THE BIOTA OF THE SANTA ANA MOUNTAINS

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Reprinted from Journal of Entomology and Zoology
Vol. 42, Nos. 3 and 4, 1951

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The Santa Ana Mountains are located in southern California about forty miles southeast of Los Angeles, ten miles east of the city of Santa Ana, and scarcely twenty miles from the Pacific Ocean.

Covering nearly 400 square miles, the range is more or less clearly defined on three sides by stream beds or canyons, while the remaining side merges without noticeable change into the low-lying terrain at its base. Thus, the north end is delimited from the Puente Hills by the canyon of the Santa Ana River, the course of which was maintained during the uplift of the range at a point where the nature and orientation of the rocks was such as to permit stream erosion. The east boundary is marked both by the stream bed of the intermittent Temescal River, Lake Elsinore and the western extension of the Perris Peneplain with which the Santa Anas merge south of the town of Elsinore, and by the Elsinore Fault, along which the range was uplifted. The Temecula River, which is the only other stream able to continue its course across the crest of the rising mountains, marks the south end of the range and the continuation of the Peninsular Range of which the Santa Ana Mountains are the northernmost extension. Finally the western boundary is formed by the low Santa Ana Coastal Plain which dips gently into the sea.

The longitudinal axis of the range, extending some 40 miles southeasterly from the Santa Ana River, is marked by a crest that is located excentrically, being nearer the eastern border, and that culminates around its midpoint in Santiago Peak. This peak, the highest of the range, attains an elevation of approximately 5691 feet above sea level. The only other peak over five thousand feet on the entire range, Modjeska Peak reaching 5481 feet, is located about one mile northwest of Santiago. The remaining major peaks (9 or so above 4000 feet, and about 28 above 3000 feet) are so situated along the crest that a line projected southeasterly from Sierra Peak, at the north, would intersect most of them and find the rest lying within two miles to the east or west. The average elevation of the crest is approximately 3500 feet.

At no point is the transverse axis of the range more than 13 miles long, and through the highest part of the range the distance from northeast to southwest piedmonts is less than nine miles. The range rises from a platform which dips from an average elevation of 1000 feet on the east to 500 feet on the west.

As a consequence of its relatively narrow width, low basement, and uniform alignment and elevation of its peaks, this range possesses many knife-edged ridges separating the coastal plain from the interior valley. Furthermore, the rather abrupt rise and acuminate apex do not lend themselves to the formation of lakes and subsequent meadows but rather favor dry slopes and ridges with plunging streams that carry water to their mouths through deep, rocky canyons.

As for views, however, it is unexcelled. From Santiago Peak one can get a comprehensive picture of the near and far terrain within which the Santa Anas are located, for on a clear day one can see from Santa Cruz Island, off the Santa Barbara coast, to Table Mountain in Mexico. Following the compass to the northwest the eye follows along the crest of the range across the abrupt canyon of the Santa Ana River to the low-rolling Puente Hills, which merge with the Los Angeles Basin near Pomona; to the west, over the relatively featureless coastal plain, lies the Pacific Ocean with Santa Catalina and San Clemente Islands; turning to the southeast one sees rather extensive mesas in the near distance and on beyond, over the Temecula River, the Palomar and Laguna Mountains; sixty miles to the east over the rolling peneplain San Jacinto Peak

rises to an elevation of 10,805 feet; finally to the north and northeast, across the great San Gorgonio Pass, the Transverse Ranges composed of the San Bernardino, San Gabriel, and Santa Monica Mountains complete the circumference.

This range was chosen for a biotic study because it had received little attention from biologists, despite the fact that its isolation from other ranges of southern California held promise of unusual patterns of animal distribution. Furthermore, it was attractive because of its lack of popularity among the general public. This unpopularity has resulted from the fact that motor roads available for public use have not as yet reached much of the range. The only road that is freely open to public travel runs across a relatively low portion of the range. Thus, foot trails offer the only means of penetrating to higher levels, since the unpaved truck trails, being restricted to the use of authorized persons, are behind locked gates. Even the foot trails are closed to use during the fire season, which lasts from six to seven months each year. And a large part of the higher terrain lies within the boundaries of a State Game Refuge, resulting in a minimum amount of hunting. For all of these reasons, the wildlife of the region has retained a "naturalness" which is inconsistent with the proximity of large population centers. The time is near at hand, however, when all of this will be changed by the proposed construction of a highway along the crest of the range.

This paper presents a survey of the plants and vertebrate animals and a study of the ecologic communities of the range. In order to compensate for both the wide scope and the large area of this study, field work was carried out most intensively on that part of the range lying between Bedford and Los Pinos peaks, on the north and south, and the boundaries of the Cleveland National Forest on the east and west. This area includes the higher portion of the range and comprises nearly 75 square miles, as measured on a plane surface map.

Field work on this project was begun in the fall of 1937 and was continued more or less uninterruptedly until November of 1941. Subsequently occasional trips have been made to the range as late as May of 1951.

GEOLOGY OF THE REGION

The earliest geologic event in the region of the present range, of which we have certain knowledge, was the deposition in Triassic of limestones and other sedimentary rocks. According to Mendenhall (1912) these beds were subjected to intense deformation in the Jurassic period. This, then, marks the first orogenic movement in the formation of the range. Following this deformation, and before the range attained its present height, its base was invaded at least five times by waters of ancient seas. During these continental subsidences rock beds several thousand feet thick were deposited along much of the southwestern face and, to a greater or lesser distance, along the northeastern piedmont. From maps presented by Reed (1933) it seems possible to say that the Santa Ana Mountains were connected to the present Catalina Island by a land bridge in lower Miocene. The last submergence of this region occurred in Pliocene, with the advent of the Fernando sea.

Probably early in the Quaternary (Dickerson: 1914), the northeast side of the range became the locus of a crustal fracture along which it was uplifted and tilted to the southwest, causing the recession of a part of the Fernando sea, and renewing stream activity on the mountain. Stream terraces are easily observed in several of the canyons, notably Silverado, on the Pacific slope. These lend credence to the belief by geologists that this last uplift was intermittent and commenced before latest Pleistocene times.

The basement complex or core of the Santa Ana Mountains is composed of metamorphic and partly metamorphosed sediments, together with granitic intrusives. The limestone elements here have yielded Triassic fossils, according to English (1926). The major granitic intrusion is commonly estimated to have occurred during Jurassic time, because it is intruded in rocks of Triassic age and overlaid unconformably by Cretaceous strata.

This central core of hard rocks is noticeably narrow at the north end of the range, but it widens out perceptibly to the southeast where it merges with the rest of the

Peninsular Ranges and the extensive Perris Peneplain which, according to English, are granitic. Along the flanks of this basement complex the principal rocks are sedimentary clays, shales, and sandstones deposited by the various ancient seas and continental agencies. These are much more common toward the north end of the range.

Evidence gained from this study substantiates the belief that there is a close correlation between the distribution of rocks, of given kind and age, and plants. This is particularly true of the north end where my distributional map of the dominant plant species fits very closely the arrangement of rocks of various types as shown by English for the same area.

THE CLIMATE OF THE REGION

All aspects of the climate of the Santa Ana Mountains are affected by the northwest-southeast trend of its axis. This orients the range at right angles to the path of the rain-bearing southwesterly winds and results in a large difference in the rainfall of the two slopes. This might be expected to create a more mesophytic vegetation on the moister slope but with the exception of protected local areas this is not true, because the moister side is also subjected to the direct effects of the sun. As a result insolation becomes an important factor in equalizing the differential of vegetation that would otherwise occur.

Some original data on temperature distribution were obtained through the use of recording thermographs. They were placed in shelters constructed with a double roof, a perforate floor, and walls made of slats. Six of these were installed at different elevations on the interior slope. Each was placed in a different type of vegetation; hence the temperatures recorded are not those of free air.

The mean annual temperature of the lowest station, located in the sagebrush community at 1400 feet, was 16 degrees F. higher than that of the highest station, which was located in the chaparral of Santiago Peak at 5600 feet. This would indicate an average depression of temperature of about 3.8 degrees F. per each 1000 feet increase of elevation. This drop is not uniform and also the apartness of the two stations cited above is greater during the night and winter than during the day and summer. This fact is probably accounted for by the greater circulation of air that occurs during the diurnal hours and summer months.

The diurnal range of temperature is greater during the summer than in the winter, and also greater at the lower stations than on Santiago Peak. It is also noticeably greater on southern exposures than on northern exposure, at the same elevation. A check made during February of 1940 on the southern and northern aspects of Santiago Peak shows a range from a high of 53 degrees F. to a low of 35 degrees F. on the former, and a lesser range from 47 degrees F. to 40 degrees F. on the north. In larger measure this may be accounted for by differences in the vegetation and consequent differences in air movement; the north-facing aspect is covered by Canyon Live Oaks, while the south-facing aspect supports a medium-to-dense chaparral.

The lowest monthly mean temperature is reached in January, though temperatures of 32 degrees F. or below may be recorded at the higher stations as early as October, or as late as April. The period of frost, at the various elevations, could not be checked very well, since 1940 was a year of moderate temperature. It was noted, however, that the earliest frost occurring on Santiago Peak came October 26, and the latest for the winter 1939-40 came on April 24. Temperatures as low as 32 degrees F. were not recorded at 1400 during 1940, a fact significant in itself.

It is a lamentable fact that thermographs were not operating during the winter of 1936-37, for it was one of the coldest experienced in this region for many years. The lowest temperatures were reached in January. Two interesting observations were made during this cold period. The laurel sumac *(Rhus laurina)* and sugar bush *(Rhus ovata)* in many places grow side by side, though the latter has the higher altitudinal range. Both plants have a very similar growth form, yet one was markedly affected by this cold period while the other was not. All of the aerial portion of the laurel sumacs was killed, while sugar bushes only a few feet away were not damaged. Observations on the

subsequent effects of this cold period have shown that only a small number of the individuals of this species were entirely killed, for stump sprouts appeared in many the following spring, and yet the damage done to all has not been entirely compensated for, even after 13 years. The majority of laurel sumacs entirely killed were growing above 2000 feet elevation.

Snowfall during this year was unusually heavy. Ordinarily only a moderate amount of snow falls on this range, but in 1937 it remained on the ground and chaparral plants in considerable depth, above 3500 feet, for several weeks. Some of the chaparral species on southeastern exposures above 4500 were severely damaged as a consequence. A possible explanation of this is found in the fact that most of the plants growing here were successional following fire and, thus, those having optimum development at lower elevations. It is pertinent to point out that the snow-line during this period reached its lower limit near 3500 feet, which is the point at which the noticeable transition from the *Adenostema-Ceanothus* to the *Arctostaphylos-Garrya* fascies of the chaparral community occurs.

All stations record the highest mean temperatures to come in the month of July. Below 3000 feet, the temperature curve rises steadily from a low-point in January to its high-point in July; above this elevation, the temperatures continue to drop, reaching a low-point in February.

Arbitrarily choosing a mean monthly temperature of 70 degrees F., the following observations as to the length of time that this or higher means are maintained may be of some interest: At 1400 feet, mean temperatures above 70 degrees F. were maintained for four consecutive months, beginning in May and ending in August; at 2700 feet, this period is of three months' duration, as it is at 3600 feet, beginning in June and running until August; but on Santiago Peak, a mean monthly temperature of 70 degrees F. is attained in July only.

A close check on the earliest date of blooming in relation to altitude was kept on three shrubs, viz., *Adenostema fasciculatum, Cercocarpus betuloides,* and *Ceanothus crassifolius.* In 1938, I found that an average lag of from 13 to 15 days per thousand feet intervened between the earliest bloom of these plants at their lowest and highest altitudinal limits. These records were kept strictly for the same slope exposure at all elevations, for on April 9, at 2500 feet, *Ceanothus crassifolius* was in full bloom on north-facing slopes and in fruit on southern exposures, though the plants were only separated by a few yards. This lag is usually longer for plants blooming in late winter than for those blooming in the spring and early summer, probably due to the greater convectional mixing of air masses in warmer months.

A pertinent observation on a possible correlation between the activities of birds and the seasonal ascent of temperatures on the mountain was made in 1940. On March 30, 1940, large numbers of Black-chinned Sparrows were concentrated in the sagebrush community all along the base of the mountain. These birds seemed not to be migrants, but birds intent on breeding here, for a large group had already filtered through the region. On April 13, the first sparrow record was obtained at 2600 feet; it was not until near the first of May that the first bird was observed on Santiago Peak. During this interval of one month, the number of birds at the lower elevations gradually thinned out until the normal equilibrium between environment and population had been reached. It is interesting to observe that the mean temperature at 1400 feet was 60 degrees F. when the first Black-chinned Sparrows were recorded at this elevation, and that this temperature was just attained on Santiago Peak when the first record of these birds was made on this peak. A similar lag occurs in nesting activities. In 1940, the first eggs of this species were found when the mean temperature had reached 73 degrees F. This was attained on May 15, at 1400 feet, and about June 15 on Santiago Peak.

Temperature inversion was detected on the range, and although this phenomenon probably occurs on suitable nights at any time of year, it is here characteristic of spring and summer months. On the basis of altitudinal distribution of temperature, we may divide the total day into four periods. The first of these, the night period, extending from about 9 p.m. to 6 a.m., is the time when temperatures are higher between 3000

and 5000 feet than below or above (inversion); then follows a period of transition, lasting about 3 hours, when radiation and convection disrupt the thermal belt and produce the temperature gradient characteristic of diurnal hours; this, in turn, is upset at dusk by the differential in radiation; and finally air drainage begins to reform the thermal belt. At night the temperature gradient may rise rapidly from the valley floor to reach a maximum difference of 15 degrees F. at 4000 feet.

A possible effect of inversion upon biological activities was observed in 1940. A few plants of buckthorn began to bloom as early as January 2, but the peak of blooming was not reached until about January 29. The unusual fact was that the bloom was uniform throughout the altitudinal range from 1400 to 4500 feet. Moreover, by March 15 many of the plants were in the fruiting stage, but those between 2000 and 4000 feet were noticeably more advanced. This created the interesting spectacle of a belt of plants in fruit separating lower and higher belts of plants still in bloom.

When considering rainfall the year is divisible into two portions of unequal length, a dry season consisting of 7 consecutive months beginning in May and ending in November, and a wet season beginning in December and ending in April. Some rainfall has been recorded in every month of the year, but over 90 per cent of the annual precipitation occurs in the five months of the wet season. Much of the remainder falls in storms of such short duration and extreme intensity, particularly in the fall, that it is of little value to either plants or animals, since much of it runs off in torrents or evaporates before penetrating far into the soil. In September thunder showers of short duration are a common occurrence, but the rainfall that accompanies these storms is largely deposited on the upper reaches of the mountain. For example, during a 7-day period in September, 1939 nearly five inches of rain were recorded from Santiago Peak, while only a trace of rain fell upon stations below 1200 feet. At this same time the fire observer on Santiago Peak recorded 400 lightning strikes on the ridges about him. Some of these started fires in the timbered sections, but the heavy rains extinguished all of them.

In order to gain some information related to the distribution of rainfall upon the range proper, six rain-gauges constructed after plans drawn by Kadel (1925) were installed at various levels during the years 1939-40 and 1940-41. These two seasons proved to be near extremes, as indicated by figures obtained from the Holtz Ranch, located at 1275 feet in Silverado Canyon. At this station the average rainfall is approximately 22 inches. The extremes for the 22 seasons (1919 to 1940) available to my study were 13.41 and 39.98 inches, occurring in 1924-25 and 1940-41 respectively. Since the total in 1939-40 was 17.28, this can be considered to be representative of a dry year, so far as the purposes of this study are concerned. Subsequently, in the period from 1946 to the present, this region has suffered from a very severe drought. Data obtained from the rain-gauges were used to document the following assertions.

Since the Santa Anas lie athwart the humid southwesterly winds, it had been expected that there would be a considerable differential of rainfall between the windward and lee slopes. It was found that the apartness of the two sides with respect to annual totals of rainfall was negligible on the piedmonts but was marked on the mountain mass. For example, whereas the windward slope exceeded the lee slope by only two inches of rainfall at 1000 feet, the former exceeded the latter by 18 inches at elevations between 2000 and 3000 feet. And this differential was maintained, although at a reducing degree, until the elevation of 4000 feet, at which point the influence of ridges and passes disrupted the pattern. Furthermore, it was found that a maximum rainbelt, lying between 2000 and 4000 feet was characteristic of the windward slope but not of the lee slope. Thus, while rainfall totals between 2000 and 4000 feet on the windward slope were greater than that of Santiago Peak (at 5691 ft.), they were always less than the latter at 2000 to 4000 feet on the lee slope.

As was mentioned before, the vegetational cover does not reflect this difference in precipitation except in those regions of the windward slope where the canyons are oriented on an east-west axis, thereby producing a north slope protected from insolation. One such area is found in upper Trabuco Canyon where the finest growth of Big-cone

Spruce and maples present on the range are to be found. Here, too, one finds the only madronas known to exist in these mountains. The whole aspect of this small area is so mesophytic that it stands out as somewhat unrelated to the rest of the range, even with regard to its fauna.

Extremes of rainfall certainly exert an important influence upon both plants and animals. At the very beginning of this study the absence of very young live oaks around or beneath large oaks caused me some concern. From size alone, it appeared that there were, in most regions, about four age-groups of the California Live Oak. The age of the youngest of them was not known, but was estimated to be at least 10 to 15 years. These trees were everywhere in the minority and extremely scarce on the range as a whole. It seemed that this species would certainly die out were it dependent, alone, upon this small number of trees for its survival. That it does not was admirably exhibited in 1941. Unusual amounts of precipitation occurred in December, which is soon after the acorns are deposited, and was followed by a relatively warm January and unprecedented rainfall in February and March. Already in February, it was clear that this would be the kind of year upon which live oaks depend for survival. Beneath every mature California Live Oak many germinating acorns were found. By April the roots of many of them had reached soil beneath the rich humus and, thus, had a good chance of surviving the dry summer period. On April 4, 1941, I counted 28 germinating acorns under one oak near the edge of Plot VII; on September 10, it was found that 21 of these were still living. At that time it seemed that some of these with shallow root systems would die before the advent of winter rains. But the survival of even one of the original population beneath each oak would be sufficient to propagate the species. It is possible that years of this kind, coming perhaps every sixty to one hundred years, account for the nearly uniform age of the older trees on our rolling hills.

Similarly, the Spadefoot Toad had not been detected by me on the Santa Anas before this heavy rain period. But in April nearly every rainpool was choked with developing larvae of this species.

There are other years of more than average rainfall which cause more harm than benefit. Usually this is due to floods which arise following extremely high deposition of rainfall in any one month. In 1938, a year of this kind, canyons were scoured out, filling pools with sand and straightening the channels of smaller streams. The effect of these seasons upon the vertebrate animals is more noticeable with respect to amphibia, but is certainly as important to some reptiles, mammals and many birds. Straightening of stream courses, removal of natural dams and filling of pools cause the streams to flow more rapidly and dry up sooner in the spring. It removes as well a large part of the amphibian population upon which water snakes and raccoons are partially dependent; and, as in 1938, the population of water insects may be reduced, which directly influences birds breeding in this community.

FOG

Fogs are common on the Pacific slope in the spring and summer months. Many of these are restricted to the coast or, at most, penetrate to the base of the range, but a few actually occur upon the southwestern slopes.

Daily records kept by the lookout on Santiago Peak, during the period from May 21 to November 27, 1939, show that: 1) on 110 days fog was prevalent on the coastal area for at least a part of the morning; 2) that on 59 days fog occurred on the southwestern slope at or below 3000 feet; 3) that only on 16 days did fog attain the vicinity of the peak at 5691 feet.

On several occasions, usually in the spring, I have watched fog attain an elevation of 4000 feet, completely covering the coastal plain and ocean as far as the eye can see, then subsequently pour through the major passes only to disappear in the dry air of the interior. These form in the late afternoon and gradually penetrate toward the range, gaining in elevation as they reach its slopes, until the height of the passes is reached. After sunset, this fog begins to penetrate farther and farther across the main divide onto the ridges and slopes of the interior.

It is my conviction that these fogs play an important role in controlling the distribution of Coulter Pine on this range. Without exception, the largest groves are adjacent to passes through which these fogs pour.

Time and again I have found the ground beneath these pines to be wet with water dropping from the needles, upon which the fog had condensed. This, together with the known fact that these pass areas receive heavy rainfall, may account for the unique distribution pattern of this tree.

WIND

The prevailing wind on Santiago Peak comes from the southeast. In May, June and July, westerly winds are common; in September, October and November, southwesterlies and northeasterlies are more common. These latter winds are not only opposite on the compass, but also in certain physical features; southwesterlies are humid winds of relatively low velocity that bring rain to the range, whereas, northeasterlies are dry winds of rather high velocity.

During the fall and again in the spring, this region suffers from winds that sweep with great speed out of the north, crossing the San Bernardino Valley and running against slopes and ridges of the Santa Anas, to die out over the ocean. Anemometer readings of between 50 and 60 miles per hour have been recorded on Santiago Peak during these winds. Usually they blow about 36 hours without respite, although they may last only a day, or as long as 3 days. These winds are locally referred to as "Santa Anas."

The "Santa Anas" probably reach their greatest velocity on the north end of the range near the Santa Ana Canyon. The effect on the vegetation in the more exposed areas is very noticeable. In these places, about the only plant that forms extensive societies is chamise *(Adenostema fasciculatum)*, although an occasional manzanita or buckthorn may be found. Instead of being of normal height (6 to 8 feet), however, these plants are stunted to a height of from 12 to 18 inches.

So far as I can determine these winds have little effect on the small mammals. Birds, however, are seldom observed in flight far above the chaparral. I have experienced a Santa Ana on Santiago Peak when the temperature varied between 16 and 26 degrees Fahrenheit, by night, and seldom went over 45 degrees by day. On one of these nights a large catch of rodents was obtained from Plot III. In the morning it was noticed that purple finches, jays, towhees, thrashers, juncos and thrushes remained huddled among the protecting branches of the chaparral plants. Few birds were feeding before 10:30 a.m. Because these conditions of cold and wind so shorten the forage period, there is little doubt but that they are a cause of considerable bird mortality, especially when they last for longer periods.

PLANTS OF THE REGION

Three hundred and forty species and varieties of plants have been detected in the Santa Ana Mountains. It is known that this is not the total number of species to be found here, but among them will be found those plants which, to the author's knowledge, most prominently affect the existence of vertebrate animals in this region. Most of these plants have been identified by the author, although considerable aid has been offered by several taxonomists in identifying species in complex genera. It has not been possible to give the exact identification for every plant, because some differences have been noted which, in the opinion of specialists, will be worthy of separate recognition. Among these plants, the more salient are chaparral species in the genera *Arctostaphylos, Garrya, Ceanothus,* and *Lepechinia.* Awaiting further work, these plants have been given the name of the species to which they are most closely related.

The number of plants endemic to the Santa Ana Mountains is not large. Even with completion of the work mentioned above, endemic species will not number over a dozen. One of the interesting features of the flora is the fact that several species reach either their northernmost or southernmost station on this range.

Five of the plant formations described by Weaver and Clements (1929) are

believed to be present on this range. Three of these, namely, the Pacific Prairie, Coastal Sagebrush, and Coastal Chaparral, are more or less typical; the other two, that is, Sierran Montane Forest and Woodland Climax, are less typical.

Of the 340 plant species, 125 belong to the chaparral community, 72 to the woodland community, 70 to the sagebrush community, 57 to grassland, 9 to the forest community, and 7 to the aquatic community. Discussion of the nature of these communities is taken up in the section on Ecologic Communities.

ACCOUNTS OF THE SPECIES

PTERIDOPHYTA

Dryopteris

D. arguta. Wood Fern. This fern is common at low elevations under live oaks and other woodland trees.

Polystichum

P. munitum. Sword Fern. Locally common on shaded slopes and in vicinity of springs at intermediate elevations. Collected at Bear Springs, Modjeska Springs, and Trabuco Canyon.

Woodwardia

W. chamissoi. Chain Fern. Relatively rare. Found only in thick tangle of mesophytic vegetation in near vicinity of water between 2000 and 4000 feet.

Pellaea

P. andromedaefolia. Coffee Fern. Common fern. Found around rocky outcrops on even the more exposed slopes. Center of distribution around 2000 feet.

Notholaena

N. californica. Particularly common around rocks under chaparral plants on the north end of the range. Collected in Upper Sierra Canyon at 2300 feet.

Cheilanthes

C. covillei. Lip Fern. Found at low elevations in rocky situations along the eastern aspect of the range from Santa Ana River to Temecula River.

Adiantum

A. jordani. Maidenhair Fern. Relatively rare. Found only around rocky outcrops on densely shaded slopes. Collected in Trabuco Canyon at 2700 feet.

Pteridium

P. aquilinum var. *pubescens.* Common fern in vicinity of water; occasional on open areas among Coulter Pines; important plant on Yaeger's Meadow.

Equisetum

E. funstonii. Horsetail. Found only in the larger canyons on the Pacific slope. All collecting stations are below 2500 feet.

E. maximum. Giant Horsetail. Rare. Found only at spring on Holy Jim Trail at 3800 feet.

SPERMATOPHYTA

Gymnospermae

Pinus

P. attenuata. Knob-cone Pine. Found only in the region of Pleasant's peak between 3500 and 4000 feet. Isolated specimens may be found in canyons at lower elevations, but usually grow in groups of from 10 to 1000 trees on ridges and slopes. These groups are usually composed of trees of uniform age. Some groups are made up of trees as young as 25 years, while tree-ring studies show others to be 70 years. Many dead or

dying trees are in evidence; none of these has over 80 annual rings. The root system is relatively shallow. Two trees, apparently in their prime, were uprooted during a winter storm in 1940, these trees had 60 annual rings. A few young seedlings are found beneath the dying trees.

P. coulteri. Coulter Pine. Found only between Los Pinos Peak to the south and Bedford Peak to the north. Grows most abundantly on interior slopes and ridges adjacent to passes through which coastal fogs pour. There appears to be a causal relationship between occurrence of fog and abundance of trees. Ranges from 3000 to 5000 feet; maximum numbers between 3500 and 4500 feet. Because it inhabits ridges and xeric slopes, this tree suffers considerably from fire.

One young grove on the ridge between Mayhew and Indian Canyons is very heavily infected with peridermium *(Cronartium coleosporiodes* (D. and H.) Arth.). It can be controlled by killing out the secondary hosts, which are herbaceous plants belonging to the family *Scrophulariaceae.* This fungus has distorted many trees by girdling the terminal spikes. Trees are also very subject to insect invasion.

Cones mature and nuts are liberated near the middle of June. On June 12, 1940 cones were bursting all through the day with a sharp, crackling report.

Pseudotsuga

P. macrocarpa. Big-cone Spruce. Found more extensively than Coulter Pine. Grows in canyon bottoms and on moist, north-facing slopes. Extends from 2000 feet in cool canyons up to 5000 feet on Santiago Peak. One finds a few spruces on almost all of the protected slopes of canyons on the Pacific slope, where the most important grove is found in upper Trabuco Canjon adjacent to Yaeger's Meadow. Because it grows in moister niches, this tree is not so frequently damaged by fire as is the Coulter Pine. New cones are abundant around March 1; new vegetation-growth is abundant about the middle of May.

Cupressus

C. forbesii. This cypress is confined to the north end of the range between Claymine Canyon and Sierra Peak. Although a few trees are found in Santa Ana Canyon and adjacent tributaries, the main grove, covering about one square mile, is found on sedimentary sandstone and claybearing formations between 1400 and 2400 feet. This grove was discovered by W. M. Pierce in 1922. So far as I know, it represents the northernmost extension of a tree with a decidedly discontinuous distribution.

Specimens examined after having been uprooted by mining operations were found to have a shallow root system. Mature pollen is produced in late October; mature cones are found about the middle of May. Because of its affinity for soils rich in clay deposits, this tree may meet its ultimate destruction on this range through mining operations.

Over 90 per cent of these trees were destroyed by fire in November 1948. By April, 1949, prodigious numbers of seedlings were pushing through the soil. By April, 1951, many seedlings had perished but those remaining were well-spaced and had grown to a height of 10 inches.

Juniperus

J. californica. California Juniper. Uncommon on the Santa Ana Mountains. Found only along the eastern foothills. More common across the Temescal Canyon on the rolling Perris Peneplain.

Angiospermae

Typha

T. latifolia. Cat-tail. Common along the edge of marshes or slowly running streams. Taken at several locations on low lands between Elsinore and Temecula.

Sparganium

S. greenei. Bur-reed. Found with *Typha* in marshy areas. Collected only on low lands south of Lake Elsinore.

Andropogon

A. saccharoides. Beard Grass. Perennial grass taken at low elevations on dry hillsides and canyon walls.

A. glomeratus. Perennial grass taken in swampy areas on the Santa Ana Coastal Plain.

Sorghum

S. halepense. Johnson Grass. Common on disturbed areas in grassland belt, particularly on Pacific slope. Invades roadsides locally.

Aristida

A. adscensionis. Triple-awned Grass. Annual grass found on rocky hillsides, below 2000 feet, principally on interior slope.

Stipa

S. speciosa. Spear Grass. Perennial grass. Very common. Found from base of mountain to Santiago Peak. Invades open areas in chaparral belt.

S. coronata. Perennial. Found abundantly on grassy hillsides below 3000 feet. Will inhabit open ridges in chaparral belt and open, dry washes.

S. pulchra. Perennial. Found particularly on Pacific slopes. Inhabits exposed ridges and slopes of successional sage.

S. lepida. Perennial. Common on successional sage areas and arid hillsides.

Muhlenbergia

M. microsperma. Annual. Inhabits exposed areas in chaparral belt, below 2000 feet.

M. californica. Perennial. Around springs and seeps at intermediate altitudes.

M. rigens. Perennial. Occasional on hillsides; more common on dry stream banks below 3000 feet.

Gastridium

G. ventricosum. Introduced annual. Found on grassy areas in sage and chaparral regions.

Avena

A. fatua. Wild Oat. Common in disturbed areas at low elevations. Has invaded grassland belt and is occasional in the sage belt.

