in western Socorro County at an

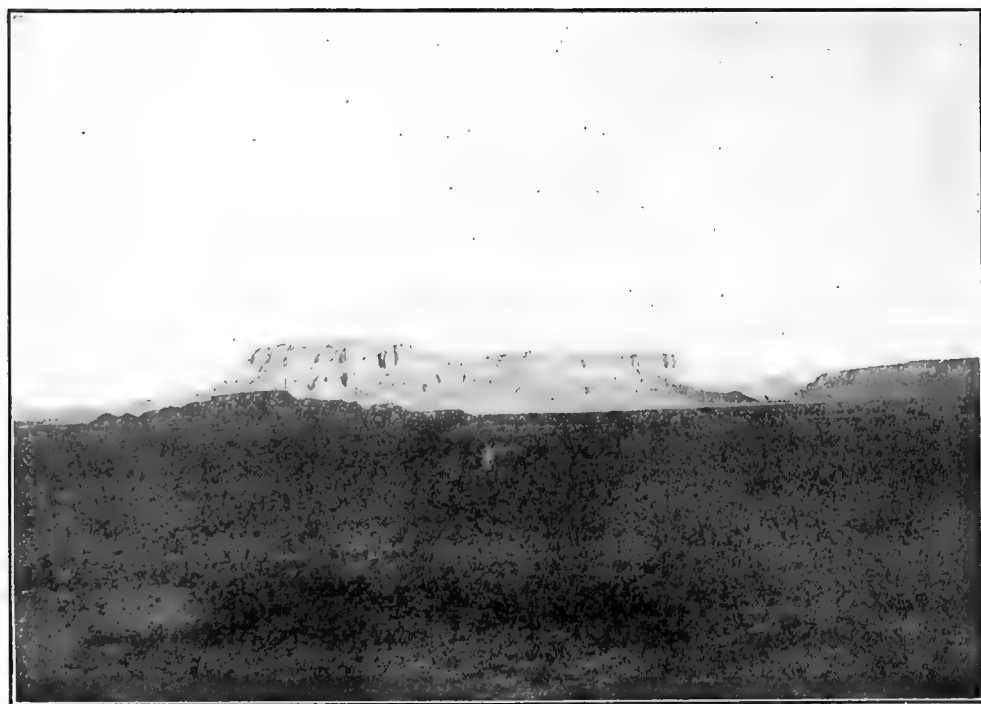


FIG. 2.—Zuni Valley and Thunder Mountain, site of the old Pueblo of Zuni, a few miles east of the present pueblo.

altitude ranging from 6,800 to 7,500 feet. It is an arid treeless plain or shallow basin on top of the plateau, partly surrounded by short irregular mountain ranges. It lies wholly in the Upper Sonoran Zone, has a fertile soil, and but for aridity would be valuable for agriculture. There are numerous arroyos cutting down from the surrounding mountains which in time of rain are short-lived torrents, but for most of the year are mere dry washes.

Permanent water is scarce and confined to springs and a few short creeks, mainly along the foothill slopes of bordering mountain

¹ Rept. Expl. and Surv. R. R. Pacific, III, p. 14, 1856.

ranges. There are a few scattering stock ranches with headquarters at the springs or watercourses, but practically no agriculture is attempted.

The bordering foothills and some rough parts of the valley have a scattered growth of juniper, nut pine, and scrub oaks, but the greater part of the plain is open country with a scattered growth of grass and desert shrubs, such as gray saltbush, white sage, and various genera and species of rabbit brush (*Chrysothamnus*, *Gutierrezia*, and *Tetradymia*).

SAN JUAN RIVER VALLEY.

An extensive area in northwestern New Mexico drained by the San Juan River and its tributaries lies entirely in Upper Sonoran Zone and mainly in its lower or valley division. It is a great arid plain with narrow bordering patches of nut pines, junipers, and oaks along the surrounding foothills and extending over some of the ridges and mesa tops. Its dominant plants and animals are those of the Great Basin Region, and a few of these do not reach even to the Rio Grande Valley. Some of these are: Utah juniper (*Juniperus utahensis*), buffalo berry (*Lepargyrea argentea*), Rocky Mountain birch (*Betula fontinalis*), and cliff rose (*Cowania mexicana*); the Hopi chipmunk (*Eutamias hopiensis*), buff-breasted canyon mouse (*Peromyscus crinitus auripectus*), Thomas wood rat (*Neotoma lepida*), harvest mouse (*Reithrodontomys megalotis aztecus*), Yavapai pocket mouse (*Perognathus flavus bimaculatus*), and Colorado cottontail (*Sylvilagus auduboni warreni*). The magpie is a common resident along the San Juan River, but this and most of the other birds inhabit also the Rio Grande Valley. A colony of eastern blue jays is established there, but they may have been introduced.

This great valley, while mainly an open plain, is also a region of deep erosion, displaying numerous canyons, dry washes, and picturesque badlands, rich coal fields, and interesting fossil beds. The greater part of the valley is waterless for most of the year, but the San Juan River and its northern tributaries furnish a fierce flood of mountain water, ample for irrigating their immediate valleys and some of the mesa country. Most of the present agriculture is near the valley bottoms, but more ditches are being carried over the mesas and higher slopes and eventually the cultivated area will be greatly increased. Already the valley has won a reputation for quality and yield of fruit, specially apples, pears, and peaches.

The greater part of the San Juan Valley is occupied by the Navajo Indian Reservation and is used mainly for stock range. The Indians have large numbers of sheep and horses and some cattle. They move from place to place as the water holes dry up or as the rains fill the pools and bring up the grass. An interesting type of "dry farming" is carried on by them all over the reservation on little flats into which

drains more than the usual amount of rain water. Melons, squashes, corn, and beans are planted on any level ground that is occasionally flooded from a "dry wash" or that can be watered by some diverted stream of muddy rain or snow water. There is usually little or no cultivation and still a crop is often harvested that will carry a family through the winter. Under the guidance of Indian agents and their farmers this practice is encouraged and good seed is provided.

CHARACTERISTIC UPPER SONORAN SPECIES OF NEW MEXICO.

The area of Upper Sonoran Zone shown on the accompanying map (frontispiece) in light yellow is based on the range of the following species of animals and plants, some of which occur throughout the zone, others in only a limited part, and still others extend through it from a lower or a higher zone and mark a part of its upper or lower border.

MAMMALS OF UPPER SONORAN ZONE IN NEW MEXICO.

[Species marked *L.* occur also in Lower Sonoran Zone; those marked *T.* also in Transition.]

- | | |
|---|--|
| <i>Tayassu angulatum sonoriense</i> , Sonora Peccary. <i>L.</i> | <i>Onychomys leucogaster melanophrys</i> , Pale Grasshopper Mouse. |
| <i>Odocoileus couesi</i> , Sonora Whitetail Deer. | <i>Peromyscus maniculatus blandus</i> , Frosted White-footed Mouse. |
| <i>Odocoileus virginianus macrourus</i> , Plains Whitetail Deer. <i>T.</i> | <i>Peromyscus boylei rowleyi</i> , Rowley White-footed Mouse. |
| <i>Odocoileus hemionus canus</i> , Gray Mule Deer. <i>T.</i> | <i>Peromyscus truei</i> , Big-eared White-footed Mouse. |
| <i>Antilocapra americana</i> , Antelope. | <i>Peromyscus nasutus</i> , Long-nosed White-footed Mouse. |
| <i>Antilocapra americana mexicana</i> , Mexican Antelope. | <i>Peromyscus crinitus auripectus</i> , Buff-breasted Canyon Mouse. |
| <i>Ovis mexicanus</i> , Mexican Mountain Sheep. | <i>Neotoma albigula</i> , White-throated Wood Rat. |
| <i>Ovis canadensis texianus</i> , Texas Mountain Sheep. | <i>Neotoma albigula warreni</i> , Warren Wood Rat. |
| <i>Sciurus arizonensis</i> , Arizona Gray Squirrel. | <i>Neotoma micropus canescens</i> , Gray Wood Rat. <i>L.</i> |
| <i>Eutamias dorsalis</i> , Rock Chipmunk. | <i>Neotoma lepida</i> , Thomas Wood Rat. |
| <i>Citellus variegatus grammurus</i> , Rock Squirrel. | <i>Neotoma lepida stephensi</i> , Stephens Wood Rat. |
| <i>Citellus spilosoma major</i> , Large Spotted Ground Squirrel. | <i>Neotoma cinerea arizonae</i> , Arizona Wood Rat. |
| <i>Citellus spilosoma obsidianus</i> , Dark Spotted Ground Squirrel. | <i>Sigmodon minimus</i> , Small Cotton Rat. |
| <i>Citellus tridecemlineatus pallidus</i> , Pale Thirteen-Line Ground Squirrel. | <i>Reithrodontomys megalotis aztecus</i> , Aztec Harvest Mouse. |
| <i>Citellus tridecemlineatus parvus</i> , Small Thirteen-Line Ground Squirrel. | <i>Reithrodontomys griseus</i> , Little Gray Harvest Mouse. <i>L.</i> |
| <i>Amnospermophilus leucurus cinnamomeus</i> , Antelope Squirrel. | <i>Microtus pennsylvanicus modestus</i> , Colorado Meadow Mouse. <i>T.</i> |
| <i>Cynomys ludovicianus</i> , Black-tailed Prairie Dog. | <i>Microtus montanus arizonensis</i> , Arizona Meadow Mouse. |
| <i>Cynomys gunnisoni</i> , Gray-tailed Prairie Dog. <i>T.</i> | |

MAMMALS OF UPPER SONORAN ZONE IN NEW MEXICO—continued.

- Microtus aztecus*, Aztec Meadow Mouse.
Fiber zibethicus osoyoosensis, Rocky Mountain Muskrat. *T.*
Fiber zibethicus pallidus, Pale Muskrat. *L.*
Castor canadensis frondator, Broad-tailed Beaver.
Geomys lutescens, Yellow Pocket Gopher.
Cratogeomys castanops, Chestnut-faced Pocket Gopher. *L.*
Thomomys aureus, Golden Pocket Gopher.
Thomomys pervagus, New Mexico Pocket Gopher.
Thomomys baileyi, Bailey Pocket Gopher.
Dipodomys spectabilis, Large Kangaroo Rat. *L.*
Perodipus montanus, Rio Grande Kangaroo Rat.
Perodipus montanus richardsoni, Richardson Kangaroo Rat.
Perodipus longipes, Large-footed Kangaroo Rat.
Perognathus hispidus paradoxus, Kansas Pocket Mouse.
Perognathus apache, Apache Pocket Mouse.
Perognathus flavescens, Plains Pocket Mouse.
Perognathus flavus, Baird Pocket Mouse. *L.*
Perognathus flavus bimaculatus, Yavapai Pocket Mouse.
Lepus californicus texianus, Texas Jack Rabbit. *L.*
Lepus californicus melanotis, Great Plains Jack Rabbit.
Lepus gaillardi, Gaillard Jack Rabbit.
Sylvilagus auduboni neomexicanus, New Mexico Cottontail.
Sylvilagus auduboni cedrophilus, Cedar Belt Cottontail.
Sylvilagus auduboni warreni, Colorado Cottontail.
Felis hipolestes aztecus, Mexican Cougar.
Lynx baileyi, Plateau Wildcat.
Urocyon cinereoargenteus scotti, Gray Fox.
Canis nebracensis, Plains Coyote. *T.*
Canis mearnsi, Mearns Coyote. *L.*
Canis estor, Desert Coyote. *L.*
Canis mexicanus, Mexican Wolf. *T.*
Canis (sp. ?), Plains Wolf. *T.*
Mephitis mesomelas varians, Long-tailed Skunk. *L.*
Mephitis estor, Arizona Skunk. *L.*
Spilogale tenuis, Rocky Mountain Spotted Skunk.
Spilogale ambigua, Chihauhau Spotted Skunk.
Spilogale arizonae, Arizona Spotted Skunk.
Spilogale gracilis saxatilis, Great Basin Spotted Skunk.
Taxidea taxus berlandieri, Mexican Badger. *L.*
Mustela nigripes, Black-footed Ferret.
Procyon (*lotor*?), Raccoon. *T.*
Procyon lotor mexicanus, Mexican Raccoon. *L.*
Bassariscus astutus flavus, Civet Cat. *L.*
Myotis velifer, Cave Bat. *L.*
Myotis californicus, Little California Bat. *L.*
Myotis thysanodes, Fringed Bat. *L.*
Myotis evotis, Long-eared Bat. *T.*
Myotis incautus, House Bat. *L.*
Myotis yumanensis, Yuma Bat. *L.*
Corynorhinus macrotis pallescens, Big-eared Bat. *L.*

BREEDING BIRDS OF UPPER SONORAN ZONE IN NEW MEXICO.

[Species marked *L.* breed also in Lower Sonoran Zone; those marked *T.* also in Transition.]

- Erismatura jamaicensis*, Ruddy Duck. *T.*
Querquedula cyanoptera, Cinnamon Teal. *T.*
Numenius americanus, Long-billed Curlew.
Podasocys montanus, Mountain Plover.
Callipepla squamata squamata, Scaled Quail. *L.*
Cyrtonyx montezumae mearnsi, Mearns's Quail.
Zenaidura macroura marginella, Mourning Dove. *L.*
Strix occidentalis huachucae, Huachuca Spotted Owl.
Otus asio cineraceus, Mexican Screech Owl.
Otus asio aikeni, Aiken's Screech Owl.
Speotyto cunicularia hypugaea, Burrowing Owl. *L.*
Coccyzus americanus occidentalis, California Cuckoo. *L.*
Dryobates arizonae, Arizona Woodpecker.
Phalaenoptilus nuttalli nuttalli, Poor-will.

BREEDING BIRDS OF UPPER SONORAN ZONE IN NEW MEXICO—continued.

- Chordeiles virginianus henryi*, Western Nighthawk. *T.*
Aëronautes melanoleucus, White-throated Swift. *T.*
Tyrannus tyrannus, Kingbird. *T.*
Tyrannus verticalis, Arkansas Kingbird.
Myiarchus cinerascens cinerascens, Ash-throated Flycatcher. *L.*
Empidonax fulvifrons pygmaeus, Buff-breasted Flycatcher.
Otocoris alpestris occidentalis, Montezuma Horned Lark.
Aphelocoma woodhousei, Woodhouse's Jay.
Corvus corax sinuatus, Raven. *T.*
Corvus brachyrhynchos hesperis, Western Crow. *T.*
Cyanocephalus cyanocephalus, Piñon Jay.
Xanthocephalus xanthocephalus, Yellow-headed Blackbird. *T.*
Agelaius phoeniceus neutralis, San Diego Redwing. *T.*
Sturnella neglecta, Western Meadowlark. *T.*
Icterus bullocki, Bullock's Oriole. *L.*
Carpodacus mexicanus frontalis, House Finch. *L.*
Astragalinus psaltria psaltria, Arkansas Goldfinch. *L.*
Chondestes grammacus strigatus, Western Lark Sparrow. *L.*
Spizella wortheni, Worthen's Sparrow.
Spizella atrogularis, Black-chinned Sparrow.
Amphispiza nevadensis (breeding?), Sage Sparrow.
Aimophila ruficeps scotti, Scott's Sparrow.
Pipilo fuscus mesoleucus, Cañon Towhee.
Passerina amoena, Lazuli Bunting.
Calamospiza melanocorys, Lark Bunting.
Piranga rubra cooperi, Cooper's Tanager.
Lanius ludovicianus excubitorides, White-rumped Shrike.
Dendroica aestiva aestiva, Yellow Warbler. *T.*
Geothlypis trichas occidentalis, Western Yellowthroat. *L.*
Icteria virens longicauda, Long-tailed Chat. *L.*
Dumetella carolinensis, Catbird.
Salpinctes obsoletus obsoletus, Rock Wren. *T.*
Thryomanes bewicki bairdi, Baird's Wren.
Telmatorhynchus palustris plesius, Western Marsh Wren.
Baeolophus inornatus griseus, Gray Titmouse.
Baeolophus wollweberi, Bridled Titmouse.
Psaltriparus plumbeus, Lead-colored Bush Tit.
Psaltriparus melanotis lloydi, Lloyd's Bush Tit.
Polioptila caerulea obscura, Western Gnatcatcher. *L.*

REPTILES OF UPPER SONORAN ZONE IN NEW MEXICO.

[Species marked *L.* occur also in Lower Sonoran Zone; those marked *T.*, also in Transition.]

Turtles.

- Chrysemys cinerea belli*, Bell's Terrapin. *L.*
Chrysemys elegans, Cumberland Terrapin. *L.*
Terrapena ornata, Painted Box Turtle. *L.*

Lizards.

- Crotaphytus collaris*, Collared Lizard.
Crotaphytus collaris baileyi, Western Collared Lizard.
Holbrookia maculata.
Holbrookia approximans.
Holbrookia flavilenta.
Uta levis, Light Sand Lizard.
Uta ornata, Painted Sand Lizard.
Sceloporus consobrinus, Scaly Fence Lizard.
Sceloporus poinsetti, Poinsett Lizard.
Sceloporus jarrovi, Yarrow's Lizard.
Phrynosoma hernandesi, Short-horned Lizard. *T.*
Phrynosoma ornatissimum, Desert-horned Lizard.
Gerrhonotus nobilis, Large Gerrhonotus.
Cnemidophorus grahami, Graham Whip-tailed Lizard.
Eumeces obsoletus, Large Skink.
Eumeces gutturalatus, Small Skink.
Eumeces multivirgatus, Many-lined Skink.

REPTILES OF UPPER SONORAN ZONE IN NEW MEXICO—continued.

Snakes.

<i>Thamnophis eques</i> , Brown Garter Snake.	<i>Pituophis catenifer deserticola</i> , Desert Bull Snake.
<i>Thamnophis macrostemma</i> , Mexican Garter Snake.	<i>Liopeltis vernalis</i> , Smooth Green Snake.
<i>Thamnophis ordinoides elegans</i> , Western Garter Snake. <i>T.</i>	<i>Lampropeltis triangulum amaurus</i> , Milk Snake.
<i>Thamnophis sirtalis parietalis</i> , Red-barred Garter Snake.	<i>Heterodon nasicus</i> , Hognosed Snake. <i>L.</i>
<i>Bascanion flagellum frenatum</i> , Coachwhip Snake.	<i>Crotalus confluentus</i> , Plains Rattlesnake.
<i>Bascanion taeniatum</i> , Mountain Racer.	<i>Crotalus molossus</i> , Black-tailed Rattlesnake.
<i>Pituophis sayi</i> , Prairie Bull Snake.	<i>Crotalus lepidus</i> , Kennicott's Rattlesnake.

AMPHIBIANS OF UPPER SONORAN ZONE IN NEW MEXICO.

[Species marked *L.* occur also in the Lower Sonoran Zone.]*Toads and Frogs.*

<i>Scaphiopus hammondi</i> , Spadefoot Toad.	<i>Bufo woodhousii</i> , Common Toad. <i>L.</i>
<i>Scaphiopus hammondi bombifrons</i> , Plains Spadefoot.	<i>Hyla arenicolor</i> , Desert Tree Frog. <i>L.</i>
<i>Bufo cognatus</i> , Toad. <i>L.</i>	<i>Hyla eximia</i> .
<i>Bufo punctatus</i> , Spotted Toad. <i>L.</i>	<i>Rana pipiens</i> , Leopard Frog. <i>L.</i>

Salamanders.

<i>Ambystoma tigrinum</i> , Tiger Salamander. <i>L.</i>	<i>Spelerpes multiplicatus</i> , Many-ribbed Triton. ¹
<i>Ambystoma trisruptum</i> .	

PLANTS OF UPPER SONORAN ZONE IN NEW MEXICO.