A. barbata. Slender Wild Oat. More common than *fatua;* occupies much the same niche.

Melica

M. frutescens. Melic Grass. Perennial. Found on openings in sage belt and on dry southern exposures below 1500 feet.

M. imperfecta. Perennial. Inhabits rocky hillsides below 1500 feet.

Lamarckia

L. aurea. Golden-top Grass. Occasional in rocky regions at low elevations.

Festuca

F. octoflora var. *hirtella.* Fescue Grass. Found abundantly on openings in chaparral belt.

F. megalura. Common in sage belt below 2000 feet.

F. reflexa. Inhabits grassy hillsides and openings in sage belt below 1500 feet.

Bromus

B. mollis. Introduced annual. Found beneath plants of sage belt at 1500 feet or below.

B. trinii. Annual. Found on dry hillsides.

B. rubens. Introduced annual. Abundant in disturbed region, as on firetrails, below 3000 feet.

B. tectorum. Native annual. Common in rocky regions and disturbed areas in dense chaparral above 2500 feet. Abundant on the clearing on Santiago Peak.

B. madritensis. Occasional along trails and firebreaks at or below 3000 feet.

Agropyron

A. parishii var. *laeve.* Found along streams at intermediate levels. Not common.

Hordeum

H. pusillum. Collected only around Lake Elsinore.

H. nodosum. Collected only around overflow of Lake Elsinore.

Elymus

E. triticoides. Found around small seepages from Santiago Peak, down to 2000 feet.

Sitanion

S. hystrix. Collected in Santiago Canyon.

Carex

C. schottii. Wet places below 2500 feet. Collected at San Juan Camp Ground.

Chlorogalum

C. pomeridianum. Soap Plant. Found only on the north end of the range between Skyline Drive and Sierra Peak. Grows in sage belt, but is much more abundant in the chaparral belt at, or above, 2500 feet. Apparently grows only on sedimentary formations; hence limitation to north end. June 18, 1940, I found many of these plants had been "hoofed out" by deer. The coarse fibers were removed from the bulb which was used for food. Bloom begins June 15 at 2700 feet.

Allium

A. haematochiton. Wild Onion. Found in grassy places and open places in sage belt below 2000 feet.

A. parishii var. *keckii.* Collected only in the near vicinity of Santiago Peak above 3000 feet.

A. sanbornii. Found at low elevations on the interior slope only. Particularly abundant on recently cleared fire trails below 2000 feet.

A. praecox. Taken only on the Coldwater Trail to Santiago Peak, at 2300 feet on damp, shaded slopes. In bloom, April 8, 1939.

Bloomeria

B. crocea. Golden-star. Common on dry slopes and grassy areas in sage belt below 2500 feet. Blooms in late April and early May. Earliest date, April 15; latest May 25, 1938.

Brodiaea

B. coronaria. Collected only on north end around Skyline Drive on sedimentary soils. Blooms in May.

B. capitata. Very common. Found most abundantly in grassland and green areas in sage belt, although it was collected as high as Santiago Peak on a southern firebreak. Blooming period begins about February 15 and ends late March, at 1400. At higher elevations is generally in full bloom around the middle of June.

Lilium

L. humboldtii. Tiger Lily. Collected in Trabuco Canyon and at Bear Springs. Found in moist regions about springs in canyon beds from 1000 to 4500 feet, particularly on Pacific Slope. Blooms from June 10 to July 15.

Fritillaria

F. biflora. Chocolate Lily. Rare on the Santa Anas. Collected only on the Bedford Truck Trail in a grassy area at 2300 feet. Blooms in late February and early March.

Calochortus

C. splendens. Grows in grass belt or open grassy places in sage and chaparral belts from base of mountain to Santiago Peak. In 1940 I checked blooming periods in relation to altitude. First blooming date on Plot I (1400 feet), April 12; first bloom on Santiago Peak (5691), May 24—a lag of 43 days for 4300 feet or 10 days per thousand feet of altitude.

C. nuttallii var. *australis.* Rare. Found only on the north face of Santiago Peak above 5500 feet. Blooms in June.

C. weedii var. *intermedius.* Less abundant than *splendens.* Found only on Pacific slope from Sierra Peak at least to Bell Canyon. Found as high as Santiago Peak, but only on the southern aspect, and on disturbed areas. Blooms in June and July.

Yucca

Y. whipplei var. *typica.* Our Lord's Candle. Abundant on the Pacific slope in successional sage belt at low elevations. Found in successional sage and other openings in chaparral belt as high as 5000 feet. Although blooming begins as early as April 1, the peak is reached in May.

Nolina

N. parryi. Parry Nolina. Found at low elevations from Sierra Peak around the southwest face of the range at least to Trabuco Canyon. Blooms in May. Nowhere abundant.

Sisyrinchium

S. bellum. Blue-eyed Grass. Grassland and green areas in sage belt below 1500 feet. Blooms from March through May.

Epiactis

E. gigantea. Common along stream banks below 2500 feet.

Populus

P. trichocarpa. Black Cottonwood. Not common. Found along streams from Pacific side of Ortega Road to Trabuco Canyon.

P. fremontii. More common than above species. Found along the lowest reaches of canyons and stream beds at the base.

Salix

S. gooddingii. Collected along Temescal Canyon, principally at Lee Lake, and Lake Elsinore. Common in Santa Ana Canyon and Pacific slope canyons below 2500 feet.

S. laevigata var. *araquipa.* Common in larger canyons at low altitudes. Collected in Temescal Canyon, but more common on Pacific slope where it is found along streams up to 3000 feet.

S. lasiolepis. Taken from low elevations up to 4300 feet, as at Bear Springs.

Juglans

J. californica. Black Walnut. Not common. Found in canyons and washes and occasionally on north-facing hillsides from the Santa Ana River south at least to Trabuco Canyon. Found mainly on the Pacific slope. Flowers in March. Much more common in Puente Hills to the north.

Alnus

A. rhombifolia. Alder. Very common along streams in narrow shaded canyons, below 3500 feet. Seldom found in canyon mouths where cottonwoods and sycamores are more common.

Quercus

Q. wislizenii var. *frutescens.* Dwarf Interior Live Oak. This oak is an important plant in the climax chaparral above 3500 feet. Grows on ridges and southern exposures. Stump sprouts after fire. This habit admirably shown on southwest face of Modjeska Peak. Blooming sequence on south face of Santiago Peak as follows: Bud 3-25-40, flower 4-13-40, in full bloom 4-28-40, fruit 5-15-40.

Q. morehus. I have found only one specimen of this tree. It is located just above Horsethief Springs at 4000 feet. Dr. Carl B. Wolf believes this oak to be a cross between *kelloggii* and *wislizenii.* The male element is believed to come from *kelloggii.* Since, to my knowledge, Q. kelloggii doesn't grow on the Santa Anas, pollen must have been transported from the Palomar or San Bernardino Mountains, a transport that is not inconceivable.

Q. agrifolia. California Live Oak. Common on broad alluvial fans and gently sloping hillsides below 2500 feet. Grows in March; blooms in April; and acorns mature in November.

Q. engelmannii. Not found north of the Ortega Road. Abundant in mountains opposite Winchester in the Tenaja Mesa region.

Q. dumosa. California Scrub Oak. Important constituent of the lower chaparral belt. More common on the interior slopes. Blooms in April; grows in June; fruit matures in September.

Q. dumosa var. *elegantula.* I have found this tree at irregular stations on the interior chaparral belt from Sierra Peak to Coldwater Canyon. Usually found between 2400 to 2800 feet, but some specimens grow as high as 4000 feet. Usually individual trees stand out clearly against the chamisal background.

Q. chrysolepis. Canyon Oak. The common oak on canyon walls and slopes above 4000 feet. Largest grove found near Los Pinos Peak in upper Trabuco Canyon; trees here 60-70 feet high.

Q. chrysolepis var. *nana.* Dwarf Oak. Together with dwarf *wislizenii,* replaces *dumosa* at higher elevations. Occupies the more mesophytic areas.

Q. macdonaldii. Oaks collected along the Temecula River are certainly not to be included in the species *dumosa* under var. *elegantula.* It appears from the work of Carl Wolf that these specimens are actually hybrids between *engelmannii* and *dumosa.* This appears to be the best disposition of this material at the present time.

Urtica

U. gracilis var. *holosericea.* Common along streams and damp places at low elevations.

Eriogonum

E. thurberi. Sandy places at low elevations.

E. gracile. Common in washes and along stream edges up to 4500 feet. In bloom during August and September.

E. elongatum. Inhabits limestone soils at intermediate altitudes. Blooms during August and September.

E. saxatile. Rare. Rocky soil above 4000 feet. Collected on Main Divide Truck Trail at 4300 feet.

E. fasciculatum. Buckwheat. Important dominant in the sagebrush belt at elevations below 2000 on interior slope and 3000 feet on Pacific slope. Inhabits dry hillsides and

other stable terrain. Blooms at peak during late June and July, but re-blooms in August, and even in January following December rains.

E. fasciculatum var. *polifolium.* Replaces the species in the successional sage at elevations above 4000 feet.

E. nudum var. *pauciflorum.* Collected on the Main Divide Truck Trail in vicinity of Santiago Peak, 5400 feet. In bloom September 3, 1937.

Oxytheca

O. trilobata. Collected in upper Trabuco Canyon, 4000 feet. In bloom September 6, 1938.

Chorizanthe

C. fimbriata. Sagebrush belt. Collected on Los Pinos Portrero. In bloom June 12, 1940.

C. staticoides. Common on recently disturbed areas such as firebreaks and trails. Blooms in May and June. Prefers limestone soil.

Abronia

A. villosa var. *aurita.* Sand-verbena. Collected at several locations on sandy soil; all at low elevation, from Temecula River to the Santa Ana River.

Mirabilis

M. laevis. Collected in Trabuco Canyon. In bloom April 3, 1938.

Montia

M. perfoliata. Common along streams and at springs at intermediate altitudes.

M. spathulata. Found in Horsethief Pine Forest at 4100 feet.

Stellaria

S. media. Common Chickweed. Weed at low elevation.

S. longipes. Collected only at Bear Springs.

Arenaria

A. douglasii. Sandwort. Collected in Temescal Canyon near Twin Springs. In bloom in May.

Silene

S. gallica. Common on recently disturbed ground below 1500 feet. Collected near San Juan Camp Ground. Naturalized from Europe.

S. laciniata. Collected in vicinity of Trabuco Peak at 4300 feet. Occasional throughout chaparral belt, particularly in soil enriched with humus. Grows beneath scrub oaks.

S. verecunda var. *platyota.* Open places in chaparral belt above 4000 feet. Collected on Santiago Peak.

Paeonia

P. brownii. Peony. Common in chaparral belt, particularly open places below 3500 feet. Blooms in February and March.

Delphinium

D. cardinale. Scarlet Larkspur. Common on disturbed areas, alluvial fans or in thick brush from 1000 to 4500 feet. Late spring of 1941, following exceptionally heavy rains, unusually abundant at low elevation. Blooms from May to July.

D. parryi. Common on grassland, sagebrush belt and disturbed areas in chaparral below 4500 feet. Begins bloom in April at low elevations. In 1938, followed blooming period in relation to altitude, lag 15 days per 1000 feet.

Thalictrum

T. polycarpum. Meadow-rue. Trabuco Canyon. Blooms April and May.

Ranunculus

R. hebecarpus. Interior slopes at low elevations.

R. californicus. Grassy areas, particularly beneath California Live Oak. Collected in bloom April 3, 1938, 1000 feet, Trabuco Canyon.

Clematis

C. lasiantha. Common. Growing over shrubs in chaparral belt. Found from Glen Ivy to Santiago Peak. Blooms in April, May, and June.

Berberis

B. pinnata. Collected only on the Bedford Truck Trail near igneous outcrop at 3500 feet. Blooming period begins about March 15 and runs to April 15.

Umbellularia

U. californica. Bay Tree. Common in canyons at low elevations; occasional on rocky slopes up to 5200 feet, as on south-facing slope of Modjeska Peak. Occasional at springs and seepages at higher elevations. Blooms from January to April.

Meconella

M. oregona var. *denticulata.* Collected along edge of chaparral; Coldwater Trail, 2300 feet. In bloom April 8, 1939.

Romneya

R. coulteri. Matilija Poppy. Found in washes and disturbed areas in sagebrush and chaparral belts from 1000 to 5700 feet; maximum numbers below 3000 feet. Blooms in May and June.

R. coulteri var. *trichocalyx.* Common at lower elevations.

Dendromecon

D. rigida. Bush Poppy. Common in chaparral belt along road cuts or open places caused by exposure. Blooms throughout the year. Occupies belt between 2000 and 4000 feet.

Eschscholtzia

E. californica. California Poppy. Locally common on grassy slopes below 1500 feet.

E. caespitosa. Found on burns at higher elevation. Collected on southwest face of Modjeska Peak, 5200 feet. Blooms in April.

Argemone

A. platyceras. Prickly-Poppy. Found only on disturbed land on Santiago Peak. Blooms from May through October.

Papaver

P. californicum. Western Poppy. Occasional on disturbed land and burns. Collected on Main Divide Truck Trail at 4000 feet. In bloom June 15, 1938.

Dicentra

D. chrysantha. Golden Ear Drops. Common along road cuts, trails, gravelly washes below 3000 feet. Blooms in June.

D. ochroleuca. Restricted to north end of mountain in vicinity of Skyline Drive.

Lepidium

L. nitidum. Common in the grassland belt; occasional on open places in sagebrush belt.

Sisymbrium

S. officinale. Hedge-mustard. Occasional on disturbed areas in sagebrush belt below 2000 feet. In flower September 3, 1937.

Diplotaxis

D. tenuifolia. Wall-rocket. Collected only on Pacific slope in disturbed areas.

Brassica

B. campestris. Yellow Mustard. Common on grassland belt and cultivated fields, principally on Pacific slope. Blooms from January through May.

B. nigra. Black Mustard. A common plant on firebreaks, at low elevations, even when not seeded.

Dentaria

D. californica. Spectacle-pod. Occasional in grassland belt.

Capsella

C. bursa-pastoris. Shepherds Purse.

Thysanocarpus

T. curvipes var. *pulchellus.* Common in grassland and disturbed areas as high as 2600 feet. Bedford Truck Trail. In bloom April 13, 1940.

Erysimum

E. asperum. Wallflower. Common on clearing, Santiago Peak. Begins bloom about middle of April until June 15.

Echeveria

E. pulverulenta. Chalk Lettuce. Common on steep, rocky canyon walls as in Trabuco Canyon and Coldwater Canyon.

E. nevadensis. Collected only along tributary of Trabuco Canyon on dry, rocky, canyon wall.

E. lanceolata var. *aloides.* Taken among rocks in *Salvia leucophylla* association on Black Star Canyon Road, Orange Co., rare; in bloom May 26, 1940.

E. edulis. Found occasionally all along the east and west faces of the range; usually in rocky situations. Collected at Temecula River, near Glen Ivy, San Juan Canyon, etc.

Saxifraga

S. californica. Occasional on grassy areas below 3000 feet.

Ribes

R. malvaceum var. *viridifolium.* A member of the chaparral belt; occasional in open places. Reaches its optimum development between 1500 and 3500 feet, although it extends as high as 4000 feet. The first bloom begins in late December and continues at higher elevations, until late February.

R. indecorum. A member of the chaparral belt; usually confined to shaded slopes, or growing beneath trees such as *Quercus chrysolepis,* etc. Found between 1000 and 4500 feet. Blooming period begins in late December and lasts nearly throughout March, at upper limits.

R. speciosum. An unimportant member of chaparral belt growing in dense chaparral or beneath canyon live oaks from 2000 to 3500 feet. A single plant at 2000 feet bloomed continuously from December through February.

R. hesperium. Grows in dense chaparral of north-facing canyon slopes up to 3000 feet.

R. roezlii. Found principally in vicinity of Santiago Peak above 4500 feet. Earliest blooming date, April 20, 1940. In fruit May 25, 1940.

Platanus

P. racemosa. Sycamore. Common in dry washes and along streams at low elevations; less common along streams as high as 4500 feet. Will grow even on hot southern exposures on rocky slopes if sufficient water available.

Holodiscus

H. discolor var. *franciscana.* Miss Arline Lei has given me this identification for material taken on north face of Los Pinos Peak at 3800 feet, and in upper Claymine Canyon. This variety is characterized by a broad, double-toothed leaf, and a relatively large, loose inflorescence. Blooming period very short; entirely in month of June.

H. boursieri. Identified by Miss Arline Lei. Restricted almost entirely to the north face of Santiago Peak. It has a very small leaf that approaches very closely *microphyllus* found in the San Bernardino and San Gabriel Mountains. Blooms in June.

Photinia

P. arbutifolia. Toyon. Common in chaparral belt up to 4000 feet; maximum development between 1500 and 3500 feet. Growing period begins in March and lasts through April. Blooms in June. Advances to 2500 feet on north-facing slopes and to 3500 feet on southeast-facing slopes.

Rubus

R. leucodermis. Western Raspberry. Very restricted. Found in vicinity of seepages on otherwise xeric slopes as at Horsethief Springs, 4000 feet.

R. vitifolius. Western Blackberry. Much more common than *leucodermis.* Forms large tangle of vegetation along moist stream banks in well-shaded areas as in Trabuco Canyon at 2500 feet. Fruit ripens in June.

Potentilla

P. lindleyi. Open areas in chaparral belt on gravelly soil, at low elevations, as on Ortega Road at 2500 feet. Blooms in April and May.

P. glandulosa var. *reflexa.* Collected only on Santiago Peak. Blooms in May and June.

Cercocarpus

C. betuloides. Some specimens approach var. *multiflores* very closely. An important plant of the chaparral belt on xeric slopes and ridges. It is capable of growing on precipitous slopes and dry, hot ridges. It comes back quickly following fire. Found from base of range to Santiago Peak, but more abundant below 4000 feet. At higher elevations it is found only on south and east facing slopes and canyon walls. Important plant in successional chaparral after fire. Begins bloom about April 1 at 1200 feet and about June 20 on Santiago Peak; a lag of approximately 13 days per thousand feet.

Adenostoma

A. fasciculatum. Chamise "Greasewood." The most abundant chaparral species in the lower, that is chamisal, chaparral belt. Found from mountain base to 4500 feet; optimum development between 2000 and 3500 feet. At elevations above 4000 feet, it is restricted to ridges and xeric slopes. Usually a shrub six to nine feet high. In unfavorable locations, particularly on the north end in the path of high velocity winds, it may form, in exposed places, a sparse mat of vegetation less than 18 inches in height.

Chamise is an important successional plant in Coulter Pine domain, because the pine, like chamise, grows best on exposed ridges.

Buds are well-formed by the end of second week in April, at low elevation. By May 6, blooming begins on southern exposures at 1000 feet; by May 17, bloom has spread as high as 2500 feet; by June 15, all plants below 2600 feet are in fruit, those between 2500 and 3500 in flower, those plants at or above 4000 feet just coming into flower. This would indicate a lag of 13 days per thousand feet in flowering period.

Growth is stimulated by late summer rains. In September, 1939, considerable rain

fell. It was followed by an unusually warm fall. During this period as much as 6 inches of new growth was measured on many plants.

This plant forms little or no humus. This, correlated with its highly inflammable nature, makes it of little value as a watershed plant. During heavy storms, I have watched water flowing almost unimpeded between the bases of these plants; extensive erosion inevitably follows. Usually chamise will sprout from the stump after fire.

Rosa

R. californica. Wild Rose. Wild rose is found in wet places at low elevation on both sides of the range, and at both ends. Nowhere common. Taken at Glen Ivy, Temecula River, Santa Ana Canyon, Trabuco Canyon, etc.

Prunus

P. ilicifolia. Hollyleaf Cherry. Common member of chaparral belt up to 3500 feet. Blooms in May and June. Growth period follows bloom.

Pickeringia

P. montana. Chaparral Pea. Unimportant member of chaparral belt on the northern one-third of range, from Pleasants Peak to Santa Ana Canyon.

Lupinus

L. densiflora var. *austrocollium.* Collected on ridge between Bedford and Brown Canyon, at 2500 feet. In bloom April 28, 1940.

L. bicolor var. *microphyllus.* Collected near Modjeska Springs, 4600 feet. In bloom April 13, 1940.

L. hirsutissimus. Collected in Trabuco Canyon, June 11, 1940.

L. truncatus. Open places in chaparral belt. Collected on ridge between Bedford and Brown Canyon, 2300 feet. In bloom April 3, 1938.

L. sparsiflorus. Disturbed areas. Collected in Trabuco Canyon. In bloom April 3, 1938.

L. latifolius var. *parishii.* Collected east ridge of Coldwater Canyon, 1200 feet. In bloom March, 1937.

L. excubitus var. *hallii.* Scattered plants in sage association at many localities. Blooms in April.

Trifolium

T. tridentatum var. *aciculare.* Common on grassy areas in open, disturbed places below 3500 feet. Collected in bloom on Holy Jim Trail, 3500 feet, April 28, 1940.

T. involucratum. Damp places in canyons.

Lotus

L. crassifolius. Dry slopes beneath chaparral species above 4000 feet.

L. strigosus. Common in open canyon mouths. Collected in bloom in Trabuco Canyon, April 3, 1938.

L. salsuginosus. Common on dry slopes in sagebrush and chaparral belts and in adjacent cultivated fields. Blooms in May.

L. eriophorus var. *heermannii.* Inhabits dry slopes and rocky canyon walls below 4500 feet.

L. scoparius. Deerweed. Important constituent of the sagebrush belt below 1500 feet. Blooms in April and May.

Psoralea

P. macrostachya. Uncommon. Collected in Trabuco Canyon and at Horsethief Springs at 4000 feet. Blooms in June.

Amorpha

A. fruiticosa. Uncommon. Collected below 1500 feet along dry stream banks. Collected at Lee Lake, May, 1938.

A. californica. Locally common. Occupies disturbed places in chaparral belt between 3200 and 4600 feet. Blooms in May and June.

Astragalus

A. leucopsis. Collected in Trabuco Canyon. In bloom April 3, 1938.

Lathyrus

L. strictus var. *barbarae.* Common below 2000 feet. Climbs over chaparral plants. Blooms in April.

Erodium

E. moschatum. Filaree. Common on grassland and disturbed areas in sagebrush belt, particularly on interior slopes. Blooms in March.

E. circutarium. Common on cultivated fields, particularly on Pacific slopes; occasional in sagebrush belt, disturbed areas.

Polygala

P. fishiae. Milkwort. Collected at Main Street Canyon, and along Temecula River. Flowers in June.

Croton

C. californicum. Collected on sandy benches in Temescal Canyon.

Rhus

R. diversiloba. Poison-Oak. Common in moist, shaded places, usually in canyons or about springs. Found up to 4500 feet. Blooms in March and April.

R. trilobata. Squaw Bush. Common in open washes and flat lands below 3000 feet. Collected in bloom, April 9, 1939.

R. laurina. Laurel Sumac. Important plant in the sagebrush and chaparral belts below 2000 feet. Plants in exposed areas badly damaged by the severe cold of winter 1936-37. Growing period begins in March and continues through April. Buds begin to form in May; first bloom at 1400 feet June 10, 1940. Mature fruits available to animals from September to January.

R. integrifolia. Lemonade Berry. Chaparral belt. Found below 2500 feet, only on the Pacific slope and on the north end of the range where it comes up through the Santa Ana Canyon to Sierra Peak. Blooms in January and February. Growing period in May and June.

R. ovata. Sugarbush. Chaparral belt. Found from 1100 feet to 5000 on both slopes. At lower elevations, blooming period begins early in April and continues, at higher elevations, until June. In fruit at lower elevations in May and June. Growth begins after blooming period.

Acer

A. macrophyllum. Maple. Riparian. Important tree in riparian association from 2500 to 4000 feet. Found principally in canyons of Pacific slope.

Rhamnus

R. californica typica. Coast Coffee-berry. Chaparral belt. Found below 2500 feet in canyons and slopes, principally on the Pacific slope. Blooms in May; fruit collected in June.

R. californica cuspidata. Chaparral belt. Typical specimens collected above 2500 feet on both slopes, although more common on the interior slope. Common on Santiago Peak. Considerable intergradation with *typica,* especially around Sierra Peak, Coldwater Canyon, etc. Blooms in June. Mature fruits found in August and September.

R. crocea typica. Collected only on the interior slope at low elevations, as at foot of Indian Truck Trail, 1200 feet.

R. crocea ilicifolia. Much more common than *typica;* collected on both slopes. Found from base of mountain up to 4500 feet.

Ceanothus

C. integerrimus. Deer Brush. Chaparral belt above 4300 feet. Very limited distribution. Collected only at Bear Springs and on Santiago Peak. Blooms in May and June. Stump sprouts after fire.

C. tomentosus var. *olivaceus.* Chaparral belt. Dr. H. C. McMinn identified this var. for me. Found from 1600 up to 4000 feet altitude. Collected from Temecula River to Sierra Peak, but more common in central half of range. Blooms in March and April. Stump sprouts.

C. oliganthus var. *orcuttii.* Chaparral belt. Dr. McMinn gives me this diagnosis for specimens collected on Holy Jim Trail, 3100 and 4000 feet; Bear Springs, 4300 feet; and Hagador Canyon, 4000 feet. Taken in flower March 19, 3100 feet; in fruit June 15 at same elevation. More abundant on southern half of range.

C. spinosus. Chaparral belt. Collected only on the Pacific slope except near Temecula River. Never found above 1700 feet. Blooms in March and April. Several plants in San Juan Canyon are spineless.

C. palmeri. Chaparral belt above 4300 feet. Infrequent. Collected at Bear Springs and Santiago Peak. Associated with *integerrimus* and difficult to distinguish from the latter species in the field, except that it blooms about two weeks earlier; May 17 as against May 28, at same altitude.

C. papillosus. Chaparral belt above 3000 feet. Collected at two stations: Holy Jim Trail, 3000 feet and Main Divide Truck Trail, in vicinity of Pleasants Peak, 3700 feet. Blooms in April and May. Represents southernmost distribution of this plant.

C. megacarpus. Chaparral belt below 2500 feet. Confined entirely to the north end of the range in vicinity of Sierra Peak. Blooms in January and February.

C. crassifolius. Chaparral belt below 4500 feet. Widespread. Most common *Ceanothus* on the Santa Ana Mountains. Common associate of chamise. Blooms in January, February, and March, depending on altitude. Lag of 13 days per thousand feet in blooming period. Stump sprouts after fire.

C. leucodermis var. *eglandulosa.* Chaparral belt from 1000 feet to Santiago Peak; more abundant above 3500 feet. Abundant in disturbed areas. Blooms in March and April.

C. sorediatus and *C. tomentosus* var. *olivaceus.* McMinn has given me this diagnosis for specimens collected in chaparral belt between 2500 and 4000 feet, between Bedford and Trabuco Peaks. In the field, these plants are indistinguishable from var. *olivaceous.* Blooms in March and April. Collected at the following stations: Indian Truck Trail, 2500 feet; Holy Jim Trail, 3100 feet; Bedford Truck Trail, 2800 feet; Bedford Peak.

Vitis

V. giardiana. Wild Grape. Riparian. Found below 4000 feet in shaded canyons. Forms hanging shrouds from trees such as Alder, California Laurel, and Sycamore. Taken at spring on southeast facing slope of Holy Jim Trail; forming dense mat of vegetation over the talus debris.

Malvastrum

M. fasciculatum. Sage and chaparral belts. Most abundant near the northern end of range on Pacific slope, as in vicinity of Black Star Canyon. Approaches var. *laxiflorum.* Blooms in May.

M. densiflorum. Chaparral belt. Collected only on the interior slope below 3000 feet. Blooms in January and February.

Helianthemum

H. scoparium var. *aldersonii.* Dry, open situations in chaparral and conifer belt on limestone soil between 2500 and 4500 feet.

Viola

V. pedunculata. Wild Pansy. Grassland and open, grassy situations in sage and chaparral belts below 4500 feet. Blooms in March and April.

V. purpurea. Open, rocky situations in chaparral belt between 3500 feet and Santiago Peak.

Mentzelia

M. micrantha. Infrequent on disturbed areas, such as roadcuts and burns between 2000 and 5000 feet.

Datisca

D. glomerata. Riparian. Common along streams at low elevations.

Opuntia

O. parryi. Collected on gravelly stream benches at low elevation on interior slope only. Blooms in May.

O. basilaris. In dry washes at low elevations, on interior slope only.

O. occidentalis. Common in sagebrush belt at low elevation on both slopes.

Zauschneria

Z. californica. Cosmopolitan from base of mountain to Santiago Peak. Appears to prefer rocky situations, but has been taken growing out of logs and in wild grape tangles. Blooms in August and September.

Z. latifolia var. *johnstonii.* Taken at Modjeska Springs and Santiago Peak. Blooms in July and August.

Epilobium

E. californicum. Riparian. Bear Springs.

Clarkia

C. rhomboidea. Chaparral belt. Open situations. Usually above 4000 feet. Blooms in June.

Godetia

G. quadrivulnera. Open, disturbed situations in chaparral belt. Collected on Modjeska Flat. Blooms in June.

G. purpurea var. *parviflora.* Taken on meadow land at summit of Skyline Drive, 2700 feet.

G. bottae var. *deflexa.* Rare. Bear Springs. In bloom, June 15, 1938.

G. epilobiodes. Bedford Truck Trail, 2600 feet. In bloom, April 13, 1940.

Oenothera

O. hookeri. Evening Primrose. Bear Springs. In bloom, June 15, 1938.

O. bistorta var. *veitchiana.* Common on disturbed areas at low elevations. Indian Truck Trail, 1200 feet; April 12, 1938, in bloom.

Lomatium

L. dasycarpum. Open ridge between Bedford Canyons, 2300 feet. Blooms in March and April.

Garrya

G. flavescens. Important member of the chaparral belt above 3500 feet. Many specimens approach var. *pallida* but others are nearly typical *flavescens.* The problem is further complicated by other material that is quite glabrous and thus approaches *G. fremontii.* However, typical plants of this species bloom earlier than the more typical *fremontii.*

G. fremontii. Important member of the chaparral belt above 4000 feet, although a few specimens found as low as 2500 feet. This plant is not typical *fremontii,* since the fruits are not as glabrous as type material.

It approaches material that has been described as *G. fremontii* var. *rigida.* It is certain that two groups of *Garrya* with opposite sets of characters are found on the Santa Ana Mountains. The most reliable difference that I have so far found is one of the blooming period. The plants that I now assign to *flavescens* bloom in November, while those plants here called *fremontii* do not begin until December. The two plants may in many instances grow side by side. Both stump sprout following fire.

Arbutus

A. menziesii. Madrona. Restricted to two colonies in the Trabuco Canyon district from 2000 to 3500 feet.

Arctostaphylos

A. glauca. Manzanita. Common member of the lower chaparral belt, but only in central portion of the range. Extends from 1000 to 4300 feet. Blooms in December and January. Doesn't stump sprout following fire. Begins growth in April.

A. drupacea. Chaparral belt. Successional in Coulter Pine forest. Taken only above 3500 feet. Blooms in January and February.

A. glandulosa. Most important manzanita in the chaparral belt. Found from 2400 feet up to Santiago Peak. Most abundant above 3000 feet. Found from Temecula River to Sierra Peak. An extremely variable species. Stump sprouts following fire. Blooms in February, March, and April.

A. bicolor. Restricted to southern end of range. Chaparral belt at low elevations. Collected in Riverside County, north of Temecula River near Pala. Associated with *Adenostoma fasciculatum* and *Ceanothus tomentosus* var. *olivaceus.*

Dodecatheon

D. clevelandii. Shooting Star. Grassland belt and open, grassy areas in sagebrush belt below 2500 feet. Blooms in January, February, and March. Plants with white flowers common on Santa Ana Mountain.

Styrax

S. officionalis var. *fulvescens.* Styrax. Chaparral belt. Grows on exposed slopes and in vicinity of live oaks. Collected only on Pacific slope from Trabuco Canyon to San Juan Canyon, between 1500 and 3000 feet. Blooms in May.

Fraxinus

F. dipetala. Chaparral belt. Common on canyon slopes below 3500 feet. Blooms in April and May.

Centaurium

C. venustum. Chaparral belt below 3000 feet. Grows beneath chamise, deer brush, etc. Blooms in June.

Asclepias

A. californica. Disturbed areas at low elevation. Blooms in May.

Cuscuta

C. californica. Sagebrush belt.

C. subinclusa. Chaparral belt.

Convolvulus

C. occidentalis var. *cyclostegius.* Along roadways and trails.

C. occidentalis var. *angustissimus.* Chaparral belt. Growing over chamise and deerbrush.

Gilia

G. gilioides var. *glutinosa.* Pioneer on firebreaks. Collected on Trabuco Peak.

G. achilleafolia. Common in open places at or above 4000 feet. Blooms in May and June.

G. inconspicua var. *diegensis.* Collected on Indian Truck Trail, 2400 feet. In bloom, April 16, 1938.

G. dianthoides. Trabuco Canyon. In bloom, April 3, 1938.

G. nuttallii. Indian Canyon, 3000 feet. In bloom, May 5, 1938.

G. californica var. *glandulosa.* Open places in chaparral belt from 1400 to 4000 feet. Seems to prefer limestone rocks. Blooms in April and August.

G. atractyloides. Disturbed places in chaparral belt.

G. virgata var. *sapphirus.* Modjeska Flat, 4500 feet. In bloom June 15, 1940.

Nemophila

N. rotata. Damp, open places in chaparral belt from 2000 to 4000 feet. Blooms in March and April.

Ellisia

E. chrysanthemifolia. Moist areas beneath chaparral below 3000 feet. Blooms in March and April.

Phacelia

P. minor. Open, gravelly areas on limestone formations from 1000 to 4000 feet. Blooms from March to June.

P. hispida. Open, gravelly areas from 1000 to 4000 feet. Blooms from June to August.

P. curvipes var. *davidsonii.* Open areas in chaparral above 3000 feet.

P. keckii. Open areas in chaparral above 4000 feet.

Emmenanthe

E. penduliflora. Dry slopes in chaparral belt. Blooms in June.

Eriodictyon

E. crassifolium. Chaparral belt, disturbed areas, from 1000 to 5000 feet. Important constituent of successional sage. Frequently in pure stands where chaparral has been cleared out. Common along roadways. Blooms March to June.

E. parryi. Grows in open places from 3000 feet to Santiago Peak. Common on clearings. Blooms from June to August.

Pectocarya

P. penicillata. Sandy areas along streams. Low elevations.

Amsinckia

A. intermedia. Common on any disturbed land below 2500 feet.

Plagiobothrys

P. californicus. Firetrails below 2300 feet.

Verbena

V. prostrata. Canyons at low elevations.

Trichostema

T. lanceolatum. Vinegar-weed. Sagebrush belt and cultivated fields. Blooms from August through September.

T. lanatum. Romero. Found principally on north end of the mountain, but occurs occasionally on disturbed areas in chaparral as far south as Santiago Peak, from 1000 to 5500 feet. Blooms in May and June, and again in fall.

Marubium

M. vulgare. Cleared areas anywhere from 1000 feet to Santiago Peak. Blooms from June to July.

Stachys

S. rigida. Moist places above 4500 feet.

S. rigida var. *quercetorum.* Ortega Road, 2000 feet; damp situation.

Salvia

S. columbariae. Chia. Common on limestone soils. Blooms in May and June.

S. mellifera. Black Sage. Important member of sagebrush belt. Grows from 1000 to 3500 feet. Blooms in April and May.

S. leucophylla. Lavendar Sage. Grows in foothills only on Pacific slope from Santiago to Black Star Canyon. From 1000 to 2500 feet. Prefers shale formation. Blooms in May.

S. apiana. White Sage. Important member of the sagebrush belt. Occurs as high as 4500 feet on southern exposures in successional sage. Blooms in May and June.

S. carduacea. Thistle Sage. Collected in bloom near Alberhill on May 14, 1939.

Lepechinia

L. calycina var. *wallacei.* This is the only name at present available for this plant. However, the *Lepechinia* found on the Santa Ana Mountains is unique. At present Dr. Carl Epling is carrying on some transplant experiments with this form and those found in San Diego and Los Angeles counties. He indicates that its closest relationship appears to be with the form found in the Santa Monica Mountains. Found from 2000 to 4500 feet. On the Santa Ana Mountains, it occurs principally on disturbed areas. Blooms in May to June and again in August.

Monardella

M. macrantha var. *ballii.* Collected near Bear Springs beneath live oaks and Big-cone spruce and in cleared area in chaparral along Main Divide Truck Trail near Modjeska Peak. Both locations over 4000 feet. Blooms in May and June.

M. hypoleuca. Trabuco Peak. Growing on exposed areas in chaparral.

M. lanceolata. Abundant on burned areas as on face of Modjeska Peak. Blooms in June.

Pycnanthemum

P. californicum. Moist areas along streams below 4000 feet.

Solanum

S. douglasii.

S. xantii.

Datura

D. meteloides. Gravelly soils in disturbed places. Blooms in July and August.

Nicotiana

N. glauca. Tree Tobacco. Disturbed areas up to 2500 feet.

Antirrhinum

A. coulterianum. Open places in chaparral belt from 1500 to 4500 feet. Blooms from April to June, and again in August.

A. nuttallianum. Taken only on Ortega Road, 1900 feet. Riverside County.

Collinsia

C. heterophylla. Moist situations on shaded slopes, usually beneath live oaks, below 2000 feet. Blooms in April and May.

Scrophularia

S. californica. Not common at any one location. Collected from 1000 to 5200 feet. Blooms in May and again in September.

Pentstemon

P. antirrhinoides. Important member of the sagebrush belt; successional in the chaparral belt. Found from 1100 to 4500 feet. Blooms in April and May.

P. cordifolius. Common in chaparral belt between 2200 and 5000 feet. Blooms in June and again in August and September.

P. ternatus. Common in dense chaparral on southeast exposures from 3800 to 5000 feet. Blooms in June and again in August and September.

P. spectabilis. Found in dry, exposed places in chaparral and along roadways from 1100 to 5200 feet. Blooms April through June.

P. spectabilis var. *subviscosus.* Collected only on the west face of Santiago Peak at 5500 feet. Blooms in May.

P. heterophyllus. Modjeska Peak, rocky situations. In bloom June 15, 1938.

P. heterophyllus var. *australis.* Modjeska Flat, 4500 feet. In bloom June 15, 1940.

Mimulus

M. cardinalis. Moist situations along streams from 1100 to 4500 feet. Blooms from June to October.

M. guttatus. Moist situations at low elevations. Blooms in April.

M. floribundus. Only record, Bear Springs.

M. diffusus. Successional sagebrush belt and natural openings in chaparral belt.

M. brevipes. Common on disturbed areas from 1200 to 4300 feet. Blooms from April to September.

M. fremontii. Limestone soils below 4200 feet. Blooms in June.

M. clevelandii. Common on limestone soils southeast of Santiago Peak. Confined to belt between 3000 and 4500 feet. Blooms in May and June.

M. longiflorus. Hardy plant that will grow on steep, loose slopes; also found in sagebrush and chaparral belts from 1200 to 4500 feet. Commences blooming in May and persists into June; dormant during summer; reblooms in fall.

M. longiflorus approaching var. *linearis.* With the species, near upper limits of distribution.

M. puniceus. Chaparral belt between 2000 and 3000 feet. Blooms from January to May.

Castilleja

C. stenantha. Bear Springs, moist situation.

C. foliolosa. Dry, exposed areas in chaparral and secondary successional sagebrush from 1200 to 4500 feet. Blooms in April.

C. douglassii. Bear Springs; secondary successional sage. Blooms in June.

C. martini. Chaparral belt above 4000 feet. In bloom, June 15, 1940.

C. miniata var. *oblongifolia.* Collected only in Hagodor Canyon.

Orthocarpus

O. purpurascens. Grassland and sagebrush belts at low elevation. Blooms in April and May.

O. purpurascens var. *pallidus.* With the species.

Cordylanthus

C. filifolius. Collected only on Trabuco Peak.

Orobanche

O. bulbosa. Common on *Adenostoma fasciculatum.*

O. fasciculata. Collected on South Trabuco Peak.

O. fasciculata intergrading with var. *franciscana.* Found with the species.

Plantago

P. hookeriana var. *californica.* Trabuco Canyon. In bloom, April 3, 1938.

Galium

G. angustifolium. Important plant in chaparral belt from 1000 to 5000 feet. Blooms in May.

Sambucus

S. coerulea. Blue Elderberry. Found from base of mountain up to Santiago Peak. Blooms in May and June.

Symphoricarpos

S. albus var. *mollis.* Chaparral belt and particularly beneath woodland trees from 1000 to 4000 feet. Most abundant on northeast-facing slopes.

Lonicera

L. johnstonii. Honeysuckle. Found from base of mountain to Santiago Peak; frequently in rocky situations. Blooms in May and June.

Cucurbita

C. foetidissima. Calabazilla. Disturbed areas at low elevations. Blooms in May and again in August.

Echinocystis

E. macrocarpa. Climbs over chaparral plants. Blooms in March and April.

Specularia

S. biflora. Disturbed places in Temescal Canyon.

Heterocodon

H. rariflorum. Moist, grassy situations.

Palmerella

P. debilis var. *serrata.* Canyons, principally on interior slope.

Brickellia

B. californica. Dry, gravelly stream beds and fans at low elevations. Collected on Temecula and Main Street Canyons. Fall blooming period.

Gutierrezia

G. californica. Infrequent member of sagebrush belt at low elevations. Blooms in July and August.

Heterotheca

H. grandiflora. Common on disturbed places at low elevations.

Solidago

S. californica. Occasional on clearings up to Santiago Peak. Blooms in August.

Aplopappus

A. pinifolius. Occasional in chaparral belt. Blooms in August and September.

A. parishii. Common in chaparral and along roadways between 3500 and 5000 feet. Blooms from August to October.

A. venetus var. *vernoniodes.* Sagebrush belt. Blooms in August.

A. squarrosus. Open places in chaparral belt below 3000 feet. Blooms in August and September.

Corethrogyne

C. filaginifolia. Top of Horsethief Trail in open Coulter Pine Forest. In bloom September 1, 1937.

Baccharis

B. viminea. Along streams and washes at low elevations. Taken in bloom in March. Low elevation.

B. glutinosa. Occasional with *viminea.* Collected at Glen Ivy and in lower Tin Mine Canyon.

B. emoryi. Common in moist places, as in Tin Mine Canyon, and on Bedford Truck Trail, at 2700 feet. Blooms in October.

Gnaphalium

G. californica. Everlasting. Occasional in open places in chaparral and conifer belts on limestone soils. Collected at top of Horsethief Trail in bloom on April 3, 1938.

G. beneolens. Common in sagebrush belt and openings in chaparral from base of mountain to Santiago Peak. Blooms in June.

Xanthium

X. spinosum. Waste places near highways. Collected on Ortega Road.

Helianthus

H. gracilentus. Open places in chaparral belt from 1100 feet to Santiago Peak. Blooms in May and June.

Encelia

E. farinosa. Found on the interior slope in sagebrush belt from Elsinore to Eagle Canyon; usually in disturbed areas. Abundant on foothills to the east.

E. californica. Occasional in the sagebrush belt; wider distribution than above.

Hemizonia

H. kelloggii. Common on formerly cultivated fields at base of mountain; occurs also in sagebrush belt.

H. tenella. Common on flat land on the southern half of range, as at Los Pinos Portrero and Ortego Road.

Layia

L. platyglosa. Grassland belt and disturbed areas up as high as 3000 feet. Blooms in early spring.

Baeria

B. chrysostoma var. *gracilis.* Alluvial fans, grassy areas at low elevations. Blooms in April.

Eriophyllum

E. confertiflorum. Common at low elevations in sagebrush belt.

E. confertiflorum var. *trifidum.* Collected in Tin Mine Canyon and on Bedford Road at 1400 feet. Blooms in May.

Chaenactis

C. artemisiaefolia. Disturbed places in sagebrush and chaparral belts.

Achillea

A. millefolium var. *lanulosa.* Collected at Bear Springs. In bloom, June 15, 1938.

Artemisia

A. tridentata var. *angustifolia.* Found sparingly along the Temecula River in association with *Artemisia californica.* In bloom, October 19, 1941.

A. californica. Coastal Sagebrush. Important member of the sagebrush belt. Blooms in July and August.

A. douglasiana.

A. ludoviciana.

Lepidospartum

L. squamatum. Common in all of the drier, open-mouthed canyons below 1500 feet. Blooms in fall.

Arnica

A. parviflora var. *alata.* Southernmost station of this variety found in this range. Collected beneath Canyon Live Oaks at Modjeska Springs, 4500 feet. Blooms in April through June.

Senecio

S. douglasii. Common on disturbed places in sagebrush and chaparral belts below 4500 feet. Blooms in August and September.

Cirsium

C. californicum. Found everywhere that original plant cover has been disturbed. Blooms in April and May. Important forage plant of hummingbirds.

Microseris

M. linearifolia. Common in shaded, grassy areas, at low elevations. In bloom, April 3, 1938.

Malacothrix

M. saxatilis var. *tenuissima.* Open areas in chaparral belt. Not common. This plant is limited to the Santa Ana Mountains.

AMPHIBIA OF THE REGION

Nine species of amphibia were detected in the Santa Ana Mountains. Of these four are caudate and five are acaudate species.

ACCOUNTS OF THE SPECIES

Triturus

T. torosus. Pacific Coast Newt. This salamander is common in pools and slowly moving streams, from 1800 to 3000 feet. These altitudinal limits are determined by the nature of the streams: the upper portions are too swift and the lower reaches dry up soon after the rain period before completion of the breeding activities of the species. Because of the greater rainfall and a more extensive rain collecting area, and probably because of the lesser gradient of the stream beds, the newt is more common on the Pacific slope than on the interior slope.

The number of newts observed in streams rises from a low in early March to a peak around the middle of June, when some streams average one animal per ten feet of open stream and nine per pool. Egg masses have been collected as early as the middle of March, and as late as the middle of June.

Batrachoseps

B. attenuatus major. Garden Salamander. Common in humus and rocky areas along streams, as high as 4600 feet. Some specimens from Orange County approach *B. attenuatus attenuatus,* especially with regard to the vomerine teeth.

Ensatina

E. eschscholtzii eschscholtzii. Oregon Salamander. A relatively uncommon salamander. Three specimens taken, all from Silverado Canyon in Orange County: one at low elevation, two at Maple Springs (4600 feet).

Aneides

A. lugubris lugubris. Arboreal Salamander. Locally common, particularly in Orange County and at fairly low elevations.

Scaphiopus

S. hammondii hammondii. Western Spadefoot Toad. Found only during years of at least normal rainfall. First adult taken on the interior slope the night of February 17, 1941. Because of the unusually heavy rainfall of this year, this species was taken in several localities where its presence had not been suspected before.

Bufo

B. boreas halophilus. California Toad. Common in canyons and on grassy slopes at low elevations; occasional individuals taken as high as 4200 feet on dry, chaparral slopes.

Hyla

H. regilla. Pacific Tree-frog. This tree-frog is the most abundant anuran on the Santa Ana Mountains. Taken as high as Santiago Peak.

H. arenicolor. Canyon Tree-frog. Common in larger canyons, but only in association with large boulders. This species is less abundant at lower elevations and in interior canyons than *regilla.* Its lower altitudinal limit seems to approximate the point to which streams recede during the dry season.

REPTILES OF THE REGION

Nine lizards, eighteen snakes, and one tortoise, or a total of twenty-eight reptilian species were collected on the Santa Anas.

ACCOUNTS OF THE SPECIES

Uta

U. stansburiana hesperis. California Brown-shouldered Lizard. Abundant in open places in the more arid vegetational belts, from the base of the mountain to Santiago Peak. Many specimens were collected on warm days in December and January, as high as 4500 feet. Road-runners feed on these lizards on firebreaks during winter months.

Sceloporus

S. graciosus vandenburgianus. Southern Mountain Swift. Mountain swifts are common in chaparral and open stands of Coulter Pine, from 3000 feet up to Santiago Peak. A female collected on June 12, at 3000 feet, had 7 eggs measuring 7 x 13 mms.; a female taken on June 13, at 5600 feet, had 7 eggs measuring 7 x 7.5 mms.

S. occidentalis biseriatus. Western Blue-bellied Lizard. Common about logs and live oaks in canyons, about large shrubs on chaparral slopes, and in open conifer forest.

Taken from mountain base up to Santiago Peak. A female taken on June 13, at 2500 feet, carried 9 eggs, measuring 12 mms.; another taken at 4100 feet on the same day possessed 11 eggs, averaging 13 mms. in length.

S. orcutti. Dusky Scaly Lizard. Scaly lizards were found only on granitic boulders toward the southern end of the range, and on outcroppings of igneous rock toward the north. They appear to be confined to a belt between 2000 and 5500 feet. It is particularly common on the southern half of the range from Los Pinos Peak to the Ortega Road and thence southward, probably because of the prevalence of granitic outcroppings on this half of the range. Two specimens were taken as far north as Santiago Peak, and I have sight records from Silverado and Black Star Canyons, but because of the scarcity of outcroppings on this northern half, the lizard is quite rare here.

The two specimens taken near Santiago Peak were collected by hand at 5500 feet on January 20, 1939, following a night with a minimum temperature of 28 degrees. A female taken on the Main Divide Truck Trail at 2700 feet on June 14 contained 5 eggs, measuring 16 mms. in length.

Phrynosoma

P. coronatum blainvillii. San Diego Horned Lizard. With reference to the frontal plates, the majority of specimens taken on this range belong to this subspecies. Some few individuals without roughened plates fit very closely the description of the subspecies *frontale.*

Horned lizards are common on gravelly soil in the sagebrush and chaparral communities from the mountain base up to 2000 feet. Above this point occasional specimens have been taken as high as 4600 feet. So far as I can determine, these lizards make their first appearance in late March and become very common in April, although the date of emergence is probably directly controlled by temperature. In 1937, after an extremely cold winter, the earliest record was obtained on April 14; in 1939, following a relatively mild winter, the earliest record was obtained on March 18.

Gerrhonotus

G. multicarinatus webbii. San Diego Alligator Lizard. Common in chaparral and woodland vegetation from the base of the mountain up to 5000 feet. At low elevations, this lizard remains active throughout the year.

Cnemidophorus

C. tessellatus stejnegeri. Stejneger Whiptail Lizard. Common lizard in sagebrush and chaparral belts on slopes and in canyons from base of mountain up to 5000 feet. The whiptail is active below 2000 feet in later April but do not become abundant above this level until June. They reach their numerical maximum on this range between 2000 and 4000 feet. After the middle of June whiptails are encountered less and less frequently until their presence is seldom noted during July and early August. But they reappear in late August and are active until October.

Eumeces

E. skiltonianus. Blue-tailed Skink. Common lizard in the sagebrush and open woodland communities.

E. rubricaudatus. Red-tailed Skink. A rather uncommon lizard in this range. One specimen found early in the morning in a deep cooking utensil beneath a Coulter Pine. All indications point to the fact that it had fallen into the pan from the tree. The only other specimen taken from the range was obtained from a rocky outcropping above Irvine Park at an elevation of 2000 feet.

Leptotyphlops

L. humilis humilis. Western Worm Snake. A single specimen of worm snake was given me by some small boys who collected it near Glen Ivy at low elevation on the interior slope. Apparently much more common on the Perris Peneplain to the east.

Lichanura

L. roseofusca roseofusca. Rosy Boa. Common about rocks in the sagebrush and lower chaparral belts from base of mountain up to 3000 feet.

Diadophis

D. amabilis subsp. Western Ring-neck Snake. Relatively uncommon snake. Collections limited to Pacific slope at low elevation.

Coluber

C. flagellum frenatus. Red Racer. Uncommon snake in canyon washes and on dry slopes in the lower chaparral belt. Many specimens were observed in the vicinity of lagoons near Laguna Beach. This species was never observed above 1500 feet.

C. lateralis. Striped Racer. This species is the most conspicuous, if not most abundant, snake on the range. It has been collected from 900 feet up to Santiago Peak. It is much more common on the Pacific slope than on the interior.

Salvadora

S. grahamiae virgultea. Patch-nosed Snake. Occasional snake in the chaparral belt, particularly on the Pacific slope. A single specimen was taken in an open stand of Coulter Pine at 4100 feet on June 16, 1940.

Pituophis

P. catenifer annectens. San Diegan Gopher Snake. Common snake in all vegetational types except the Stream-side Woodland association. Collected as high as 5600 feet; apparently active throughout the year even at this increased altitude.

Lampropeltis

L. multicincta. Mountain King Snake. This species occupies the more mesophytic chaparral slopes and woodland vegetation in canyons from 2000 to 5000 feet. It was collected in Holy Jim, Silverado, and Santiago Canyons. A group of road workers found a small specimen above Bear Springs on June 15, 1938. Persisting in the belief that it was poisonous, despite my statements to the contrary, they insisted on carrying it to their camp tied to the end of a long pole.

L. getulus boylii. Boyle's King Snake. Common in the sagebrush belt at low elevations. This form of the species is the common one around the base of the mountain on both slopes.

L. getulus californiae. California King Snake. This form was not found on the range proper. It appears to be confined to a narrow strip of Santa Ana Coastal Plain running parallel to the range. The two specimens captured are almost intermediate with respect to coloration between the banding of *boylii* and the striping of *californiae.*

Rhinocheilus

R. lecontei lecontei. Western Long-nosed Snake. It is difficult to determine the environmental preference or even the abundance of this species since the single specimen that I have was found dead on the Ortega Road in San Juan Canyon on June 12, 1939. The vegetation on either side of the road (900′) was coastal sage; there were, however, numerous rocks in the vicinity.

Hypsiglena

H. ochrorynchus ochrorynchus. Spotted Night Snake. A single specimen of this species was found dead on the road at 1700 feet on the Ortega Road on June 15, 1941. The specimen was abroad during daylight since it was not present on this road at 6:00 a.m. when I had gone down to check mammal traps. On my return at 7:30 a.m. the snake, obviously recently killed, was found in the center of the road.

Thamnophis

T. ordinoides hammondii. California Garter-snake. Common snake along water courses between 1000 feet and 4300 feet. It is much more prevalent on the Pacific slope, probably because of the greater rainfall and longer period of time through which these streams carry water.

Tantilla

T. eiseni. California Tantilla. Collected at two locations: at 2400 feet on the Bedford Truck Trail, on December 26, 1940; and in upper Silverado Canyon, 2500 feet, in February, 1941. The first of these was discovered while scraping a level surface on a firebreak for a rain-gauge. The snake was observed to emerge from an ant burrow about one inch below the ground surface. It was very active despite a soil temperature of 15 degrees C.

Trimorphodon

T. vandenburghi. California Lyre Snake. Apparently the lyre snake is rather common, although it is not encountered frequently without a search. I have removed it from around granite boulders, toward the south end of the range. Harold Woodall reported to me that he had taken it in Silverado, Ladd, and Black Star Canyons, all of which are near the north end of the range.

Crotalus

C. ruber. Red Diamond Rattlesnake. This is the most common rattlesnake in the Santa Ana Mountains at low elevations. It reaches maximum abundance in rocky regions of the greasewood chaparral. On April 10, 1949 a small group of us collected 12 *ruber* in an area of two square miles above Irvine Park on the Pacific slope. At the same time only one each of *viridis* and *mitchellii* were taken. Collecting was facilitated by the fact that all of the chaparral had been destroyed by an extensive fire that had swept the region in November of 1948. Furthermore, early in the season this species is easier to capture in large numbers because they have not as yet spread from the wintering areas. All specimens were taken from sand-bottomed depressions around rocky ledges. It is interesting to note that several partially burned specimens were found among the rocks.

Because of its preference for chaparral, this species is killed in large numbers each year by road crews and trail crews engaged in clearing brush. A crew of five men killed 40 rattlesnakes between May 15 and June 15, 1938. Some of these are known to have been *ruber;* it is suspected that many of the others were also.

C. viridis oregonus. Pacific Rattlesnake. Believed to be the least common of the three rattlesnakes on this range. Unlike the other two, this form is more abundant in canyons than in chaparral and rocky places in sagebrush.

C. mitchellii pyrrhus. Speckled Rattlesnake. Without doubt this is the most widespread rattlesnake on the Santa Ana Mountains. Specimens have been collected or examined from many environments at all elevations. It appears to reach maximum numbers at intermediate elevations and in the near vicinity of outcroppings. Surpasses *ruber* in numbers at higher elevations.

On May 17, 1940 George Hutchinson, lookout on Santiago Peak at the time, told me that he had killed 6 rattlers on the peak since the first of May. The rest of his story is of wider interest: it appears that he had the habit of placing the dead snakes on a rock near his cabin. One evening he was attracted by a clattering sound coming from these rocks. Upon investigation he saw a small group of deer congregated around the rocks. The next morning he found that the deer had so stamped upon the snakes that only remnants of the skin remained on the rocks.

In the morning of June 12, 1941 I nearly stepped upon a Speckled Rattlesnake near my camp in Trabuco Canyon. It had come from dense sagebrush and was progressing toward the nearby stream. In its retreat into the brush it imbedded itself so well beneath a layer of grass that it was difficult to find it even though I had watched it disappear.

Two young rattlers of this species were taken on Santiago Peak: one in May and

the other in June. Each measured less than 12 inches in length and had only the button.

As recorded elsewhere (see Mammals: Accounts of Species), I observed a bobcat eating an individual of this species which it had just killed.

Clemmys

C. marmorata. Pacific Terrapin. Locally common in canyons supporting deep pools. It was collected in Black Star and Silverado Canyons, and in one stream in the Tenaja district southeast of Wildomar.

BIRDS OF THE REGION

One hundred and thirty-nine species of birds were detected in the Santa Ana Mountains. Since observations were made throughout the year, the total includes winter visitant birds. Of the 139 species, 62 are believed to be resident, 5 to be both resident and winter visitants, 5 to be both resident and summer visitants, 29 to be summer visitants, 19 winter visitants and 19 transients. Thurber's Junco and the Band-tailed Pigeon are good example of those birds placed in the resident-winter visitant category. During the winter large numbers of these birds inhabit the chaparral and Ridge-slope Woodland communities, but in April the bulk of the population moves out, leaving only a few birds of each species. Here and there, usually in shaded canyons well above stream sources, breeding juncos will be found; also, pigeons breed in relatively small numbers at various elevations, usually in association with oaks.

Costa's Hummingbird, the Phainopepla, Dusky Poorwill and others have been placed in the resident-summer visitant category. Although they are most numerous in summer, a few consistently remain year after year throughout the winter period.

One hundred and one species of birds are believed to breed on the Santa Anas. Nests, eggs, and young have been observed for many of these, although this definite evidence is lacking for some species. Considering the size, particularly the height, of the range this number compares favorably with the San Bernardino and San Jacinto Mountains which have approximately 123 and 131 breeding species respectively. The most noticeable difference between the Santa Anas, on the one hand, and the San Bernardinos and San Jacintos, on the other, resides with the summer visitants. Together the latter ranges average 63 birds in this category, whereas the Santa Anas have only a total of 34 summer birds, including those that remain in the winter. If, however, we add to this number those birds included under transients, the majority of which breed on the higher mountains, the total would reach 53.