[Species marked *L.* occur also in Lower Sonoran Zone; those marked *T.*, also in Transition.]*Trees, shrubs, and herbaceous plants.*

<i>Pinus edulis</i> , Nut Pine, Pinyon.	<i>Populus wislizeni</i> , Rio Grande Cottonwood. <i>L.</i>
<i>Pinus cembroides</i> , Mexican Nut Pine.	<i>Populus acuminata</i> , Lance-leaf Cottonwood.
<i>Juniperus monosperma</i> , One-seeded Juniper.	<i>Salix wrighti</i> , Wright Willow. <i>L.</i>
<i>Juniperus utahensis</i> , Utah Juniper.	<i>Salix nigra</i> , Black Willow.
<i>Juniperus megalocarpa</i> , Large-fruited Juniper.	<i>Salix exigua</i> , Gray Willow.
<i>Juniperus pachyphloea</i> , Checker-barked Juniper.	<i>Alnus oblongifolia</i> , Long-leaved Alder.
<i>Juniperus scopulorum</i> , Silky Juniper. <i>T.</i>	<i>Negundo aceroides</i> , Box Elder.
<i>Quercus grisea</i> , Gray Live Oak.	<i>Fraxinus velutina</i> , Leatherleaf Ash.
<i>Quercus arizonica</i> , Arizona Gray Live Oak.	<i>Fraxinus cuspidata</i> , Fringe Ash.
<i>Quercus emoryi</i> , Black Live Oak.	<i>Adelia neomexicana</i> , Forestiera.
<i>Quercus undulata</i> , Scrub Oak.	<i>Celtis reticulata</i> , Hackberry.
<i>Quercus oblongifolia</i> , Oblong-leaf Oak.	<i>Morus microphylla</i> , Small-leaf Mulberry.
<i>Quercus pungens</i> , Shin Oak.	<i>Cercocarpus parvifolius</i> , Small-leaf Mountain Mahogany.
<i>Quercus acuminata</i> , Chinquapin Oak.	<i>Cercocarpus paucidentatus</i> , Southern Mountain Mahogany.
<i>Juglans major</i> , Arizona Walnut.	<i>Cowania mexicana</i> , Cliff Rose.
<i>Platanus wrighti</i> , Arizona Sycamore.	

¹ Collected in the Jemez Mountains by Prof. Junius Henderson. Specimen No. 42921, U. S. Nat. Mus. Coll. First record for New Mexico.

PLANTS OF UPPER SONORAN ZONE IN NEW MEXICO—continued.

Trees, shrubs, and herbaceous plants—Continued.

- Fallugia paradoxa*, Poniel, "Apache Plume."
Fallugia paradoxa acuminata, Poniel, "Apache Plume." L.
Amelanchier bakeri, Juneberry, Service Berry.
Schmaltzia trilobata, Skunk Bush.
Schmaltzia pumila, Velvet-leaved Sumac.
Schmaltzia glabra, Smooth Sumac. T.
Ribes cereum, Red Currant. T.
Ribes longiflorum, Flowering Currant.
Choisya dumosa, Star-leaf.
Farsellesia spinescens.
Ceanothus greggi.
Berberis haematocarpa, Red Barberry.
Berberis fremonti, Blue Barberry.
Berberis wilcoxi, Wilcox Barberry.
Garrya wrighti, Silk-tassel Bush.
Garrya goldmani, Silk-tassel Bush.
Philadelphus microphyllus, Syringa Bush.
Philadelphus argyrocalyx, Syringa Bush.
Fendlera rupicola.
Arctostaphylos pungens, Manzanita.
Lepargyrea argentea, Buffalo Berry.
Ptelea angustifolia, Narrow-leaved Trefoil.
Vitis arizonica, Wild Grape. T.
Ephedra viridis, Green Joint Fir.
Lycium pallidum, Pale Boxthorn.
Sarcobatus vermiculatus, Greasebrush. L.
Atriplex canescens, Salt Bush, Gray Shadscale. L.
Atriplex confertifolia, Salt Bush.
Atriplex wrighti, Salt Bush.
Atriplex powelli, Salt Bush.
Atriplex argentea, Salt Bush.
Eurotia lanata, White Sage, Winter Fat.
Eriogonum hieracifolium, Eriogonum.
Eriogonum polycladon, Eriogonum.
Eriogonum densus, Eriogonum.
Eriogonum cernuum, Eriogonum.
Eriogonum subreniforme, Eriogonum.
Eriogonum wrighti, Eriogonum.
Eriogonum divergens, Eriogonum.
Croton texensis, Texas Croton.
Croton fruticosus.
Stillingia linearifolia, Spurge.
Argemone hispida, Prickly Poppy.
Argemone intermedia, Prickly Poppy.
Argemone platyceros, Prickly Poppy.
Mimosa biuncifera, Cat's-claw.
Mimosa fragrans, Fragrant Cat's-claw.
Mimosa dysocarpa, Cat's-claw.
- Mimosa lemmoni*, Cat's-claw.
Acacia cuspidata, Toothed Acacia.
Acacia jamesi, James Acacia. L.
Chamaecrista leptadenia.
Calliandra humilis. T.
Hoffmanseggia drapanocarpa. L.
Parosela calycosa, Dalea.
Parosela enneandra, Dalea.
Parosela brachystachys, Dalea.
Parosela jamesi, Dalea.
Parosela grayi, Dalea. L.
Parosela ardiae, Dalea. L.
Psoralea micrantha, Small-flowered Psoralea.
Psoralea tenuiflora, Narrow-flowered Psoralea.
Lupinus pusillus, Small Lupine.
Lupinus aduncus, Lupine.
Lupinus dispersus, Lupine. L.
Lupinus brevicaulis, Lupine. T.
Lathyrus decaphyllus, Prairie Vetchling.
Meibomia bigelovi, Tick Trefoil.
Meibomia neomexicana, Tick Trefoil.
Meibomia grahami, Tick Trefoil.
Dolicholus texensis.
Galactia wrighti, Milk Pea.
Phaseolus acutifolius, Wild Bean.
Phaseolus macropoides, Wild Bean.
Phaseolus angustissimus, Wild Bean. L.
Cologania pulchella.
Petalostemon purpureum, Violet Prairie Clover.
Petalostemon tenuifolium, Silky Prairie Clover. T.
Petalostemon oligophyllum, White Prairie Clover. T.
Parryella filifolia.
Astragalus diphyus, Milk Vetch.
Astragalus nuttallianus, Milk Vetch.
Astragalus bigelovi, Milk Vetch.
Astragalus praelongus, Milk Vetch.
Astragalus pattersoni, Milk Vetch.
Astragalus missouriensis, Milk Vetch.
Astragalus shortianus, Milk Vetch.
Astragalus amphioxus, Milk Vetch.
Astragalus ceramicus, Milk Vetch.
Astragalus thurberi, Milk Vetch.
Astragalus allochrous, Milk Vetch.
Astragalus sonorae, Milk Vetch.
Krameria secundiflora. L.
Artemisia tridentata, Black Sagebrush. T.
Artemisia arbuscula, Brown Sagebrush. T.

PLANTS OF UPPER SONORAN ZONE IN NEW MEXICO—continued.

Trees, shrubs, and herbaceous plants—Continued.

- Chrysothamnus graveolens*, Rabbit Brush.
Chrysothamnus linifolius, Rabbit Brush.
Chrysothamnus stenophyllus, Rabbit Brush.
Chrysothamnus bigelovi, Rabbit Brush.
Chrysoma laricifolia, Rabbit Brush.
Isocoma heterophylla, Rabbit Brush. L.
Gutierrezia tenuis, Rabbit Brush.
Gutierrezia longifolia, Rabbit Brush.
Gutierrezia filifolia, Rabbit Brush.
Tetradymia inermis, Rabbit Brush.
Crassina grandiflora.
Ximenesia exauriculata.
Opuntia arborescens, Tree Cactus, Cane Cactus. L.
Opuntia spinosior, Arizona Tree Cactus.
Opuntia davisii, Davis Bush Cactus.
Opuntia whipplei, Whipple Bush Cactus.
Opuntia clavata, Creeping Cactus.
Opuntia sphaerocarpa, Dwarf Cactus.
Opuntia trichophora, Dwarf Cactus.
Opuntia polyacantha, Dwarf Cactus.
Opuntia camanchica, Camanche Prickly Pear.
Opuntia tenuispina, Slender-spined Prickly Pear.
Opuntia cymochila, Yellow-spined Prickly Pear. L.
Opuntia balli, Ball Prickly Pear.
Opuntia engelmannii, Engelmann Prickly Pear.
Opuntia dillei, Dille Prickly Pear.
Opuntia wootoni, Wooton Prickly Pear.
- Opuntia phaeacantha*, Brown-spined Prickly Pear.
Mamillaria lasiacantha, Pincushion Cactus.
Mamillaria meiacantha, Pincushion Cactus.
Mamillaria heyderi, Pincushion Cactus. L.
Mamillaria dasyacantha, Pincushion Cactus.
Mamillaria radiosa, Pincushion Cactus. T.
Echinocereus viridiflorus, Green-flowered Petaya.
Echinocereus fendleri, Purple-flowered Petaya.
Echinocereus triglochidiatus. L.
Echinocereus paucispinus, Few-spined Petalla.
Echinocereus coccineus, Red-flowered Petalla. T.
Agave applanata, Guadalupe Century Plant.
Agave palmeri, Palmer Century Plant.
Agave parryi, Parry Century Plant.
Nolina greenii, Greene's Beargrass.
Nolina microcarpa, Small-seeded Beargrass.
Yucca baccata, Banana-fruited Yucca.
Yucca glauca, Narrow-leaved Low Yucca.
Yucca schottii, Wide-leaved Tree Yucca.

Grasses.

- Hilaria jamesii*, Galleta Grass.
Andropogon hallii, Blue Stem.
Bulbilis dactyloides, Buffalo Grass.
Bouteloua curtipendula, Tall Grama Grass. L.
Bouteloua hirsuta, Hairy Grama Grass. T.
Bouteloua oligostachya, Blue Grama Grass.
Bouteloua bromoides, Large Mesquite Grass.
Oryzopsis micrantha, Rice Grass.
Muhlenbergia vaseyana, Dropseed Grass.
Muhlenbergia pungens, Dropseed Grass. L.
Muhlenbergia distichophylla, Dropseed Grass.
Muhlenbergia mexicana, Dropseed Grass. L.
- Muhlenbergia monticola*, Dropseed Grass.
Muhlenbergia arenicola, Dropseed Grass. L.
Muhlenbergia affinis, Dropseed Grass.
Muhlenbergia acuminata, Dropseed Grass.
Stipa neomexicana, Feather Grass.
Stipa comata, Feather Grass.
Stipa fimbriata, Feather Grass. T.
Stipa editorum, Feather Grass.
Erioneuron pilosum.
Eragrostis lugens, Eragrostis.
Eragrostis trichodes, Eragrostis.
Eragrostis oxylepis, Eragrostis.
Eragrostis sessilis, Eragrostis.
Eragrostis major, Meadow Grass (probably always introduced).
Nazia aliena (introduced). L.
Sporobolus cryptandrus, Bunch Grass.

PLANTS OF UPPER SONORAN ZONE IN NEW MEXICO—continued.

Grasses—Continued.

<i>Epicampes rigens.</i>	<i>Aristida fendleriana</i> , Poverty Grass.
<i>Eatonia obtusata</i> , Eaton Grass.	<i>Aristida purpurea</i> , Poverty Grass. <i>L.</i>
<i>Puccinellia distans</i> , Meadow Grass.	<i>Aristida cirrhatus</i> , Poverty Grass. <i>L.</i>
<i>Festuca octoflora</i> , Fescue Grass.	<i>Eriocoma cuspidata</i> , Indian Millet. <i>L.</i>
<i>Agropyron spicatum</i> , Wheat Grass.	<i>Schizachyrium scoparium</i> , Broom Grass. <i>T.</i>
<i>Panicum arizonicum</i> , Panic Grass. <i>L.</i>	<i>Poa fendleriana</i> , Spear Grass, Mutton Grass. <i>T.</i>
<i>Panicum halli</i> , Panic Grass. <i>L.</i>	<i>Elymus canadensis</i> , Wild Rye. <i>T.</i>
<i>Panicum pampinosum</i> , Panic Grass.	<i>Sitanion longifolium</i> . <i>T.</i>
<i>Chloris verticillata</i> , Prairie Chloris. <i>L.</i>	<i>Sitanion pubiflorum</i> , Lyme Grass.
<i>Trichloris fasciculata</i> . <i>L.</i>	
<i>Aristida wrighti</i> , Poverty Grass.	

UPPER SONORAN ZONE CROPS.

In New Mexico, Upper Sonoran is the principal zone of small grains, including wheat, oats, rye, barley, and emmer. Under irrigation early varieties of corn succeed in most parts of the zone. Sorghum, kafir corn, milo maize, and millet are especially adapted to the Upper Sonoran. White potatoes mature to great perfection in suitable soils, alfalfa yields two or three good crops in a season, and sugar beets give a good yield and show a high percentage of sugar. Squashes, beans, peas, and a great variety of garden vegetables thrive. Fruits of many kinds reach their greatest perfection in the Great Basin division of the zone; but, owing to the elevation and aridity and consequent lack of deep snows to delay the flowering time in spring, the late frosts render unfruitful many of the early-flowering varieties and reduce the list of fruits that can be safely recommended to the late-flowering, hardy, or frost-resistant varieties.

The North and Central Utah Experiment Stations at Logan and Lehi, Utah, are in this division of the zone and have much the same climate and set of native species. The reports of crops and fruits tested at these stations apply fairly well to this part of the zone in New Mexico, but there would be some advantages in substations for testing crops in both the Great Basin and Great Plains subdivisions of the zone in western and eastern New Mexico.

APPLES.

Upper Sonoran is the great apple zone of the Rocky Mountain region, and many valleys within this zone in Utah, Colorado, and New Mexico have become famous for the quality and flavor of this fruit. The varieties recommended by the American Pomological Society as tested in their district No. 12 (including Utah, most of Colorado, and the northern third of New Mexico and Arizona) are suited to practically all Upper Sonoran Zone localities in New Mexico except the Great Plains division.¹ The following list contains only

¹ Fruits Recommended by the American Pomological Society for Cultivation in the Various Sections of the United States and Canada, Bull. 151, Bur. Plant Industry, U. S. Dept. Agric., pp. 14-22, 1909.

the varieties classed by the society as *highly successful*, and would have been much longer if the *successful* and *promising* varieties had been included:

Ben Davis.	Missouri.	Summer Pearmain.	York Imperial.
Chenango.	Oldenburg.	Wealthy.	Hyslop (crab apple).
Early Harvest.	Rambo.	White Pearmain.	
Gano.	Red June.	Winesap.	Transcendent (crab apple).
Grimes.	Rhode Island	Wolf River.	
Jonathan.	Greening.	Yellow Bellflower.	
Maiden Blush.	Rome Beauty.	Yellow Transparent.	

All but six of these were recommended for the arid Upper Sonoran area by Dr. Merriam.¹

Most of the preceding and a few additional varieties are included in the lists reported by Prof. Garcia as satisfactory in purely Upper Sonoran valleys in northwestern New Mexico.² Those additional to the previous list are:

Arkansas Black.	Arkansas (Mammoth Black	Snow.
Cooper's White.	Twig).	Smith's Cider.
Janet.	Greening.	

QUINCES.

The following quinces are recommended by the American Pomological Society as *successful* in their district No. 12:³

Champion.	Missouri.	Orange.
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PEARS.

Some of the most delicious pears I ever tasted were raised in the Upper Sonoran Zone of New Mexico, where they seem to bear well and reach great perfection. The varieties listed as *highly successful* are:⁴

Anjou.	Bartlett.	Louise.	Seckel.	Winter Nelis.
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CHERRIES.

Upper Sonoran is the zone of cherries in the Rocky Mountain region. Except where the flowers are endangered by late spring frosts, many of the standard varieties bear well and mature excellent fruit. Of these, the sour cherries are considered most reliable. Those reported most favorably to the State horticulturist from Upper Sonoran localities are as follows:⁵

Early Richmond.	English Morello.	Montmorency.
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These and the Napoleon are listed by the American Pomological Society as *highly successful*.⁶ Others listed as *known to succeed* are:

Knight.	Windsor.	Large Montmorency.	May Duke.
Oxheart.	Choisy.		Ostheim.
Tartarian.	Dyehouse.	Late Duke.	Royal Duke.

¹ Life Zones and Crop Zones, Bull. 10, Biol. Survey, pp. 37-38 and 59-60, 1898.

² Garcia, F., Apple Culture under Irrigation, Bull. 75, New Mex. Agric. Exp. Sta., p. 28, 1910.

³ Bull. 151, Bur. Plant Industry, p. 47, 1909.

⁴ Ibid., pp. 40-41.

⁵ Garcia, F., Orchard Notes, Bull. 39, New Mex. Agric. Exp. Sta., p. 111, 1901.

⁶ Bull. 151, Bur. Plant Industry, pp. 26-27, 1909.

NECTARINES.

In the Jemez Canyon, at about the middle of the Upper Sonoran Zone, I have eaten delicious nectarines from thrifty trees, but could not learn the variety. The American Pomological Society lists four varieties *known to succeed* in this zone:

Boston.	Golden.	New White.	Snow Flake.
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PEACHES.

Peach trees are generally thrifty and sound throughout the Upper Sonoran Zone, but their tendency is to blossom so early that fruit is rarely produced, except in unusually protected localities. When they do bear, the fruit is of excellent quality and flavor, but until better methods of controlling the flowering time are devised, it is not safe to recommend even the hardy varieties.

APRICOTS.

In some years there is a fair crop of seedling apricots in Upper Sonoran Zone localities in New Mexico, but usually the flowers come out so early as to be killed by the frost. It is doubtful if any variety would prove a safe crop in this zone except in peculiarly protected spots. Still, for the Upper Sonoran area of Colorado, Utah, and northern Arizona and New Mexico (district No. 12) the American Pomological Society¹ recommends one variety (Moorpark) as *highly successful* and six others as *known to succeed*:

Breda.	Newcastle.	Peach.	Royal.
Early Golden.	Orange.		

GRAPES.

The Mission grape is raised and does well in many of the warmer Upper Sonoran valleys of New Mexico. Other varieties recommended by the American Pomological Society for district No. 12 should be equally adapted to all but the Plains division of Upper Sonoran Zone in New Mexico. Those listed as *highly successful* are:²

Delaware.	Moore.	Niagara.	Worden.
Concord.			

Varieties *known to succeed*:

Agawam.	Goethe.	Lindley.	Salem.
Brighton.	Isabella.	Prentiss.	Wilder.
Duchess.	Ives.		

CURRANTS.

Currants listed as *highly successful* by the American Pomological Society are:³

Cherry.	Red Dutch.	Versaillaise.	White Dutch.
Fay.			

¹ Bul. 151, Bur. Plant Industry, p. 23, 1909.

² *Ibid.*, pp. 30-33.

³ *Ibid.*, p. 28.

Those listed as *known to succeed* are:

Albert.	London.	Victoria.	White Grape.
Holland.			

GOOSEBERRIES.

Gooseberries listed by the American Pomological Society as *highly successful* are: ¹

Downing.	Houghton.	Josselyn.	Smith.
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Those *known to succeed* are:

Berkeley.	Chautauqua.	Oregon.	Whitesmith.
Champion.	Industry.		

BLACKBERRIES.

Blackberries listed by the American Pomological Society as *highly successful* (l. c., pp. 24, 25) are:

Britton.	Minnewaska.
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Those *known to succeed* are:

Acme.	Erie.	Lawton.	Wilson.
Early Harvest.	Kittatinny.	Stone.	

DEWBERRIES.

The only dewberry listed by the American Pomological Society as *highly successful* is the Lucretia.

RASPBERRIES.

Raspberries listed by the American Pomological Society as *highly successful* (l. c., pp. 48, 49) are:

Gregg.	Kansas.	Cuthbert.	Marlboro.
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Those *known to succeed* are:

Columbian.	Nemaha.	Souhegan.	Golden.
Shaffer.	Ohio.	Tyler.	Loudon.
McCormick.	Palmer.	Brandywine.	Turner.

STRAWBERRIES.

Strawberries listed by the American Pomological Society as *highly successful* (l. c., pp. 50, 51) are:

Bederwood.	Crescent.	Gandy.	Haverland.
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Those *known to succeed* are:

Brandywine.	Downing.	Parker Earle.	Warfield.
Captain Jack.	Glen Mary.	Saunders.	Wilson.
Cumberland.	Jessie.	Sharpless.	Woolverton.

TRANSITION ZONE.