Upon analysis of the summer visitant population of these higher ranges, it appears that 47 per cent of their summer birds breed in the Transition and Boreal Life Zones. Remembering that of these zones only a weak development of the Transition is present on the Santa Ana Mountains, an explanation of this difference is apparent. It would be expected, then, that the total of summer visitant species on the Santa Ana Mountains would be equal to 53 per cent of the total in the higher ranges, or approximately 34 species. This is exactly the number recorded by me for this range.

The reader is advised to interpret the following list of species on the basis of facts stated in the following paragraphs. In the first instance, only a few bird specimens were taken for purposes of identification. Among these were thrushes, juncos, one or two species of sparrow, and a woodpecker. This means that almost all identifications are formulated on the basis of sight records alone, but each identification was made only after very careful study of the bird in the field. The use of trinomial nomenclature may appear too presumptuous when based on sight records alone. However, subspecific names are not used to add an appearance of preciseness, but rather to place the range in its proper zoogeographic position. It is felt that the systematics of California ornithology is sufficiently advanced to warrant this procedure.

Copious notes have been kept of observations of many birds. It was hoped that these might be used to state more precisely the relative abundance of bird species, not only on the range but also within the community. This has not been possible, however,

so that the usual statements such as "abundant," "common," "rare," etc., have been resorted to. It is left to the reader to interpret these statements. They are used advisedly for each species. It is obvious that the use of the word "common" for the California Condor and the Band-tailed Pigeon should connote widely divergent numbers for each bird; for the Condor a mere half dozen birds would be in order, while several thousands would need to be present before pigeons could be called common. In the list of species to follow the words are used to represent the relative abundance of the species as compared to other regions within each bird's range.

This will aid, too, in interpreting the length of the list of birds, which may appear large for a mountain range of rather small proportions. It is to be remembered, however, that it takes only one record to enter a bird on a list. For example, the Western Tanager, the Bailey Mountain Chickadee, Thurber's Junco, and hermit thrush, are included as breeding birds, yet probably not more than a few dozen of each species nest on the entire range. The reason is obviously due to the limited number of suitable breeding areas. In fact, these birds are restricted to semi-mesophytic canyons between 2000 and 4500 feet. Here in these canyons, isolated by large gaps of chaparral or sage, one or two pairs of each species may be found. Often the condition will be found where birds frequently mentioned as indicators of the Transition Life Zone breed at intermediate elevations, anywhere from 1500 to 3600 feet below others of the Upper Sonoran Zone.

Comparing the avian population of this with other ranges in Southern California, other differences appear particularly with reference to factors limiting the population size of individual species. Grinnell (1908), referring to the San Bernardino Mountains, reports that several bird species do not begin to utilize the community space suitable and available to their requirements during the summer season. He holds that these birds (Audubon Warbler, junco, etc.) are forced to descend the mountain into the valley during the winter season. Here the limited food supply, especially for insectivorous birds, determines the maximum number that may exist throughout the winter and thus return to the mountains for the next breeding season. As pointed out above, it is apparently not the food supply that is lacking in the Santa Ana Mountains, for the population of most of these same species undergoes a marked increase in the winter period, but rather the restricted breeding area.

While considering limiting factors it seems pertinent to record the following observations. In the Stream-side Woodland Association the house wren is commonly observed, but several estimations in optimum regions have averaged only 4 pairs per acre. Formerly the reason for this was not clear, for suitable habitat seemed ample and, certainly, the food supply was sufficient. A possible answer was unknowingly furnished by a bird enthusiast who had, up to 1940, maintained a bird sanctuary in Santiago Canyon. This station was established primarily for feeding hummingbirds, but subsequently barrel-like bird houses were hung up in oaks and sycamores bordering the stream. During May of 1940, 16 pairs of house wrens were found to be nesting in these houses on one acre of this property. At least in this canyon it is the paucity of breeding holes that limits the numbers of this species.

But certainly this same fact cannot account for the unusual abundance of hummingbirds breeding in the near vicinity of this sanctuary. Very likely a proper nesting site is not as difficult for a hummingbird to find as it is for a house wren; but at the same time the available food supply, that is, the availability of suitable flowers in the late spring, is a problem which these birds must meet usually by rather extensive foraging. When the food supply is furnished, as it was at this station in the form of water sweetened with sugar, the hummers increase markedly in abundance.

ACCOUNTS OF SPECIES

Farallon Cormorant *Phalacrocorax auritus albociliatus.* Occasional bird on the Irvine Reservoir where on June 11, 1941 three birds, two adults, one immature, were observed on projecting limbs of dead stumps near the east end of the lake; observed at the same place on December 10, 1940.

California Heron *Ardea herodias hyperonca.* Occasional bird on Irvine Reservoir where they were observed on April 3, 1938, April 1, 1939, December 10, 1940; and also in marshy areas south of Lake Elsinore on October 19, 1941. At latter location they were feeding on small fish in irrigation ditches.

American Egret *Casmerodius albus egretta.* Occasionally on Irvine Reservoir in spring and winter months, viz., April 3, 1938 and December 10, 1940.

Brewster's Egret *Egretta thula brewsteri.* Infrequent. Observed only along coast and about marshy pools in lowland south of Lake Elsinore, as on October 19, 1941.

Black-crowned Night Heron *Nycticorax nycticorax hoacti.* Along edge of Irvine Reservoir, April 1, 1939; and perched in eucalyptus trees near Glen Ivy, March 30, 1938.

Mallard Duck *Anas platyrhynchos platyrhynchos.* Common on Irvine Reservoir, particularly in September.

Pintail Duck *Dafila acuta tzitzihoa.* Very abundant on Irvine Reservoir on September 13, 1940.

Ruddy Duck *Erismatura jamaicensis rubida.* Common on Irvine Reservoir from September until April 15.

Turkey Vulture *Cathartes aura septentrionalis.* It is probable that few individuals remain throughout the winter near the southern border of range, but majority move out of the region around Santiago Peak about November 1. Earliest return record is February 18, 1941. Immature birds common in August and September. Roost in large numbers in rocky regions on southeast face of Santiago Peak.

Condor *Gymnogyps californianus.* Occasional visitor to this range in fall; may remain as late as April. First record on October 8, 1937, in company of L. H. Miller, near Santiago Peak at 5200 feet. Bird was rising out of Holy Jim Canyon at 8:50 a.m., went up out of sight within five minutes. Same bird, or another, reported from near Horsethief Canyon at 9:00 a.m. Two birds circling around Santiago Peak were reported to me on November 14, 1937. On February 14, 1938, a single bird was observed in Mayhew Canyon, 2000 feet. Two birds were reported in the fall of 1940 from Santiago Peak. It is interesting to record that H. S. Swarth found the "remains of a condor in one of the higher gulches," under date of September, 1908. (Notes filed in Museum of Vertebrate Zoology, Berkeley, California.)

Sharp-shinned Hawk *Accipiter striatus velox.* Winter visitant. Earliest date of arrival for five years is October 8, 1937; latest date of departure, April 14, 1937. Rarely seen below 2000 feet.

Cooper Hawk *Accipiter cooperii.* Resident. Fairly common on oak-covered hills and canyon slopes below 4000 feet. This hawk reacts vigorously to imitations of horned owl notes, particularly during nesting period. On April 8, 1939, a female perched on telephone pole was seen to drop the carcass of a California Jay from which the head had been eaten. Birds are always seen in pairs during early April. On March 19, 1938, I watched a Cooper's Hawk attempt to prey upon Cliff Swallows. Although it tried for five minutes, no swallows were captured.

Western Red-tail Hawk *Buteo borealis calurus.* Very common hawk from base of mountain to Santiago Peak. Resident, although much more common in spring and summer. Plumage variable in this region, but tendency toward melanism predominates. On December 24, 1939, an almost complete albino bird was seen over the Kilgore Ranch on the interior slope near Temescal Canyon. Young in nest on May 24, 1940. Parent bird captured a large gopher snake in sagebrush belt near Plot 1 and carried it one mile to nest in sycamore tree. Nest discovered in upper Holy Jim Canyon, 4000 feet, on June 13, 1941. Nest inaccessible in a spruce from which the top had been knocked by lightning. Pair of hawks began to circle and dive as I approached the tree. Young birds common from June 19. It is an absorbing sight in June and July to watch

these immatures learning to soar and flex glide. Common in the fall is the sight of a red-tail poised on the wind rushing through a pass.

Red-bellied Hawk *Buteo lineatus elegans.* Occasional along water courses. Nest observed in Santa Ana Canyon high in a large sycamore. Adult bird observed in a thicket of willows at the mouth of Trabuco Canyon, April 8, 1941.

Swainson's Hawk *Buteo swainsoni.* One bird observed at the foot of Indian Canyon as late as June 15, 1938, suggests that nesting may occur occasionally in this region. Aside from this record, recorded only in late September and October.

Golden Eagle *Aquila chrysaëtos canadensis.* Three pairs were observed on infrequent occasions throughout the period of the study. All of the birds inhabit very inaccessible, heavily-wooded canyons between 3000 and 4000 feet. From these places they spread out onto adjacent foothills for purposes of forage. During the summer of 1940 Mr. Worthington tells me of a pair that returned consistently day after day to Santiago Peak. He described the peculiar antics of the birds, which might best be described as a "barrel roll," which I have found to be very characteristic of the birds in this region. On October 1, 1937, an eagle was surprised at Bear Springs where it had been drinking from the stream.

Marsh Hawk *Circus hudsonius.* Resident. In summer commonly observed along the Temecula and Santa Ana Rivers; in winter more widespread. On two occasions, both in winter, marsh hawks were seen circling over Santiago Peak.

Sparrow Hawk *Falco sparverius sparverius.* Abundant in the grassland and sagebrush belts. On February 26, 1937, a nest was under construction in a tall eucalyptus at Glen Ivy. Young birds common in May and June. An immature from Glen Ivy on June 15, 1938, had apparently just left the nest. It was raised in captivity for several months, then released.

Valley Quail *Lophortyx californica vallicola.* Abundant in the sagebrush belt on slopes and canyon walls below 2000 feet, occasionally as high as 4000 feet. A covey of 30 birds was consistently observed on Plot 1 from 1939 to 1940. On December 11, 1940, I found a covey of 150 birds in Hagador Canyon. The laurel-sumac is a very common roosting site, wherever it is found. This quail forages in clearings, in sage or chapparal, such as firebreaks, but never far from denser cover. Birds are quite well protected on this range by game refuges and private property posted against hunting, but the preferred habitat is rapidly being utilized for agricultural purposes, which means a crowding of the species between ranch land and dense chaparral.

Mountain Quail *Oreortyx picta eremophila.* Abundant in the chaparral belt from 1200 to 5500 feet. Particularly common in canyons and in the vicinity of springs. In winter Mountain Quail frequent the chaparral-covered washes and alluvial fans at the mountain base. Pairing observed on March 30, 1940. Young birds are very common in June. On June 10, 1940, a female with about 12 young was encountered on the trail in Trabuco Canyon, about 2400 feet. The young were easily picked up, but much to the displeasure of the mother who repeatedly rushed at my feet with tail spread and tilted and wings outstretched, and uttering a harsh curring note. On June 15, 1940, an adult with 2 young was seen at Bear Springs; there was an abundance of feathers in the region, suggesting that a large part of the brood had been lost to predators.

Coot *Fulica americana americana.* Common on Irvine reservoir throughout the year.

Killdeer *Oxyechus vociferus vociferus.* Occasional along lower reaches of larger streams; common on the marshy land south of Lake Elsinore.

California Gull *Larus californicus.* Occasional on Irvine Reservoir in winter months.

Band-tailed Pigeon *Columba fasciata monilis.* Abundant winter visitant; fairly common resident in the woodland vegetation along streams from 2000 to 4500 feet. Late in October and early November, the number of pigeons increases many fold. This large number of birds remains until the middle of March, when they move out of the

district in great flocks. During these winter months flocks of 100 to 200 birds are common. On December 26, 1940, I was counting the annual rings on a large spruce near Modjeska Springs when a small flock of pigeons alighted in the tree. In a few moments another and another flock flew into the same tree. At this time I counted 103 birds. I frightened them off so that I could get an idea of the size in the air of a flock of about 100 birds. They circled and then flew back but perched in a dead tree nearby. Almost immediately they were jointed by other small groups until the number had grown to 300. Suddenly the entire flock left as a single bird, diving at a sharp angle to float easily back over the perch. The cause of this takeoff had been the approach of a pair of red-tail hawks, which were forgotten after the initial reaction. The number of birds in this flock gave some indication of unusual numbers in the Santa Anas. I returned to the same area on January 11; at this time the number of band-tails could only be estimated in thousands. I was able to fairly accurately "count" the number of birds as they flew very low overhead. I estimated the average flock to contain at least 2000 birds. Ten of these flocks were in the air at the same time.

On February 3, 1941, I visited the oak and grass mesa known as the Avenaloca Mesa on the southern portion of the range. Here I found great numbers of pigeons. They cruised slowly about 75 feet overhead with an audible musical whirr of wings. On this occasion the birds were so numerous that the sky was darkened by their presence. I know this year to be an unusual one for band-tails on the Santa Ana Mountains. It is believed that the failure of the acorn crop in the San Bernardino and San Gabriel Mountains may have caused this great influx of birds. By March 15, 1941, these great flocks of 1500 to 2000 birds began to regroup themselves into more compact units and by April the population was more nearly normal.

A few pigeons remain on the Santa Anas for the breeding season. In June, 1941, pigeons were observed in Trabuco Canyon at 2000 feet, but a thorough search in the wooded areas did not yield a single occupied nest. However, large numbers of abandoned nests were found in live oaks.

It is cause for awe to watch these birds feed upon the large acorns of the canyon live oak, which they engulf whole. Once having the acorn in the bill, the bird throws its head back and then pumps the seed down with jerking movements of the neck. They also feed upon the fruits of cascara.

Mourning Dove *Zenaidura macroura marginella.* Fairly common resident although most noticeable on the mountain proper during May, June, and July. Probably most common in sagebrush and grassland, but during May doves are always found in large numbers feeding on firebreaks in the chaparral belt between 2000 and 2500 feet. In June they feed very commonly in similar areas as high as 3000 feet.

Numerous nests have been found in the larger canyons, and usually in sycamores. On June 12, 1941, a bird was flushed from a nest on top of a sycamore limb about 8 feet above ground. No eggs were present at the time. Subsequent investigation showed that the bird did not return to the nest. I have found the most common roosting places to be willows and oaks that border grassy portreros. At sunset doves pour into these regions singly and in two's and three's from all points of the compass.

Road Runner *Geococcyx californianus.* Common resident. Usually found in the sagebrush belt adjacent to chaparral, but in spring observed on firebreaks as high as 4500 feet. The song of the road runner is a common sound in the sagebrush in April. It is repeated, but less vigorously in August. Nests are commonly found in cactus patches or in laurel-sumac bushes. A nest was found in a patch of cactus about 3 feet above ground in San Juan Canyon on June 15, 1941. The three young were estimated to be about 4 or 5 days old and were at this time being fed brown-shouldered lizards.

Barn Owl *Tyto alba pratincola.* Fairly common resident. During night of October 20, 1932, two barn owls alighted on the tower on Santiago Peak. On January 27, 1940, one was heard calling over the Indian Pine Forest. Several specimens were found dead on highways around the base of the mountain.

Screech Owl *Otus asio quercinus*. Common resident in woodland belt on slopes and in canyons from 1000 to 4500 feet.

Pacific Horned Owl *Bubo virginianus pacificus*. Common resident in woodland and conifer belts on slopes and in canyons from 1000 to 4500 feet. On several occasions from my camp in the Indian Pine Forest, I was able by imitating the note of this species to call three horned owls into the near vicinity. Two of these were males and one female. They always appeared from the same place and would advance only so far, usually within 100 feet, and then stop.

Saw-whet Owl *Cryptoglaux acadica acadica*. This owl was first heard on January 27, 1940, when call notes were heard at 7:30 p.m. coming from a group of Coulter Pines at 3600 feet. It seemed that the owls were attracted, if not agitated, by the beam of my spot-light which I had been shining on horned owls, for they came within a few feet of where I stood. As they approached they drove at me and uttered clacking notes which were repeated while they perched on a limb nearby. I was not certain of my identification at first, but Dr. L. H. Miller later assured me that this was the Saw-whet Owl. On March 16, 1940, Dr. Miller and I heard at least three different owls in this same region. The note is higher than that of the Pigmy Owl and repeated at a faster interval. On May 24, 1940, I heard three owls at Modjeska Springs, 4500 feet, but on June 10, 1940, no further evidence of their presence could be found. Subsequently this species was recorded from Modjeska Springs in April of 1948 and January of 1951.

Dusky Poor-will *Phalaenoptilus nuttalii californicus*. Common summer visitant and occasional resident in open areas in any vegetational belt from 1000 to 4500 feet. A young bird, still unable to fly, was captured on June 13, 1938. It was discovered when a female was flushed from beneath a manzanita bush on a north-facing slope at 3400 feet. The young bird was just moulting the natal down; it was able to utter a note similar to that of the adult, but without the definite "poor-will" tone; legs relatively long and bird able to run rapidly with wings outstretched.

Texas Nighthawk, *Chordeiles acutipennis texensis*. Occasional summer visitant particularly on the Pacific slope, from base of mountain as high as 4000 feet. Two sight records, one on August 15, 1937 on slope near Trabuco Canyon; the other, on June 12, 1940, on a chaparral slope in Holy Jim Canyon, 4100 feet.

Black Swift *Cypseloides niger borealis*. Probably transient only. Two sight records; first seen on May 17, 1940 flying over the Bedford Truck Trail at 2600 feet; the other, over the Indian Truck Trail at 4000 feet on August 12, 1940. In May several birds were seen among swallows and Vaux Swifts; on the latter date only a lone bird was observed.

Vaux Swift *Chaetura vauxi*. Transient. Seen on the Bedford Truck Trail, 2600 feet, on May 17, 1940, and in the Santa Ana Canyon in September.

White-throated Swift *Aëronautes saxatilis saxatilis*. Common in spring and summer above 2500 feet, occasional in late fall and winter at low elevations. This does not imply that swifts are not found below 2500 feet, but the majority of the population is found during warmer months at higher elevations. In June, 1938, the writer observed numerous swifts on Santiago Peak that appeared every day around the lookout tower. At this time birds would dive at and hit with audible noise bits of paper tossed from the tower and caught in warm updraughts of air. Swifts were nesting in crevices in rocks on a steep northwest-facing canyon wall in Cascade Canyon, at 3200 feet on June 13, 1941. The nests were inaccessible, but from the number of visits that parent birds made to the nests, newly hatched young must have been present.

Black-chinned Hummingbird *Archilochus alexandri*. Common summer visitant in the woodland belt, usually in association with California Live Oak, below 2500 feet. The earliest record for this species is April 14, 1937, when several birds were seen at 1600 feet on the Coldwater Trail to Santiago Peak. A set of eggs found in a live oak overhanging stream on May 26, 1940. A nest containing two eggs was found in Trabuco Canyon on June 11, 1941; young were in the same nest on the morning of June 14. A

nest containing two young ready to leave was found on a sprig of poison oak on the Ortega Road, 2500 feet, on June 15, 1941. Observed in Santa Ana Canyon as late as September 15.

Costa Hummingbird *Calypte costae*. Common summer resident in sage brush and successional sage brush belts usually below 2500 feet, occasionally as high as 5500 feet. A few birds pass the winter in this region. I have numerous records of birds feeding on *Zauschneria californica* as late as November 27. On May 26, 1940, one egg found in nest in *Rhamnus crocea* in Santiago Canyon. Several nests with eggs found as late as June 13, 1941. Costa's hummers are always abundant in May around the thistle *Cirsium* that has invaded Santiago Peak via firetrails. On October 8, 1937, I observed a Costa taking a bath at Bear Springs. It landed on a stone embankment over which a small amount of water trickled down into the stream bed; it ducked its bill and head into the oncoming water. It was not noticeably disturbed by my presence within 10 feet.

Anna's Hummingbird *Calypte anna*. Abundant resident in woodland belt, but usually along streams or at springs, although found occasionally in chaparral on dry slopes. On May 24, 1940, at Modjeska Springs young males were performing the nuptial dive, but without the sound at end of dive characteristic of adult birds. In winter birds are common in areas supporting Coulter Pines.

Rufous and Allen Hummingbirds. Transients. Common in March, less common in April, and occasional as late as May 22.

Calliope Hummingbird *Stellula calliope*. I know little of this bird on the Santa Ana Mountains. Positively identified by L. H. Miller and myself at Modjeska Springs on May 24, 1940.

Kingfisher *Megaceryle alcyon caurina*. Occasional along the Santa Ana and Temecula Rivers. Observed as late as October 12 at the latter station.

Red-shafted Flicker *Colaptes cafer collaris*. Abundant resident in woodland belt. Invades chaparral extensively during winter months. Commonly feeds on fruits of laurel-sumac from October to January.

California Woodpecker *Balanosphyra formicivora bairdi*. Abundant resident in woodland belt and in canyons up to 4500 feet. Nests found in sycamores, oaks, and spruces. One pair nesting in sycamore in Temescal Canyon on August 2, 1937.

Lewis Woodpecker *Asyndesmus lewis*. Abundant winter visitant in woodland areas, but only in Engelmann and California Live Oaks south of Ortega Road. Recently killed bird found on road near Black Star Canyon on April 2, 1941.

Southern Red-breasted Sapsucker *Sphyrapicus varius daggetti*. Occasional winter visitant. Bird observed feeding on berries of *Rhamnus crocea* var. *ilicifolia* in August, 1937. Fresh drillings found on eucalyptus trees on December 24, 1939.

Cabanis Woodpecker *Dryobates villosus hyloscopus*. Rare resident in conifer belt around 4000 feet.

Nuttall Woodpecker *Dryobates nuttallii*. Common resident in woodland association along streams in spring and summer, invades oaks and chaparral more extensively during winter.

Arkansa Kingbird *Tyrannus verticalis*. Common summer resident in woodland association in mouths of larger canyons. In Trabuco Canyon on April 2, 1938, nest building was in full swing.

Cassin Kingbird *Tyrannus vociferans*. Occasional throughout the year. All of my records are along the base of the mountain on both slopes. Usually observed on fence lines in sagebrush belt.

Ash-throated Flycatcher *Myiarchus cinerascens cinerascens*. Abundant summer resident in woodland, conifer and chaparral belts. Earliest date of arrival on April 2, 1938, in mouth of Trabuco Canyon. Nest found in old Coulter Pine stump at 4100 feet on

June 16, 1938. Commonly feeds in chaparral areas where a great deal of foraging is done on the ground. Majority of birds are gone by first of September.

Black Phoebe *Sayornis nigricans nigricans.* Common resident along streams and near human habitations at low elevations. Peak of nesting period reached around middle of June.

Say Phoebe *Sayornis saya saya.* Common winter visitant in open sagebrush belt below 2500 feet. Earliest record of arrival September 10; latest date of departure March 17. However, birds were so common on this latter date that it is possible that they move through this region until later in March, but a thorough search was negative on March 30.

Western Trail Flycatcher *Empidonax traillii brewsteri.* Only one record. Northeast facing chaparral-covered slope at 2600 feet, September 12, 1940.

Western Flycatcher *Empidonax difficilis difficilis.* Abundant in the larger canyons in woodland association below 3500 feet. March 30 earliest date of arrival on two successive years and latest entry made on September 12. A nest found in an alder over stream in Trabuco Canyon at 2500 feet had 4 eggs slightly incubated on June 13. Other nests were found at this time on stone ledges and on scales of alder bark, but always near water.

Western Wood Pewee *Myiochanes richardsonii richardsonii.* Abundant in larger canyons and in vicinity of springs in woodland association below 5000 feet. May 6 earliest date of arrival and October 9 date of last entry in notebook. In the fall they spread out into the chaparral belt. Nest with 2 eggs found in crotch of sycamore near stream at 2900 feet in Trabuco Canyon on June 13, 1941.

Olive-sided Flycatcher *Nuttalornis mesoleucus.* Occasional in conifer belt along streams and near springs. Usually associated with Big-cone Spruce. Nest found about 50 feet above ground in spruce in Trabuco Canyon. Recently constructed, but no eggs in nest on June 12, 1941.

Horned Lark *Otocaris alpestris actia.* Probably resident but only in small numbers, birds move out onto coastal slopes from December until March. Noticeable influx of paired birds on March 9. Breeding begins at this time and apparently occurs through May. On May 17, a horned lark was observed in nuptial flight. Restricted rather closely to grassy areas in the sage and chaparral belts below 2600 feet. I have no evidence of any upward movement after the nesting season. They remain at elevations below 2400 feet in August when temperatures are at least 100 degrees F.

Violet-green Swallow *Tachycineta thalassina lepida.* Occasional transient and summer visitant. Earliest record on February 17. A nest was found in a south-facing, sedimentary road embankment at 2500 feet in Trabuco Canyon on June 13, 1940; two young were found in nest lined with owl feathers. Nest cavity unoccupied at same time in 1941. Noted at several other locations during nesting season, but usually in canyons and at elevations well below 4500 feet.

Tree Swallow *Iridoprocne bicolor.* Only one record. In sycamore and cottonwood covered wash of San Juan Canyon on June 15, 1941.

Bank Swallow *Riparia riparia riparia.* Only one record. Same time and place as the above species. Colony in embankment overlooking isolated pool.

Barn Swallow *Hirundo erythrogaster.* Several nests found under eaves of stable on Kilgore Ranch near base of Eagle Canyon Truck Trail. Young in nest on June 16, 1940.

Cliff Swallow *Petrochelidon albifrons albifrons.* Abundant summer visitant. First record March 19, but much more abundant on May 17. First nest construction noted on April 20. Undoubtedly two broods since young birds were removed from nests as late as July 7.

Purple Marten *Progne subis subis.* Locally common summer visitant to the conifer belt, usually above 3500 feet. Earliest date of arrival, April 2; nesting in dead spruce at Bear Springs on April 16, 1938. Nesting in Coulter Pine stump at Horsethief and Indian Pine Forests on June 13, 1938.

California Jay *Aphelocoma californica californica.* Abundant resident in chaparral belt from base of mountain to Santiago Peak. Invades sagebrush belt where there are a sufficient number of laurel-sumacs and alluvial benches grown to live oaks. Heard in whisper song on April 8, 1939.

American Raven *Corvus corax sinuatus.* Uncommon resident in isolated districts. Only a few pairs are known to inhabit the northern portion of the range in vicinity of Sierra Peak. Scattered pairs observed south of Lake Elsinore in October. On December 11 and 12, 1940, I watched a single pair circling over sandstone knolls of upper Sierra Canyon. They glide and soar a great deal; occasionally the wings are alternately folded and outspread as the bird descends rapidly in a step-like manner producing a low vibratory tone. Known to be more common in the Puente Hill district to the north.

Western Crow *Corvus brachyrhynchos hesperis.* Uncommon resident. Found principally in willow and cottonwood woodland in mouths of canyons on Pacific slope. Nests found in San Juan, Santiago and Black Star Canyons. In winter large flocks invade fields and grazing land, particularly in southern districts.

Bailey Mountain Chickadee *Penthestes gambeli baileyae.* Uncommon resident in woodland and conifer regions. In nesting season found only in a few canyons dominated by spruce and canyon liveoaks around 4000 feet. In winter observed occasionally in chaparral, and Coulter Pines.

San Diego Titmouse *Baeolophus inornatus transpositus.* Abundant resident. In breeding season usually found in oaks of several species from 1000 feet to 4500 feet; in winter found extensively in chaparral as high as Santiago Peak, although they return to base of mountain during unusually cold periods. Birds in song early in April. Young birds being fed insects on June 10, 1940, at Modjeska Springs.

Coast Bush-tit *Psaltriparus minimus minimus.* Abundant resident in woodland belt along streams and on drier slopes up to Santiago Peak. Invades chaparral during post-breeding season. A nest found in *Quercus Wislizenii* in open stand of Coulter Pines on March 16, 1940. Flocks reformed on June 15, 1940.

Slender-billed Nuthatch *Sitta carolinensis aculeata.* Uncommon resident. In breeding season found in pines, spruces, maples and canyon live oaks around 4000 feet; during post-breeding period found more frequently in live oaks in larger canyons.

Red-breasted Nuthatch *Sitta canadensis.* Only occasional birds are seen in spruce groves in fall and early winter. Observed in Trabuco Canyon in September and October.

White-naped Nuthatch *Sitta pygmaea leuconucha.* Rare resident. Only records are all from Coulter Pines Forest in Horsethief Canyon district, in March, June, and October; elevation 4100 feet.

Pallid Wren-tit *Chamaea fasciata henshawi.* Very abundant resident in chaparral and sagebrush belt, where *Pentstemon antirrhinoides* and laurel-sumac are found, from base of mountain to Santiago Peak.

Western House Wren *Troglodytes aëdon parkmanii.* Common summer visitant and occasional resident, in canyons and in vicinity of springs up to 4500 feet. A few birds remain on the mountain throughout the winter. Noticeable increases in numbers observed around March 15, many birds in song on March 17. On April 2, 1938, a nest was under construction in a limb scar of a sycamore in Trabuco Canyon. This bird was carrying sticks as large as her body. On May 24, 1940, at Tucker's Bird Sanctuary, 16 pairs nesting on an area about an acre in extent. On June 10, 1940, young birds were being fed at Modjeska Springs. On June 15 of the same year, young were found in nests in spruce stumps at Bear Springs. Certainly at least two broods since young were found

in nest on June 12, 1941, in Trabuco Canyon while on June 13 several nests were under construction in the near vicinity. House wrens are very abundant in these canyons on the Pacific slope. First egg laid on June 17.

San Diego Wren *Thryomanes bewickii correctus.* Common resident in the chaparral belt from the base of the mountain up to 4500 feet during breeding and winter seasons; in fall, found on Santiago Peak. On June 10, 1940, young birds being fed by parents found at Modjeska Springs.

Northern Cactus Wren *Heleodytes brunneicapillus couesi.* Locally common resident at elevations below 1500 feet. Found in Santa Ana, San Juan, and Temescal Canyons in sagebrush and wash complex vegetation.