The Transition Zone in New Mexico covers the middle slopes of the higher mountains and the upper slopes or tops of most of the lower ranges. Its area is about 10,000 square miles. Approximately it

¹ Bull. 151, Bur. Plant Industry, p. 29, 1909.

runs from 7,000 to 8,500 feet on northeast slopes and from 8,000 to 9,500 on southwest slopes, but almost every range of mountains shows some variation. Owing to the more elevated base level in the northern part of the State (6,000 to 7,000 feet), the effect of latitude is more than counterbalanced, and the borders of the zone instead of being lower are pushed higher than in the southern part, where the base level is mainly below 5,000 feet. As is well known, a broad elevated plateau or valley, acting as a warm radiating surface, raises the zones. This is one of the disturbing factors which interrupt the

natural uniform depression of the zones toward the north.

In places the Transition Zone covers broad mesas, as over the tops of the Chusca and Zuni Mountains and along the sides of most of the higher ranges. It is the zone of the principal timber tree of the State, the yellow pine, which forms extensive forests of great value and beauty. These forests are almost invariably open, clean, and grassy and are valuable for grazing as well as for lumber. On some mesa tops where both trees and bushes are absent the zone is less clearly



FIG. 3.—Narrow-leaved cottonwood (*Populus angustifolia*), a beautiful Transition Zone tree of the stream valleys.

marked and can be determined only by inconspicuous species and by the absence of those of the Sonoran Zone. Such an area is found on top of Chaca Mesa, where the absence of junipers and nut pines and the presence of a broad expanse of sagebrush plains on northerly slopes above the 7,000-foot contour indicate Transition Zone. Some high valleys also, such as Moreno Valley in the Sangre de Cristo Mountains, and Valle San Antonio, Valle Grande, and Valle Santa Rosa in the Jemez Mountains, while treeless, belong to the Transition Zone.

Farming is carried on in some of these valleys and good crops of potatoes, grain, and garden vegetables are raised for home use, usually, however, in connection with stock ranches, for which the

valleys are especially favorable. There are usually sufficient rain and snow for good crops without irrigation if dry-farming methods are applied in the preparation and cultivation of the soil, and in many places there are streams which may be used for irrigation.

The Transition Zone is extremely uniform in climate and species throughout New Mexico, as it is throughout most of the Rocky Mountain States. Even the isolated Transition Zone areas (practically islands) of the Sacramento, Manzano, Sandia, San Mateo, Zuni, Chusca, Mogollon, Mimbres, and Burro Mountains have few species not common to the Transition fauna and flora of the main mass of the Rocky Mountains.

Restricted areas in the Animas, Peloncillo, and Big Hatchet Mountains, near the southwest corner of the State, bring in many species from the Mexican tableland, and a few of these, especially the birds, stray across to the Mogollon Mountains.

MAMMALS OF TRANSITION ZONE IN NEW MEXICO.

[Species marked *U.* occur also in the Upper Sonoran Zone; those marked *C.*, also in the Canadian.]

- Cervus merriami*, Merriam Elk. *C.*
Odocoileus hemionus, Mule Deer. *U. C.*
Sciurus aberti, Abert Squirrel.
Sciurus aberti mimus, Tuft-eared Squirrel.
Eutamias cinereicollis, Gray-collared Chipmunk.
Eutamias cinereicollis cinereus, Gray-sided Chipmunk.
Eutamias cinereicollis canipes, Gray-footed Chipmunk.
Eutamias quadrivittatus, Rocky Mountain Chipmunk.
Eutamias quadrivittatus hopiensis, Hopi Chipmunk.
Callospermophilus lateralis, Say Ground Squirrel. *C.*
Callospermophilus lateralis arizonensis, Arizona Ground Squirrel.
Cynomys gunnisoni, Gray-tailed Prairie Dog. *U.*
Neotoma mexicana, Mexican Wood Rat.
Neotoma mexicana fallax, Colorado Wood Rat.
Neotoma pinetorum, San Francisco Mountain Wood Rat.
Neotoma cinerea orolestes, Colorado Bushy-tailed Wood Rat.
Castor canadensis frondator, Broad-tailed Beaver. *U.*
Microtus pennsylvanicus modestus, Colorado Meadow Mouse. *U.*
Microtus mogollonensis, Mogollon Meadow Mouse.
Microtus mexicanus guadalupensis, Guadalupe Meadow Mouse.
Zapus luteus, Jumping Mouse. *U.*
Erethizon epixanthum, Yellow-haired Porcupine. *C.*
Erethizon epixanthum couesi, Arizona Porcupine.
Thomomys fessor, Mountain Pocket Gopher. *C.*
Thomomys fulvus, Fulvous Pocket Gopher. *C.*
Thomomys aureus apache, Apache Pocket Gopher.
Lepus campestris, White-tailed Jack Rabbit.
Sylvilagus floridanus holzneri, Holzner Cottontail.
Sylvilagus cognatus, Manzano Mountain Cottontail.
Sylvilagus nuttalli pinetis, Rocky Mountain Cottontail.
Felis hippelestes, Rocky Mountain Mountain Lion. *C.*
Felis hippelestes aztecus, Mexican Mountain Lion. *U.*
Lynx uinta, Mountain Bobcat.
Canis mexicanus, Mexican Wolf. *U.*
Canis lestes, Mountain Coyote.
Taxidea taxus, Badger. *C.*
Mustela arizonensis, Arizona Weasel. *C.*
Lutra (canadensis?), Otter.
Lutreola, Mink. *C.*

MAMMALS OF TRANSITION ZONE IN NEW MEXICO—continued.

<i>Mephitis estor</i> , Arizona Skunk. U.	<i>Ursus horribilis horriacus</i> , Mexican Grizzly. C.
<i>Procyon lotor</i> , Raccoon.	<i>Eptesicus fuscus</i> , Brown Bat. U.
<i>Ursus americanus ambliceps</i> , Black Bear. C.	<i>Myotis lucifugus longicrus</i> , Long-legged Bat. U.
<i>Ursus (horribilis?)</i> , Grizzly Bear. C.	

BREEDING BIRDS OF TRANSITION ZONE IN NEW MEXICO.

[Species marked U. breed also in the Upper Sonoran Zone; those marked C., also in the Canadian.]

<i>Erismatura jamaicensis</i> , Ruddy Duck. U.	<i>Pica pica hudsonia</i> , Black-billed Magpie.
<i>Querquedula cyanoptera</i> , Cinnamon Teal. U.	<i>Hesperiphona vespertina montana</i> , Western Evening Grosbeak.
<i>Spatula clypeata</i> , Shoveler.	<i>Poocetes gramineus confinis</i> , Western Vesper Sparrow. U.
<i>Dendragapus obscurus obscurus</i> , Dusky Grouse. C.	<i>Spizella passerina arizonae</i> , Western Chipping Sparrow. U.
<i>Meleagris gallopavo merriami</i> , Merriam's Turkey.	<i>Spizella breweri</i> , Brewer's Sparrow. U.
<i>Columba fasciata fasciata</i> , Band-tailed Pigeon.	<i>Junco phaeonotus dorsalis</i> , Red-backed Junco. C.
<i>Accipiter velox</i> , Sharp-shinned Hawk. C.	<i>Melospiza melodia montana</i> , Mountain Song Sparrow.
<i>Accipiter cooperi</i> , Cooper's Hawk.	<i>Pipilo maculatus montanus</i> , Spurred Towhee.
<i>Otus flammeolus flammeolus</i> , Flammulated Screech Owl.	<i>Oreospiza chlorura</i> , Green-tailed Towhee.
<i>Cryptoglaux acadica acadica</i> , Saw-whet Owl.	<i>Zamelodia melanocephala</i> , Black-headed Grosbeak. U.
<i>Glaucidium gnoma pinicola</i> , Pygmy Owl.	<i>Piranga ludoviciana</i> , Western Tanager.
<i>Dryobates villosus monticola</i> , Rocky Mountain Hairy Woodpecker. C.	<i>Piranga hepatica</i> , Hepatic Tanager. U.
<i>Dryobates villosus leucothorectis</i> , White-breasted Woodpecker.	<i>Lanius solitarius plumbeus</i> , Plumbeous Vireo.
<i>Melanerpes formicivorus formicivorus</i> , Ant-eating Woodpecker. U.	<i>Vermivora virginiae</i> , Virginia's Warbler.
<i>Asyndesmus lewisi</i> , Lewis's Woodpecker.	<i>Vermivora celata celata</i> , Orange-crowned Warbler.
<i>Colaptes cafer collaris</i> , Red-shafted Flicker. C.	<i>Peucedramus olivaceus</i> , Olive Warbler.
<i>Antrostomus vociferus macromystax</i> , Stephens's Whippoorwill.	<i>Dendroica auduboni auduboni</i> , Audubon's Warbler. C.
<i>Chordeiles virginianus henryi</i> , Western Nighthawk. U.	<i>Dendroica graciae</i> , Grace's Warbler.
<i>Aëronautes melanoleucus</i> , White-throated Swift. U.	<i>Dendroica nigrescens</i> , Black-throated Gray Warbler.
<i>Cyanolaemus clemenciae</i> , Blue-throated Hummingbird.	<i>Oporornis tolmiei</i> , Macgillivray's Warbler. C.
<i>Archilochus alexandri</i> , Black-chinned Hummingbird. U.	<i>Setophaga picta</i> , Painted Redstart.
<i>Myiochanes richardsoni richardsoni</i> , Western Wood Pewee.	<i>Cardellina rubrifrons</i> , Red-faced Warbler.
<i>Empidonax wrighti</i> , Wright's Flycatcher.	<i>Oreoscoptes montanus</i> , Sage Thrasher.
<i>Otocoris alpestris leucolaema</i> , Desert Horned Lark. U.	<i>Troglodytes aëdon parkmani</i> , Western House Wren. U.
	<i>Sitta carolinensis nelsoni</i> , Rocky Mountain Nuthatch.
	<i>Sitta pygmaea pygmaea</i> , Pygmy Nuthatch.
	<i>Penthestes selateri</i> , Mexican Chickadee.

BREEDING BIRDS OF TRANSITION ZONE IN NEW MEXICO—continued.

<i>Penthestes gambeli</i> , Mountain Chickadee. U.	<i>Planesticus migratorius propinquus</i> , Western Robin. C.
<i>Hylocichla fuscescens salicicola</i> , Willow Thrush.	<i>Sialia mexicana bairdi</i> , Chestnut-backed Bluebird.

REPTILES OF TRANSITION ZONE.

[Species marked U. occur also in the Upper Sonoran Zone.]

*Lizards.**Phrynosoma hernandesi*, Short-horned lizard. U.*Snakes.**Thamnophis ordinoides elegans*, Western Garter Snake. U.

PLANTS OF TRANSITION ZONE IN NEW MEXICO.

[Species marked U. occur also in the Upper Sonoran Zone; those marked C., also in the Canadian Zone.]

Trees and shrubs.

<i>Pinus scopulorum</i> , Yellow Pine.	<i>Rhamnus ursina</i> , Bear Buckthorn.
<i>Pinus arizonica</i> , Arizona Pine.	<i>Rhamnus fasciculata</i> , Buckthorn.
<i>Pinus chihuahuana</i> , Chihuahua Pine.	<i>Rhamnus betulaeifolia</i> , Buckthorn.
<i>Pinus mayriana</i> , Mayr Pine.	<i>Ribes inebrians</i> , Red Currant.
<i>Pinus strobiformis</i> , Mexican White Pine.	<i>Ribes mescalerium</i> , Mescalero Red Currant.
<i>Pseudotsuga mucronata</i> , Douglas Spruce. C.	<i>Grossularia pinetorum</i> , Spiny-fruited Gooseberry.
<i>Cupressus arizonica</i> , Arizona Cypress.	<i>Grossularia inermis</i> , Purple Gooseberry.
<i>Populus angustifolia</i> , Narrow-leaved Cottonwood.	<i>Grossularia leptantha</i> , Black Gooseberry.
<i>Quercus gambeli</i> , Gambel's Oak.	<i>Sericotheca dumosa</i> .
<i>Quercus venustula</i> .	<i>Opulaster monogynus</i> , Western Ninebark.
<i>Quercus submollis</i> .	<i>Rubus parviflorus</i> , Thimbleberry. C.
<i>Quercus utahensis</i> , Utah Oak.	<i>Rubus neomexicanus</i> , New Mexico Thimbleberry.
<i>Quercus vreelandi</i> , Vreeland Oak.	<i>Amelanchier oreophilus</i> , Juneberry, Service berry.
<i>Quercus leptophylla</i> , Scale-leaved Oak.	<i>Crataegus rivularis</i> , Thorn Apple.
<i>Quercus gunnisoni</i> , Gunnison Oak.	<i>Crataegus erythropoda</i> , Thorn Apple.
<i>Quercus novomexicana</i> , New Mexico Oak.	<i>Crataegus wootoniana</i> , Thorn Apple.
<i>Quercus hypoleuca</i> , White-leaved Oak.	<i>Rosa fendleri</i> , Wild Rose.
<i>Quercus wilcoxi</i> , Wilcox Oak.	<i>Rosa maximiliani</i> , Wild Rose.
<i>Quercus reticulata</i> , Lace-veined Oak.	<i>Berberis repens</i> , Blue Barberry.
<i>Salix bebbiana</i> , Bebb Willow. C.	<i>Berberis fendleri</i> , Fendler Barberry.
<i>Salix monticola</i> , Mountain Willow.	<i>Ceanothus fendleri</i> , Wild Tea Bush.
<i>Salix cordata watsoni</i> , Diamond Willow.	<i>Arctostaphylos uva-ursi</i> , Bearberry.
<i>Salix lasiandra</i> , Western Black Willow.	<i>Edwinia americana</i> , Edwinia.
<i>Betula fontinalis</i> , Rocky Mountain Birch.	<i>Svida riparia</i> , River Cornel.
<i>Acer grandidentatum</i> , Large-toothed Maple.	<i>Symphoricarpos oreophilus</i> , Mountain Snowberry.
<i>Acer neomexicanum</i> , New Mexico Maple.	<i>Sambucus neomexicana</i> , New Mexico Elderberry.
<i>Robinia neomexicana</i> , New Mexico Locust.	
<i>Prunus americana</i> , Wild Red Plum.	
<i>Prunus melanocarpa</i> , Choke Cherry.	
<i>Prunus salicifolia acutifolia</i> , Black Cherry.	
<i>Arbutus arizonica</i> , Arizona Madrone.	

PLANTS OF TRANSITION ZONE IN NEW MEXICO—continued.

Herbaceous plants.

<i>Humulus lupulus neomexicanus</i> , Wild Hop.	<i>Vicia pulchella</i> , Vetch.
<i>Eriogonum pharanacioides</i> , Eriogonum.	<i>Vicia leucophaea</i> , Vetch.
<i>Eriogonum bakeri</i> , Eriogonum.	<i>Lathyrus leucanthus</i> , Wild Pea.
<i>Eriogonum jamesi</i> , Eriogonum. U.	<i>Phaseolus retusus</i> , Wild Bean.
<i>Eriogonum racemosum</i> , Eriogonum. U.	<i>Astragalus yaquianus</i> , Milk Vetch.
<i>Aquilegia elegantula</i> , Wild Columbine.	<i>Astragalus scalaris</i> , Milk Vetch.
<i>Aquilegia formosa</i> , Wild Columbine.	<i>Astragalus humistratus</i> , Milk Vetch.
<i>Lupinus kingi</i> , Lupine, Bluebonnet.	<i>Astragalus rushbyi</i> , Milk Vetch.
<i>Lupinus neomexicanus</i> , Lupine.	<i>Astragalus bisulcatus</i> , Milk Vetch.
<i>Lupinus parviflorus</i> , Lupine.	<i>Astragalus haydenianus</i> , Milk Vetch.
<i>Thermopsis pinctorum</i> , Yellow Thermopsis.	<i>Astragalus gilensis</i> , Milk Vetch.
<i>Vicia americana</i> , Vetch.	<i>Juncus dudleyi</i> , Rush, Tule.
	<i>Juncus brunescens</i> , Rush, Tule.
	<i>Juncus parous</i> , Rush, Tule.

Grasses.

<i>Andropogon chrysocomus</i> , Beard Grass.	<i>Poa occidentalis</i> , Western Bluegrass.
<i>Savastana odorata</i> , Holy Grass.	<i>Poa pratensis</i> , Kentucky Bluegrass.
<i>Stipa minor</i> , Feather Grass.	<i>Poa longipedunculata</i> , Spear Grass.
<i>Stipa scribneri</i> , Feather Grass.	<i>Poa bigelovi</i> , Spear Grass. U.
<i>Stipa viridula</i> , Feather Grass.	<i>Panicularia nervata</i> , Manna Grass.
<i>Stipa vascyi</i> , Sleepy Grass.	<i>Bromus polyanthus</i> , Brome Grass, Chess.
<i>Muhlenbergia richardsonis</i> , Dropseed Grass.	<i>Bromus lanatipes</i> , Brome Grass.
<i>Muhlenbergia cuspidata</i> , Dropseed Grass. U.	<i>Bromus frondosus</i> , Bluegrass. U.
<i>Muhlenbergia racemosa</i> , Dropseed Grass. U.	<i>Bromus portieri</i> , Brome Grass.
<i>Muhlenbergia comata</i> , Dropseed Grass.	<i>Bromus richardsoni</i> , Brome Grass. C.
<i>Muhlenbergia gracilis</i> , Dropseed Grass. U.	<i>Sitanion molle</i> , Lyme Grass.
<i>Muhlenbergia subalpina</i> , Dropseed Grass.	<i>Alopecurus geniculatus</i> , Foxtail.
<i>Blepharoneuron tricholepis</i> .	<i>Sorghastrum nutans</i> , Indian Grass. U.
<i>Agrostis exarata</i> , Red top.	<i>Panicum bulbosum</i> , Panic Grass. U.
<i>Agrostis hiemalis</i> , Rough Hair Grass. C.	<i>Panicum plenum</i> , Panic Grass. U.
<i>Bouteloua prostrata</i> , Low Grama.	<i>Eragrostis neomexicana</i> , New Mexico Eragrostis. U.
<i>Koeleria cristata</i> , June Grass.	<i>Agropyron smithi</i> , Wheat Grass.
<i>Melica parviflora</i> , Melic Grass.	<i>Agropyron arizonicum</i> , Arizona Wheat Grass. U.
<i>Poa annua</i> , Annual Meadow Grass.	<i>Agropyron pseudorepens</i> , Wheat Grass. C.

CANADIAN ZONE.

The Canadian Zone covers most of the higher parts of the mountains and extends on cold slopes approximately from 8,500 to 11,000 feet and on warm slopes from 9,500 to 12,000 feet, varying, however, as much as 1,000 feet, according to local conditions in different ranges. Its area is estimated at approximately 2,000 square miles, lying generally in narrow and very irregular strips.¹ The largest continuous area lies on the Sangre de Cristo (the main range of the Rockies east of the Rio Grande), and there are less extensive areas on the San Juan, Jemez, Sacramento, and Mogollon Mountains, and

¹ In this more than in the lower zones the outlines are generalized on the zone map.

comparatively restricted areas on the Mount Taylor, Zuni, Chusca, Datil, San Francisco, Mimbres, Magdalena, San Mateo, Manzano, Sandia, Capitan, and Raton ranges. There is a trace also in the Animas Mountains and on some of the higher buttes and isolated peaks.

The zone is densely forested with spruce, balsam, and aspens, except in areas that have been burned, and even these quickly produce fresh growth, usually of aspens followed by conifers. In the midst of an arid region it is a humid zone, catching the maximum fall of rain and snow and holding the deep snows until late spring. Even in midsummer great banks of snow remain on shaded slopes among the trees, and long after they have disappeared the mellow soil of the mountain basins is saturated with snow water. During the summer there are also frequent, often daily, showers of rain and hail. The humidity of the zone is its greatest protection from forest fires, but in dry seasons destructive fires are frequent. Throughout the summer months it is a zone of cool crisp air and occasional frosty nights, which result in the exclusion of lower zone plants and of practically all crops.

The timber of the zone consists mainly of slender spruces, firs, and aspens, usually growing on elevated slopes difficult of access. It is of comparatively little commercial value, but locally it is valuable for mining timbers and eventually will have other uses for which its careful conservation is important. Its greatest and ever-increasing value, however, lies in the protection it affords the water supply for the surrounding agricultural valleys. Although a zone with little agriculture of its own, it is the fountain head of the agricultural wealth of the surrounding country.

The lower edge of the zone is generally sharply marked and easily recognized, but the upper edge blends almost insensibly with the narrow border of Hudsonian, which in these mountains forms but a minor division of the Boreal Zone.

MAMMALS OF THE CANADIAN ZONE IN NEW MEXICO.