Dotted Canon Wren *Catherpes mexicanus conspersus.* Locally common resident in rocky canyons from 1000 to 4000 feet. Found principally on Pacific drainage. On May 26, a nest was under construction in rocky ledge in Santiago Canyon at 1100 feet. On June 13, another nest was under construction in Trabuco Canyon at 2500 feet. One pair of birds with two immatures, still being fed, were seen on a talus slope in Falls Canyon at 3300 feet.

Rock Wren *Salpinctes obsoletus obsoletus.* Relatively rare wren. I have no notes on breeding, although birds have been observed during June, October, November, and December from Santa Ana to Temecula Canyon.

Western Mockingbird *Mimus polyglottos leucopterus.* Occasional resident in the chaparral belt below 1000 feet. Much more common in cultivated orchards and parkways around the base of the range.

California Thrasher *Toxostoma redivivum redivivum.* Abundant resident in the chaparral belt from base of mountain up to Santiago Peak; common in sagebrush belt and occasional in woodland belt.

Western Robin *Turdus migratorius propinquus.* Sporadic winter visitant. Abundant in some years while only occasional in others. Arrive after middle of November and usually leave in February and early March when Toyon berries are gone.

Northern Varied Thrush *Ixoreus naevius meruloides.* Common winter visitant. Arrives in late October in time to feed extensively upon cascara berries.

Alaska Hermit Thrush *Hylocichla guttata guttata.* Abundant winter visitant in chaparral and woodland communities. Specimen from Plot VIII identified by A. J. Van Rossem.

Sierra Hermit Thrush *Hylocichla guttata sequoiensis.* This subspecies is placed on this list only tentatively. The basis for inclusion is the song heard above Yaeger's Meadow, about 4:30 p.m., on June 12, 1941. I am personally confident that the song was that of a hermit thrush. Heard again on June 15, 1944.

Russet-backed Thrush *Hylocichla ustulata ustulata.* Occasional in canyons at low elevations, but principally on the Pacific slope.

Western Bluebird *Sialia mexicana occidentalis.* Common resident. Population increased by winter visitants, but breeding known to occur. A nest found in Black Star Canyon in sycamore on May 26 contained young birds. Found on Santiago Peak during October and November.

Mountain Bluebird *Sialia currucoides.* Locally common winter visitant in southern third of range, particularly in mesa grassland around Avenaloca mesa.

Townsend Solitaire *Myadestes townsendi.* Commona winter visitant in woodland belt about 4000 feet, particularly in near vicinity of springs. They appear to travel in pairs during winter in this vicinity.

Western Gnatcatcher *Polioptila caerulea amoenissima.* A common resident in chaparral and woodland belts from base to Santiago Peak, spreads out into sagebrush

during winter season. Nest under construction on sycamore branch on Holy Jim Trail, 4000 feet, on May 6, 1938. Young birds being fed by parents observed at Modjeska Springs, 4500 feet, on June 10, 1940.

Ruby-crowned Kinglet *Corthylio calendula cineraceus*. Common winter visitant. Earliest record, October 6; latest record, April 14. Common in chaparral, woodland and conifer belts, as high as 4500 feet.

American Pipit *Anthus spinoletta rubescens*. Winter visitant. Occasional flocks noted in November and December as high as 3000 feet.

Cedar Waxwing *Bombycilla cedrorum*. Occasional at all seasons; most common in February. I have no nesting records, but many small flocks found around interior base of mountain after middle of May.

Phainopepla *Phainopepla nitens lepida*. Common summer visitant. Arrive in large numbers on May 4. Nest in chaparral on alluvial fans and on slopes as high as 4000 feet during May and June. Many birds, either females or young, remain in mouths of larger canyons during winter months.

Shrike *Lanius ludovicianus gambeli*. Occasional in open places in sagebrush and chaparral and belts as high as 1500 feet. More common south of Lake Elsinore.

Hutton Vireo *Vireo huttoni huttoni*. Common resident in woodland vegetation, particularly California and Canyon Live Oaks, as high as 4500 feet. Nest with incubated eggs found on April 7; young birds left nest on May 10.

Least Vireo *Vireo bellii pusillus*. Common summer visitant to willow and Baecharis vegetation along streams below 1500 feet. Earliest record, April 2; latest notation September 8. Found more abundantly on the Pacific drainage in Trabuco and Santiago Canyons.

Cassin Vireo *Vireo solitarius cassinii*. Occasional summer visitant to woodland vegetation in canyons about 2500 feet, and in conifer regions on drier slopes during migration. Earliest record on March 16; no date for departure.

Western Warbling Vireo *Vireo gilvus swainsonii*. Common summer visitant to woodland vegetation in canyons, above 2500 feet. Building nest in maple in Trabuco Canyon on June 13.

Lutescent Warbler *Vermivora celata lutescens*. Common migrant as early as March 17; occasional summer visitant breeding in woodland vegetation and foraging in chaparral as high as 4500 feet. Observed in vicinity of Los Pinos Peak on September 4.

Dusky Warbler *Vermivora celata sordida*. Probably migrant only. Definitely identified in Trabuco and Santiago Canyons as late as September 14.

Yellow Warbler *Dendroica aestiva brewsteri*. Abundant summer visitant to woodland vegetation in vicinity of streams. They may arrive much earlier, but certainly most noticeable after middle of May. Nest found, about 25 feet up in sycamore in Trabuco Canyon on June 12. Cowbird from nest by warbler attracted attention to its location. Follows water courses as high as 4500 feet.

Audubon Warbler *Dendroica auduboni auduboni*. Abundant winter visitant during most years to sagebrush and chaparral belts particularly associated with *Rhus laurina*. Earliest record of arrival on October 8; during early spring they work their way up the mountain in woodland and conifer belts from which they leave as late as March 30. Another group passes through the region in woodland belts in middle April and early May. Observed again at Bear Springs on May 7, after wintering birds had all left by March 30.

Black-throated Gray Warbler *Dendroica nigrescens*. Common migrant and occasional summer visitant to the woodland vegetation as high as 4500 feet. Common from May 3 to October 1, but only occasional specimens are encountered in vicinity of springs during May and June.

Hermit Warbler *Dendroica occidentalis.* Status unknown. Highly probable that a few birds breed in this region. Only one record; Bear Springs, 4300 feet, on June 13.

Macgillivray Warbler *Opornis tolmiei.* Migrant. One record only; Modjeska Springs, October 9.

Golden Pileolated Warbler *Wilsonia pusilla chryseola.* Common during migration in March; occasional summer resident in woodland vegetation around springs as high as 4500 feet.

English Sparrow *Passer domesticus domesticus.* Occasional at base of mountain around poultry or livestock ranches. Never observed away from such places. A noticeable decrease in numbers has occurred since 1937.

Western Meadowlark *Sturnella neglecta.* Common resident in grassland and sagebrush belts and in openings in chaparral as high as 3000 feet.

San Diego Red-wing *Agelaius phoeniceus neutralis.* Found in *Typhus* at edge of Irvine Reservoir on April 1, 1939. Large flock feeding in fields below Glen Ivy on February 10, 1939. Flocks of 30 - 50 birds common in marshy regions south of Lake Elsinore.

Arizona Hooded Oriole *Icterus cucullatus nelsoni.* Common summer visitant to canyons below 3000 feet. Earliest record in Trabuco Canyon on April 2, 1938.

Bullock Oriole *Icterus bullockii.* Occasional summer visitant to woodland vegetation on slopes and in canyon mouths.

Brewer Blackbird *Euphagus cyanocephalus.* Surprisingly rare bird in this range. Observed in vicinity of barnyards or on cattle range. Occasional specimens found with redwings. Birds were actively collecting nesting material at mouth of Indian Canyon on April 4. First eggs laid on April 6. More common along highways.

Dwarf Cowbird *Molothrus ater obscurus.* Apparently not very common. Only one record. Being pursued by a yellow warbler in Trabuco Canyon, 2400 feet, on June 12, 1941.

Western Tanager *Piranga ludoviciana.* Occasional summer visitant. Occupy rather dense woodland and conifer vegetation in canyons and near springs, from 2500 feet to 4500 feet. Observed from May to October.

Black-headed Grosbeak *Hedymeles melanocephalus maculatus.* Abundant summer visitant from April to September in canyons and occasionally found in chaparral as high as Santiago Peak.

Blue Grosbeak *Guiraca caerulea salicarius.* Common along dry, Baccharis-dominated arroyos on the Pacific drainage below 1500 feet. Feed extensively on sage-covered hillsides. Eight adults with several young birds were observed on June 15, 1941; apparently breeding activities well past by this time. Earliest record, April 2, 1938; nothing known about dates of departure.

Lazuli Bunting *Passerina amoena.* Common summer visitant to woodland and chaparral belts in dry washes and arroyos, and also on restricted meadow land as high as 3000 feet. Arrives in April and observed in Santiago Canyon as late as October 31. Found nesting in scrub oak at mouth of Indian Canyon on May 17 at which time eggs were present, and on brachen covered meadow on Yaeger's Meadows on June 13. At latter point, feeding on myriad grasshopper nymphs.

California Purple Finch *Carpodacus purpureus californicus.* Common resident in canyons dominated by woodland and conifer vegetation above 3000 feet. Flocks found at lower elevations during winter, but majority of birds remain on the mountain as high as Santiago Peak throughout the coldest months.

California Linnet *Carpodacus mexicanus frontalis.* Abundant resident in canyons at low elevations, and particularly around orange and lemon groves at the base of

mountains. Occasionally found around springs as high as 4500 feet at any season. Feed extensively on fruits of *Garrya* and *Photinia* during fall and winter.

Pine Siskin *Spinus pinus pinus*. Status unknown. Only one record of a flock, about 30 birds, at Modjeska Springs on October 9, 1937.

Willow Goldfinch *Spinus tristis salicamans*. Apparently breeds occasionally in sycamores in canyons, although much more common during winter months. Observed singly in Trabuco Canyon on June 13; in flocks at various dates from September to February.

Greenbacked Goldfinch *Spinus psaltria hesperophilus*. Abundant resident in canyons, chaparral slopes at 4500 feet during breeding season. Abundant above 4000 feet during September and October, while they descend into canyons and foothills when first cold weather appears. Occupied nests found in sycamores in Trabuco Canyon, 2500 feet, on June 10.

Lawrence Goldfinch *Spinus lawrencei*. Occasional summer resident. Large flock found on Bedford Truck Trail, 2400 feet, on April 28, 1940. From this date on they are seldom found below 4000 feet. Male and female with two young observed feeding on seeds of popcorn flower on June 15, 1940 at Bear Springs.

San Diego Towhee *Pipilo maculatus megalonyx*. Abundant resident of chaparral covered slopes and thickets of *Rubus* along streams from 1000 feet to Santiago Peak. Invades sagebrush belt where an occasional *Rhus laurina* is present. Nests found as early as April 7 at low elevations; three nests found in stream border thickets at 3300 feet, on June 13—eggs in both localities.

California Towhee *Pipilo fuscus crissalis*. Abundant resident. Common around orange groves, where they nest, and in sagebrush belts below 2000 feet. They invade higher elevations via firetrails; observed on firebreak on Santiago Peak, June 15.

Savannah Sparrow *Passerculus sandwichensis* subsp. Observed occasionally in grassland belts and on cultivated fields during winter months. Particularly common on the interior drainage during November, 1938.

Western Grasshopper Sparrow *Ammodramus savannarum bimaculatus*. Occasional in sagebrush and grassland belts. All observations on the Pacific drainage from 1200 feet out onto coastal plain.

Lark Sparrow *Chondestes grammacus strigatus*. Common resident in the sagebrush belt below 2000 feet. Large flocks in fields and grassland belts. Young lark sparrows being fed on May 17.

Rufous-crowned Sparrow *Aimophila ruficeps* subsp. Occasional in grassland and openings in sagebrush belt below 1500 feet. Observed on April 1, 1939; actions indicated nest might be in near vicinity.

Bell Sparrow *Amphispiza belli belli*. Locally common resident in sagebrush belt below 1500 feet; occasionally as high as 2400 feet, but only on successional sagebrush.

Thurber Junco *Junco oreganus thurberi*. Abundant winter visitant arriving about October on Santiago Peak, leaves about April 1; infrequent resident, restricted to woodland vegetation in canyons above 4000 feet. Nest with two eggs found at base of Canyon Live Oak in forest of oaks and maple near Los Pinos Peak, on June 14, 1938. Heard in song and observed around all of the springs with which I am acquainted, although one or two pairs at most occupy any one spring region.

Chipping Sparrow *Spizella passerina stridula*. Occasional resident. I am certain, however, that the large population found here in the winter does not breed on this range. From my records it would appear that chipping sparrows move up the mountain slopes during April, reaching Santiago Peak during early May, and that movements away from the range occur at this time. However, breeding birds were seen on two successive years at Yaeger's Meadow on June 13.

Black-chinned Sparrow *Spizella atrogularis cana.* Abundant summer visitant. First record for 1941 and 1942 is March 30. Although I have no conclusive evidence it appears that they concentrate at lower elevations after first appearing and then gradually move into the higher slopes. Thus, March 30, 1940, date of first record at 1400 feet; April 13, first record at 2800 feet; and April 28, first record at 5600 feet. These data were gathered while regular trips to check weather instruments were undertaken. Occupies sagebrush and chaparral belt. Nest containing three eggs found in *Artemisia californica,* at 1400 feet, on May 17, 1940. Young birds in natal down found on May 24; these had abandoned nest sometime before June 10.

Gambel Sparrow *Zonotrichia leucophrys gambelii.* Abundant winter visitant to sagebrush and chaparral belts below 2500 feet. First record on September 22; April 25 latest entry. There is, however, a noticeable reduction in numbers after March 30.

Golden-crowned Sparrow *Zonotrichia coronata.* Common winter visitant to every part of region and in chaparral, sagebrush, and woodland belts.

Fox Sparrow *Passerella iliaca* subsp. Fox sparrows are abundant during the winter months. They arrive early in October and remain in large numbers until the end of April. However, two specimens were seen at Modjeska Springs as late as May 24, 1940.

Lincoln Sparrow *Melospiza lincolnii lincolnii.* Winter visitant. Only two records: near Glen Ivy on April 3, 1937; and on Santiago Peak on January 11, 1941. The first specimen was shot, the second was taken in a rodent trap.

San Diego Song Sparrow *Melospiza melodia cooperi.* Occasional along stream bottoms in shaded canyons below 1500 feet. Young song sparrows found on May 5 in Santiago Canyon.

MAMMALS OF THE REGION

Thirty-seven species and subspecies of mammals were encountered on the Santa Ana Mountains during the period of this study.

Conspicuous in their absence are the gray squirrel and the chipmunk. Until this study it has generally been assumed by zoogeographers that these species were present here, but I found no evidence of their presence nor could I find anyone in the vicinity of the range who knew of the past existence of either species in the Santa Anas, although apparently suitable ecological niches are present. I received several reports that chipmunks had been sighted at one point or another on the range, but always a determined check revealed the supposed chipmunk to be an immature ground squirrel.

Within this century and the memories of several persons residing at the base of the mountain, the grizzly bear was an important member of the fauna of the Santa Anas. So far as I could determine, the last specimen was observed on the west face of Santiago Peak in the fall of 1908. Available records indicate that the grizzly was more common at low elevations on the Pacific slope than at higher elevations and in the more precipitous canyons and slopes of the interior. Sadly enough this, too, was the principal domain of cattlemen and bee keepers; hence the extinction of such a large and intrepid animal was inevitable.

This story of extinction, which was written so quickly for the grizzly by the introduction of the repeater rifle, is gradually but surely being compiled for the mountain lion, one of the last biological links with the unsettled West. Ironically enough this action will no doubt be consummated by one of our governmental agencies which purportedly was established for the conservation of our natural resources. In fact nineteen mountain lions, six of them being taken in a span of four months in 1940, were killed in the Santa Ana Mountains in the few years devoted to the earlier part of this investigation.

Three hundred mammal preparations were made during this study. For the most part these were used for purposes of identification only. It is quite possible that some racial differences may be found by systematists working over this material in the future.

ACCOUNTS OF THE SPECIES

Didelphis

D. virginiana virginiana. Virginia Opossum. Opossums are abundant in the larger canyons, particularly those inhabited by human beings, below 2000 feet.

Scapanus

S. latimanus occultus. Southern California Mole. This species is widespread along the waterways of the region and also the chaparral belt. Largely confined to the waterways during summer and fall, they spread among the chaparral plants on ridges during the winter and early spring.

Sorex

S. ornatus ornatus. Adorned Shrew. This shrew was not taken during the period of this study. A single specimen obtained by H. S. Swarth is in the Museum of Vertebrate Zoology at Berkeley, California. It was collected at 1700 feet in Trabuco Canyon on September 14, 1908.

Notiosorex

N. crawfordi crawfordi. Gray Shrew. A single specimen of the Gray Shrew was taken from Plot 1 on December 21, 1939. It was trapped in a sparse growth of *Eriogonum fasciculatum* and *Artemisia californica* with a thick growth of grass intervening. The animal was captured during the second of five nights of trapping in a snap trap set in a well-defined runway from which a harvest mouse had previously been taken and in which were captured, subsequently, a pocket mouse and a meadow mouse.

Myotis

M. californicus californicus. Common bat during the early summer season about open areas in chaparral and washes. Abundant at dusk when day-flying insects are still on the wing. A female specimen shot on June 15, 1941 carried one foetus almost to term.

Eptesicus

E. fuscus. Large Brown Bat. Occasional in open conifer forest or adjacent chaparral during late spring and summer months.

Antrozous

A. pallidus pacificus. Pacific Pallid Bat. Abundant in the sagebrush community below 2000 feet.

Procyon

P. lotor psora. California Coon. Although the coon is most abundant along the more permanent waterways, it was trapped in dry washes and observed in the chaparral and woodland communities, as high as 5000 feet.

On March 3, 1951 two female specimens were trapped in the lower reaches of Lord Canyon. One weighed 9.5 pounds and measured 31.5 - 11.5 - 4.9 - 2 inches, while the other weighed 12.5 pounds and measured 33.3 - 12.3 - 4.9 - 2.1 inches. The latter's greater weight was due largely to a quarter-inch-thick layer of fat over the rump, flanks, and inguinal region.

Bassariscus

B. astutus octavus. San Diego Ring-tailed Cat. On December 20, 1940 unmistakable tracks of this animal were found at Bear Springs at 4300 feet. This is the only evidence that I have for the presence of ring-tailed cats, since the State trapper has not taken any specimens in his rather extensive trap lines. This need not mean that the animals are extremely rare, since his traps were set in open areas on ridges where ring-tailed cats are not likely to be found, and because he used such large traps that small animals would be unable to spring them.

Spilogale

S. gracilis phenox. California Spotted Skunk. Common in the sagebrush belt on both slopes.

Mephitis

M. mephitis holzneri. Southern California Striped Skunk. Although this striped skunk is found in the sagebrush belt, it is more abundant in the open chaparral and adjacent woodland habitats. Observed from base of mountain up to Santiago Peak.

Taxidea

T. taxus neglecta. Although living badgers were not observed, evidences of their presence in the way of burrows are common enough. They appear to be confined to the *Adenostema-Ceanothus* community between 2000 and 3000 feet. On several occasions, notably on and in the vicinity of Plot VIII, badger workings were encountered in extremely dense chaparral where the animal had excavated the burrow systems of pocket gophers and kangaroo rats. Large tunnels are found occasionally in the center or edges of truck trails where badgers have excavated pocket gopher burrows.

Four badgers were taken by the State trapper during the period from April to August, 1940. This must certainly have been a major part of the population around Santiago Peak.

Urocyon

U. cinereoargenteus californicus. California Gray Fox. The gray fox is the most abundant carnivorous mammal in the chaparral community. It ranges from 1000 to 5600 feet.

Unlike bobcats, foxes are seldom active during the daylight hours. Occasional individuals were observed sunning themselves, usually in mid-afternoon in the winter months. Numerous sight records were obtained while driving the roads at night. Among these I might cite that early in the evening of November 21, 1941, under conditions of a light fog, six foxes were observed in the drive from Santiago Peak to the Bedford Truck Trail, a distance of seven miles. This number should be interpreted with the fact that a professional trapper had removed 50 foxes from this region during the previous summer.

Three foxes were trapped during 1951. February 19 a male, weighing 7 pounds and measuring 38 - 14.75 - 5.1 - 3.5 inches, was taken one mile above the base of the Indian Truck Trail. Its stomach contained four baby brush rabbits, representing at least two litters. February 23 a 3-legged female, weighing 6.75 pounds and measuring 31 - 9 (bob-tail) - 4.75 - 3.25 inches, was taken at the base of the Indian Truck Trail. It was bearing three tiny embryos, and its stomach contained grass. February 28 a male, weighing 9.5 pounds and measuring 40 - 17.25 - 5.5 - 3.75 inches, was trapped one mile above the base of Lord Canyon.

Canis

C. latrans ochropus. California Valley Coyote. The coyote occupies a different niche than do the fox and wildcat. Whereas the latter are confined more to the chaparral community, the coyote frequents canyons and valley floors on both slopes. Sight records for this species are less numerous than for either foxes or wildcats. Except for tracks, dung, vocalization, and the results of trapping, one might believe them to be relatively scarce. Actually I am certain that the coyote is the most abundant carnivore in the Santa Anas, taking the whole range into scope. During the first eight months of 1940, the combined total of coyotes removed by state and federal agencies from that part of the range centered about Santiago Peak reached the 111 mark.

On May 17, 1940, a coyote was flushed from a den located in a culvert in the sage association at the foot of the Bedford Truck Trail. Late in the afternoon of December 26, 1940, a coyote was encountered traveling at 3200 feet on the Bedford Truck Trail. Backtracking showed that this individual had come out of Bedford Canyon near the base of the mountain and was penetrating into the high country. Early in January of 1941, a single individual was tracked for eight miles along the Bedford and Main Divide motorways before the tracks turned down a well-defined animal trail that would eventually lead it to the valley floor. At 3:00 p.m. on January 30, 1942, a coyote was frightened from the carcass of a cow near the summit of Skyline Drive. This animal

was followed along the roadway for two miles until it turned down a firebreak and headed for the low country.

All of these records indicate that coyotes are animals of the lowlands, for in each case they were either observed there or retreated there upon being encountered. Apparently most coyotes pursue a great forage circuit which leads out of the den down the canyon and thence onto trails and roads upon which they travel into the mountains for variable distances. With few exceptions, tracks on roads and ridges point upwards; those in the canyons downwards.

Study of dung material has yielded the following: berries of cascara and manzanita; auditory bullae of wood rats and brush rabbits; deer hair, probably from carcasses; and, in addition, one was observed feeding upon a dead cow, as was mentioned above.

Felis

F. conclor californica. California Mountain Lion. Mountain lions have been abundant on the Santa Ana Mountains. Although lions were not observed alive during the period of this study, numerous data were gathered from trappers and observation of tracks.

On May 19, 1940, a lion hunter encountered a female with two kittens on the Main Divide Truck Trail adjacent to Modjeska Springs (4500 feet). These lions jumped out of the chaparral directly into the path of his truck. He immediately turned his dogs after them with the result that the two immatures were captured a few hours later, one being treed in a spruce in the bottom of Silverado Canyon, and the other killed by the dogs. The female was trapped that night on the ridge where the lions were first observed. The young lions weighed 62 and 58 pounds respectively.

Early in the morning of June 16, 1940, I encountered a drag mark running transversely across the dirt truck trail about one mile below Modjeska Springs. Investigation indicated that a lion had dragged a deer across the road into the dense chaparral bordering the eastern side. I found the point where the lion had made the kill, for the imprint of the deer's body on the grass on a clearing to the side of the road was still present; a few blood-stained hairs were found in the bedding impression. From here the lion had dragged the carcass across the road, over a clump of dense manzanita, and down into a well-worn lion trail under the chaparral plants. Freshly broken manzanita twigs clearly marked the path taken by the lion with its kill. It was almost incredible to think that a lion encumbered with a deer could negotiate this tunnel, which measured only 2.5 by 1.5 feet. Intent upon determining the disposition of the carcass, I crawled into the tunnel for a short distance. But my inability to maneuver without great effort, and the memory of rattlesnakes that were observed in similar places soon caused me to abandon the search. Going back over the trail that the lion had made previous to encountering the deer, which was easily done in the dust of the Main Divide Truck Trail, I found the point at which it had come onto the road. A distance of 16.1 miles separated this point from that where the kill had been made. It is not known how far the lion had come before entering the road, or how far it went after leaving it with its kill.

During July of the same year, a large male lion, weighing 190 pounds, was taken out of Silverado Canyon. I learned also that another male, weighing 140 pounds, had been taken a little later in the season, but the exact locality of capture was not ascertained.

On August 1, 1940, Eulis Worthington, who was a lookout on Santiago Peak at the time, reported to me that he had seen a small lion on the peak the night before. On August 18, I discovered a set of tracks made by an adult and two immatures. August 30, Mr. Worthington encountered a medium-sized lion on Santiago Peak. It seemed clear that a female with her two kittens had established themselves in this vicinity. Nothing more was seen of these lions until September 10, when I found the tracks of one of the smaller ones on the road about a mile and a half below Santiago Peak. Unfortunately, the following day, the State trapper caught a female lion near this point. It seems clear that this was the female known to have been frequenting this region.

From these observations it is safe to conclude that at least eight lions were present in the region around Santiago Peak at the same time. Of these, two were adult males, two adult females, and four were immatures.

Lynx

L. rufus californicus: California Wildcat. Although not restricted to these vegetational or altitudinal limits, wildcats are very common predators in the chaparral belt between 2000 and 4000 feet.

I have eight sight records of this animal from as many points on the range. At least two of these are of more than usual interest. In mid-afternoon of February 10, 1939, I came upon a large wildcat that was stalking birds in the chaparral above Glen Ivy. Instead of bolting when it saw me, the animal merely walked off slowly up the trail ahead. Knowing that the trail switched back not so far ahead, I decided to cut through the chaparral to the trail above and wait to see if the wildcat would follow the trail up to my new vantage point. This it did—even beyond my expectations—coming within ten feet of my hiding place before I stepped out into the trail. This time it showed great agitation evidenced by the flattened ears, switching tail, and low, rumbling growl. I fully expected an armful of wildcat at any moment. We stood in challenging positions for at least two minutes until I clapped my hands with resounding force. This was sufficient to send the animal bounding through the chaparral.

In April 1940, I came upon a bobcat that was eating something in the middle of the Main Divide Truck Trail at 3500 feet. The approach of my car had not frightened the cat away until I was within fifty feet. Investigation revealed that the animal had been eating a rattlesnake *(Crotalus mitchellii pyrhus)*. Although the anterior third of the snake had been eaten (poison glands, fangs and all), the remaining portion lashed slowly back and forth. Since the roadway was damp, it was easy to determine where the bobcat had emerged from the chaparral behind the snake and pounced upon it. It was equally clear that no other car had used the road that day.

Wildcats are probably less numerous than either coyotes or foxes on the Santa Anas. During the five-month perior, from April to August, 1940, the State trapper removed only 39 wildcats from that portion of the range between Trabuco and Bedford Peaks. A careful study of tracks on the motorway from Sierra Peak to Bedford Peak, at an average altitude of 3300 feet, showed that a bobcat had crossed the road on an average of every 1.7 miles.

During February, 1951 two specimens were trapped on the eastern face of the range. On February 18 a male, weighing 18.5 pounds and measuring 33.3 - 6.3 - 6.9 - 3.1 inches, was trapped about one mile above the beginning of the Indian Truck Trail. Its stomach contents were composed of the remains of Peromyscus. On March 3 a female, weighing 9.75 pounds and measuring 28 - 5 - 5.5 - 2.9 inches, was trapped one and one-half miles above the mouth of Lord Canyon. It carried two embryos, each about 1.5 inches long.

Citellus

C. b. beecheyi. Beechey Ground Squirrel. Common on cultivated, formerly cultivated, and submarginal lands at the base of the mountain; occasional in the sagebrush and chaparral belts up to Santiago Peak.

This animal is always associated with disturbed conditions when found on the mountain proper; thus, along truck trails, firebreaks and clearings for buildings. Members of the Forest Service informed me that ground squirrels were not found on Santiago Peak prior to the construction of roadways and firetrails up to this point. In August, 1937, I trapped six adult specimens on Santiago Peak. They were localized about rocky areas in the clearing made for the lookout tower. At this time I estimated at least another six individuals constituted the total of this one colony. Apparently ground squirrels use clearings as highways upon which to penetrate into formerly unoccupied terrain.

In August of 1937, I found ground squirrels as high as 2000 feet on the Indian Truck Trail, a roadway that had only been completed about two years prior to this

date. By November of 1938 they had penetrated to 3000 feet. In February, 1940, I found a colony that had established itself in the mixed chaparral and conifer belt at 3600 feet on the same roadway. Since that time, occasional individuals have been observed on the same road up to 3800 feet, which is the altitude of the junction between this roadway and the Main Divide Truck Trail. This means that squirrels from the two sides of the mountain have met at the Main Divide, for ground squirrel mounds were observed on a firebreak on South Trabuco Peak as early as June 15, 1940. It may be expected that increasing numbers of ground squirrels will be found on the mountain proper.

Adult animals are not active during the hottest part of the summer in the lowlands, but as indicated above, they remain active throughout the summer on Santiago Peak where diurnal temperatures apparently do not reach the critical aestivation point.

Thomomys

T. bottae palescens. Grapeland Pocket Gopher. Pocket gophers were obtained from the base of the mountain to Santiago Peak, but they occur most abundantly at low elevation on the Pacific slope toward the southern third of the range, south of the Ortega highway. They are particularly common in the rich soil of wide canyon bottoms and on rolling hills grown to grassland. Portreros or plateau lands that are occasionally encountered as high as 4600, as near Modjeska Spring, support large populations of this burrowing form. Nonetheless, a few specimens were taken on the precipitous, rocky slopes of southern Santiago Peak.