[Species marked *T.* occur also in the Transition Zone; those marked *H.*, also in the Hudsonian Zone.]

<i>Cervus canadensis</i> , Elk. <i>T.</i>	<i>Callospermophilus lateralis</i> , Say Ground Squirrel. <i>T.</i>
<i>Cervus merriami</i> , Merriam Elk. <i>T.</i>	<i>Marmota flaviventer</i> , Rocky Mountain Woodchuck. <i>H.</i>
<i>Odocoileus hemionus</i> , Mule Deer. <i>T.</i>	<i>Peromyscus maniculatus rufinus</i> , Rusty White-footed Mouse. <i>T.</i>
<i>Sciurus fremonti</i> , Colorado Spruce Squirrel.	<i>Phenacomys orophilus</i> , Mountain Lemming Mouse.
<i>Sciurus fremonti mogollonensis</i> , Arizona Spruce Squirrel.	<i>Evotomys gapperi galei</i> , Gale Red-backed Mouse.
<i>Sciurus fremonti lychnuchus</i> , White Mountain Spruce Squirrel.	
<i>Eutamias amoenus operarius</i> , Colorado Chipmunk.	

MAMMALS OF THE CANADIAN ZONE IN NEW MEXICO—continued.

<i>Erinomys limitis</i> , Southern Red-backed Mouse.	<i>Mustela streator leptus</i> , Dwarf Weasel.
<i>Microtus mordax</i> , Rocky Mountain Meadow Mouse.	<i>Martes caurina origines</i> , Marten.
<i>Microtus nanus</i> , Dwarf Meadow Mouse.	<i>Ursus americanus ambliceps</i> , Black Bear. T.
<i>Erethizon epixanthum</i> , Yellow-haired Porcupine. T.	<i>Sorex palustris navigator</i> , Water Shrew.
<i>Thomomys fossor</i> , Mountain Pocket Gopher. T.	<i>Sorex obscurus</i> , Dusky Shrew. H.
<i>Lepus bairdi</i> , Snowshoe Rabbit.	<i>Sorex obscurus neomexicanus</i> , New Mexico Shrew.
<i>Lynx canadensis</i> , Canada Lynx.	<i>Sorex vagrans monticola</i> , Mountain Shrew.
<i>Vulpes fulva macroura</i> , Mountain Red Fox.	<i>Sorex personatus</i> , Masked Shrew. H.
<i>Mustela arizonensis</i> , Arizona Weasel. T.	<i>Nycteris cinerea</i> , Hoary Bat.
	<i>Lasionycteris noctivagans</i> , Silver-haired Bat.

BREEDING BIRDS OF THE CANADIAN ZONE IN NEW MEXICO.

[Species marked T. breed also in the Transition Zone; those marked H., also in the Hudsonian Zone.]

<i>Mergus americanus</i> , Merganser. T.	<i>Zonotrichia leucophrys leucophrys</i> , White-crowned Sparrow. H.
<i>Dendragapus obscurus obscurus</i> , Dusky Grouse. T.	<i>Junco phaeonotus caniceps</i> , Gray-headed Junco. H.
<i>Astur atricapillus striatulus</i> , ¹ Western Goshawk.	<i>Melospiza lincolni lincolni</i> , Lincoln's Sparrow.
<i>Picoides americanus dorsalis</i> , Alpine Three-toed Woodpecker. H.	<i>Tachycineta thalassina lepida</i> , Northern Violet-green Swallow. T.
<i>Sphyrapicus varius nuchalis</i> , Red-naped Sapsucker. T.	<i>Wilsonia pusilla pileolata</i> , Pileolated Warbler.
<i>Sphyrapicus thyroideus</i> , Williamson's Sapsucker. T.	<i>Cinclus mexicanus unicolor</i> , Dipper or Water Ouzel. T.
<i>Selasphorus platycercus</i> , Broad-tailed Hummingbird. T.	<i>Certhia familiaris montana</i> , Rocky Mountain Creeper.
<i>Stellula calliope</i> , ¹ Calliope Hummingbird. T.	<i>Sitta canadensis</i> , Red-breasted Nuthatch.
<i>Nuttallornis borealis</i> , Olive-sided Flycatcher.	<i>Penthestes atricapillus septentrionalis</i> , Long-tailed Chickadee. T.
<i>Empidonax difficilis difficilis</i> , Western Flycatcher. T.	<i>Regulus satrapa satrapa</i> , Golden-crowned Kinglet. H.
<i>Cyanocitta stelleri diademata</i> , Long-crested Jay. T.	<i>Regulus calendula calendula</i> , Ruby-crowned Kinglet.
<i>Perisoreus canadensis capitalis</i> , Rocky Mountain Jay. H.	<i>Myadestes townsendi</i> , Townsend's Solitaire.
<i>Carpodacus cassini</i> , Cassin's Purple Finch.	<i>Hylocichla guttata auduboni</i> , Audubon's Hermit Thrush.
<i>Loxia curvirostra stricklandi</i> , Mexican Crossbill. T.	<i>Sialia currucoides</i> , Mountain Bluebird. T.
<i>Spinus pinus</i> , Pine Siskin.	

¹ Not positively known to breed. So little work has been done in this zone during the early breeding season that the list is very incomplete.



FIG. 1.—OPEN YELLOW PINE FOREST ON TOP OF THE CHUSCA MOUNTAINS.
Navajo sheep corral in foreground.



FIG. 2.—YELLOW PINE FOREST OF THE MOGOLLON MOUNTAIN PLATEAU.
The G O S ranch on the head of Sappello Creek.

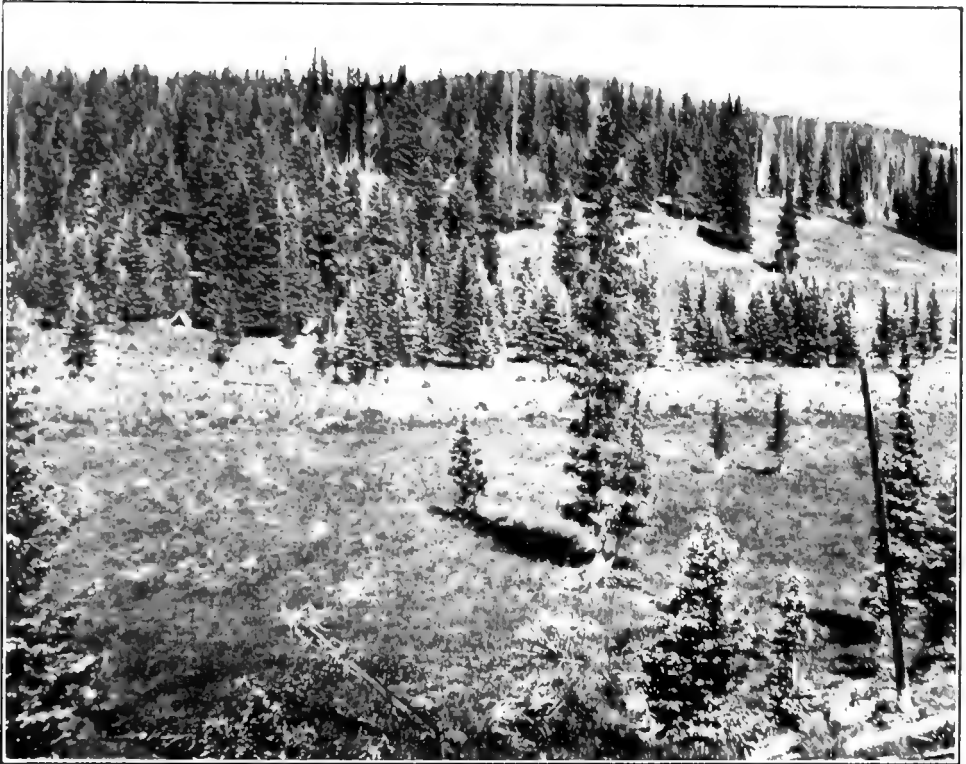


FIG. 1.—CANADIAN ZONE FOREST OF SPRUCE AND FIR AT 11,000 FEET ON JACK CREEK NEAR THE HEAD OF PECOS RIVER.



FIG. 2.—BLUE COLUMBINE, ONE OF THE ABUNDANT AND CONSPICUOUS FLOWERS OF THE CANADIAN ZONE PARKS, AT 11,000 FEET, PECOS MOUNTAINS.



FIG. 1.—DWARF SPRUCE AND FIR AT 11,800 FEET ON EAST SIDE OF PECOS BALDY.

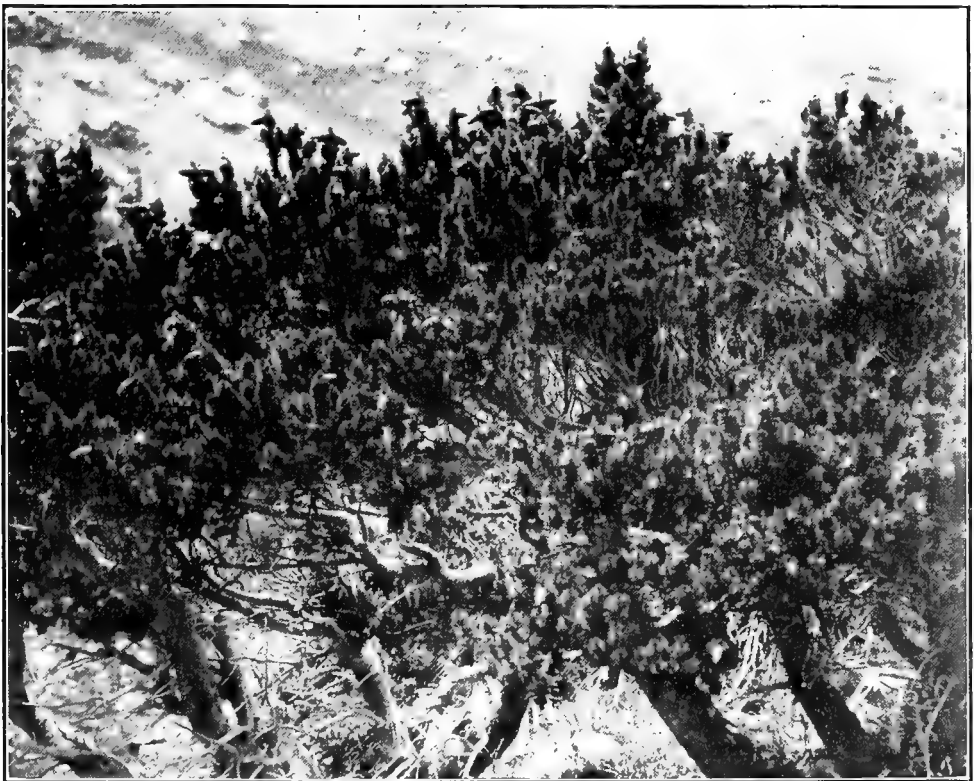


FIG. 2.—FOXTAIL PINES AT 11,800 FEET ON EAST SIDE OF PECOS BALDY. TYPICAL HUDSONIAN ZONE TREES.



FIG. 1.—TRUCHAS PEAKS FROM THE SOUTH. HIGHEST PEAK, 13,300 FEET, TAKEN FROM 11,800 FEET ON THE SIDE OF PECOS BALDY.



FIG. 2.—SANTA FE BALDY FROM THE NORTH. HIGHEST PEAK, ABOUT 12,600 FEET, TAKEN FROM TOP OF PECOS BALDY.

On both Truchas and Santa Fe Baldy the whole width of Hudsonian and Arctic-Alpine zones are shown, and appear much the same on the cold slope of the lower as on the warm slope of the higher peak.

PLANTS OF THE CANADIAN ZONE IN NEW MEXICO.

Species marked *T.* occur also in the Transition Zone; those marked *H.*, also in the Hudsonian; those marked *A.*, also in the Arctic-Alpine.]

Trees and shrubs.

Picea parryana, Blue Spruce.
Picea engelmanni, Engelmann Spruce.
Abies concolor, White Fir.
Pinus flexilis, Rocky Mountain White Pine.
Pseudotsuga mucronata, Douglas Spruce.
T.
Juniperus sibirica, Shrubby Juniper.
Populus tremuloides, Aspen.
Acer glabrum, Rocky Mountain Maple.
Alnus tenuifolia, Alder.
Salix bebbiana, Bebb Willow. *T.*
Lepargyrea canadensis, Canadian Buffalo Berry.

Pachystima myrsinites.
Vaccinium erythrococcum, Red Blueberry.
H.
Vaccinium oreophilum, Mountain Blueberry.
Ribes wolfi, Blue Currant.
Ribes coloradense, Black Currant.
Sorbus scopulina, Mountain Ash.
Sambucus microbotrys, Red Elderberry.
Lonicera involucrata, Black-fruited Honeysuckle.
Dasiphora fruticosa, Shrubby Cinquefoil.

Herbaceous plants.

Drymocallis convallarioides, Cinquefoil.
Veratrum tenuipetalum, Hellebore.
Aquilegia caerulea, Blue Columbine.
Delphinium cockerelli, Larkspur.
Aconitum porrectum, Monkshood.
Linnæa americana, Twinflower.
Pyrola secunda, Winter Lettuce.
Pyrola picta, Painted Pyrola.
Moneses uniflora, One-flowered Moneses.
Chimaphila umbellata, Pipsissewa.
Micranthes arguta, Saxifrage.
Parnassia fimbriata, Grass-o-Parnassus.
Parnassia parviflora, Small-flowered Grass-o-Parnassus.
Frasera stenosepala, Fräsera.
Gentiana parryi, Mountain Closed Gentian.
Gentiana elegans, Mountain Fringed Gentian.
Mertensia (several species), Lungwort.
Polemonium confertum, Musky Jacob's Ladder. *H., A.*

Polemonium foliosissimum, Pale Jacob's Ladder. *H.*
Pentstemon (several species).
Aragallus richardsoni, Richardson Milk Vetch.
Pedicularis racemosa, Purple Lousewort.
Elephantella groenlandica, Elephant-head.
Actæa viridiflora, Green-flowered Baneberry.
Viola nephrophylla, Blue Violet.
Viola neomexicana, Tall White Violet.
Dodecatheon radicum, Shooting Star.
Sisymbrium vaseyi, Hedge Mustard.
Solidago parryi, Goldenrod.
Erigeron superbus, Large-flowered Erigeron.
Arnica cordifolia, Heart-leaved Arnica.
Carduus parryi, Yellow Thistle.
Carex bella, Sedge.
Carex aurea, Sedge.

Grasses.

Oryzopsis asperifolia, Mountain Rice.
Calamagrostis hyperborea americana, Reed Grass.
Deschampsia caespitosa, Hair Grass.
Deschampsia alpicola, Hair Grass. *H.*
Trisetum montanum, False Oats.
Avena striata, Oat Grass.
Danthonia spicata, Wild Oat Grass.
Danthonia intermedia, Wild Oat Grass.

Danthonia parryi, Wild Oat Grass.
Agrostis idahoensis, Redtop.
Festuca thurberi, Thurber Fescue.
Festuca arizonica, Arizona Fescue. *T.*
Festuca brachyphylla, Shortleaf Fescue.
H.
Agropyron violaceum, Wheat Grass. *H.*
Agropyron bakeri, Wheat Grass. *H.*
Hordeum nodosum, Foxtail. *H.*

HUDSONIAN ZONE.

The Hudsonian Zone is found on the peaks that reach near or above timberline, mainly along the Sangre de Cristo Range, including the Pecos, Taos, Costilla, and Culebra Mountains, with traces on the White, Capitan, Sandia, and Jemez Mountains, Mount Taylor, and the Mogollons. Its total area in New Mexico probably does not exceed 300 square miles of steep mountain slopes. It is a narrow zone of about 1,000 feet in vertical extent, reaching normally from 11,000 to 12,000 feet on northeast slopes and 12,000 to 13,000 on southwest slopes, but often sending narrow tongues down steep gulches 1,000 feet below normal. It is generally well marked by a stunted growth of gnarled and dwarfed timber, mainly Engelmann spruce, cork-barked fir, and foxtail pine, but has many open slopes swept by wind and avalanche, where only depauperate vegetation, such as dwarf willows, gooseberries, geums, gentians, saxifrages, and clovers, mark the zone. The timber has little or no commercial value, a fact which is favorable to the continued usefulness of the zone as a conservator of water.

Buried under deep snows for 7 or 8 months of the year, the Hudsonian Zone contributes to agriculture mainly by storing water, which it holds until late in summer and yields during the driest part of the year. For a few months of late summer there is good grazing for sheep, the only animals adapted to these elevated slopes, but if overgrazed the steep slopes quickly become barren wastes of slide rock, and the grass cover has far greater value when left to protect the soil and conserve the water than when used to support a few sheep.

MAMMALS OF HUDSONIAN ZONE IN NEW MEXICO.

[Species marked C. occur also in the Canadian Zone.]

<i>Ovis canadensis</i> , Mountain sheep.	<i>Ochotona nigrescens</i> , Dusky Rock Cony. <i>Sorex obscurus</i> , Dusky Shrew. C. <i>Sorex personatus</i> , Masked Shrew. C.
<i>Marmota flaviventer</i> , Rocky Mountain Woodchuck.	
<i>Ochotona saxatilis</i> , Gray Rock Cony.	

BREEDING BIRDS OF HUDSONIAN ZONE IN NEW MEXICO.

[Species marked C. breed also in the Canadian Zone.]

<i>Picoides americanus dorsalis</i> , Alpine Three-toed Woodpecker. C.	<i>Zonotrichia leucophrys leucophrys</i> , White-crowned Sparrow. C. <i>Junco phaeonotus caniceps</i> , Gray-headed Junco. C. <i>Regulus satrapa satrapa</i> , Golden-crowned Kinglet. C.
<i>Perisoreus canadensis capitalis</i> , Rocky Mountain Jay. C.	
<i>Nucifraga columbiana</i> , ¹ Clark's Nutcracker.	
<i>Pinicola enucleator montana</i> , Rocky Mountain Pine Grosbeak.	

¹ While this is one of the most characteristic summer birds of the Hudsonian Zone and is often seen in family parties, it breeds very early and probably in a lower zone. But few nests have been found and most of these in the Transition Zone.

PLANTS OF HUDSONIAN ZONE IN NEW MEXICO.

[Species marked *C.* occur also in the Canadian Zone; those marked *A.*, also in the Arctic-Alpine.]

- | | |
|---|---|
| <p><i>Pinus aristata</i>, Foxtail Pine.</p> <p><i>Abies arizonica</i> (dwarf), Cork-barked Fir. <i>C.</i></p> <p><i>Picea engelmanni</i> (dwarf), Engelmann Spruce. <i>C.</i></p> <p><i>Salix saximontana</i>, Creeping Willow. <i>A.</i></p> <p><i>Salix glaucops</i>, Gray-leaved Willow.</p> <p><i>Ribes lentum</i>, Bristly Red Currant.</p> <p><i>Clementsia rhodantha</i>, Red Orpine. <i>A.</i></p> <p><i>Rhodiola integrifolia</i>, Rosewort. <i>A.</i></p> <p><i>Rhodiola polygama</i>, Rosewort. <i>A.</i></p> <p><i>Rhodiola neomexicana</i>, Rosewort.</p> <p><i>Polemonium delicatum</i>, Slender Jacob's Ladder.</p> <p><i>Phlox douglasi</i>, Douglas Phlox. <i>A.</i></p> <p><i>Pentstemon gracilis</i>, Purple Pentstemon.</p> <p><i>Sieversia turbinata</i> (<i>Geum rossi</i>), Mountain Avens. <i>A.</i></p> <p><i>Potentilla filipes</i>, Cinquefoil. <i>A.</i></p> <p><i>Sibbaldia procumbens</i>, Sibbaldia. <i>A.</i></p> <p><i>Caltha leptosepala</i>, Elkslip (White Cowslip).</p> <p><i>Trifolium parryi</i>, Dwarf Clover. <i>A.</i></p> <p><i>Trifolium nanum</i>, Dwarf Clover. <i>A.</i></p> <p><i>Trifolium stenolobum</i>, Dwarf Clover. <i>A.</i></p> <p><i>Delphinium macrophyllum</i>, Large-leaved Larkspur.</p> | <p><i>Delphinium alpestre</i>, Alpine Larkspur. <i>A.</i></p> <p><i>Orthocarpus luteus</i>, Yellow Orthocarpus.</p> <p><i>Castilleja</i>, Painted Cup.</p> <p><i>Primula parryi</i>, Parry Primrose.</p> <p><i>Gentiana romanzovi</i>, Dwarf Closed Gentian.</p> <p><i>Swertia perennis</i>.</p> <p><i>Arenaria fendleri</i>, Sandwort.</p> <p><i>Polygonum bistortoides</i>, Twisted Polygonum.</p> <p><i>Carduus scopulorum</i>, Yellow Thistle.</p> <p><i>Dugaldea hoopesi</i>, Yellow Dugald.</p> <p><i>Dodecatheon radicatum</i>, Shooting Star</p> <p><i>Veronica wormskjoldi</i>, Speedwell.</p> <p><i>Heuchera parvifolia</i>, Alum Root.</p> <p><i>Senecio amplexens</i>, Paintbrush.</p> <p><i>Senecio triangularis</i>, Paintbrush.</p> <p><i>Senecio crassulus</i>, Paintbrush.</p> <p><i>Antennaria marginata</i>, Everlasting.</p> <p><i>Carex bella</i>, Sedge.</p> <p><i>Carex variabilis</i>, Sedge.</p> <p><i>Carex alpina</i>, Sedge.</p> <p><i>Juncoides parviflorum</i>, Wood Rush. <i>A.</i></p> <p><i>Agropyron caninum</i>, Wheat Grass. <i>C.</i></p> <p><i>Trisetum subspicatum</i>, Oat Grass.</p> <p><i>Phleum alpinum</i>, Alpine Timothy.</p> |
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ARCTIC-ALPINE ZONE.