Specimens that I have from Trabuco Canyon, on the Pacific slope, are indistinguishable from those taken at Glen Ivy on the interior. However, specimens from Santiago Peak are decidedly smaller than those taken at the base of the mountain. This appears to be a general characteristic of pocket gophers; that species found high on mountain eminences are smaller than valley inhabiting species. It would appear that a similar parallel exists with reference to individuals of a single species.

Perognathus

P. fallax fallax. Short-eared Pocket Mouse. The short-eared pocket mouse is found entirely within the successional and climax phases of the sagebrush belt, in fact it is one of the characteristic animal associates of this vegetation. Eighteen specimens of this species were taken; all in the relatively narrow belt between 1000 and 2000 feet. *Fallax* is much more abundant on the interior slopes, from which it spreads across the sagebrush domain of the Perris Peneplain into the San Jacinto Valley. Apparently, on the Pacific slope, its place in the sagebrush belt is held only on the mountain proper, as in Silverado Canyon (Plot VII) and in Trabuco Canyon at 1000 feet, for specimens taken at 900 feet in San Juan Canyon, and in the hills behind Laguna Beach, at 200 feet are definitely *californicus. Fallax* was not taken at either of these locations, although it does reappear along the coast at San Onofre, San Diego County. Additional trapping will be necessary to confirm this peculiar distribution pattern, which has other aspects that will be pointed out in the discussion of *californicus.*

Although the metropolis of this species is in the typical sagebrush belt of the interior slope, individual specimens were taken in regions tending toward chaparral, on the one hand, and grassland, on the other. For example, an adult female taken late in August, 1938, at the mouth of Mayhew Canyon was trapped within the edge of the chamisal chaparral, where it had evidently gone in order to gather the seeds of *Adenostema,* for both pouches were crammed with them. Again, a specimen taken from the northeast ridge of Claymine Canyon, 1200 feet, was trapped among rocky outcroppings away from the sagebrush belt.

In addition to fruits of *Adenostema* mentioned above, seeds from the following plants have been removed from the pouches of captured specimens: *Lotus scoparius, Salvia mellifera, Salvia apiana, Yucca whipplei, Rhus laurina, Avena fatua, Eriogonum fasciculatum,* and *Artemisia californica.* Many of these are available to pocket mice from late summer to mid-winter. During these months this mouse is active, storing away large

quantities of seeds. I have counted as many as 150 seeds of *Lotus scoparius* in each pouch or a total of 300 per mouse. Each one of these had been carefully hulled before being placed in the pouch. However, this practice appears to be of individual preference. As a rule, one type of seed is collected at a time, usually when it is most abundant; but young individuals may pick up a heterogeneous mixture.

P. californicus dispar. Allen California Pocket Mouse. A part, at least, of the Santa Ana Range forms a zone of intergradation between two races of *P. californicus,* namely, *dispar* from the north, and *femoralis* from the south. Taken as a whole, the specimens that I have in my possession approach *dispar* very closely, but three specimens taken from Plot VIII are certainly to be considered as *femoralis.* These specimens are larger and darker than any others in my collection. Comparison of these specimens with typical *femoralis* from San Diego County is favorable to this determination; whereas specimens from above Glen Ivy, 1200 feet, Santiago Peak, etc., are smaller and lighter of pelage, matching *dispar* from Los Angeles County.

So far as the distribution of these two races on the Santa Ana Range is concerned, more trapping will have to be done in significant regions to confirm my present beliefs. At the present time I am inclined to believe that *femoralis* inhabits only the denser chaparral while *dispar* prefers the more open chaparral on gravelly soils, and will invade even the sagebrush belt. The problem is an interesting one and has several ramifications. On the interior slope, I have never taken a pocket mouse of the species *californicus* in the sagebrush belt, nor a *fallax* in pure chaparral. In short, on this slope, there is a clean-cut demarcation between the vegetational affinities of these two species. As a consequence, as one progresses up the mountain slopes into the chaparral domain, *fallax* is left behind so that above 2000 feet the successional sagebrush and chaparral belts are inhabited by pocket mice of the species *californicus,* and so far as I can determine, of the race *dispar.* This condition is maintained up to and including Santiago Peak. Now, on the Pacific slope, the situation appears to be different. *Perognathus fallax* has been taken in Trabuco Canyon and Silverado Canyons at 1000 feet in the sagebrush belt, as it should be. But trapping carried on in the sagebrush and chaparral of the Santa Ana Coastal Plain out to the Pacific Ocean, as at Laguna Beach, has not yielded *fallax,* as might be expected, but rather *californicus.* Unfortunately these specimens are immature, but from the nature of their habitat, I would suspect them to be *dispar.* This indicates the probability that *fallax* does not occupy this broad coastal expanse, but rather that *dispar* continues its range southward across this plain and onto the Santa Ana Mountains where it is much more common at higher elevations in open chaparral.

This species relies upon seeds as the main source of its food supply. In the chaparral it uses seeds of Adenostema and Ceanothus (one specimen had 864 chamise seeds in its pouches). In the successional sagebrush higher on the mountain the seeds of the dominant plants form the bulk of its diet.

P. californicus femoralis. Dulzura Pocket Mouse. The inclusion of this subspecies in the fauna of this range is dependent upon three specimens taken from Plot VIII. In October, 1941 my identification of two pocket mice as *dispar* was confirmed by Dr. S. B. Benson. He added, however, that since this was an area of intergradation between *dispar* and *femoralis,* a large series would have to be gathered before positive identification could be made. A month later Plot VIII was trapped and the pocket mice from here are so different from others in my collection that the above classification of them seems wise.

Dipodomys

D. stephensi. Stephen's Kangaroo Rat. This species is relatively rare on the Santa Ana Mountains, at least toward the northern end. I have only two specimens in my collection from these mountains. They were taken on Plot I in a mixture of sagebrush and grassland associations. It appears probable that this species exists only on the interior slope of the mountain and that it is much more common around the Elsinore region, that is, where the mountains merge with the Perris Peneplain. Although this species

exists in the same local regions supporting *Dipodomys a. agilis,* it is closely restricted to the sagebrush belt and probably locally with gravelly soil, while Gambel's Kangaroo Rat is equally at home among sage or chaparral plants and is capable of living at higher elevations.

D. agilis agilis. Gambel Kangaroo Rat. This species is more common than *Dipodomys stephensi.* Fourteen specimens were taken at eight different localities of which the lowest was 1100 feet and the highest 3000 feet. The measurements of eight adults, of which two are females, agree quite well with those given by Grinnell (1922) for this subspecies. In every case, however, the trend is toward the smaller range of the extremes, in each character particularly with reference to the hind foot and ear which are smaller than the minima given by Grinnell.

Specimens were taken from both Plots I and VIII which indicates that this animal is capable of living in both the sage and chaparral belts. It is particularly associated with open areas within either belt. A firebreak cleared along the base of the mountain near Plot I supported a large population of kangaroo rats that apparently had moved into the region following the clearing, and had established burrows in a linear order about 60 feet apart. This irregular chain of burrows were at first unprotected by a single vestige of vegetation, but were even then interconnected by a well-traveled pathway that passed before each burrow opening. As herbs began to invade the region the following winter, the runway was maintained. These burrows were systematically cleared out and apparently enlarged following each rain. Every one of the burrows opened down the slight incline, which, incidently, also pointed away from the approach of rain and with the slope.

Each burrow was immediately repaired and cleaned out in the early summer following the reclearing of the firebreak done with the aid of a tractor and drag.

The purpose of the runway to which each burrow was connected by a short spur is not known, but it indicates that these animals travel well-defined pathways when away from their burrows. It is clear that foraging for food would have to be done quite far from the burrow opening, since the region surrounding was absolutely barren of vegetation during most of the year. Probably each animal followed the same general pathway to food. This predilection for fire trails is not unique, for another example of a similar situation exists on a clearing made in chamisal belt above Glen Ivy. Here the same interconnecting runways were observed.

Several specimens were taken that had already filled or partially filled their pouches with seeds. In August and September large quantities of buckwheat seeds were utilized. In October, they appear to concentrate on the collection of grass seeds, particularly those that may be growing along the open areas which they are inhabiting. Several specimens were taken in November whose pouches were crammed with the seeds of chamise, while those taken in December were picking up the seeds of laurel-sumac. In fact a specimen from Plot VIII had nearly 300 chamise seeds in its pouches when captured.

The enemies of the kangaroo rat are chiefly other nocturnal animals, particularly the coyote and barn owl. Near Plot I, barn owl pellets repeatedly yielded whole kangaroo rat skulls, and the scat of coyotes was occasionally found to contain parts of the bulla. It is possible that gopher snakes and rattlesnakes prey to a certain extent on this species. In early October, I found a remarkably distinct snake track across the dirt road below Plot I. From the straight, non-undulating nature, and width of the track, I believe it to be that of a rattlesnake, probably *Crotalus ruber.* I noticed that at three places separated by intervals of about six feet, the snake track was interrupted by cross markings, as if something had momentarily halted the animal. Closer inspection showed that a kangaroo rat had come upon the snake in its transit across the road and getting slightly to the side and probably in front of the moving snake, had tossed dust toward it.

The only breeding note obtained is of an adult female taken March 31, at 1200 feet in chaparral, that possessed three very small embryos. Most of the other specimens were taken in November and December.

Reithrodontomys

R. megalotis longicaudus. Long-tailed Harvest Mouse. Although it is found in open grassy areas in the sagebrush and chaparral belts as high as Santiago Peak, the harvest mouse is most abundant in the grassland belt at low elevations.

The breeding period begins in the early spring, but the following records indicate that young are born throughout the year. On August 28, a female taken on Plot V had three embryos measuring 7 mm.; the following day a female with 4 embryos 14 mm. in length was taken in the same plot. On September 9, a female with embryos measuring 4.7 mm. was taken from Plot VII. A female taken in lower Tin Mine Canyon, 1300 feet, as late as December 12, had four embryos.

Peromyscus

P. eremicus fraterculus. Dulzura White-footed Mouse. This white-footed mouse shows a decided preference for the sagebrush community, and for two plants, viz., buckwheat and black sage, that are characteristic parts of the vegetation of this community. In areas supporting typical stands of climax sage, it is one of the most abundant rodents per unit area.

This species was not encountered above 2700 feet even in the successional sagebrush community which, on some slopes, extends as high as 4000 feet. It is most abundant between 1000 and 2000 feet, but only where a fairly dense stand of either one or both of the above mentioned plants is found. The reason for this seemingly strict altitudinal limitation is not known. In part, it may be conditioned by the fact that black sage and the variety of buckwheat with which it associates at lower levels are seldom found above 3000 feet, or it may be that here is a mouse that cannot withstand the reduced temperatures of higher levels.

The two specimens taken on Pot VIII were, in each case, trapped in the vicinity of *Eriogonum fasciculatum* and *Salvia mellifera.* These plants are no doubt remnants of a once dominant sagebrush vegetation that invaded the chaparral complex following fire. The expectation would be that the *Peromyscus* would be eliminated when the climax chaparral has again taken over the area.

A unique niche occupied by this mouse was discovered on the north end of the range where several nests were found in caverns that had been leached and clawed out of sandstone ridges. Occasional specimens were recovered from traps set in dry, sandy washes.

It is interesting to note that two specimens taken from these buff-colored sandstone are, in fresh pelage, indistinguishable from *Peromyscus eremicus eremicus* of the deserts.

P. californicus insignis. Southern Parasitic Mouse. This species is found from the base of the mountain on both slopes to the top of Santiago Peak. It occupies all of the vegetational associations, with the exception of pure grassland, although it is more common in some than in others. Comparing unit-areas it is most abundant in the successional conifer forest with its lower layer of chaparral plants, but since this is so limited in extent, the chaparral belt itself provides the most important habitat for this species on the Santa Ana Mountains. Several specimens were obtained on plots in the sagebrush belt, but usually only where the laurel-sumacs or other shrubs were present. The only two individuals taken in the sagebrush of Plot I were immature, suggesting that populations pressure had forced them, at least temporarily, into this more unfavorable mixture of grassland and sagebrush. It is interesting to note that of ten rodent specimens taken in groves of Forbes' Cypress nine were of this species.

Almost without exception the parasitic mouse is closely associated with woodrats, even to the extent of occupying the same house with the latter species. It is probably true that the parasitic mouse usually inhabits houses unoccupied by woodrats, but on several occasions I have flushed both species from the same house. With the exception of Plot I, which I believe to be a special case, parasitic mice are taken with woodrats, no matter what the habitat may be. In upper Trabuco Canyon I found them in chambers built in fractures of low rocky outcrops; even here, woodrats were found.

Although the peak of breeding activities of this species probably occurs in the spring months, some young are produced throughout the year. A female taken on January 31, 1940 at 3600 feet elevation had two embryos almost to term. Another taken ten days later at similar elevation had enlarged mammae which, with the hemorrhagic condition of the uterus, indicated the recent bearing of young. On February 7, 1940, a female taken at 5600 feet had 4 very young embryos. From this point into the summer the number of pregnant females and the number of embryos per female increases until the peak in late June after which a steady decline in births occurs. On August 29, a female bearing two embryos was taken from Plot V. A female taken from Tin Mine Canyon, 1300 feet, on December 11, 1940 had one 27 mm. embryo. On December 12, one female taken at 2400 feet, was found to be pregnant with extremely small embryos.

Certain observations relative to preferred foods of rodent species may be ascribed directly to this species. Late in August of 1941 I observed piles of buckwheat flowering heads that were at the time just turning to seed both in and to the side of a runway previously made by woodrats but undoubtedly used by other species. The flowers had been gnawed from the shrub with a short length of stem remaining. Unbaited traps set among the shrubs and in the buckwheat seeds captured parasitic mice. Subsequent investigations revealed similar flowering heads in the food caches of woodrats and other species probably poached from the stores of the parasitic mouse.

P. maniculatus gambeli. Gambel White-footed Mouse. Grinnell (1933) has claimed this species to be the most abundant single mammal of California. It is not, however, the most abundant rodent, nor even the most abundant species of the genus *Peromyscus,* on the Santa Ana Mountains. The distribution of this species follows closely that of the sagebrush association, especially where the sage plants are scattered. This preference for the sage belt is especially evident where successional sage is found in territory otherwise dominated by chaparral species. A good example of this condition is to be found at Bear Springs, at 4300 feet, which is also the highest record I have for *maniculatus.* Here the dominant vegetation is woodland *(Quercus chrysolepis, Acer macrophyllum* and *Pseudotsuga macrocarpa)* along the stream and north-facing slopes, and chaparral on the east and west-facing slopes. But on the precipitous south slope there exists a patch of successional sage composed of white sage, buckwheat, thistle, yucca, and Yerba Santa. Gambel's White-footed Mouse was taken only in this latter region of an acre's extent, while the adjacent associations yielded woodrats, parasitic and Boyle's White-footed mice, but not one *maniculatus.* It is true that a few will be found in the lower chamisal chaparral, as on Plot VIII, but usually these are immature or subadult animals. Or, as on Plot VIII, they may represent vestiges of a larger population that thrived in the area when it was supporting successional sage species. With the return of chaparral plants other species better adapted to this community undoubtedly offer too severe competition for the continued survival of *maniculatus.*

There is a strong positive correlation in the distributions of this species and the black sage *(Salvia mellifera).* Trapping carried on in measured plots where the vegetation had previously been mapped revealed that *maniculatus* was taken in greatest numbers where this sage predominated. Stomach analyses of many specimens during September revealed that the animal had fed almost exclusively upon black sage seeds. This mouse will also feed upon animals recently caught in traps, even in some cases where the animal was still alive before the attack.

Breeding animals were trapped as late as December, although it seems that in this species too the number of embryos is reduced during this season.

P. boylii rowleyi. Rowley White-footed Mouse. This species is most abundant in the woodland and chaparral belts between 4000 feet and the top of Santiago Peak. Outside this area it is found locally in chamisal chaparral communities as low as 900 feet. Although they are found in fair abundance in riparian areas, they are equally common in woodland regions far from running water. In fact it was found to be the most common rodent on Santiago Peak rather distantly located from any

standing or running water. This species has a great predilection for acorns, as evidenced by stomach analysis.

P. truei martirensis. San Pedro Martir White-footed Mouse. This mouse is the least abundant of the five species of Peromyscus, and, with the possible exception of Stephen's Kangaroo Rat, bids fair to being the least common of all rodents on the Santa Ana Mountains. The three specimens that I have, two of which are females, are adults. Their measurements are on the average larger than those of topotypes of *martirensis,* and differ in certain ways from those of specimens which I have examined from the San Jacinto Mountains. The measurements are as follows: total length 222 mm.; tail length 119 mm.; hind foot 24 mm.; ear from notch (dry) 22 mm.

Neotoma

N. fuscipes macrotis. San Diego Wood Rat. This species is one of the most common rodents on this range. In fact I believe that accurate comparison would show them to be here in greater abundance than on any other mountainous area of cismontane southern California. In 1908, H. S. Swarth, who was then en route home from work in the San Jacinto Mountains, visited Trabuco Canyon and was sufficiently impressed to record in his notes concerning woodrats that they "are very abundant in this region."

Specimens were taken from 1000 feet on the interior slope, across the mountains through Santiago Peak, and over the Santa Ana Coastal Plain to the hills behind Laguna Beach at 200 feet. Aside from pure grassland, they are to be found in every recognized vegetational complex, and even in more or less barren rocky outcroppings.

In this race, the house-building instinct apparently is flexible enough to allow the rat to adapt its living quarters to environmental differences, for several modifications of the structure and location of the house have been noted. The size of the house is variable, probably varying directly with the size and thus age of the mouse inhabiting it. The largest house measured 70 inches in height, the smallest only 26 inches, while the average is probably closer to 36 inches. There may be from one to five outside openings, depending upon the nature of the surrounding terrain and the location of foraging areas. Near the top there is usually a large chamber that serves as a repository for food substances. On one occasion a nest of the parasitic mouse was found in this chamber. A passageway usually runs down through the house from the storage chamber into a middle room, which shelters the woodrat's true nest. The latter is made of grasses and macerated bark of chamise or coastal sagebrush. Another passageway commonly leads from this middle chamber down into a short underground burrow system.

Certain differences attributable to conditions changed with elevation were observed. It was found that houses built in the higher (4000 feet and above) reaches of the mountain had a more extensive subterranean system with a decrease in the size of the house. It is possible that the more extensive burrow provided greater protection against the lower temperatures prevailing here. In some places the house consisted of slash material stacked by workmen clearing trails, there being little attempt by the woodrat to improve upon it. In one instance a woodrat was removed from a burrow which had no covering material.

In rocky regions of granitic or fractured metamorphic outcroppings, houses were constructed among the fractures simply by plugging up some of the openings with sticks, leaves and small rocks.

As is well-known the houses of this species may be perched anywhere from 10 to 30 feet above the ground in live oaks when found in narrow canyons. This is an obvious protection against winter torrents.

On several occasions woodrats were observed voluntarily away from their houses during diurnal hours. In April, 1940 I noticed a woodrat staring at me from a tangle of chaparral while I was changing a thermograph chart on Santiago Peak. I was surprised when it suddenly began to undergo a series of shaking or vibrating move-

ments that involved first the anterior and then moved to the posterior part of the body. This was continued at regular intervals for two or three minutes, during which time no sound was produced, then it moved leisurely off. Apparently this is not correlated with the unique sounds produced by these animals at various times. On other occasions, especially during the summer months, I observed woodrats that came into camp after rinds of grapefruit and oranges in daylight and in spite of the proximity of persons engaged in conversation.

I was impressed with the fact that woodrats travel considerable distances in foraging when a midden in an outcropping on a steep, nearly barren slope was found to contain the pits of the fruits of California Bay of which there was none growing nearer than 150 feet down the precipitous slope. This midden contained a great number of empty snail shells, suggesting another possible article of diet. In addition the following plants were found to be used by this animal: *Rhus laurina* (leaves and stems), *Rhus ovata* (leaves and stems), *Yucca Whipplei* (seeds), *Galium angustifolium* (seeds and stems), *Eriogonum fasciculatum* (fruiting heads), Matilija Poppy (pods), *Adenostema fasciculatum* (new shoots), *Solanum Xantii* (vegetation), and the acorns of all of the oaks.

Microtus

M. californicus sanctidiegi. Southern California Meadow Mouse. This species is a characteristic animal of the grassland community. Despite its predilection for moist areas, this species was taken on even small patches of successional sagebrush which were distant from streams or springs. It has no altitudinal limits on this range and is active throughout the year at all elevations. It is a rodent which is characteristic of disturbed vegetational areas; it is sure to be found on plots where the chaparral has been temporarily removed either by fire or clearing.

March 28th, while excavating a burrow system, I found a nest containing nine young which were at most 3 days old. The nest was only 18 inches from the burrow opening, but barely 6 inches below the soil-surface. Digging beyond the nest, I found storage chamber filled with fresh and neatly-cut pieces of filaree *(Erodium)* and wild oat, and at the blind end of the burrow I encountered a large tarantula. In order to get in or out the tarantula would necessarily have crossed directly over the young mice. It is possible, of course, that it had spent the winter in the burrow and had not as yet ventured forth.

Mus

M. musculus. House Mouse. Rare on the Santa Ana Mountains, probably because of the relatively few human habitations on or near the range. I took only one specimen and this from the base of the mountain near a deserted field and assorted farm buildings.

Lepus

L. californicus bennettii. San Diego Jack Rabbit. Common, but at this time not abundant in the sagebrush belt and adjacent open growth of chaparral on slopes and dry alluvial fans below 1500 feet altitude. In the general region it is certainly most abundant in or about orange groves.

Sylvilagus

S. audubonii sanctidiegi. San Diego Cottontail. Persistent hunting has reduced noticeably the numbers of this species. But it is still common on private tracts of sagebrush posted against hunting, and chaparral slopes within the Game Refuge, as high as 3000 feet. Particularly common in sandy washes at mouths of the larger canyons.

S. bachmani cinerascens. Ashy Brush Rabbit. This is the most common lagomorph on the Santa Anas. Although found occasionally in dense sagebrush, it is most frequent on chaparral-clothed slopes up to Santiago Peak. Occasionally both cottontails and brush rabbits will be observed together, particularly if in successional territory, but the usual tendency is to find brush rabbits in dense vegetation at higher elevations, cottontails in open vegetation at lower levels and jackrabbits in open washes and adjacent sagebrush around the piedmont.

Odocoileus

O. hemionus Mule Deer.

subsp. *californicus.* California Mule Deer.

subsp. *fuliginatus.* Southern Mule Deer.

Two subspecies of mule deer appear to reach one extreme of their distribution on the Santa Ana Range. Ranging from Monterey County on the north, the subspecies *californicus* reaches its southernmost distribution in the Santa Anas, while *fuliginatus* reaches out southward from here into the San Pedro Martirs of Lower California.

Beyond doubt *fuliginatus* is the more common of the two races. Both occupy the chaparral belt, in one season or another, from the base of the mountain to Santiago Peak. From September until May the greater number of deer are found below 3500 feet; in June and early July they occupy the canyons near water and adjacent brushy vegetation; then later in July and most of August they occupy the higher reaches of the mountain above 3000 feet. About the first of September large numbers begin to move down onto the lower slopes, and there is some evidence that a southward movement into the portreros south of Los Pinos Peak takes place. It is at this time that the two races begin to separate, for most individuals of *californicus* do not undergo this vertical movement. Instead they tend to remain at levels above 4000 feet, particularly in the vicinity of Trabuco, Santiago, and Modjeska Peaks. Thus during the winter months one finds the majority of *californicus* on the ridges and slopes at higher elevations, and *fuliginatus* in the broad chaparral dominated canyons and grassy portreros at lower elevations.

The majority of specimens brought in by hunters during the early winter are animals referable to the race *fuliginatus;* only an occasional *californicus* is found. Particularly interesting is the small number of animals that might be called intergrades. Both of these facts coincide with the movements outlined above, since hunters are not permitted into the upper reaches of the range occupied by *californicus,* and the small number of intergrades might be explained by this apparent separation prior to breeding.

Time and the scope of this work have not permitted a full study of the breeding habits of deer in this range, although they do appear to be worthy of further study. Several observations indicate that fawning and consequently the breeding season take place earlier here than I had expected. Fawns have been observed in late March, and they are common in April. This would probably place the breeding period in late September and October. This assumption is partially borne out by the fact that bucks appear in breeding condition in early October. Fighting between bucks occurs in earnest during the latter part of September. By November bucks begin to fraternalize and in December bands of from five to eight bucks are common sights.

It is difficult to estimate the number of deer on the range, because large meadows on which deer gather to feed in the evenings are very scarce. Occasionally the Forest Service conducts drives in January, but these are so limited in scope that little accurate information is gained. The survey of 1940 estimates the number to be around 3500 for the entire range.

On June 19, 1940 I undertook a limited census of the deer between Sierra Peak and Bedford Peak—a distance of about 15 miles. I drove the Main Divide Truck Trail between these points, stopping at those points where this dirt road had intersected a regular deer trail. I counted all of the tracks within the limits of a normal stride and divided by four. I found an average of 15 deer per mile along this road at this time. After considerable study of the terrain traversed by the trails and the tracks in the canyons and on side roads leading down the mountain, I judged that deer within at least a mile of the road on either side were tallied in this census. This would mean about 7 deer per square mile. But I am certain that this portion of the range is not as well-stocked as that south of Bedford Peak which could not be counted because of the difficult terrain. Nonetheless, since there are about 400 square miles of territory available to deer in this region the total number would approach 2800. The true value undoubtedly lies somewhere between this figure and 4000.

Near Santiago Peak I stumbled upon the remains of a unique tragedy. In a little clearing in the dense chaparral I found a complete skull with antlers of a large four-point California buck. The skull was upright with a sturdy telephone wire coiled about one tine and in such a way as to have pressed against the neck. A reconstruction of the event showed that the buck had apparently entangled an antler in the wire as it stretched over the chaparral and across the trail, then becoming frightened by the drag of the wire it had plunged down the slope with the wire wrapped around the antler and its neck, with the result that the harder it pulled the sooner death came. The signs of a terrific struggle were still evident in the scarred soil devoid of grass for several feet behind the skull even though the event must have happened many months before. Most of the rest of the skeleton was strewn down the hillside but all bore evidence that coyotes had profited at the deer's expense.

The presence of a more or less isolated population of the California Mule Deer on the Santa Anas is a situation that lends itself to some speculation. The known center of distribution of *californicus* lies in Santa Barbara County. Even in the past, the low-lying terrain that separates the Santa Anas from northern mountain chains must have been a kind of barrier to the southward movement of this race. Today, and in the future, the great metropolitan centers will serve to make this barrier more effective. Thus, interbreeding of even low frequency between the two races may well cause a disappearance of *californicus* on the Santa Anas.

ECOLOGIC COMMUNITIES OF THE REGION

The first step in this study of the ecologic communities of the Santa Ana Mountains involved an analysis of the fauna and flora entailing a search for common properties and differential characters which would permit a logical division of the total biological environment into comprehensible units. There then followed the step involving description and definition of these units in a manner intelligible to others. The final and most difficult step required a study of the polyphasic relationships existing among organisms and between organisms and the physical environment or habitat.

In any undertaking of this character one is not handicapped by a paucity of technical terms, but rather is confronted by the problem of determining just which of the available terminologies are best suited to the problem at hand.

So far as Life Zones are concerned, three exist in this region of which the Upper Sonoran is most extensive and most characteristically developed, while the Lower Sonoran is only moderately developed near the base, and the Arid Transition is confined to discontinuous localities at intermediate elevations. While Life Zones are useful in comparative studies, mainly within western America, they are too inclusive to be of value in studies of this kind.

The concepts of formations and their associational subdivisions are better suited for descriptive purposes, since they combine both classification and laconic descriptions of environmental units in a single phrase. Biotic emphasis has been given in this study through the practice of listing all of the vertebrate animals found in the community, which taken together with the plants would constitute at least a part of the biome, or plant-animal formation. In most instances the biotic communities have been named for their more salient plant constituents. The larger communities have been subdivided into associated communities not only to permit more concise description, but also to reflect the more constant variations in the biome. It should be noted that the life-form of plants is one criterion upon which the separation of communities is based; whereas the associated communities are dependent upon differences in species correlated with changing edaphic factors.

Sufficiently detailed observations of the terrestrial vertebrates were made to justify their being listed in order of numerical superiority. A more precise statement of the frequency of individuals can be made for most of the species of rodent, since extensive trapping records were obtained from measured plots in each of the biotic communities recognized in the report.

Initially the plots encompassed one acre and supported only 93 traps. The traps were set out uniformly without regard for runways or other evidences of rodent activity, and trapping was at first carried out for five consecutive nights, or until the plot was presumably exhausted of resident rodents. The traps were baited lightly with moistened rolled oats.

After trapping several plots, two changes in procedure were indicated. First, the size of the plot was reduced to one-half acre, because it was very difficult to lay out plots in vegetation as impenetrable as that found on the main mountain mass; and, second, the number of trap-nights was reduced from five to three, because a study of the data obtained from the first plot revealed that eighty per cent or more of the total catch was taken on the first and second nights.

The dimensions of the new plots were set at 165 feet by 132 feet, giving 21,780 square feet or the area of one half acre. The traps were set by steel tape at intervals of one rod along nine parallel rows each one rod apart. A uniform grid of 99 traps, all separated by the same distance, was thereby created. Actually this more than doubled the number of traps per unit of area on the original plots, thus compensating for the reduction in trap-nights and reducing the magnitude of error introduced by rodents from adjacent areas straying onto the plot when competitors had been removed. Obviously the latter point would only be important if attempts were made to compute the ratio between population size and area.

Plots were numbered according to the order in which they were laid out, but it has been more convenient in reporting results to discuss them under the appropriate community heading without regard to the original order.