Arctic-Alpine, the zone of the mountains corresponding to the Arctic barren grounds or tundra of the far north, caps the highest peaks along the Sangre de Cristo range, on the coldest slopes covering all above 12,000 feet, or on especially steep places all above 11,500 feet; on the warmest slopes covering all above 13,000 feet, or on very gradual slopes all above 12,500 feet. The total area of this zone in New Mexico probably does not amount to 100 square miles, most of which lies on cold slopes.

It is the treeless zone above the last dwarfed spruces, marked by low and often matted vegetation of hardy alpine plants, many of which occur on the Arctic tundra and reach their southernmost limits on these peaks. All are species adapted to a region where a frostless night rarely occurs during the short cold summer and where for 8 or 9 months they are buried under deep snows. On many of the cold slopes snow banks remain all summer, melting entirely only in exceptionally warm or dry years.

The zone owes its practical importance to its storage of moisture, which it lets down slowly during the summer when most needed in the arid valleys below. These cold mountain peaks seem to catch

and hold the storms that gather and roar about them and cross from one to another in sweeping torrents of rain and hail while the valleys below lie dry and scorched. Thus by showers and melting snows the streams are fed and the best of the thirsty land below is watered.

The Arctic-Alpine Zone has in New Mexico no species of mammal not found in the zones below, and it has only three species of breeding birds. It contains, however, a considerable number of characteristic plants.

MAMMALS.

While the Arctic-Alpine Zone has in these mountains no species peculiar to it and no species that seem especially characteristic of it, unless the mountain sheep (*Ovis canadensis*) may be in part so considered, still several species penetrate into it to some extent, especially in summer. The long-tailed meadow mouse (*Microtus mordax*), a pocket gopher (*Thomomys fessor*), and the gray rock cony (*Ochotona saxatilis*) are sometimes taken in the Arctic-Alpine Zone, and may even winter under cover of its deep snow. The woodchuck (*Marmota flaviventer*), Colorado chipmunk (*Eutamias amoenus operarius*), red fox (*Vulpes fulva macroura*), and weasel (*Mustela arizonensis*) run over the peaks and ridges in summer, but apparently do not remain.

BREEDING BIRDS OF ARCTIC-ALPINE ZONE IN NEW MEXICO.

<i>Lagopus leucurus leucurus</i> , White-tailed Ptarmigan.	<i>Leucosticte australis</i> , Brown-capped Rosy Finch.
<i>Anthus rubescens</i> , Pipit, Titlark.	

PLANTS OF ARCTIC-ALPINE ZONE IN NEW MEXICO.

[Species marked *H.* occur also in the Hudsonian Zone.]

<i>Eritrichium argenteum</i> , Alpine Forget-me-not.	<i>Salix chlorophila</i> , Green Willow. <i>H.</i>
<i>Mertensia caelestina</i> , Alpine Lungwort.	<i>Oxyria digyna</i> , Mountain Sorrel.
<i>Claytonia megarrhiza</i> , Arctic Spring Beauty.	<i>Gentiana romanzovi</i> , Dwarf Closed Gentian.
<i>Ranunculus macauleyi</i> , Woolly Buttercup.	<i>Silene acaulis</i> , Stemless Catchfly.
<i>Paronychia pulvinata</i> , Cushioned Whitlow-wort.	<i>Alsinopsis obtusiloba</i> , Sandwort.
<i>Papaver coloradense</i> , Colorado Poppy.	<i>Orthocarpus haydeni</i> , Hayden Orthocarpus.
<i>Saxifraga cernua</i> , Arctic Saxifrage.	<i>Pedicularis parryi</i> , Short-beaked Lousewort.
<i>Leptasea chrysantha</i> , Yellow-flowered Saxifrage.	<i>Polemonium confertum</i> , Jacob's Ladder. <i>H.</i>
<i>Leptasea flagellaris</i> , Filamentose Saxifraga.	<i>Phacelia serisea</i> , Silky Phacelia. <i>H.</i>
<i>Micranthes rhomboidea</i> , Wide-leaved Saxifrage.	<i>Androsace carinata</i> .
<i>Besseya alpina</i> .	<i>Delphinium alpestre</i> , Alpine Larkspur.
<i>Sedum stenopetalum</i> , Stonecrop.	<i>Aragallus parryi</i> , Parry Loco.
<i>Salix petrophila</i> , Rock Willow. <i>H.</i>	<i>Potentilla diversifolia</i> , Cinquefoil.
<i>Salix saximontana</i> , Creeping Willow. <i>H.</i>	<i>Sieversia turbinata</i> (<i>Geum rossi</i>), Mountain Avens.
	<i>Sibbaldia procumbens</i> , Sibbaldia.

PLANTS OF ARCTIC-ALPINE ZONE IN NEW MEXICO—continued.

<i>Polygonum viviparum.</i>	<i>Erigeron leiomeres</i> , Fleabane.
<i>Draba streptocarpa</i> , Whitlow Cress.	<i>Senecio holmi</i> , Holm Paintbrush.
<i>Draba cana</i> , Whitlow Cress.	<i>Tonestus pygmaeus</i> .
<i>Draba neomexicana</i> , Whitlow Cress.	<i>Achillea subalpina</i> , Alpine Yarrow.
<i>Ligusticella eastwoodae</i> , Angelica.	<i>Juncus drummondi</i> , Rush.
<i>Oreoxis bakeri</i> , Cymopterus.	<i>Juncus triglumis</i> , Rush.
<i>Thalictrum alpinum</i> , Alpine Meadow Rue.	<i>Carex alpina</i> , Sedge.
<i>Artemisia scopulorum</i> , Alpine Sagebrush.	<i>Carex ebenea</i> , Sedge.
<i>Solidago ciliosa</i> , Goldenrod.	<i>Carex nova</i> , Sedge.
<i>Solidago decumbens</i> , Goldenrod.	<i>Carex siccata</i> , Sedge.
<i>Erigeron melanocephalus</i> , Fleabane.	<i>Carex saxatilis</i> , Sedge.

THE MOUNTAINS OF NEW MEXICO.

New Mexico is bountifully supplied with mountains, which are as essential to agriculture as valleys. In fact, without the valleys the mountains would still be of great value for timber, grass, and ores, while without the mountains the valleys would be of little value because they would be almost waterless. For half the year the higher mountains are practically uninhabitable on account of cold weather and deep snow, but for the other half, when they are pouring streams of pure water into the lowlands, they are serving also as the summer resort and pleasure ground for the valley dwellers, not only from New Mexico, but from other States. There is therefore an imperative need for the careful guarding of these valuable assets of a developing state: Water, forests, grass, and a great outdoor playground for its people. An intimate knowledge of the more important ranges is the first step toward adequate protection of their natural resources.

SANGRE DE CRISTO MOUNTAINS.

Two branches of the main Rocky Mountain mass of Colorado extend into northern New Mexico, the San Juan Range on the west and the Sangre de Cristo Range¹ on the east of the Rio Grande Valley. The Sangre de Cristo is the highest and most extensive range in the State, with broad plateaus, high mountain valleys, and three groups of peaks (Culebra, Taos, and Truchas) rising above 13,000 feet. From Colorado it extends south between and a little beyond Santa Fe and Las Vegas in a broad and well-defined range. The lowest saddle in this range is Taos Pass, 9,280 feet; the highest point is Wheeler Peak, 13,600 feet. There is usually a central crest of sharp peaks and ridges rising above the broad shoulders of the elevated plateau. In places the range is double, with high interior valleys, and throughout it has a complex series of long, steep, and often rocky exterior ridges reaching down to the outer plains. The upper slopes, lying mainly above 10,000 feet, are deeply cut or broadly rounded

¹ The United States Geographic Board has ruled that the name Sangre de Cristo shall apply to this range north to Poncha Pass, Colorado. The names Culebra, Costilla, Taos, Cimarron, and Pecos Mountains are applied locally to sections of the range and should be used only in a restricted sense.

by comparatively recent glacial action. Numerous cirques or glacial amphitheatres cutting into the base of the higher ridges and peaks give ample evidence of the forces that chiseled the cliffs and gouged the hollows. Numerous and often extensive lateral or terminal moraines stretch across or along the edges of the valleys. An example of the usual type of stream source in these well-watered mountains is the head of Pecos River. A mile below the little lake, at 11,700 feet, from which the river rises, the stream rushes down a morainal dam, apparently 500 or 600 feet high, to flow for some distance through a round-bottomed valley, after which it cuts its way out of the mountains through a sharp-bottomed gulch. Numerous other lakes, some mere shallow ponds of snow water, others deep green basins left behind the moraines or scooped out of the solid rock in glacial paths, form the headwaters of visible or hidden streams. These are mainly near or above 11,000 feet, but lower down the stream courses are almost devoid of natural reservoirs. Springs and creeks are numerous from near timber line down through the Hudsonian and Canadian Zones, but become scarcer toward the base of the mountains as the streams gather into larger and more widely separated channels.

Until the midsummer rains begin the mountain slopes are drenched with melting snow. As late as August 14, 1903, a few large snow banks still occupied the cold slopes of the Truchas Peaks, while one small drift yet remained behind the crest of Pecos Baldy. On August 12, 1904, a little of the old snow still clung to the cold slopes on Taos and Wheeler Peaks, and on August 20 some large banks were found on Culebra Peak. It is doubtful if the winter's snow ever entirely leaves these tall crests of the range, which during most of the short summer are heavily streaked with white.

During July and August showers, often violent, are of frequent occurrence about the peaks. In consequence of this abundant moisture over the upper slopes, vegetation has a vigorous growth, even where reduced to a carpet of Alpine plants. The coniferous forests of the upper slopes where undisturbed by fire are dense and clean. Grass is abundant in the open, and the parks and timber-line meadows are brilliant flower gardens. Even the highest peaks, when not of bare rock, are carpeted with dwarf Arctic and Alpine plants of exquisite beauty and fragrance.

The forests lie in well-marked belts, or zones, around these mountains, as is plainly seen where a broad view of the range can be had from an elevated point on some opposite range, and as is approximately shown in colors on the zone map. The upper timber zone, or Hudsonian, is but a vanishing fringe of forest, where the foxtail pine and stunted spruce and fir struggle for bare existence among the rocks.

The zone of spruce and fir, or Canadian Zone, covers most of the high central part of the mountains from about 9,500 feet to 12,000 feet on southwest slopes and from 8,500 feet to 11,000 feet on northeast slopes. It extends down in broad strips on the outer slopes, even reaching in narrow tongues in canyons as low as 7,500 feet or clear through the Transition Zone. At one place at 7,500 feet where the Pecos flows through a deep narrow gulch, spruces and firs cover the cold slope, while just over the crest of the ridge on the warm slope 10 rods distant there are nut pines, junipers, and live oaks. Such overlapping or interlacing of zones merely shows the extreme effect of local configuration on temperature. Both upper and lower edges of the zone are regular only in a broad sense, as they vary in altitude with slope exposure, steepness of the slopes, and to a less extent with air currents, moisture, and soil cover. When unmarred by fire this forest is usually characterized by dense areas of slender pointed spruces (*Picea pungens* and *engelmanni*) and firs (*Abies concolor* and *arizonica*), but much of the timber has been burnt and replaced by equally dense areas of white-stemmed aspens. Most of the timber is small, but here and there large old spruces stand out alone or tower above their neighbors. In the deep shade of the timbered areas a few characteristic wood plants dot the brown carpet of needles, but there is rarely much undergrowth until fire has swept away or thinned out the timber. Repeated burning has cleared extensive areas which now lie as open meadows or grassy parks.

The zone of yellow pine, or Transition Zone, covers the lower slopes of the mountains from approximately 7,500 to 9,700 feet on southwest slopes and 7,000 to 8,500 feet on northeast slopes. Its upper limit is variable on account of the varying steepness of the slopes, rising even to 10,000 feet on steep rocky southwest slopes, or falling to 7,500 feet in steep northeast gulches.¹ The yellow pine forest, as shown in blue on the zone map, encircles the Sangre de Cristo Mountains, and extends over the big mesa south of the Santa Fe Railroad and along the cold slope down the river below San Miguel, then over other mesa tops to the east as far as Mesa Yegua and north to Sierra Grande and the Raton Mesa. Usually the yellow pines stand in scattering growth or open forest, occasionally in dense groves of young trees. The Douglas spruce also is an important tree in the upper part of this zone, which it invades from the Canadian Zone above, while several of the deciduous oaks are irregularly distributed through it, and the narrow-leaved cottonwood borders most of the streams.

¹ These extremes, due to local details of topography and slope, have, to avoid confusion, been commonly ignored in discussions of life zones; and in certain cases this fact has been used by persons unfamiliar with the effects of slope exposure and local air currents in criticism of well-established laws of distribution.

The zone of juniper and nut pine, or Upper Sonoran Zone, covers the foothills and reaches out over the surrounding plains and valleys. Along the Pecos River Valley it ascends on southwest slopes to about 7,500 feet and along the west base of the range to about the same altitude. On northeast slopes in the Pecos Valley and along the east base of the range it reaches to about 7,000 feet. The upper edge of the zone is marked by the limit of nut pine, juniper, several species of cactuses and yuccas, and many shrubby plants, and the beginning of tall yellow pine timber.

Animal life in these mountains is abundant and in many ways is of unusual interest. Such rare birds as rosy finches, pine and evening grosbeaks, pipits, solitaires, three-toed woodpeckers, and ptarmigan are found during summer high up in the mountains, while Clark's nutcrackers, Rocky Mountain jays, and long-crested jays are regular camp visitors. Water ouzels bob in the streams, thrushes, kinglets, warblers, vireos, tanagers, juncos, and sparrows sing exuberantly during their breeding season, and brilliant humming-birds flash among the flowers. There are also a few band-tailed pigeons and some dusky grouse and wild turkeys.

White-tailed and mule deer are present, although becoming scarce, coyotes and black bears are fairly common, and there are still a few grizzlies or silvertips, gray wolves, and red foxes. The beavers are increasing under recent protection. The big tuft-eared gray squirrels are an interesting feature of the yellow pine belt, while the little spruce squirrels and striped chipmunks give added life and interest to the forest. Big woodchucks whistle from the ledges and boulders and the odd little rock conies squeak and stack their hay under slide rock near timberline. Pocket gophers, mice, and shrews burrow into the mountain slopes or make tiny roads under cover of protecting vegetation.

Most of the streams are well stocked with trout, which often penetrate to the very sources of the little creeks above 10,000 feet. With proper restrictions good fishing and hunting can be permanently maintained and even greatly improved.

The mountains form a natural park and ideal pleasure ground for summer camping and attract more campers each year. Some day they may be more highly valued for this purpose than for sheep range and lumber yield.

From the majority of campers here, as elsewhere, much remains to be desired in camp ethics, especially in guarding the forests from fire and their inhabitants from wanton destruction, in beautifying rather than desecrating camp grounds, in guarding streams from pollution, and so sharing health and happiness with others and passing these advantages on to future generations. The useless destruction of song birds and harmless animals is due mainly to ignorance. To any but a human brute the beauty and songs and interesting ways of

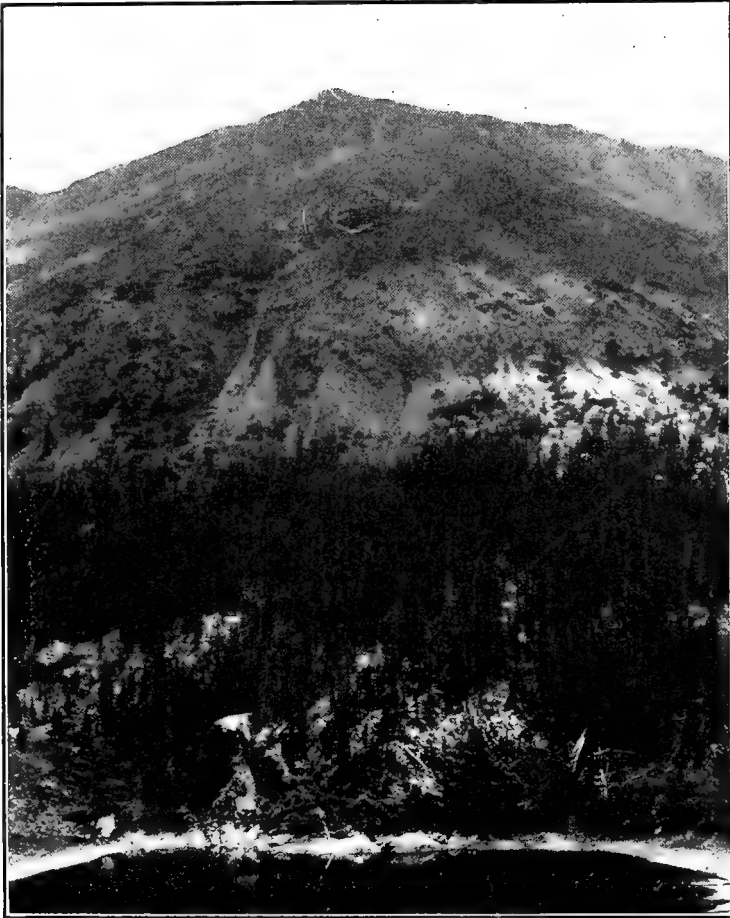


FIG. 1.—WHEELER PEAK, 13,600 FEET, THE HIGHEST POINT IN NEW MEXICO. TAKEN FROM THE WEST BASE AT 11,200 FEET, SHOWING FULL RANGE OF HUDSONIAN AND ARCTIC ALPINE ZONES. TIMBER LINE IS ABOUT 12,000 FEET.

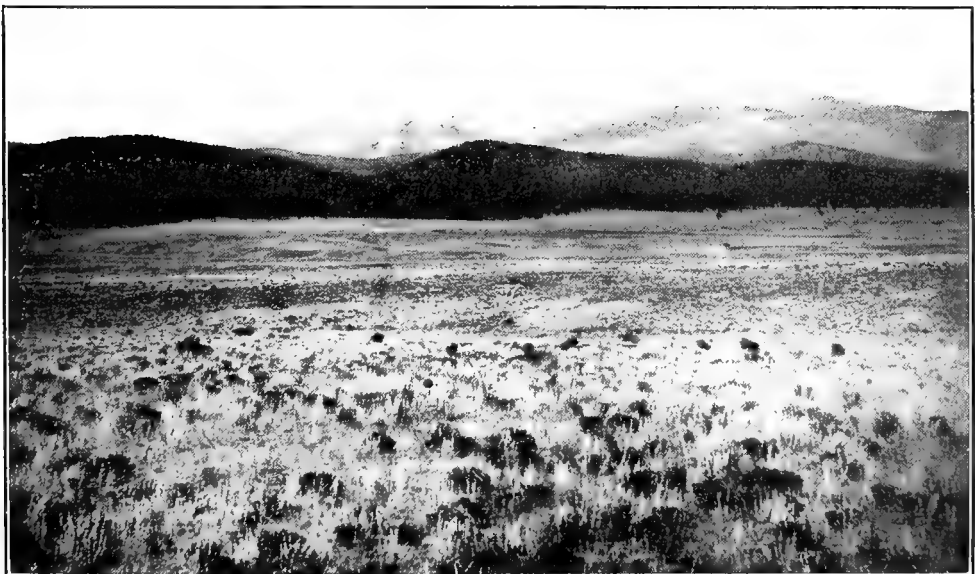


FIG. 2.—SANGRE DE CRISTO MOUNTAINS, TAKEN FROM THE EAST ACROSS MORENO VALLEY AT 8,000 FEET.

The highest peaks are not shown. The timber bordering valley is yellow pine.



FIG. 1.—MEADOW PARK AT 10,000 FEET ON TOP OF THE SAN JUAN MOUNTAINS.
The timber is spruce and fir.

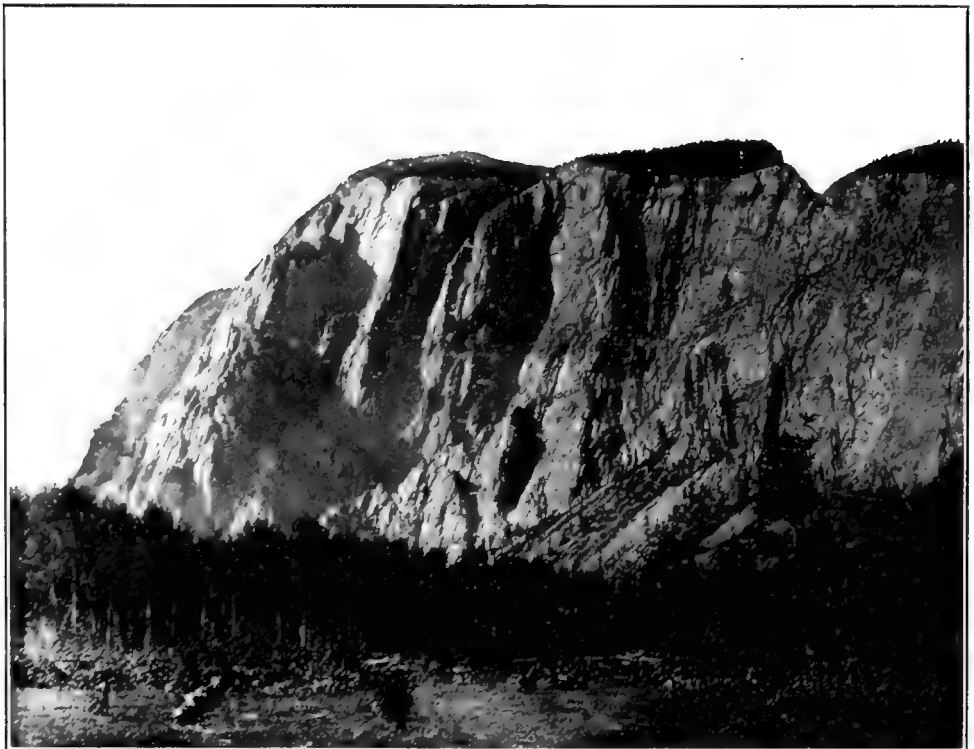


FIG. 2.—EL CHORO, A 3,000-FOOT GRANITE WALL OF BRAZOS CANYON, ON WEST SLOPE
OF SAN JUAN MOUNTAINS.



FIG. 1.—VALLE SANTA ROSA AT 8,500 FEET IN JEMEZ MOUNTAINS.

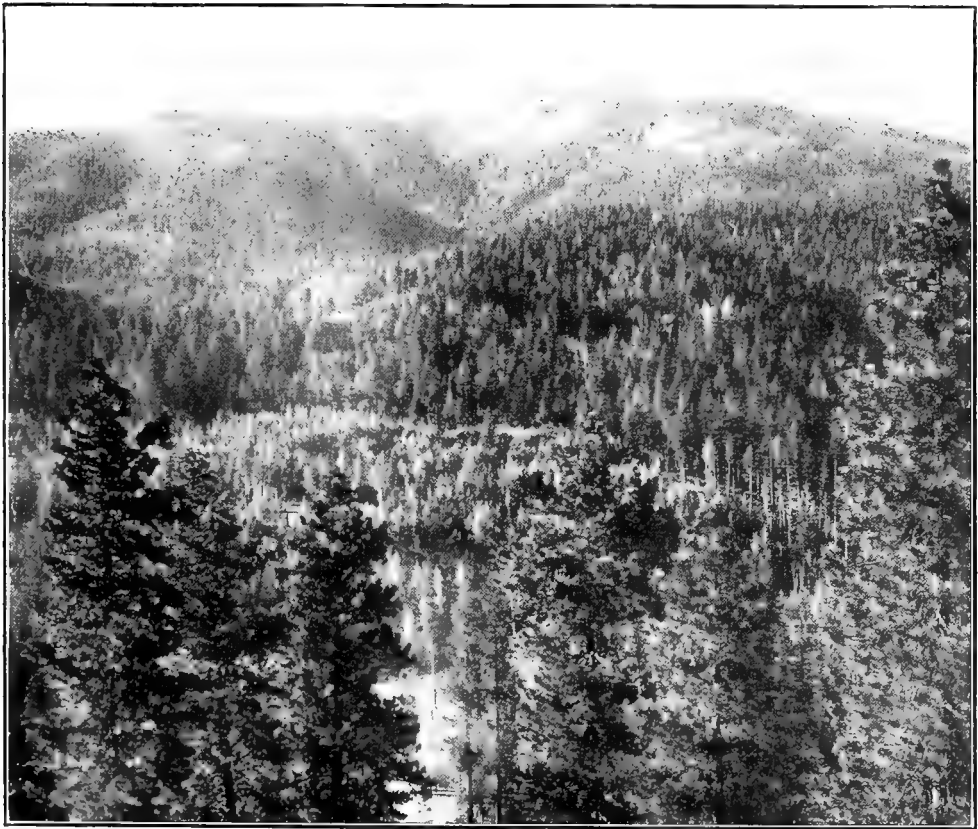


FIG. 2.—NORTH SLOPE OF GOAT MOUNTAIN (10,400 FEET) FROM HEAD OF SANTA CLARA CREEK AT 8,500 FEET.

Yellow pines in foreground; distant timber mainly spruce and fir.



FIG. 1.—RAILWAY STATION OF KETTNER AT EDGE OF YELLOW PINE FOREST IN ZUNI MOUNTAINS.



FIG. 2.—YELLOW PINE FOREST IN ZUNI MOUNTAINS LOOKING NORTH FROM MOUNT SEDGWICK.

Photograph by E. A. Goldman.

our wood neighbors in feather or fur appeal more strongly than do their dead and mangled bodies. From the boy or man who once begins to study them more closely than at rifle or shotgun range they are comparatively safe.

SAN JUAN MOUNTAINS.

West of the Rio Grande Valley the San Juan Mountains extend from Colorado south to the Chama River, which separates them from the Jemez Mountains and interrupts what would be otherwise a continuous range. The San Juans are a wide and not very high range, with a broad expanse of plateau top at about 10,000 feet and few points rising to 11,000 feet. Their broad middle slopes are largely covered with open yellow-pine forests and the upper slopes with dense growth of spruce and fir, alternating with great grassy parks and meadows. On the west slope deep canyons cut into the range, and along at least one of these, the Brazos Canyon, east of Tierra Amarillo, rise sheer granite cliffs, Yosemite-like in size and structure. The lack of timberline peaks gives a tameness to these mountains that is increased by gentle slopes and good roads over the highest parts of the range, but among the advantages are ease of access to many beautiful camp grounds, good springs, abundant grass, cool forests, and sunny slopes, while many rough canyons offer picturesque grounds for exploration.

These mountains differ from the Sangre de Cristo range in animal and plant life, mainly in the absence of Hudsonian and Arctic forms of higher altitudes. Both ranges are characterized by the Rocky Mountain species of southern Colorado, with comparatively few sub-specific variations.

JEMEZ MOUNTAINS.

The Jemez Mountains are of about the same extent and general character as the San Juans, from which they are separated by the deep narrow canyon of the Chama River. They are largely volcanic, with the highest peaks standing as remnants of old crater rims 10,000 to 11,500 feet high. Santa Clara is the highest peak, while several others are only a little lower.¹ Pelado Peak is 11,266 feet high, Abiquiu 11,240, and Goat Peak, just south of the head of Santa Clara Creek, 10,400.

None of these reaches true timberline, although on northeast slopes near their summits the timber is dwarfed and a few Hudsonian Zone plants are found.

On the middle slopes of the mountain, streams and springs are numerous, but the high peaks and ridges are generally without water. Some of the streams disappear or are used for irrigation before they

¹ Santa Clara is the peak just north of the headwaters of Santa Clara Creek and south of Abiquiu Peak. The name seems to have been omitted from recent maps, but it is correctly located and named on the maps of the Wheeler Survey of 1874.

extend far into the valleys, while others carry their surplus water to the Rio Grande. Numerous dry washes show evidence of fierce floods that tear down them during heavy rains. The mountains are generally well covered with soil and vegetation except where cliffs and canyon walls break through and long lines of broken lava extend down from the peaks. A number of large park-like valleys at 8,000 to 9,000 feet afford valuable grazing land, but most of the mountain area is well forested.

Spruces, firs, and aspens fill most of the Canadian Zone, yellow pines and Gambel's oaks mark the Transition Zone, and nut pines, junipers, and live oaks cover the Upper Sonoran foothills.

The plant and animal life is mainly that of the southern Colorado mountains, and rock conies (*Ochotona*) and snowshoe rabbits reach here almost as far south as in the Pecos Mountains. Elk and Mountain sheep have disappeared, but mule deer are still found in fair numbers. There are a few black bears, but grizzlies are now very scarce if any remain. There are a few mountain lions and many bobcats, coyotes, gray foxes, badgers, porcupines, prairie dogs, squirrels, and chipmunks. Wild turkeys are now scarce, but dusky grouse are common high up in the mountains. The jays, magpies, woodpeckers, and song birds are much the same as in the Sangre de Cristo Mountains. There is good trout fishing in many of the streams and delightful camp grounds are easy of access. Still some of the most delightful are accessible only by pack outfit through forests or over rough trails.

Stock raising is the principal industry. In summer great numbers of cattle and sheep range over the upper valleys and slopes and in winter return to the valleys. Few people live in the mountains, as they are mainly too high for agriculture, but the warm Upper Sonoran canyons at their bases have long been occupied by Pueblo Indians living on the grounds of their cliff-dwelling ancestors, or by settlers on the numerous land grants.

The agricultural land of the region is restricted to narrow valley bottoms that can be irrigated. Small ranches along these valleys usually show primitive methods and poor crops, but the soil is very productive and in a few places under better management good crops of wheat, corn, potatoes, chili, beans, and alfalfa are raised and such fruits as apples, pears, peaches, nectarines, and grapes do well.

MOUNT TAYLOR RANGE.

Southwest of the Jemez Mountains lies the Mount Taylor Range or group,¹ in close connection with the Zuni Mountains; then come the

¹ There has been much confusion in regard to the name of this group of mountains, parts of which have been called San Mateo, Sierra Chivato, and Cebolleta Mountains. The name San Mateo is also applied to the range west of San Marcial; the other names apply to local ridges or mesas. As Mount Taylor is the highest point, its name has been used to designate the group.

Datil and Pinon Mountains leading across the high plains to the Mogollons, the last great link in the broken chain between the Rocky Mountains and the Sierra Madre of Mexico.

The Mount Taylor group is a broad volcanic plateau with the great ruin of an old lava crater, Mount Taylor proper, at its southern end, standing 11,389 feet at the highest point of its wide semicircular rim and inclosing a steep little secondary cone about 1,000 feet high. Part of the plateau is lava from this old crater, part from numerous smaller craters scattered over its surface. Series of great sandstone ridges stretch away to the west beyond Fort Wingate, including Hosta Butte, Navajo Church, Mesa Butte, and Sierra de Los Lobos, which almost connect with the Zuni and Chusca Mountains. These ridges, 7,000 and 8,000 feet high, are mainly flat-topped mesas like the Chusca and the western part of the Zuni Mountains. The mountains are not well watered. A beautiful permanent creek winds down inside the old crater of Mount Taylor and cuts its way out through the broken rim on the south. A few other little creeks and scattered springs breaking out around the edges of the mountains are permanent, but the greater number of streams are merely spring torrents from melting snow.

The greater part of both outer and inner slopes of the old crater is densely forested with spruce, fir, and aspen, and much of the lower part is open grass land.

The Canadian Zone area is so restricted and isolated that it seems to lack many of the mammals and birds of the more extensive areas to the north and south, although more species will doubtless be found when it is thoroughly worked. Mule deer, black bears, porcupines, a meadow mouse which may be *M. mordax*, and a little shrew seen but not collected, were found in this zone. Long-crested jays, red crossbills, evening grosbeaks, western goshawks, white-crowned and Lincoln's sparrows, and juncos were common here in September, and crossbills, thrushes, and pileolated warblers were found by Hollister in August, but these were not necessarily all on their breeding grounds. Wild turkeys breed here, but I could find no trace of blue grouse.

The mesa tops and lava plateau and most of the outer slopes of Mount Taylor itself are covered with a scattered forest of yellow pine and patches of Gambel's oak. The Transition Zone area is more extensive and less isolated than the Canadian and is characterized by many of the Rocky Mountain species of mammals and birds. The tuft-eared gray squirrels, chipmunks, Colorado wood rats (*Neotoma mexicana fallax*), pocket gophers, Rocky Mountain cottontails, raccoons, and such birds as band-tailed pigeons, pygmy and Rocky Mountain nuthatches, Audubon's and Grace's warblers, hairy and ant-eating woodpeckers, western robins, and chestnut-backed bluebirds are common.

The Upper Sonoran foothills of these mountains are generally covered with junipers, nut pines, and live oaks, and inhabited by rock squirrels (*Citellus variegatus grammurus*), rock chipmunks (*Eutamias dorsalis*), white-throated wood rats (*Neotoma albigula*), pocket mice, kangaroo rats, Texas jack rabbits, Woodhouse's jays, bush tits, and the usual set of species of this part of the zone, which spreads over the valleys without restriction.

Agriculture in the more fertile Upper Sonoran gulches around the edges of these mountains is mainly of a primitive type and carried on by Indians and Mexicans.

CHUSCA MOUNTAINS.

The Chusca Mountains¹ are a long low range, in reality a long mesa or plateau, extending from a little north of Gallup northward across the New Mexico and Arizona line and almost connecting with the Carrizo Mountains, a higher, rougher group lying mainly in Arizona. Most of this mesa is of sandstone, 8,000 to 9,000 feet high, with abrupt rimrock margins, but toward the north there are ridges of rough lava rock and basaltic cliffs. The top is an undulating forested country with great numbers of shallow lakes, usually without outlets. Below the rim are numerous springs and short creeks that rise in the canyons and flow for a short distance down the steep slopes or in a few cases out into the neighboring valleys. There is abundance of water for stock, but very little for irrigation.

The cold upper slopes, especially of the rims and canyons, are covered with aspens and a few firs and spruces (*Abies arizonica*, *Picea pungens*, and *Pseudotsuga taxifolia*). Rocky Mountain maple, Canadian buffalo berry (*Lepargyrea canadensis*), and shrubby juniper (*Juniperus communis*), are common, but nowhere is an extensive area of Canadian Zone. The spruce squirrel (*Sciurus fremonti mogollonensis*), Colorado chipmunk (*Eutamias amoenus operarius*), mountain meadow mouse (*Microtus mordax*), pocket gopher (*Thomomys fessor*), and little shrew (*Sorex vagrans monticola*) are common Canadian Zone species. The birds, as noted in October, include a few that probably breed there in the Canadian Zone—the long-crested jay, Clark's nutcracker, junco, and white-crowned sparrow—but most of the species observed then were migrants.

The main part of the top and upper slopes of this plateau range lies in the Transition Zone and is covered with a beautiful clean open forest of yellow pines with generally a carpet of grass or low shrubs beneath. Gambel's oak covers many of the steep slopes and the Douglas spruce grows in some of the gulches. Bearberry (*Arctosta-*

¹ The name Chusca, or Choiskai, is generally applied to the southern half, and Tunicha, or Tunitcha, to the northern half of this perfectly continuous and nearly uniform range. There is certainly not room for two names, and I have used the one that seems better known and in its shorter form, which is in common use among local residents.

phyllos uva-ursi) and wild tea (*Ceanothus fendleri*) often carpet the ground. A little cactus (*Mamillaria vivipara*) and a depauperate narrow-leafed yucca (*Yucca baileyi*) grow on open arid slopes in this zone. Some of its most characteristic mammals are the tuft-eared Abert squirrel, prairie dog, Colorado woodrat (*Neotoma fallax*), Apache pocket gopher, and Rocky Mountain cottontail. A few of the resident birds found in the Transition Zone in October and that undoubtedly breed there are the wild turkey, ant-eating woodpecker, and the pygmy and Rocky Mountain nuthatches.

The Navajo Indians live in large numbers in the open canyons or wide gulches around the base and lower slopes of these mountains. Here on moist, mellow flats their garden patches yield a good supply of corn and wheat, beans and squashes for winter provisions; their herds of sheep, goats, cattle, and horses range out on the plains or up the mountain sides; scattered nut pines, junipers, and live oaks furnish not only fuel and shelter but even food; and the yellow pines come down low enough to be available for house logs and timbers. It is a region of primitive comforts but with no possibility of a great future in agriculture.

In summer many of the Indians with their herds migrate to the cool broad top of the range, where there is good grazing and abundance of water. Numerous "hogans," summer huts of rude pattern, are scattered over the top, but there are no evidences of attempted agriculture except the sheep corrals and occasional little horse pastures. During my trip over the Chuscas in October, 1908, the mountains were practically deserted except for stray bands of cattle and ponies, and wisely so on account of cold nights, driving wind, and rain and snow.

The Navajo Indians in their religious reverence for feathered spirits have made their great reservation to some extent a bird preserve. Ducks are unmolested in the lakes and doubtless breed there in considerable numbers. Wild turkeys have held their own unusually well, but have suffered somewhat from hunting by outsiders and Christianized Indians. Some mammals, considered sacred, especially the black bear and coyote, have also thrived, while the mule deer and antelope have been exterminated over a wide area. Prairie dogs are now popular game animals and the Indians, who shoot and dig them out for food, have almost depopulated some of the dog towns.

ZUNI MOUNTAINS.

At their highest eastern end, where Mount Sedgwick rises to an altitude of about 9,300 feet, the Zuni Mountains are rough and volcanic, but to the west they are great flat-topped ridges 8,000 to 9,000 feet high, largely of sandstone with abrupt rimrock edges. Extensive lava fields with numerous small craters stretch off to the south and east, while isolated buttes and ridges are scattered beyond.

The mountains are well timbered but poorly watered. The few small streams that flow down the mountain valleys reach the plains only during high water. The timber is mainly yellow pine in open forest, now largely cut over but originally of great extent and value. There are some Douglas spruces and Gambel oaks; aspens and spruces cover the higher cold slopes and we found there in June a number of Canadian Zone birds, such as the western goshawk, long-crested jay, Clark's nutcracker, junco, Williamson's and red-naped sapsuckers, broad-tailed hummingbird, western flycatcher, pine siskin, ruby-crowned kinglet, Audubon's warbler, brown creeper, and Audubon's hermit thrush.

Although considerable collecting has been done in these mountains, the only purely Canadian Zone mammal yet found is the silver-haired bat (*Lasionycteris noctivagans*), taken in June at 8,600 feet, but probably there are others.

Transition Zone birds and mammals are common and include both northern and southern forms. The painted redstart and Mearns's quail reach their northern limits here, though they are of rare occurrence. Wild turkeys are becoming scarce. The hairy woodpecker, western wood pewee, spurred and green-tailed towhees, black-headed grosbeak, western tanager, Grace's warbler, pygmy and Rocky Mountain nuthatches, western robin, and chestnut-backed bluebird are found in the breeding season. The little Sonora white-tailed deer reaches its northern limit in the Zuni Mountains, according to reports of hunters, but it is very scarce there now. The Abert squirrel, Rocky Mountain chipmunk (*Eutamias quadrivittatus*), Colorado wood rat (*Neotoma fallax*), Mogollon field mouse (*Microtus mogollonensis*), fulvous pocket gopher (*Thomomys fulvus*), Arizona porcupine (*Erethizon epixanthum couesi*), and Rocky Mountain cottontail (*Sylvilagus nuttalli pinetis*) are characteristic of the Transition Zone.