AQUATIC COMMUNITIES

Although water exerts an important influence on the habits and distributions of vertebrate animals in this comparatively arid region, habitats in which water is the prominent feature comprise a relatively small part of the total environment.

There are few streams on the Santa Ana Mountains that maintain a flow of water to the base throughout the dry season. In fact, many of the smaller streams carry no surface water during years of average or less rainfall. During the winter and early spring months, however, most of the larger canyons carry quantities of swiftly-moving water to the base of the mountain and beyond. The Temescal River, an intermittent stream, which parallels the eastern base of the mountains, receives most of the water from the interior slope, north of Lake Elsinore, and empties into the Santa Ana River near Corona.

Water from the southwest slope reaches the Pacific along two principal routes. Santiago Creek collects from the major canyons north of Santiago Peak, with the exception of a few on the northern end which drain directly into the Santa Ana River, and then empties into the Santa Ana River approximately one mile northwest of the city of Santa Ana. Trabuco Creek carries almost all of the water collected south of Santiago Peak and north of the Ortega Road into the Pacific near San Juan Capistrano. The fact that all amphibian species are much more abundant on the Pacific slope than on the interior is no doubt correlated with the greater rainfall and more extensive waterways on this side.

During the spring months the lower portions of these waterways furnish more favorable situations for vertebrates than do the rushing mountain streams. At this season the evident population of all amphibia reaches its highest peak. The California Newt, Canyon Tree Frog, Pacific Tree Frog and to a lesser extent the California Toad utilize the more slowly-moving portions for breeding. Usually newts are most abundant in pools, while the canyon frog frequents swifter waters between pools and the Pacific Tree Frog confines its activities to the slower waters at the canyon mouths, particularly where grassland is adjacent. The California Toad apparently prefers to breed in those pools which are formed by the recession of high waters.

Occasionally tadpoles of the three salientian species listed above are found together,

but for the most part the canyon frog's tads have drifted into these areas from which they emigrate shortly after metamorphosis.

A common predator on these tadpoles is the water bug, *Lethocerus,* which will prey also upon adults. The latter are also preyed upon by the water snake *(Thamnophis ordinoides hammondii),* which is a common inhabitant of these slower waters and of pools in which it feeds upon newts.

In a few canyons on the Pacific slopes, the mud turtle inhabits the deeper and more extensive pools, usually associating with red-legged frogs and newts.

Rain pools, usually of small size and located in natural basins, cultivated fields, or troughs along roadways, exist only during a relatively short part of the rainy season after the first heavy rains have brought the soil moisture to the point of saturation. Despite the ephemeral nature of these pools, the spadefoot toad's existence is largely dependent upon their formation. But because the temperature of the water is a prime requisite of larval development, the pools are not utilized to any appreciable extent until late February or March. Adult spadefoot toads have been collected here as early as February 17, but larvae are nowhere abundant until March. Large numbers of metamorphosing toads were collected from rain pools along the interior base as early as April 6 in 1941. By the middle of April most of the larvae have metamorphosed and may for a time be found in mud depressions around the pool's perimeter, but by June there is little evidence that a pool ever existed. Frequently the California Toad breeds in the same pools. Although bufo eggs are found earlier than those of scaphiopus, larvae of both species occupy the pools together. This is an advantage to the spadefoot larvae, considering their carnivorous habits.

The only other impounds of standing water are pools found in the low, marshy land along the interior drainage south of Lake Elsinore and impounded behind Santiago Dam (Irvine Reservoir) in lower Santiago Canyon, and Lee Lake in the Temescal Canyon. The pools, inhabited by small fishes of undetermined kind, are attractive to herons, night herons, egrets and red-winged blackbirds; the larger reservoirs are regularly visited by ducks, and some geese, especially in August and September when thousands of mallards, widgeons, and pintails are migrating. Coots, a few mallards and night herons have taken these places as permanent abodes. Most of the birds found in canyons are more closely associated with the Woodland Community; hence they will be discussed under that heading.

Racoons, bobcats, and opossums are common visitors along the lower portions of streams during the spring months. Racoons are particularly common along the Temecula River where dung heavily laden with the exoskeletons of crayfish betrays their presence. As these streams dry up at the base of the mountain, amphibia like the newt retreat to logs, stones, and tunnels in the soil, while the Canyon and Pacific Tree Frogs move with the receding water. In August I have taken these frogs as high as 4000 feet, while these portions of the same streams did not yield a single specimen during the spring. Racoons perform a similar movement, occasionally being found as high as 5500 feet in late fall. From observations of tracks, it would appear that racoons and bobcats take up regular patrols of the lower reaches of these receding streams, searching for trout captured in small pools which form and disappear rapidly on a hot day.

GRASSLAND COMMUNITY

Grassland, existing as a pure plant formation and a distinctive ecologic community, dominates only a small part of the vegetation of this range. Figures obtained from a map of the vegetation of this region published by the United States Forest Service (1938 & 1940) show that grassland covers only 1100 acres within those boundaries of the Cleveland National Forest limited to the Santa Ana Mountains. This is only 4.5 per cent of the acreage dominated by sagebrush, and 1.0 per cent of the acreage of chaparral.

Grassland is usually found at low elevations, 1500 feet or below, and is confined to flat land or gently sloping hillsides that have a deep layer of clay-bearing soil. The vegetation is not entirely composed of plants in the Family *Gramineae.* Numerous

herbaceous plants, both annual and perennial, are common members of this community. In those places where grazing occurs more or less regularly the purer grassland has given way to the encroachment of some half-shrubs and cactus. The greater bulk of grass species constituting grassland are introduced annuals. Among these one frequently encounters brome grass *(Bromus mollis & rubens)*, wild barley *(Hordeum murinum)*, wild oats *(Avena barbata & fatua)*, and species of the Genera *Festuca* and *Gastridium*. A lesser number of grasses are native perennials, of which the more salient are two spike grasses, viz., *Stipa coronata* and *Stipa pulchra*. In the grassland of alkaline marshes, *Distichilis spicata* is the dominant species.

The herbaceous plants group themselves into definite societies that are dominant at different parts of the winter and pre-vernal periods. Growth of both the grasses and herbaceous plants begins in December soon after the first heavy rains, but the flowering sequence usually does not begin until late January. Of the herbaceous plants, the mustards *(Brassica campestris* and *nigra)*, shooting star *(Dodocatheon clevelandii)*, peppergrass *(Lepidium nitidum)*, hyacinth *(Brodiaea capitata)*, buttercup *(Ranunculus californicus)*, chocolate lily *(Fritillaria biflora)*, and various species of lupine predominate during February and March. The following plants replace these in April: *Sisyrinchium bellum, Layia platyglossa, Baeria chrysostoma, Viola pedunculata,* with an occasional *Orthocarpus purpurascens* which, along with *Calochortus splendens* and *Bloomeria crocea,* predominates during late April and May. In June the tarweeds *(Hemizonia kelloggii* and *fasciculatum)*, farewell-to-spring *(Godetia quadrivulnera)*, and *Lotus salsuginosus* complete the late vernal period. During the summer the grassland community is largely quiescent, being composed of thoroughly dried plants. Here and there a few gourds *(Cucurbita foetidissima)* and milkweeds *(Asclepias eriocarpa)* may remain green and in bloom.

In those areas where sagebrush species have invaded the grassland, one finds scattered plants of buckwheat *(Eriogonum fasciculatum)*, coastal sage *(Artemisia californica)*, and *Lotus scoparius*. Here much the same progression in blooming occurs, with the addition that the lotus becomes dominant in mid-April and part of May, followed by buckwheat in June and early July, to be followed by coastal sage in August and September. Some large local communities of cactus *(Opuntia occidentalis)* occur where heavy grazing activities have bared the soil through trampling and consequent erosion. It is recognized that these plants reach optimum development in the sagebrush community, but their presence here is noteworthy, since without them animals like the jackrabbit and pocket mouse are not present in the grassland community.

Higher on the mountain, especially on rocky hillsides and slopes that have been burned over, or on areas cleared by man, localized regions may be invaded by grass species. One of the brome grasses *(Bromus tectorum)* is common on the clearing on Santiago Peak. At lower altitudes, another brome *(B. rubens)* and the Golden-top Grass *(Lamarckia aurea)* are commonly found on firebreaks. On the slopes, *Stipa lepida* and *coronata* are characteristic grasses along with a host of annual herbs.

Plot VI, chosen to represent the grassland community, is a one-half acre plot situated about one and one-half miles west of Irvine Park, just outside the northwest boundary of the Cleveland National Forest. More exactly, it lies in the east-central portion of section No. 24, of township No. 4, S., and range No. 9, W., at an elevation of 500 feet.

The vegetation here is a mixture of grassland and sagebrush species of which the former are: *Festuca megalura, Festuca reflexa, Gastridium ventricosum, Avena fatua, A. barbata,* and *Bromus mollis*. The only half-shrubs are buckwheat and coastal sagebrush, with an occasional plant of *Lotus scoparius* and cactus. Despite the admixture of sagebrush species, grass species cover most of the plot. The half-shrubs do not occur in aggregations but only as individual plants separated from one another by several feet and about equally divided between buckwheat and sagebrush.

The soil on this plot is composed of river gravel and other river alluvium deposited by Santiago Creek during Quaternary times. This mixture of fine sediments and light gravels forms a typical adobe soil.

This plot was trapped for three nights, beginning September 8 and ending September 10, 1941.

Thirty individuals of four rodent species were taken as indicated below:

SPECIES	MALE	FEMALE	TOTAL
Microtus c. sanctidiegi	6	7	13
Reithrodontomys m. longicaudus	7	5	12
Perognathus f. fallax	1	2	3
Thomomys b. palescens	1	1	2
	15	15	30

The three age groups commonly used by mammalogists are adult, subadult, and immature. Subadult individuals are those that do not attain the average measurements of adults of the species, that show only a small amount of wear on the teeth, and that show no evidence of breeding upon examination of the sex organs. This is an important group in the population of any rodent species, for it is the source of potential breeding animals. It is largest in the fall and winter. Upon it the species probably depends in large measure for new spring animals.

The distribution of individuals among the relative age groups in the rodent population of Plot VI appears as follows:

	ADULT	SUBADULT	IMMATURE	
Female	8	3	4	15
Male	9	2	4	15
	17	5	8	

This plot shows a relatively high percentage of young animals, of which all the subadults were meadow mice and 63 per cent of the immatures were harvest mice, but this is considered normal for early fall.

Each species, and probably each individual thereof, appears to have occupied a fairly discrete area. In no instance was a reithrodontomys taken in a trap that had, or subsequently, captured either a microtus or perognathus. Also, in only two instances were two members of the same species taken in the same trap, and one of these was an immature animal.

Since a record of the plants growing at the location of each trap was kept, it might be pertinent to present the following observations: (1) meadow mice were taken in the grassiest portions of the plot, but only where a bush of buckwheat was growing; (2) harvest mice were taken where the grasses were sparser and about a bush of coastal sagebrush, and (3) pocket mice were taken only at those places where all three of the sagebrush species, i.e., the above two and *Lotus scoparius,* were located. This agrees closely with observations made on Plot V.

In addition to the animals listed above, one cottontail rabbit was repeatedly flushed from this plot.

The following lists are composed of vertebrate animals considered to represent the animal formation of this community.

MAMMALS	*Microtus c. sanctidiegi*	20
	Reithrodontomys m. longicaudus	15
	Thomomys b. pallescens	7
	Citellus b. beecheyi	common
	Perognathus f. fallax	4
	Lepus c. bennettii	occasional
	Sylvilgus a. sanctidiegi	rare
	Canis l. ochropus	occasional

BIRDS	Meadowlark Lark Sparrow Grasshopper Sparrow Savannah Sparrow Horned Lark (with some sage) Mourning Dove (grown over cultivated) Shrike (with some sage) Rufous-crowned Sparrow	Cooper Hawk Turkey Vulture Marsh Hawk Barn Owl Red-tailed Hawk Red-bellied Hawk Golden Eagle
REPTILES	Gopher Snake *(Pituophis catenifer)* California King Snake *(Lampropeltis getulus)* Striped Racer *(Coluber lateralis)* Ring-necked Snake *(Diadophis amabilis)* Horned Lizard *(Phrynosoma blainvillii)*	

The meadow mouse, harvest mouse, and pocket gopher are the characteristic rodents of the more or less natural remnants of grassland; pocket mice are found on semi-disturbed areas, while ground squirrels are characteristic of submarginal and cultivated areas. Jackrabbits are found only where sufficient brush is present to provide refuge places during the day. Cottontails are less abundant than jackrabbits, but like the latter they are found only where some brush is present. It is very likely that the badger was once an important member of this community, but today it has been forced to retreat to chaparral for protection. Undoubtedly, its main source of food was the pocket gopher. A significant part of the coyote's foraging is carried out on that grassland adjacent to canyon mouths. Even in reduced numbers, it is probably the dominant single animal of this community. It preys largely on rabbits.

As a group the predatory birds play a most important role in controlling this community. Barn owls exact a large toll of pocket gophers; eagles and red-tailed hawks prey upon jackrabbits, ground squirrels and snakes; while marsh hawks feed extensively upon meadow mice in the moister portions of the grassland. Seed-eating species play a less vigorous role in the life of this community, but in many ways are much more characteristic of it than the predators. These, in their turn, are preyed upon by Cooper Hawks.

An abundance of food for prey as well as predator is the principal advantage of the grassland community. Seeds of grasses and herbaceous plants are provided for gramnivorous animals; vegetative material for rabbits and meadow mice is abundant; while roots, rhizomes and bulbs are present for pocket gophers. In addition material for constructing the nests of both mammals and birds is easy to obtain. But against these advantages must be weighed the fact that grassland offers only a thin stratum in which foraging must be carried out. Also it is characterized by a relatively small amount of rainfall, a large range of temperatures, extreme light intensity and vulnerability to fire during the otherwise critical part of the year. It is, therefore, not surprising that the majority of the mammals are fossorial and confine their activities to the nocturnal hours. The ground squirrel regularly aestivates during the hottest part of the summer and hibernates part of the winter period. It is interesting to note in this connection that ground squirrels living on Santiago Peak did not become inactive during the summer, but did during the winter.

SAGEBRUSH COMMUNITY

The Santa Ana Range is, with a few minor exceptions, completely encircled by the Coastal Sagebrush Formation. Its optimum development as climax vegetation is attained between grassland and chaparral, usually around and below 1500 feet; as a successional vegetation, it may extend as high as 4000 feet especially on south and west exposures.

There is still no general agreement among plant ecologists as to just how much of the observed sagebrush should be considered as climax and how much is successional. McKenney (1901), working in Orange County, California, described sagebrush as being characteristic of foothills, while chaparral was considered by him to constitute a

"mountain formation." Abrams (1910), on the other hand, treated sagebrush in the coastal region as a lower division of the chaparral belt, intermediate between Lower and Upper Sonoran Life Zones. In 1920 Clements described coastal sagebrush as a distinct vegetational unit unrelated to chaparral, and wholly climax in nature. He contended that typical sagebrush in the coastal area of southern California was represented in some areas by pure sócieties of either buckwheat, black sage, white sage, or coastal sage *(Artemisia californica)*. Furthermore, he pointed out that any one of these plants might dominate a localized area, where optimum conditions were available for its development, but that over extensive areas a combination of several societies made up the Coastal Sage Formation. Cooper (1922) pointed out that Clements' interpretation that all sagebrush was of a climax nature did not agree with observed facts. He did recognize that a part was undoubtedly climax, but postulated that sagebrush growing in disturbed areas would be supplanted eventually by a true chaparral climax. My observations on the Santa Ana Mountains would seem to substantiate this latter point of view. The largest part of the successional sagebrush owes its presence to fire in this region.

Because the climax sagebrush reaches its optimum development on both slopes at altitudes around 1500 feet, each year its area is being diminished by increasing extension of agricultural interests. Under the recent war conditions this expansion of agriculture progressed with renewed vigor. In 1934, the area dominated by sagebrush in the national forest was computed to be about 24,000 acres. A large part of this is presumable successional in nature so that it will eventually be replaced by chaparral.

The dominant plants of climax sagebrush are buckwheat *(Eriogonum fasciculatum)* and coastal sage *(Artemisia californica)*. Common associates of these are *Salvia apiana, Salvia mellifera* and *Lotus scoparius*. The even growth of these half-shrubs is occasionally broken by groups of *Rhus integrifolia, Rhus laurina,* and *Rhamnus crocea,* which are important biological adjuncts to this formation. In protected places, usually near the line of mergence of sagebrush with the chaparral formation, *Penstemon antirrhinoides* is characteristic. The Purple Sage *(Salvia leucophylla)* is an important species of the climax sage on the sedimentary limestones from Black Star Canyon north to the Santa Ana Canyon.

The successional sagebrush at low elevations consists of irregular plantings of the primary dominants with *Encelia farinosa* and *californica, Eriodictyon crassifolium, Senecio douglasii,* and one or more species of true sage. One might well consider the *Lepidospartum squamatum* found in washes and on alluvial fans as a member of this formation.

Higher on the mountains, in the normal domain of chaparral, I observed extensive areas of sagebrush that were obviously the successional aspect of this formation. Most of these places coincide in position with those given on the U.S. Forest Service Fire Map as having been burned over within the past twenty years. Not one fire, but very probably repeated fires have so completely destroyed the chaparral plants that they have been unable to regain possession of the area by stump sprouting or reseeding. On these burns buckwheat and white sage are the dominant plants.

The blooming period of the sagebrush community is considerably later than that of the grassland community. It is initiated in March by *Lotus scoparius,* continued in April and May by *Salvia mellifera* and *S. apiana,* and largely completed by *Eriogonum fasciculatum* in June and July. After a period of quiescence in the summer, a second blooming period is begun by *Artemisia californica.*

Because climax sagebrush is not everywhere uniform with respect to either the plants that compose it or the animals that depend upon it, it is possible to subdivide this community into two ecologic associations each presenting greater uniformity than would sagebrush taken as a unit. Each association has a characteristic assemblage of plants and animals, though many species are common to both. In this paper these associations have been named for the genera of the dominant plants, viz., the *Erigonum-Artemisia* association and the *Eriogonium-Rhus laurina* association. The successional sagebrush is more conveniently discussed under the chaparral community.

Eriogonum-Artemisia Association:

This association occupies the rolling hills on the piedmont. On the one hand, it grades evenly into grassland, and on the other it merges with the *Eriogonum-Rhus laurina* association. Its close relationship to grassland is revealed by a prevalent lower stratum of grass and herbaceous plants, without which certain birds and rodents are absent.

Plot I is considered to be characteristic of this division of the Sagebrush Community. It covers one acre near the northeast boundary of section No. 29, township No. 4, S., range No. 6, W., about 100 yards east of a dirt base road known as the Bedford Truck Trail, and at an elevation of 1400 feet. The plot slopes gently to the north, there being a fall of about 20 feet along the 265 feet beween its south and north boundaries. The soil is a deep sedimentary, constituted principally of weathered sandstone, probably of Triassic age, with a mixture of red clay. This material characteristically absorbs large quantities of water during heavy rains, becoming sticky and swollen in appearance.

The principal plants of Plot I are listed below in estimated numerical superiority.

1. *Artemisia californica*
2. *Eriogonum fasciculatum*
3. *Lotus scoparius*
4. *Salvia mellifera*
5. *Salvia apiana*
6. *Brodiaea capitata*
7. *Sisyrinchium bellum*
8. *Erodium moschatum*

Common grasses are *Festuca reflexa, Festuca megalura* and *Bromus mollis.*

Trapping was carried out for five nights, beginning the night of December 20, 1939, and ending the night of December 24, 1939. A total of thirty animals was taken during this period, of which all but two were rodents, one being an insectivore and the other a lagomorph. Of this number, 80 per cent were trapped during the first two nights, with an additional 10 per cent catch on the third night.

The following species were trapped from Plot I:

Reithrodontomys m. longicaudus	9
Peromyscus m. gambeli	6
Microtus c. sanctidiegi	4
Perognathus f. fallax	4
Peromyscus c. insignis	2
Dipodomys a. agilis	1
Dipodomys stephensi	1
Thomomys b. pallescens	1
Sylvilagus a. sanctidiegi	1
Notiosorex crawfordi	1
	30

The distribution of individuals among the relative age groups of the rodents only is shown below.

	ADULT	SUBADULT	IMMATURE	
Male	11	7	1	19
Female	7	2	0	9
	18	9	1	

The small number of females captured suggests that this period marks the beginning of the breeding period for several of the species at which time the females may not be as active on the surface as males.

Nearly eight and one-half years after the original trapping, I returned to the site of Plot I and retrapped the area. At this time, however, three important changes in the

conditions of trapping were instituted or observed. An electric fence designed to prevent movements of animals into and from the plot was erected along its boundaries (see Pequegnat and Thomson, 1949). Also, there was an important difference in the vegetation of the plot itself: a firebreak had been cleared across the upper edge of the old plot, in the construction of which all vegetation with the exception of a few mustard and filaree plants had been removed from a belt some 65 feet in width. Finally, the season of trapping was spring rather than winter.

Trapping was continued until all rodents had been removed from the plot. It began the night of April 15, 1947 and ended April 24, at which time no animals were captured in the traps. The list of species, age-group breakdown, and sex ratio data are tabulated below. The animals are given in the same order as the table above.

SPECIES	ADULT MALE	ADULT FEMALE	SUBADULT MALE	SUBADULT FEMALE	IMMATURE MALE	IMMATURE FEMALE	TOTAL
R. m. l.	2	4	0	0	1	1	8
P. m. g.	5	5	1	0	3	3	17
M. c. s.	1	2	0	0	1	0	4
P. f. f.	0	1	0	0	0	0	1
P. c. i.	0	0	1	0	0	0	1
D. a. a.	5	5	0	0	1	0	11
T. b. p.	1	2	0	0	1	1	5
	14	19	2	0	7	5	47
	33		2		12		

The list of rodents removed is the same as that obtained in 1939; but the number of individuals captured is larger, the relative abundance of some species has changed, and the ratios of age-groups have changed. These factors have changed, however, in accordance with expectation.

The over-all increase of population from 28 to 47 individuals can be accounted for by (a) the great increase of immature animals, (b) a more normal balance of sexes, and (c) an absolute as well as relative increase of two species.

In 1939 only one animal or four per cent of the population was immature; in 1947, 12 individuals comprising 26 per cent of the population were immature. And this latter figure would have been increased considerably had trapping been carried out two weeks or so later, since 22 embryos were removed from captured mice. The species distribution of these embryos when coupled with similar data for the immature animals provides information on the peaks of breeding. The embryos were distributed as follows: 12 carried in four *Dipodomys agilis,* 7 carried by two *Reithrodontomys,* and 3 carried by one *Peromyscus maniculatus.* Because Peromyscus presented a large number of immatures and a small number of embryos, we may conclude that the peak of its breeding season was over. Because Dipodomys, on the other hand, exhibited a low percentage of immatures and a high percentage of embryos, we may conclude that the peak of their breeding season was imminent. This probably applies to Reithrodontomys as well. Obviously the season of trapping accounted for the increase of immatures and the decrease of subadults, the latter dropping from 32 per cent of the population in December, 1939 to 4 per cent in April, 1947.

The marked increases in abundance recorded for Dipodomys and Thomomys can be attributed to the presence of the firetrail, since the burrows of both were constructed there and every individual of these genera was captured on this denuded area.

It may be of interest to record that the aggregate weight of this rodent population amounted to 3.2 pounds. Small as this may appear, the total effect of these animals on the vegetation is significant, as evidenced alone by the simple observation that one pocket gopher destroyed two large black mustard plants together with filaree leaves and seeds in a period of four days of the study.

Birds noted at various localities, and, as an assemblage, considered characteristic of this association are:

Bell Sparrow	Brown Towhee
Black-chinned Sparrow	California Quail
Gambel Sparrow	Roadrunner
Lincoln Sparrow	Say Phoebe
Lark Sparrow	Cassin Kingbird
Red-tailed Hawk	Cooper Hawk
Barn Owl	Dusky Poorwill
Texas Nighthawk	Shrike
Mourning Dove	Meadowlark

Reptiles captured in this association are:

Red Diamond Rattlesnake *(Crotalus ruber)*
Gopher Snake
California King Snake
Worm Snake
Black-headed Snake
Rosy Boa

The Eriogonum-Rhus laurina association:

It is confined principally to the belt between the pure sagebrush of the lowlands and the chaparral of the mountain slopes. Common associates of the type plants are *Salvia mellifera, Mimulus longifloris, Penstemon antirrhinoides, Romneya coulteri* and an occasional *Photinia arbutifolia.* A lower stratum composed of grasses and herbs, which was so characteristic of the Eriogonum-Artemisia association, is only locally common here. Nonetheless the presence of both microtus and reithrodontomys in this association is dependent upon these plants.

Plot V was chosen to represent this association, of the Sagebrush Community. It is located three and one-half miles south of the center of Corona, on the east ridge of Main Street Canyon, or it occupies the east-central portion of section No. 14, of township No. 4, S., range No. 7, W., and on the 1400-foot contour.

Plants found within the boundaries of the half-acre plot are:

1. *Eriogonum fasciculatum*	6. *Romneya coulteri*
2. *Rhus laurina*	7. *Mimulus longiflorus*
3. *Artemisia californica*	8. *Festuca reflexa*
4. *Salvia mellifera*	9. *Bromus mollis*
5. *Lotus scoparius*	10. *Solanum xantii*

The soil is a buff sandstone that was dated by Packard (1915) as being of Miocene age. It is well-drained and supports an unusually fine growth of sagebrush plants.

Trapped for three nights (August 28, 29, 30, 1941) this plot yielded the following array of rodents:

Perognathus f. fallax	10
Peromyscus eremicus fraterculus	8
Neotoma fuscipes macrotis	7
Reithrodontomys m. longicaudus	6
Peromyscus c. insignis	4
Microtus c. sanctidiegi	3
Peromyscus m. gambeli	3
Mus musculus	1
	42

The frequencies in the relative age categories are as follows:

	ADULT	SUBADULT	IMMATURE	
Male - - - - - - - -	13	7	2	22
Female - - - - - - - -	13	6	1	20
	26	13	3	42

Two harvest mice and one parasitic mouse contained embryos, but less than the number characteristic of the height of the breeding period in the early spring.

Several parallels between plant and animal distribution were easily discerned in the plot. In the first instance, all of the wood rat houses were located in clumps of *Rhus laurina. Peromyscus californicus* was taken in the same areas occupied by the resident woodrats.

The concentration of *Peromyscus eremicus* in the northeast corner is believed to be correlated with the unusually fine growth of buckwheat and black sage here. Both plants were loaded with mature fruits at this time.

Perognathus fallax was taken in the main along the east-central boundary of the plot where the vegetation is dominated by *Lotus scoparius.* This plant, also, was dropping large quantities of seeds of which many were found in the pouches of this mouse.

All of the meadow mice and harvest mice were taken on the southwest portion of the plot where the only development of grasses is found.

Birds noted at various localities, and, as an assemblage, considered characteristic of this association are:

California Quail
Audubon Warbler
Roadrunner
Brown Towhee
San Diego Towhee
Pallid Wren-tit
Western Gnatcatcher
California Jay
Alaska Hermit Thrush
California Thrasher

Reptiles captured in this association are:

Stejneger Whiptail Lizard
Western Blue-bellied Lizard
California Brown-shouldered Lizard
Striped Racer
Red Diamond Rattlesnake
Gopher Snake

The Dulzura Mouse, Gambel Mouse, Short-eared Pocket Mouse, and harvest mouse are characteristic of the rodent assemblage of the Sagebrush Community. Largely because of the presence of *Rhus laurina,* the woodrat and parasitic mouse make their appearance in this community. The total number of species of rodents is larger in this than in any of the other communities. Nearly three-quarters of the population of individuals of this assemblage are accounted for by the five species mentioned above. Of these, the Gambel Mouse and harvest mouse are most common in the Eriogonum-Artemisia association, which of all the sage community is most nearly allied to grassland.

Characteristic of the denser sagebrush in the Eriogonum-Rhus laurina association are *Peromyscus eremicus* and *Perognathus fallax.* The presence of *Neotoma fuscipes* and *Peromyscus californicus* indicate the close relationship of this association to chaparral, in which these species attain characteristic abundance.

The jackrabbit is decidedly less abundant in this community. It is only present in one of the two associations and, here, only in very small numbers. This might be correlated with this animal's dependence upon speed for escape from enemies. In place of the jackrabbit, the cottontail attains maximum numbers in this community. The brush rabbit is present, but only in reduced numbers. These two species are seldom found together, since brush rabbits inhabit the denser brush of the Eriogonum-Rhus laurina association, in which I did not find the cottontail.

The number and kinds of predatory mammals increase commensurate with the increase of their food supply. The coyote is still dominant, but both the fox and bobcat are present here.

For smaller mammals and birds, too, the food supply is amply abundant. As discussed elsewhere, several rodent-to-plant dependencies were noted. Stems, leaves, fruits, and bark of all the dominant plants are used for food and also for nesting material.

Although the dominant birds of this community are resident, it is not less characterized by the large number of Audubon Warblers that forage in and from the laurel sumacs and Gambel Sparrows that forage among the half-shrubs, in winter; nor by the Black-chinned Sparrow that nests here in the early summer.

The importance of the laurel sumac in this community cannot be over-emphasized. No less than the following animals are dependent upon it in one way or another for at least a part of their existence: Audubon Warbler, California Quail, Roadrunner, Hermit Thrush, California Thrasher; woodrat, parasitic mouse, and brush rabbit.

CHAPARRAL COMMUNITY

Chaparral is the most prevalent and intricately formed vegetational unit on the Santa Ana Mountains extending from near the base to the top of the highest peak (Santiago Peak, 5691 feet) on both slopes and from the northwestern to the southeastern extremities of the range, thereby covering approximately 110,000 acres within those boundaries of the Cleveland National Forest found on the range.