A few ranches are situated in the Transition Zone valleys, where good crops of potatoes and oats are raised on the rich mountain soil, but most of the agriculture of the region is carried on in the Upper Sonoran valleys around the base of the mountains.

MOGOLLON MOUNTAINS.

The necessity for a group name for the mountains of western Socorro County, New Mexico, is apparent to all who know or speak of them. While the maps give names to the many local ranges comprising this group, people constantly speak of these ranges collectively by the name of the highest central peaks, the "Mogollons." In the broadest sense this term is made to include the Mogollon, Burro, Black, Mimbres, Diablo, Little, Elk, Tularosa, Tucson, Datil, Pinyon, Oak Spring, and San Francisco Ranges, which form one extensive and irregular mountain mass, a continuation of the chain which

includes the White Mountains of Arizona. The name has now become restricted to that part of this chain lying in middle western New Mexico. To the northwestward they are loosely connected through the White and San Francisco Mountains of Arizona with the ranges extending through central Utah, and still more loosely through the Zuni Mountains with the Rocky Mountains of northern New Mexico and Colorado. But in both these cases the connection is much closer than with the Sierra Madre of Mexico to the south, where a broad belt of low plains intervenes.

The greater part of the Mogollon Mountain mass is a rough plateau 7,000 to 8,000 feet high, deeply cut with many canyons and here and there ridged with 9,000- and 10,000-foot ranges. At least three of the central peaks of the Mogollons reach an altitude of about 11,000 feet, but not high enough for any true timberline or for many Hudsonian Zone species. Still they are high enough to be of great importance, for on the border of a region of low hot deserts they receive a heavy fall of rain and snow. They feed most of the sources of the Gila River, several forks of which rise close under the highest peaks, and they have been called the Gila Mountains. They are covered by the Datil National Forest on the north and the Gila National Forest on the south, formerly mainly included under the name Gila National Forest.

The mountains are largely volcanic, and many of the high ridges and plateau tops are of very old, deeply cut, and eroded lava rock. There are many other formations, however, including numerous ore-bearing strata. Many of the cliffs and canyon walls along the branches of the Gila and San Francisco Rivers are sandstone, much eroded and full of cracks and caves.

The Canadian Zone covers most of the higher peaks and ridges above 8,500 feet on cold slopes and 9,500 feet on warm slopes. Except for the burned-over areas it is a zone of dense forest of spruce, firs, and aspens; with a few dwarf maples and many undershrubs, such as *Juniperus communis*, *Sorbus scopulina*, *Pachystima myrsinites*, *Vaccinium oreophilum*, *Ribes wolfi*, *Grossularia pinetorum*, *Rubacer parviflorus*, *Distegia involucrata*, and other purely Rocky Mountain species.

The following birds found in these mountains in early spring and late summer probably breed in the Canadian Zone, although little work has been done there during the actual breeding season: dusky grouse, alpine three-toed woodpecker, broad-tailed hummingbird, western wood pewee, long-crested jay, Clark's nutcracker, pine siskin, Cassin's purple finch, white-crowned sparrow, junco, Audubon's warbler, ruby-crowned kinglet, dipper or water ouzel, and Audubon's hermit thrush.

The Canadian Zone mammals are Merriam elk (now extinct), Arizona spruce squirrel, Rocky Mountain meadow mouse, red-backed mouse, and mountain shrew.

The area covered by this zone is generally steep and difficult of access, of little value for timber, and of less use for stock or agriculture. Its worth as a source of water supply for rich valleys below can hardly be realized. As a permanent breeding ground for game birds and mammals, as a source of beautiful and teeming trout streams, and as an ideal camping resort to which people flock from the hot valleys below, its importance is steadily increasing.

The Transition Zone spreads in wide areas over the plateau tops and the middle slopes of the ranges from approximately 6,500 to 8,500 feet on cold slopes and 8,000 to 9,500 feet on warm slopes. It is characterized by beautiful open forests of yellow pines, with scattered Douglas spruce and a sprinkling of Mexican white pine. In places there are scrubby oaks of the *gambeli* group, the white-leaved oak, and New Mexico locust, and along the streams are generally fringes of narrow-leaved cottonwood, alders, willows, and cornel. Among the low and scattered undershrubs are *Ceanothus fendleri*, *Berberis repens*, *Arctostaphylos uva-ursi*, *Symphoricarpos oreophilus*, *Sericotheca dumosa*, and the nonshrubby vegetation includes *Wyethia arizonica*, *Frasera speciosa*, *Gilia pulchella*, and *Pentstemon torreyi*.

A few of the Transition Zone birds are Merriam's turkey, band-tailed pigeon, Lewis's woodpecker, Cabanis's woodpecker, ant-eating woodpecker, Stephens's whippoorwill, western wood pewee, evening and black-headed grosbeaks, western vesper sparrow, spurred towhee, western tanager, western martin, red-faced warbler, painted redstart, and pygmy and Rocky Mountain nuthatches.

The mammals of this zone are the handsome Abert squirrel, gray-collared chipmunk, Arizona ground squirrel, San Francisco Mountain wood rat, rusty white-footed mouse, Mogollon meadow mouse, Arizona porcupine, fulvous pocket gopher, Rocky Mountain cottontail, and brown bat.

This open clean-trunked forest is not only of great and permanent value as a source of lumber supply to a vast treeless region, but it affords much of the finest grazing land in the State. There is far more humidity than in the valleys, and if the range is not overstocked the grazing need not interfere with forest growth and reproduction.

Some agriculture on very restricted areas would be possible in this zone, but its value would be little in comparison with that of the present forest, water, and grazing. Over a great part of the area the surface presents the formation commonly termed "malpais," which consists of extensive lava beds partly covered with thin layers of soil and with angular fragments of lava strewing the ground so thickly as to make traveling difficult, and in most places to render cultivation impossible.

The Upper Sonoran valleys of the Mogollon Mountain region are the part of greatest agricultural importance, but these have been treated under the subdivisions of that zone, mainly under the Gila Valley.

MAGDALENA AND SAN MATEO MOUNTAINS.

The Magdalena and San Mateo Mountains are so closely connected with the Mogollon Mountains and resemble them so much in general features and fauna and flora that they might well be included in the group if narrow Upper Sonoran valleys did not intervene. The following description is from reports by E. A. Goldman, who has worked in both ranges.

They extend along the west side of the Rio Grande Valley in Socorro County as steep, rugged desert ranges, reaching approximately 10,000 feet in altitude. They are very rocky, with numerous side canyons and sharp ridges and steep slide rock slopes. They retain but little of the water that falls on them, and while showing deep erosion they have few streams and only occasional springs. The little available water along their basal slopes is, however, of great value, as the surrounding country is devoted mainly to stock raising. They are scantily forested with the usual Rocky Mountain trees.

Three life zones are represented: Canadian, Transition, and Upper Sonoran. The Canadian Zone covers a narrow crest along each range and extends down to 9,500 feet altitude on hot slopes and to 8,500 feet on cold slopes. It is characterized by such trees as the aspen, white fir, Douglas spruce, and Rocky Mountain maple; by the long-crested jays, Clark's nutcracker, junco, and Townsend's solitaire; and by the Rocky Mountain meadow mouse, a red-backed mouse, and a little shrew.

Transition Zone covers the lower slopes of the mountains from about 7,000 to 8,500 feet on cold slopes and from 8,000 to 9,500 feet on hot slopes. It is characterized by scattered yellow pines, narrow-leaved cottonwoods, oaks of the *Quercus gambeli* group, *Ceanothus fendleri*, *Sericotheca*, *Prunus*, gooseberries, and currants. Its birds and mammals are practically the same as those of the Transition Zone of the Mogollon Mountains.

The Upper Sonoran foothills and basal slopes are characterized by the usual juniper, nut pine, live oak, bear grass, yucca, and cactus. There are numerous dry washes and a few springs and streams. Agriculture is limited mainly by lack of water to a few garden patches and a little fruit raised for home use in the canyons and gulches. There is usually good grazing over the foothills and basal plains, and stock raising is an important industry.

SAN LUIS AND ANIMAS MOUNTAINS.

The San Luis and Animas Mountains form in the southwestern corner of New Mexico the northern terminus of the Sierra Madre of Mexico. The higher part of the San Luis range lies south of the boundary line, but the Animas range north of San Luis Pass is practically a continuation of it, and attains an altitude of 8,600 feet near its northern end. The Big Hatchet Mountains (8,300 feet) and Peloncillo Mountains (about 6,500 feet) are outlying ranges less closely connected with the main Sierra Madre but largely occupied by the same set of species. Hemmed in on the north, east, and west by hot Lower Sonoran valleys, these steep, rough, arid little ranges are widely separated from the Mogollons and Rocky Mountains on the north. As the Animas peaks are the highest and most northern part of this ragged terminus of a great range, their plant and animal life is of particular interest.

Their altitude is sufficient to give them a trace of Canadian Zone, represented in cold gulches near the summits by patches and streaks of aspens, a few long-crested jays and red-backed juncos, western flycatchers, and hoary bats.¹ But little collecting has been done in these high gulches, and more work will probably increase the list of Canadian species.

The Transition Zone area in the Animas Mountains is more extensive than the Canadian and better known, reaching on northeast slopes from 7,000 feet to the top (8,600), and on southwest slopes from 8,000 feet to the top, and to the south almost connecting with that of the San Luis Mountains. It contains a number of small streams and although mainly on steep, rather dry slopes it is far from barren. Besides the scattered forest of large trees it is partly occupied by a tangle of undergrowth. The timber, which is most abundant on the colder and moister slopes, is composed of Douglas spruce, yellow, white, Arizona, and Chihuahua pines, several oaks, including *Quercus hypoleuca*, *reticulata*, *wilcoxi*, and *gambeli*, Arizona madrone, and willow-leaved cherry. Part of the oaks are shrubby, and with them are also buckthorn (*Rhamnus smithi*), *Sericotheca dumosa*, *Rubus neomexicanus*, *Ceanothus fendleri*, brake (*Pteridium aquilinum pubescens*), wild potato (*Solanum tuberosum*), and many other characteristic Transition Zone plants.

Few of the mammals are restricted to the Transition Zone in so limited an area, but the wood rat (*Neotoma mexicana*), fulvous pocket gopher (*Thomomys fulvus*), cottontail (*Sylvilagus f. holzneri*), black and grizzly bears, and mountain lion are common residents.

Transition Zone birds are represented by Merriam's turkey, the band-tailed pigeon, Cabanis's woodpecker, Stephens's whippoorwill,

¹ Two hoary bats shot in the Animas Valley on Aug. 10 probably came down out of the mountains for water, although they may have been migrating.

broad-tailed and Rivoli's hummingbirds, spurred towhee, black-headed grosbeak, western tanager, Stephens's vireo, Virginia, black-throated gray, and red-faced warblers, painted redstart, pygmy and Rocky Mountain nuthatches, Mexican chickadee, and western robin. These were found between July 26 and August 9, and all may have been bred in these mountains.

The Upper Sonoran Zone covers the base of these mountains and reaches up on the warm slopes to the tops of all but a few of the highest peaks. On open foothill slopes it is marked by scattered live oaks (*Quercus arizonica* and *emoryi*), junipers (*Juniperus monosperma* and *pachyphloea*), a tree yucca (*Yucca schottii*), two species of century plant (*Agave palmeri* and *schottii*), bear grass (*Nolina lindheimeriana*), sotol (*Dasylirion wheeleri*), and an arborescent cactus (probably *Opuntia versicolor*), and along dry washes by gum elastic (*Bumelia rigida*), sycamore (*Platanus wrightii*), and black walnut (*Juglans major*), while above on the steeper slopes its vegetation thickens up to a dense chaparral with the addition of several shrubby oaks, manzanita (*Arctostaphylos pungens*), mountain mahogany (*Cercocarpus paucidentatus*), silk tassel (*Garrya wrightii*), skunk bush, (*Schmaltzia trilobata*), and *Fendlera rupicola*. A few of the five-leaved Mexican nut pines (*Pinus cembroides*), scattered through this chaparral, yield good nuts which with the acorns, walnuts, juniper berries, and many other seeds and fruits provide abundant food for birds and beasts. Animal life is abundant and well protected by the dense vegetation.

The common Upper Sonoran mammals of the mountains and foothills are the little Sonora white-tailed deer (*Odocoileus couesi*), rock squirrel (*Citellus variegatus grammurus*), rock chipmunk (*Eutamias dorsalis*), white-throated wood rat (*Neotoma albigula*) Rowley white-footed mouse (*Peromyscus boylei rowleyi*), gray fox (*Urocyon cinereoargenteus scotti*), civet cat (*Bassariscus astutus flavus*), and spotted skunk (*Spilogale ambigua*).

The mountain birds of this zone are Mearns's quail, the Arizona and ant-eating woodpeckers, poor-will, black-chinned hummingbird, Arizona jay, canyon towhee, hepatic tanager, Baird's wren, and bridled titmouse.

While the San Luis and Animas Mountains are of relatively slight importance for lumber, grazing, or agriculture, they still catch moisture and render the surrounding valleys habitable and valuable. There are no rivers of any importance for irrigation, but the streams that sink at the base or half way up the sides of the mountains break out lower down in springs, or carry a supply of good water below the surface to the bottoms of broad valleys. Thus stock raising becomes the most important industry, and where open water can not be found within reach of good grazing areas, wells or tanks are used. Eventually parts of these warm rich-soiled valleys will be reclaimed by

pumping from wells or reservoirs supplied by water from the mountain slopes.

Incidentally the mountains are of some value as natural game preserves, but in such small areas the game will soon be exterminated unless protected. At present the country is so thinly settled that protection for game depends mainly on the interest of the ranch owners and the more intelligent settlers. In most cases, however, local interests are powerless against outside hunting parties and irresponsible campers.

BIG HATCHET MOUNTAINS.

The following description is by E. A. Goldman, who was in the range in July, 1908:

The Big Hatchet Mountains in the southeastern part of Grant County form a steep, rugged, desert range with a trend from northwest

to southeast. They are steep and rough on all sides, but are tilted upward very abruptly toward the west. The highest peak, near the northern end of the range, is over 8,000 feet high. Toward the southern end the range divides and nearly surrounds a small, open valley, while farther south rises another rugged but lower desert range or group called the Alamo Hueco or Dog Mountains. On the northeast of the Big Hatchet Mountains the low range called Doyle Hills crosses the international boundary into Chihuahua, and farther to the eastward in Chihuahua is the Sierra

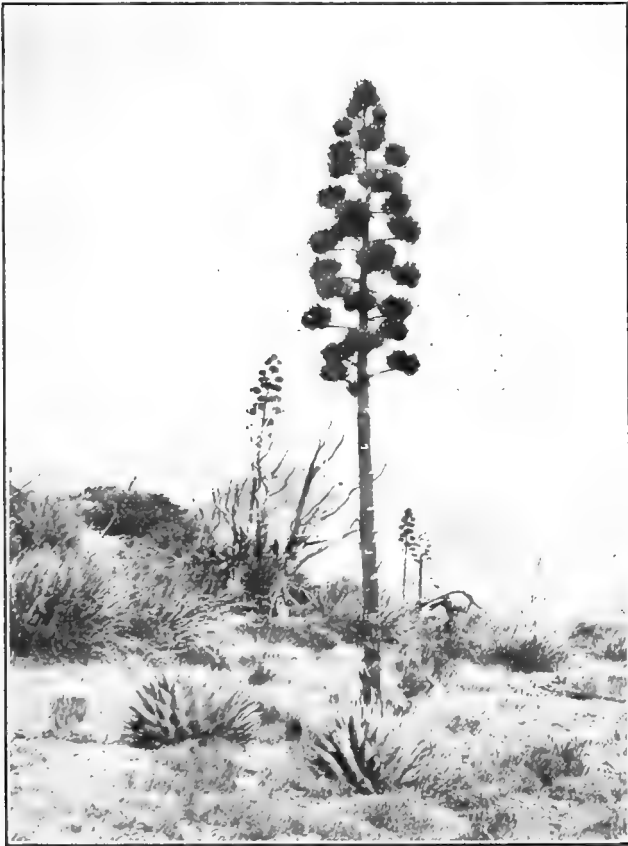


FIG. 4. — Parry century plant in full flower at 8,100 feet on top of the Big Hatchet Mountains. Photograph by E. A. Goldman.

Boca Grande, similar in height, trend, and general character to the Big Hatchet Mountains. All the mountains of the general region are very arid, and no permanent water or even temporary "tanks" were found in the Big Hatchet Mountains. The broad, gently sloping

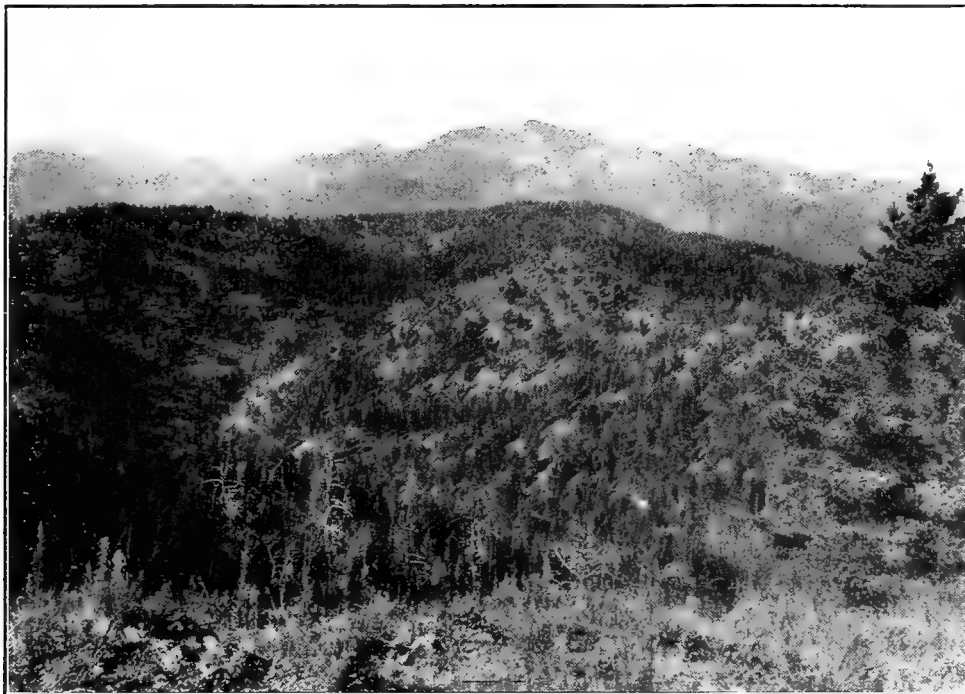


FIG. 1.—MIMBRES MOUNTAINS FROM TOP OF SAWYERS PEAK (10,000 FEET), LOOKING NORTH.



FIG. 2.—MIMBRES MOUNTAINS FROM TOP OF SAWYERS PEAK, LOOKING SOUTH.



FIG. 1.—UPPER TIMBERED SLOPE OF MAGDALENA MOUNTAINS.
Photograph by E. A. Goldman.

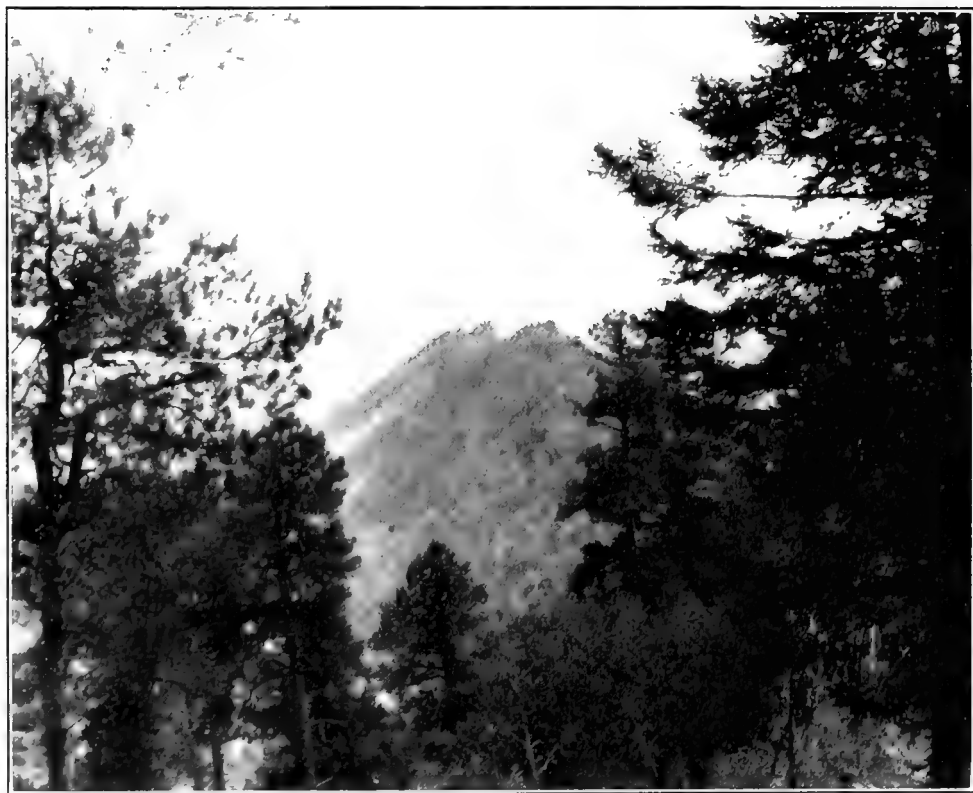


FIG. 2.—UPPER TIMBERED SLOPES OF SAN MATEO MOUNTAINS.
Photograph by E. A. Goldman.



FIG. 1.—ANIMAS PEAK (8,600 FEET) FROM NORTHWEST BASE.
Live oaks, cactuses, yuccas, and bear grass in foreground.

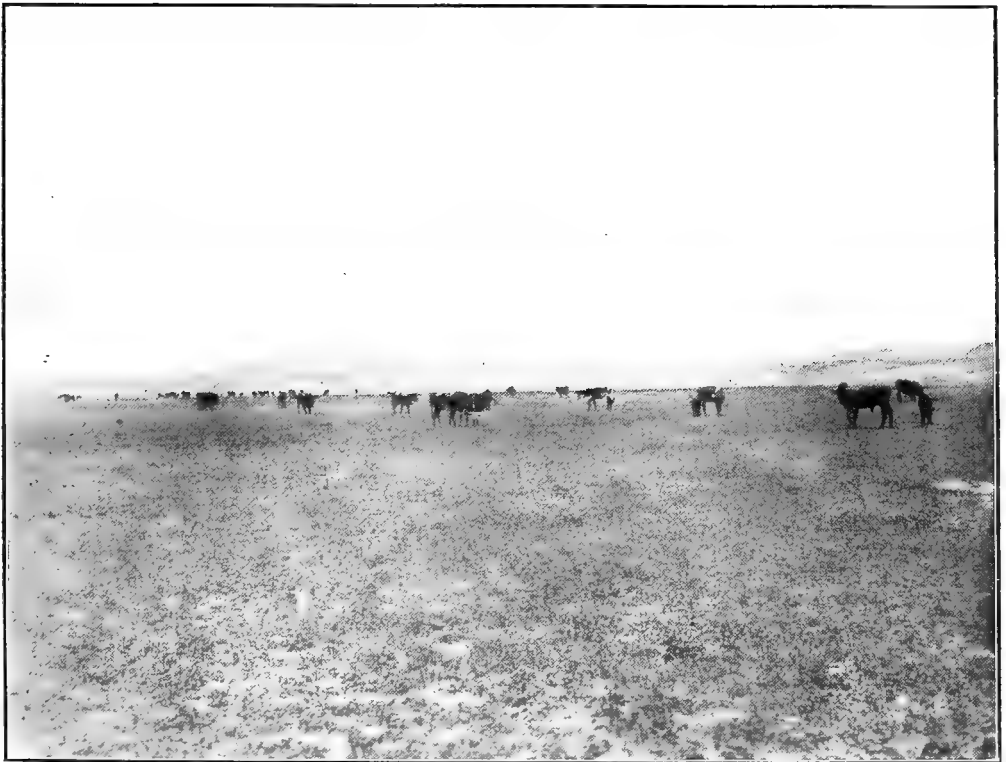


FIG. 2.—UPPER SONORAN BORDER OF THE ANIMAS VALLEY.
An excellent stock range.



FIG. 1.—FIELD OF OATS AMONG THE YELLOW PINES ON THE EAST SLOPE OF THE SACRAMENTO MOUNTAINS AT 7,800 FEET.



FIG. 2.—FOREST AT 9,000 FEET IN THE SACRAMENTO MOUNTAINS.

Blue spruce and white fir on the cold slopes, yellow pine on warm slopes, and parks full of flowers between.

Hachita Valley extends along the eastern side of the mountains, at about 4,200 feet altitude, with drainage toward Lake Guzman, Chihuahua, while the Great Playas Valley lies west of the mountains.

The Big Hatchet Mountains lie mainly within the Upper Sonoran Zone, which gives way to the Lower Sonoran along the east slope of the foothills at about 4,700 feet altitude. The north slope above about 7,000 feet should be Transition Zone in climate, although the mountains are very barren and no characteristic species of the zone were recorded. The common Upper Sonoran vegetation consists of Mexican nut pine, checker-barked and silky junipers, several oaks, fringe ash (*Fraxinus cuspidata*), shrubby trefoil (*Ptelea*), two species of silk-tassel bush (*Garrya wrighti* and *goldmani*), *Fendlera rupicola*, *Ceanothus greggi*, southern mountain mahogany (*Cercocarpus paucidentatus*), *Sericotheca*, *Fallugia*, cat's claw (*Mimosa biuncifera*), *Cassia wislizeni*, *Nolina*, and on top the beautiful Parry century plant.

MANZANO AND SANDIA MOUNTAINS.

The Manzano and Sandia Mountains form the eastern border of the Rio Grande Valley opposite Albuquerque and Belen. The northern part of the range is known as the Sandias and the southern part as the Manzanos, the two ranges being separated by a high pass or open saddle. The Manzanos are joined loosely toward the south to the lower San Andres Mountains by way of the Cerro Montoso, Chupadero Mesa, and Sierra Oscuro, but the main part of the range includes only the Manzano and Sandia Mountains, which reach altitudes of about 10,000 and 11,000 feet, respectively, and carry narrow crests of the Canadian Zone and a wider and continuous area of the Transition Zone. On the west these ranges drop abruptly to the low Rio Grande Valley, while eastward they slope off gradually to the high open plains. The upper zones are narrow on the steep, barren west slope and much wider on the gradual and better-forested eastern side. Though in the midst of an arid country, these mountains are high enough to induce considerable precipitation, which results in a good cover of vegetation and extensive forests. There are numerous springs and a good supply of underground water far down the slopes, but streams are few and mainly ephemeral.

The Canadian Zone covers the tops of these mountains and the cold slopes down to about 8,000 feet. It is well marked by a rather meager forest of white fir, blue spruce, Douglas spruce, *Pinus flexilis*, aspen, and Rocky Mountain maple, with mountain ash, alders, and willows in cold gulches and along streams. It has a few characteristic mammals, the spruce squirrel, pocket gopher, dusky shrew, and probably others not yet recorded. The breeding birds are little known, as most of the field work done in the range has been late in the season. On July 30 I found half-grown wild turkeys near the top of

the Manzano range, but they may have wandered up from below after the nesting season. I also found olive-sided flycatchers, juncos, and thrushes that were probably on their breeding grounds.

The Transition Zone covers the greater part of the mountains from approximately 7,000 to 8,000 feet on cold slopes and 8,000 to 9,000 feet on warm slopes. On the east side of the range it spreads out over a wide area of gently sloping ridges and mellow-soiled valleys, well clothed with open yellow pine forest, scattered oaks of the *Quercus gambeli* group, New Mexico locust, and low undergrowth of *Ceanothus fendleri*, *Berberis repens*, *Sericotheca*, *Opulaster*, and many other Rocky Mountain plants. Some of the common birds in July were flickers, ant-eating and hairy woodpeckers, western wood pewee, black-headed grosbeak, spurred towhee, western chipping sparrow, and pygmy and Rocky Mountain nuthatches, while a flock of young turkeys seen up in the Canadian Zone were probably hatched in the Transition. Of the mammals collected in this zone the chipmunk, Guadalupe meadow mouse, Manzano cottontail, and brown bat are among the most characteristic. There are still some mule deer and black bears in the mountains. There is good grazing throughout the zone, which seems of greater value for timber, stock, game, and summer camping grounds than for its very limited possibilities of agriculture.

The Upper Sonoran Zone of the foothills and surrounding valleys is the main zone of agriculture and stock raising. The foothill division of this zone is of particular interest along the eastern slope of the mountains, where it carries picturesque little forests of nut pine, juniper, and scrub oaks, with tree cactus, prickly pear, yuccas, red barberry, skunk brush (*Schmaltzia trilobata*), and other shrubs scattered between. Many little farms and stock ranches are located along this slope in sheltered corners where some irrigation is obtained from flood water and where dry farming yields occasional crops. The old apple trees at Manzano, from which the mountains are named, are said to be over 100 years old. They are very large but yield poor ungrafted fruit. Much if not most of this juniper belt would seem admirably adapted to apples if sufficient moisture for the growth of trees and fruit could by proper cultivation be conserved in the soil. The natural growth of grama and other grasses is good and forms fine grazing, while the gulches and timber afford good shelter for stock.

SACRAMENTO MOUNTAINS.

The name Sacramento Mountains is applied by the United States Geographic Board to the range lying west of Pecos Valley, New Mexico, and includes the groups locally known as the Jicarilla, Sierra Blanca, Sacramento, and Guadalupe Mountains. These form a practically continuous chain of ranges about 140 miles in length and 30

miles in greatest width. They lie between the Pecos and Alamogordo valleys and extend a little below the Texas line. On the west and north they are distantly linked by high mesas with the Manzano Range and these again by other high mesas with the Sangre de Cristo Mountains, which are part of the Rocky Mountains proper.

Sierra Blanca, the highest peak in the range, rises 11,880 feet. The Capitans are over 10,000 feet, the Sacramentos, near Cloudercroft, 9,500 feet, and the Guadalupe, near the Texas line, 9,000 feet. The lowest pass is over the Guadalupe arm, which comes down to about 7,000 feet. On the west and at the north and south ends the mountains are abrupt and rugged, while on the east in the broad central part

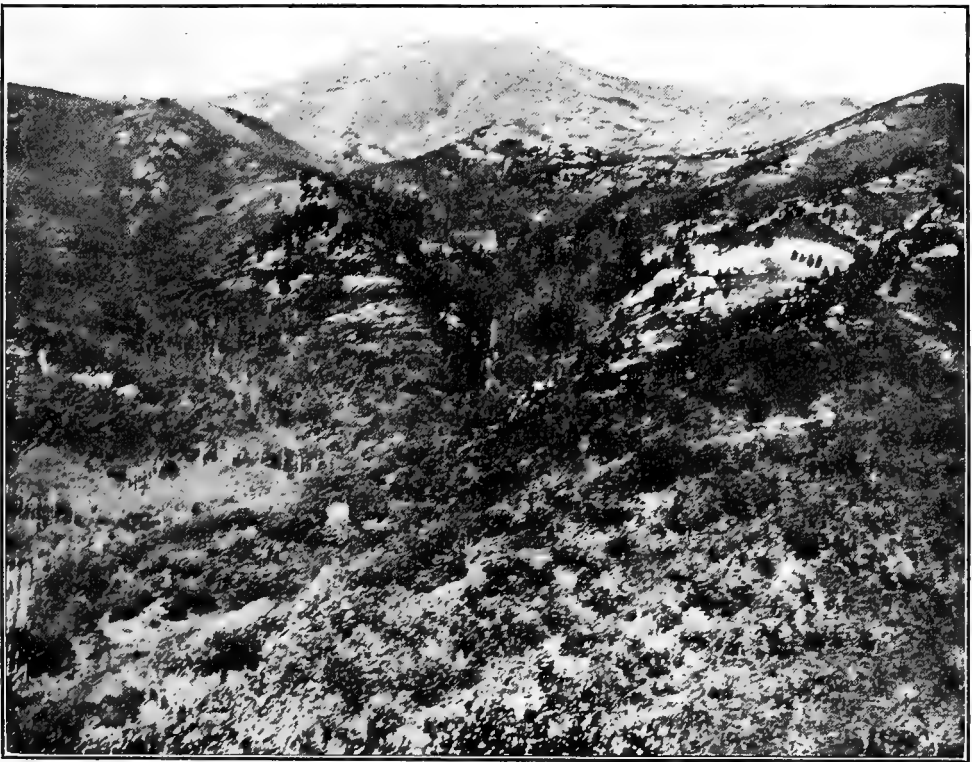


FIG. 5.—Sierra Blanca, or White Mountain Peak, from the southeast, looking over the head of Ruidosa Creek. Timber mainly Douglas spruce and aspens.

they slope gradually down to the broad plains of the Pecos Valley. The various groups form a well-timbered range in the midst of arid plains, carrying a few Mexican or peculiar species or subspecies of animals and plants, but dominated largely by Rocky Mountain species. They rise through the successive zones from Lower Sonoran to Hudsonian.

The Hudsonian Zone is represented on the top and northeast slope of Sierra Blanca, or White Mountain Peak, by many dwarf plants such as *Silene*, *Arenaria*, *Saxifraga*, *Rhodiola neomexicana*, *Sedum*, *Orthocarpus*, *Erigeron*, *Ligusticum*, and on narrow crests of two lateral ridges by a few dwarf *Picea engelmanni* that reach to within 200 feet

of the summit. The whole upper south slope is bald and grassy and the north slope steep and rocky, so that the presence of a true timberline can be inferred only from these narrow strips of spruce.

On September 13, I found Clark's nutcracker, Townsend's solitaire, and the pipit on or near the peak, but practically nothing is known of the breeding birds or of the mammals high up on this mountain. There were numerous burrows and runways of *Microtus* and pocket gophers nearly to the top. My work on the mountains consisted of a single day's trip to the peak and back to my 7,000-foot camp on Ruidoso Creek.

The Canadian Zone covers most of the higher peaks and cold slopes of the Capitan, White, and Sacramento Mountains, and is represented by a trace at the southern end of the Guadalupe. It is a narrow, irregular, and broken area that reaches its full vertical width only on the White Mountains. It is characterized by forests of spruce, fir, and aspens and by many of the Rocky Mountain trees and shrubs of the zone. It is difficult to say whether Douglas spruce and Chihuahua white pine are mainly Canadian or Transition, as they occur in both zones. Rocky Mountain maple is common in places and *Pachystima myrsinites* and several species of *Ribes* are common in the zone. The mammals of the Canadian Zone of this range are the mule deer, spruce squirrel, gray-footed chipmunk, long-tailed meadow mouse, white-footed mouse, porcupine, fulvous pocket gopher, and a small shrew. Some of the breeding birds are the long-crested jay, red crossbill, pine siskin, red-backed junco, Audubon's hermit thrush, broad-tailed hummingbird, western flycatcher, and brown creeper.

Throughout this zone of cool coniferous forests are numerous open parks and spruce-bordered grassy gulches where springs and little streams afford conditions for delightful summer camps. For the people of southeastern New Mexico and much of western Texas it is the most convenient resort during the long hot summers. Railroads and wagon roads make the mountains easy of access at many points and the national forests should insure the protection of this natural park region. Only a few years ago it was famous for its variety and abundance of game, especially elk, mule deer, white-tailed deer, antelope, bighorn, black and silver-tip bears, and wild turkeys. The elk are now exterminated and other game birds and animals are becoming scarce, but it is hoped that they can be protected so that present numbers at least shall be maintained.

The Transition Zone in these mountains covers a wide plateau and is almost continuous for the whole length of the range. It reaches from about 6,500 to 8,000 feet altitude on northeast slopes and from 7,500 to 9,500 feet on southwest slopes. On some very steep southwest slopes it reaches from 8,000 to 10,000 feet. It includes wide stretches of beautiful forest, open, clean, and grassy underneath the

smooth-trunked yellow pines which dominate the forest. Some Douglas spruce, white pine, large-leaved maple, New Mexico oak, and locust occupy secondary places in this forest. There are extensive open parks or grassy glades and along some of the stream valleys these are occupied by little farms, but the great value of this zone is its timber, grass, and water, its cool climate, shade, and beauty in the midst of a wide expanse of low hot plains.

Its characteristic mammals are white-tailed and mule deer, two species of chipmunks, a 13-lined ground squirrel, Colorado wood rat, Guadalupe meadow mouse, fulvous pocket gopher, mountain cottontail, and brown bat. Some of the breeding birds of the Transition Zone are the wild turkey, band-tailed pigeon, Huachuca spotted owl, screech owl, hairy woodpecker, ant-eating woodpecker, red-shafted



FIG. 6.—Checker-barked junipers in Dog Canyon in the Guadalupe Mountains.

flicker, broad-tailed hummingbird, green-tailed and spurred towhees, western tanager, Audubon's and Grace's warblers, pygmy and Rocky Mountain nuthatches, western robin, and chestnut-backed bluebird.

The Upper Sonoran Zone covers the lower slopes of the Sacramento Range, including the foothills and many long spurs and ridges. The arid slopes are usually steep and either bare or densely covered with juniper, nut pine, scrub oak, and other chaparral. Water is scarce, especially on the west slope of the range, and extensive areas are uninhabited. Some of these densely clothed and almost impenetrable slopes and canyons provide safe cover and abundant food supply for deer, bears, Mearns's quail, and other animals, and have played an important part in keeping up the supply of game. The steeper and barer slopes along the southern part of the range

are still the home of the Mexican bighorn, which, under the double advantage of favorable environment and legal protection, is apparently on the increase.

Other more open foothill valleys in the Upper Sonoran Zone lie along streams such as the Peñasco, Felix, Ruidosa, Bonito, and Tularosa, and are important agricultural areas.

IMPROVEMENT OF STOCK RANGES.

Many of the arid valleys in New Mexico have been for years so overstocked that the best grasses have been killed out and parts of the range rendered almost worthless. Some of the valleys show mile after mile of ground almost bare or overgrown with worthless vegetation that stock does not eat. Around most of the watering places the grass is killed for a long distance, often from 1 to 3 miles, the ground is trampled and baked, and the little rain that falls runs down the trails and is wasted. All of the public stock range¹ needs protection, and some of it needs reseeding. Over a great part of the privately owned range simple methods can be employed to improve the grass and greatly increase the grazing capacity. Grass is generally the best on very gentle slopes and poorest on steep slopes or on flooded bottoms. In most of the valley country there is at best not enough rain for a complete soil cover of grass and on the half-bare sloping sides of the valleys a great part of the water that falls quickly runs off. If this water could be held where it falls and be well distributed in the soil the grass crop would in many places be greatly increased.

Good results have been obtained on a small scale by simple and inexpensive methods that ranchmen could easily adopt on their own land. Contour furrows (or furrows plowed on a level), 4 to 6 feet apart along the sloping side of a valley, will hold most of any ordinary rain and take the water into the ground in such a way as to do the greatest good and also retain the richness of the soil.

The numerous small water channels cutting down the side slopes of the valleys can be closed at intervals so as to throw the water out through diverging furrows over side slopes and redistribute that which has come down from higher slopes. Each arroyo should thus arterially distribute water along its way instead of sucking it in from countless capillaries.

If watering places were provided at more uniform intervals over the range, the grass would not be destroyed in some places and allowed to go to waste in others. Even small reservoirs or cemented cisterns that would supply water for a month or more after each rain would serve this purpose. Where good water is to be had at a reasonable

¹ For a comprehensive treatment of the range problem in New Mexico, see Bull. 66, N. Mex. Agric. Exp. Sta., by E. O. Wooton, 1908.

depth, wells and windmills are of course simple means of supplying water, but there are extensive areas where subterranean water has not been obtained and reservoirs are the only possible substitute.

Prairie dogs, rabbits, and the big kangaroo rats should not be allowed to multiply on good stock range. They consume and destroy a large amount of grass and keep wide spaces about their burrows bare and nonproductive. They are easily destroyed at very small expense. Pocket gophers are a decided benefit to range land and need not be destroyed except along ditches or on cultivated ground.

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