Throughout its long horizontal distribution this formation maintains a remarkable uniformity of both physical form and component species, but changes in elevation are followed by gradual differences in constituent species and physical form. For purposes of description it has been convenient to recognize two phases of chaparral separated by these differences in plant species that are correlated with elevational changes.

The dominant shrub of the lower chaparral belt is chamise *(Adenostema fasciculatum)*. It tolerates or prefers arid habitats and hence attains dominance, even to the extent of forming pure societies, on dry ridges and exposed slopes. Its most common associate in more protected areas is deerbrush *(Ceanothus crassifolius)*. It is convenient, therefore, to designate this lower chaparral belt as the *Adenostema-Ceanothus* association.

To a great extent the upper chaparral belt is dominated by manzanitas and the silk tassels *(Garrya Fremontii* and *G. flavescens)*. Thus this has been designated as the *Arctostaphylos-Garrya* association.

Adenostema-Ceanothus Association:

This association reaches its optimum development between 1400 feet and 3500 feet, while as successional vegetation it may range up to 4500 feet. For the most part it is composed of plants varying in height from 6 to 12 feet, although some are normally taller and others shorter.

Among the salient plants characteristic of this association are *Adenostema fasciculatum, Ceanothus crassifolius, Cercocarpus betuloides, Quercus dumosa, Q. dumosa* var. *elegantula, Ceanothus tomentosus* var. *olivaceus, C. megacarpus, Dendromecon rigida* (disturbed areas), *Fraxinus dipetala, Ribes malvaceum, R. hesperium, Arctostaphylos glauca, A. bicolor, Photinia arbutifolia* (lower edge), *Prunus ilicifolia, Rhamnus californicus typica,* and *R. crocea* var. *ilicifolia.* Some of these plants are restricted in their distribution, both latitudinally and from the standpoint of exposure. By way of examples one might cite that *Ceanothus megacarpus* is restricted to the northern end of the range; *Arctostaphylos glauca* is confined to the central portion and largely on the interior slope, while *Arctostaphylos bicolor* inhabits the southern end only and mainly on the Pacific slope; and *Quercus dumosa* is found on protected slopes, while *Cercocarpus betuloides* is more common on arid southern exposures.

At higher elevations on south- and west-facing slopes a chaparral interpreted as being successional and allied to this association is composed of chamise and *Ceanothus leucodermis.*

An important characteristic of the whole association is the small amount of litter or humus at the base of the plants. In stands of chamise or buckthorn it may be sparse or absent, leaving the soil barren and subject to erosion. A more valuable watershed humus is formed in those areas dominated by scrub oak. Still this is negligible in amount in comparison with that formed by plants of the manzanita belt, which is the prevailing association in the zone of maximum rainfall.

Plot VIII was chosen to represent this subdivision of the Chaparral Community. It is located near the Bedford Truck Trail in the west-central portion of section No. 32, of township No. 4, S., and range No. 6, W., and at an elevation of 2700 feet.

The vegetation of this plot forms a very dense chaparral. In addition to the dominants, chamise and buckthorn, one finds an occasional *Quercus dumosa* var. *elegantula* and scattered patches of black sage and buckwheat. For the most part, however, the latter two species were growing beneath the chaparral plants and were obviously being crowded out of existence. It was clear that fire had burned over this region in the near past. Counts of the annual rings of a few chamise and buckthorn plants revealed 30 annual rings, dating the fire somewhere around 1910.

Having regained dominance the chaparral plants are now shading the sagebrush species out of existence. This is manifested by the appearance of the lower plants which display remnants of former luxuriant growth, but which are now choked with dead material. Most of these plants have been eliminated at this date. The few remaining grassy areas are near the point of extermination.

It seems possible, therefore, to expect that between 35 and 50 years are necessary for this chaparral association to grow back following fire. But obviously this statement can only apply to this slope exposure (northeast) for on southern and western exposures all successional stages appear to be delayed.

According to Packard (1916), Plot VIII is located upon the basement complex of the range. The amount of loamy material is small and restricted to local areas near the oaks. Much of the region on and around the plot is covered with low outcroppings of red sandstone.

The following species of rodents were taken from this half-acre plot during the three nights from November 19 to 21, 1941:

	MALE	FEMALE	TOTAL
Neotoma f. macrotis	1	4	5
Perognathus c. femoralis	2	2	4
Peromyscus c. insignis	3	1	4
Dipodomys a. agilis	3	1	4
Reithrodontomys m. longicaudus	3	1	4
Peromyscus e. fraterculus	2	0	2
Peromyscus m. gameli	0	1	1
Microtus c. sanctidiegi	0	1	1
Thomomys b. palescens	0	1	1
	14	12	26

Twenty-six individuals representing nine species and seven genera of rodents were taken from this plot. This is the largest number of rodent genera recorded from any of the plots. It will be noticed that no one of the species was present in distinctly superior numbers. It is significant, however, that the single specimen each of pocket gopher and meadow mouse were taken from an isolated grassy patch and that the two species of *Peromyscus,* viz., *maniculatus* and *eremicus,* were taken from the relict areas of sagebrush, so that it is highly probable that these species will be forced out as the chaparral once again dominates the vegetation.

The following lists represent the vertebrate animals observed at different places in this association:

Mammals

Peromyscus c. insignis	29
Neotoma f. macrotis	14
Dipodomys a. agilis	13
Perognathus c. dispar	6
Peromyscus e. fraterculus	6
Perognathus c. femoralis	4
Reithrodontomys m. longicaudus	4
Peromyscus m. gambeli	3
Peromyscus boylii rowleyi	2
Microtus c. sanctidiegi	1
Thomomys b. pallescens	2
Scapanus latimanus occultus	occasional
Taxidea taxus neglecta	occasional
Urocyon cinereoargenteus californicus	common
Canis latrans ochropus	common
Felis concolor californica	common
Procyon lotor psora	occasional
Odocoileus hemionus fuliginatus	common

Birds

California Jay	Golden-crowned Sparrow
San Diego Towhee	Junco
San Diego Wren	Coast Bush-tit
California Thrasher	Green-backed Goldfinch
Mountain Quail	Dusky Poorwill
Black-chinned Sparrow	Phainopepla
San Diego Titmouse	Red-shafted Flicker
Western Robin	Ruby-crowned Kinglet

Reptiles

Patch-nosed Snake	California Horned Lizard
Red Diamond Rattlesnake	San Diego Alligator Lizard
Speckled Rattlesnake	Dusky Scaly Lizard
Stejneger Whiptail Lizard	California Brown-shouldered Lizard

Arctostaphylos-Garrya Association

In this association one finds the densest vegetation of the Santa Anas. Individual plants intermingle in such complex patterns that it is in many places actually easier to walk upon the plants than through them.

This association takes precedence in the chaparral above the 3500 foot contour from which it continues up and over Santiago Peak, except in those local regions that have been damaged by fire within the near past.

Although the most common plants in the association belong to the two genera *Arctostaphylos* and *Garrya,* some areas may be dominated by *Ceanothus integerrimus,* others by *Quercus wislizenii* var. *frutescens,* and still others by *Holodiscus boursieri.*

The typical vegetation of this association forms a thick humus that serves as an excellent water absorbing layer. This is of considerable importance when coupled with the fact that the bulk of this vegetation lies within the limits of the belt of maximum rainfall. Apparently, however, this thick humus renders the association unsuitable for most rodent species.

There are many indications that this association is not a climax everywhere that it

exists at present. A considerable part of it is found where the presence of young Coulter Pines pushing up among the chaparral plants suggests its successional nature.

The blooming period in this association is initiated by the silk tassels *(Garrya)* in November and December, followed in January and February by the manzanitas and terminated in June by both *Ceanothus palmeri* and *C. integerrimus.*

It was not possible to trap a plot containing the two plant genera for which this association was named. But Plot IX, lying in the west-central portion of section No. 13, of township No. 5, S., and range No. 6, W., at an altitude of 4600 feet, will serve as an indicator of the rodent populations of this dense chaparral.

Approximately 95 per cent of the area of this plot is covered by two species of manzanita *(Arctostaphylos glandulosa* and *drupacea)* with the remainder supporting a few stunted chamise and one plant of *Ceanothus tomentosus* var. *olivaceus.* The manzanita plants are so closely packed together that they form a veritable carpet of vegetation elevated from 3 to 7 feet above the humus.

The vegetation of this plot was burned over in 1926. That it has grown back to form such an impenetrable mass of plants in this short period of time is undoubtedly due to the ability of these plants to sprout from the stump following fire, as was clearly shown by examination of the numerous burls on or above the surface of the humus, some of which were pitted and charred but still were able to support luxuriant vegetative growth.

A layer of humus from 6 to 7 inches thick covered most of the plot. Since a large amount of the humus must have been burned out by the fire, it would seem that this material had collected at an average rate of one-half inch per year in the 14 years between the fire and my examination. This rate is probably not maintained as the plants mature, for as it is now with shrubs so closely packed together leaves are borne only on the periphery of the top of each bush. Kneeling down so that the eye level is brought below this leaf-line reveals only a maze of small leafless branches that only slightly interrupts one's vision from one side of the plot to the other. This zone of quiet air forms an excellent refuge for small birds such as hermit thrushes, juncos, fox sparrows and chickadees.

This association supports the smallest number of rodent species. Trapping of this half-acre plot yielded only nine individuals of two species. Of these, six were *Peromyscus c. insignis* and three were *Neotoma fuscipes macrotis.* Lack of food, which is explained by the fact that the dense nature of the dominant plants will not permit growth of herbaceous annuals or perennials, is undoubtedly the explanation of the scarcity of rodents. It is possible also that the deep humus deters burrowing forms.

The following lists represent the vertebrate animals observed at different places in this association:

Mammals

Peromyscus californicus insignis	10
Neotoma fuscipes macrotis	8
Peromyscus truei martirensis	5
Peromyscus boylii rowleyi	4
Perognathus californicus dispar	2
Sylvilagus bachmanni cinerascens	common
Felis concolor	tracks (trapped)
Odocoileus hemionis californicus	common

Birds

Fox Sparrow	California Thrasher
Hermit Thrush	California Jay
Junco	Chickadee

Reptiles

Pacific Rattlesnake *(Crotalus viridis)*

Mountain King Snake *(Lampropeltis multicincta)*

Stejneger Whiptail Lizard *(Cnemidophorus tessellatus)*

More animals are found in the chaparral community than in any other. This is true despite the fact that the number of birds falls below that of the woodland community, and the number of rodents is slightly less than that in the sagebrush community. But chaparral is the realm of deer, mountain lions, foxes, bobcats, parasitic mice, woodrats, certain kangaroo rats and certain pocket mice. There is here an abundance of berries upon which carnivores, rodents and birds may feed. Robins and varied thrushes feed extensively upon cascara and toyon berries. Purple finches feed especially upon the nut-like fruits of ceanothus. Furthermore, the plants of this community form a reasonably deep stratum within which kinglets, gnatcatchers, bush-tits and chickadees may forage on insects that inhabit the bark and leaves. There is also sufficient litter at one place or another to furnish suitable forage for spotted towhees, fox sparrows, juncos and hermit thrushes.

The leaves and stems of Ceanothus and other chaparral plants, with the grasses that grow in open area, furnish excellent food for deer. In addition, the relatively dense growth of the characteristic plants offers excellent refuge for these animals, as well as others. The importance of these refuge places is not to be minimized in this region. During the period when winds of great velocity are sweeping across the face of the range, birds of all kinds flock into the calm air about the plants.

But even with these advantages life is not easy in this community. Here is a region of large daily and seasonal temperature variations, of low humidity, of low soil moisture and, in many places, of maximum insolation. To these should be added the vulnerability of this community to fire, and the scarcity of water during the summer and fall. The rigorous nature of the habitat demands that only organisms of broad tolerance for extremes of the above factors inhabit this community, although certain structural modifications and changes of habit have been resorted to by both plants and animals alike.

The plants are sclerophyllous with hard and sometimes needle-like leaves; and with a dual root system of which a part penetrates deeply and another lies superficially; the majority grow during the winter and spring months; and many produce stump sprouts following damage from cold or fire.

The birds that breed here are largely residents; very few summer birds breed in this community. Breeding begins early in March and is largely through by the end of May. During the hottest part of summer days, most birds are inactive, preferring to rest in the shade. Some may retire to higher altitudes or to the cooler temperatures of the woodland vegetation.

Rocky areas in this community are inhabited by canyon wrens, cliff swallows, and White-throated Swifts, for birds; and by scaly lizards, lyre snakes, night snakes, and rosy boas, for reptiles. The only mammals found here are woodrats and others that are more common elsewhere.

WOODLAND COMMUNITY

The woodland plant formation is composed of trees which form a canopy, vary in diameter from a few inches up to 30 or more inches and vary in height from 30 to 60 feet.

Two topographic aspects of this formation are discernible on the Santa Anas. The first, usually found on ridges, north slopes, mesa lands, or in steep canyons, is characterized by the presence of the following oaks: *Quercus agrifolia* and *Quercus engelmannii,* at lower elevations, and *Quercus wislizenii* and *Quercus chrysolepis* above 3500 feet. In local areas the California Walnut and the California Laurel, either alone or together, may form an important part of the association. The relationship of this community to the more mesophytic portions of chaparral is marked by the shrubby forms of some of the oaks, viz., *wislizenii* and *chrysolepis,* which merge evenly with chaparral plants.

The second association dominates the vegetation in the moister portions of canyons. It is composed of riparian trees that are capable of growing in or alongside of running water. Prominent among them are sycamores, cottonwoods, alders, bays, willows and maples.

It has been convenient to name each association after its topographic affinity: the Ridge-slope Woodland and the Stream-side Woodland Associations.

Ridge-Slope Woodland Association:

The oak dominated ridge-slope association has an irregular distribution with an altitudinal range from approximately 500 feet to the top of Santiago Peak. At lower elevations, 2500 feet and below, the California Live Oak is the common woodland species. It covers large areas of rolling slopes and is the dominant plant on stable portions of canyon bottoms. On the knolls overlooking the moist portreros south of the Ortega Road, its most common associate is *Quercus engelmannii.*

At intermediate altitudes between 2700 and 4000 feet, the important woodland species are smaller trees such as the arborescent chaparral variety *Quercus wislizenii frutescens,* which may be 30 or more feet tall.

Above 4000 feet the Canyon Live Oak is the major tree referable to woodland. It commonly forms pure stands on steep, rocky slopes; occasionally in the upper reaches of canyons it forms groves, the closed-top of which excludes most herbaceous and shrubby plants.

Plot III illustrates the composition of the rodent population of this aspect of the woodland community. The location of this plot was not chosen entirely because of a characteristic vegetation; but rather because it would be situated on the highest point of the range. Nonetheless, the plant species found here represent a combination of chaparral and woodland vegetation with the latter predominating. The central portion of the plot is covered with a tangle of *Ceanothus integerrimus, Rhamnus californica cuspidata, Holodiscus Boursieri* and *Sambucus coerulea,* while oaks ring the peripheral portion.

The plot slopes to the north with an inclination of 22 degrees. Here and there low outcroppings of igneous materials are found. But angular stones of small size form most of the ground matrix through which the plants are growing and rodents build their burrows. A thin veneer of soil has developed near the oaks and around the densest tangle of shrubs.

Trapping was carried out for three nights, beginning on February 7 and ending February 9, 1940. The following rodents were taken:

	MALE	FEMALE	TOTAL
Peromyscus boylii rowleyi	15	12	27
Peromyscus c. insingnis	6	4	10
Peromyscus t. martirensis	3	2	5
Neotoma fuscipes macrotis	4	4	8
	28	22	50

Thirty-two of the fifty animals taken from this plot were adult. The remaining eighteen were equally divided among subadult and immatures of which thirteen were *Peromyscus boylii.* This would seem to indicate a late fall breeding period for this species at this elevation. One female of each of the other species of peromyscus was bearing very young embryos. This probably marks the beginning of the breeding season for these species. It is interesting to note that females of *Peromyscus insignis* taken two weeks earlier at 3600 feet were carrying embryos almost to term. This would suggest that there might be a lag in the onset of breeding of some three weeks between 3600 and 5600 feet.

Fourteen of the twenty-seven *Peromyscus boylii* were taken the first night. Of these there were 5 adult males, 2 adult females, 2 subadult males, 2 immature males, and 3 immature females. On the second night of trapping an additional 11 individuals of this

species were taken. Of these 2 were adult males, 3 adult females, 1 subadult male, 2 subadult females, 2 immature males, and 2 immature females.

Seven of the eight woodrats were taken during the first two nights of trapping. Since 12 houses were counted within the confines of the plot, it seems reasonable to conclude that all eight were resident on the plot.

I cannot agree with those who claim that the activities of rodents are, within certain limits, proportional to the temperature of the air. This large total of rodents was taken from this plot during the coldest weather that I have experienced on this range. During the first night of trapping the temperature dropped to 26 degrees Fahrenheit; during the second day a strong north wind arose and blew all through the day and the following night and morning. At this time the temperature dropped to 16 degrees.

During August, 1937, I trapped for a few nights near the location of Plot III. The area had been cleared about 5 years before. Three species not taken on the plot were obtained at this time, namely, harvest mice, meadow mice and *Perognathus californicus dispar*. Failure to take the latter of these on the plot might indicate that this pocket mouse hibernates during the coldest part of the winter at this elevation. Undoubtedly the harvest mice and meadow mice are restricted to the disturbed regions at this elevation.

The following lists are comprised of those animals aside from mammals considered characteristic of this association:

Birds

San Diego Titmouse
Hutton Vireo
California Woodpecker
Red-shafted Flicker
Lewis Woodpecker
Black-chinned Hummingbird
Pasadena Screech Owl
Pacific Horned Owl
Nuttall Woodpecker
Cooper Hawk
Bullock Oriole
Arizona Hooded Oriole
Slender-billed Nuthatch
Black-headed Grosbeak
Townsend Solitaire
Band-tailed Pigeon
California Jay
Coast Bush-tit

Reptiles

Alligator Lizard
Western Blue-bellied Lizard
Blue-tailed Skink

Amphibia

Slender Salamander
Garden Salamander
Oregon Salamander

Stream-side Woodland Association:

This association reaches its best development along the more permanent water courses. Here the trees form a canopy over the stream and the dense shrubby undergrowth produces almost impenetrable thickets beneath the trees up to the water's edge. This shrubby lower layer is absent near canyon mouths where the more open vegetation is constituted principally of sycamores and cottonwoods.

With the beginning of the more protected canyon areas, alders, bays, and willows begin to form a dense canopy that keeps the ground beneath in almost perpetual shade. Beneath these trees thickets of blackberry are common where sufficient soil space is available. Tangles of wild grape shroud the trunks and larger branches of some of the trees. In more open areas wild rose bushes add to the tangle found in these riparian thickets.

With an increase in altitude, the alders are gradually replaced by the Big-leafed Maple, and the lowland willows, such as *Salix Goodingii* and *Salix laevigata,* are succeeded by *Salix lasiolepis*. Since few of the streams have their sources above the 4000 foot level, the upper canyons are invaded by Big-cone spruce and canyon oaks.

Because of the arid climate during the summer and the rather strict water requirements of the trees and shrubs in this association, this vegetational belt is very narrow. Where some of the canyons trend along an east-west axis, south-facing slopes carry sage and chaparral almost to the canyon bottom where, if there is sufficient soil, live oaks hold forth; while a mesophytic community of maples, canyon oaks and spruces may extend up the opposite canyon wall.

The following lists are comprised of those animals considered characteristic of this association.

Mammals

Peromyscus boylii rowleyi	10
Neotoma fuscipes macrotis	3
Sorex inornatus	1
Scapanus latimanus occultus	runways
Procyon lotor psora	tracks (common)
Lynx rufus californicus	tracks (occasional)
Odocoileus hemionus fuliginatus	common

Birds

Western Flycatcher	Golden-crowned Sparrow
Willow Goldfinch	Pine Siskin
Yellow Warbler	Spotted Towhee
Black Phoebe	Mourning Dove
House Wren	California Woodpecker
Warbling Vireo	Tree Swallow
Cassin Vireo	Western Bluebird
Least Vireo	Sparrow Hawk
Russet-backed Thrush	Red-bellied Hawk
Hermit Thrush	Blue Grosbeak

Amphibia

Slender Salamander	Oregon Salamander

Well over half of the birds living at one time or another on this range are assignable to this community during a part of their existence. For the most part, however, only those birds breeding in this community were placed in the above lists.

Certain seasonal differences in the number of birds are evident in the two subtypes of this community. In the Ridge-slope Association, 75 per cent of the birds are resident species which remain throughout the year in or near the community, while only 20 per cent are summer visitants that arrive for the breeding season and remain for a short period thereafter. The resident population of the Stream-side Association, on the other hand, is scarcely 35 per cent of the total species, while nearly 60 per cent of the birds are summer visitants. It would be expected, therefore, that the ridge-slope regions would maintain a more stable bird population throughout the year, while the stream-side niches would be inhabited largely during summer months. This is substantiated by observation. During late May and June the stream-side niches are filled with nesting flycatchers, warblers, vireos, house wrens, phoebes, etc. At this time the association is dominated by birds. But during the winter months, the reverse is true—scarcely a bird species will be found here, save for an occasional flock of Golden-crowned Sparrows, siskins, or a mixed flock of goldfinches that come to feed on willow and alder fruits.

Well known are the facts that in the riparian association the food source available to birds fluctuates markedly with the season, and that at its height in spring and summer it consists largely of insects. This means that birds remaining on the range throughout the year would be forced to vacate this community for a considerable period of time. As well, a large part of the resident birds are not principally insect eaters, at least not of the kinds that frequent watered areas.

Although I was unable to study temperature, humidity and other edaphic factors in the stream-side region by means of instruments, it is conceded by personal experience that the diurnal temperatures and humidity are less extreme here than elsewhere on the range. In other words, during May, June and July the local climate is more equable along streams than in the surrounding chaparral or Ridge-slope Association. It is only natural, then, that birds which perform migrations (possibly to escape extremes of temperature, waning food, etc.) would inhabit a place with an abundant, suitable food supply; with a temperate local climate; and which, for the above reasons, is not occupied by resident birds.

Thus it is that the resident population of birds can absorb a large influx of summer visitants without a noticeable change in its economy. The populations are complementary in every respect; there is little competition.

The number of mammals in this community as a whole is small when compared to others, such as the sagebrush and chaparral communities. The predominant rodent is *Peromyscus boylii rowleyi.* Apparently it is better able to utilize as food the acorns and mosses available here than are some of the more strictly gramnivorous forms.

During the dry season when a reduction of flow of small springs and seeps occurs, many animals make daily excursions to the Stream-side Association for water.

FOREST COMMUNITY

The Forest Community on the Santa Ana Mountains is composed almost exclusively of two conifers, namely, the Big-cone Spruce *(Pseudotsuga macrocarpa)* and the Big-cone Pine *(Pinus Coulteri).* Two additional species belonging to the conifer group are present on this range, but in such restricted areas that they are of little biotic value.

The first of these, the Knob-cone Pine *(Pinus attentuata),* is restricted to localized colonies within an area of 3 to 4 miles around Pleasants Peak. Here it appears to favor protected canyon slopes, although it is found as well in reduced numbers on relatively dry ridges. Usually an understory of chaparral species such as *Arctostaphylos glandulosa, Adenostema fasciculatum* and *Ceanothus crassifolius* is present.

The second of these odd conifers is Forbes' Cypress *(Cupressus Forbesii).* It is confined to the northern end of the range, overlooking Santa Ana Canyon, where it occupies about a square mile of clay soil, between 1400 and 2400 feet altitude.

Assertions to the contrary, it is pertinent to point out that the Western Yellow Pine *(Pinus ponderosa)* is not present on the Santa Ana Mountains. Several affirmative claims have been made to me concerning the presence of this pine, but the usual reference given for such assertions is Sudworth (1908). He lists this pine in the Santa Ana Range as being found "at about 1600 feet." It is very evident that this record was confused with the Coulter Pine.

The Coulter Pine reaches its best development on the northeast slope of the range, within the general area extending 2 miles northwest and 6 miles southeast of Santiago Peak. In fact, these are the limits beyond which this species is not found. Altitudinally, it is confined to a belt extending from 3000 to 5000 feet, within which optimum growth occurs between 3400 and 4200 feet. The fact that only four stands of any size are found on the range at the present time is due largely to the small amount of proper terrain found within its altitudinal tolerances and to the heavy toll of trees taken by fire.

Another member of the conifer community is the Big-cone Spruce. It extends from one end of the range to the other, but is most common in cool canyons and on shaded slopes, from 2000 to 5000 feet. The spruce complements the distribution of the pine, so that between them a rather continuous belt of cone-bearing trees is found in optimum places, although in the strict sense of the word these two species seldom form an association. It is interesting to note that because of its preference of habitat, the spruce is not so often damaged by fire as is the pine. An exceptionally fine stand of this spruce is to be found in Trabuco Canyon.

THE EFFECT OF FIRE ON THE FOREST COMMUNITY

Nothing is more effective in altering the equilibrium of the ecologic community than fire. Its results are instantly disastrous and usually long-lasting, especially in an arid clime. Some idea as to the length of time involved in the period of readjustment and reestablishment of the stable community after fire in the Coulter Pine belt is presented below.

Study of the fire map in the Corona Office of the United States Forest Service shows that only six major fires have occurred in the Santa Ana Mountains during the last thirty-five years. One of these, occurring in 1926, started in the lowlands outside the forest boundary on the Pacific slope. It swept up Harding and Silverado Canyons and finally burned out on the main divide in the vicinity of Modjeska Peak. In 1940, the course taken by the fire was still very evident: sagebrush now grows on the lower slopes where chaparral was formerly present, and the same is true of southern exposures at higher altitudes; but on the cooler northern exposures the dead limbs of chaparral plants are being hidden by new growth emerging from the stumps. Those pines located on slopes were entirely killed; a few on the main divide were only scarred. Young pines are numerous around these damaged trees.

Counts of the annual rings of the shrubs and trees on the west face of Modjeska Peak indicated that the *Garrya Fremontii* and *Quercus chrysolepis* var. *nana,* both of which were sprouting from the stump, had begun to grow the first year following the fire. The Coulter Pines, on the other hand, possessed only 12 annual rings, indicating that they had germinated during the second year. Some of these young trees directly on top of the ridge were 5½ inches in circumference, while others only a few feet away, but on the northern exposure, were 8 or more inches in circumference. All were found to be the same age. With this information concerning the length of the lag between fire and the appearance of young pines, it is easier to interpret the history of other pine areas for which definite dates are not available.

Plot II was established near the Indian Truck Trail, at an elevation of 3600 feet, in a dense growth of chaparral and Coulter Pine. More exactly it is located in the southwest corner of section No. 22, of township No. 5, S., range No. 6, W., with its southern boundary removed thirty feet from the firetrail.

This vegetational complex was chosen because it represents a very typical situation on the Santa Ana Mountains, namely, successional recovery of a vegetational unit after fire. The dense growth of Coulter Pines, many of them no more than four feet apart, together with the tangle of chaparral species, many of which were dying out, indicated a relatively recent fire.

In December of 1940, I studied the annual rings of the pine trees of this plot through the use of an increment bore. I found that two age groups were represented here, as follows: The older trees averaged 51 annual rings with a circumference varying from 26 to 93 inches; while the younger trees averaged only 24 annual rings and varied in circumference from 7 to 30 inches.

This evidence might indicate two fires had swept through this district, dating the earliest fire around the year 1888. But the mingling of individuals of the two groups precludes the possibility of a more recent fire. It is highly suggestive that the younger generation is composed of trees which germinated from seeds of those trees that sprang up after the fire. It is not clear, however, just why so many trees were produced at the same time in this second generation. It would appear that some stimulus nearly as effective at bringing about germination of pine seeds as fire had operated to produce this uniform growth of young pines. Recourse to rainfall figures shows that beginning in 1916 and ending in 1919 this general region suffered a period of drought. Whether this correlation of dates is merely coincidental or the basis for a causal relationship cannot be stated with any degree of certainty.

The following is a list of the plants found on Plot II:

Pinus Coulteri	*Ceanothus leucodermis*
Arctostaphylos drupacea	*Photinia arbutifolia*
Arctostaphylos glandulosa	*Quercus wislizenii*
Adenostema fasciculatum	*Rhus ovata*
Ceanothus tomentosus	*Quercus chrysolepis*
Ceanothus crassifolius	*Arctostaphylos glauca*

In general one would describe the vegetation as being dominated by the pines and more closely related to the manzanita chaparral than to the chamisal of the lower slopes.

The plot slopes rather abruptly to the north with an inclination of 30 degrees from the level. The soil is a light tan, much weathered and porous limestone, with a consistency that might best be described as that of a medium gravel. It is interesting to note that the Coulter Pine is found only on this limestone in the Santa Ana Mountains. The trees follow the contours of this Triassic rock so closely in regions of contact that mere coincidence is ruled out. I have reason for believing, however, that other factors of which fog is the most influential play an important role in determining the distribution of this tree on this range.

Trapping was carried out for three nights, beginning on January 30 and ending the night of February 1, 1940. The rodents taken from this one-acre plot are as follows:

	MALE	FEMALE	TOTAL
Peromyscus c. insignis	7	6	13
Neotoma fuscipes macrotis	2	3	5
Peromyscus boylii rowleyi	1	1	2
Citellus b. beecheyi	1	0	1
	11	10	21

Other mammals observed here were coyote, mole and a single species of bat *(Myotis californicus californicus)*.

Of the twenty-one animals taken on this plot, only four were not adults. Two of the parasitic mice possessed embryos almost at term. Trapping done only eight days later in a similar situation revealed a female of this species that was suckling young. Each female possessed two embryos only; a number decidedly below the number carried by others of this species during the same period but at lower elevations.

The following birds were observed on the plot:

California Jay	San Diego Titmouse
Spotted Towhee	Saw-whet Owl
California Thrasher	Pacific Horned Owl
Red-shafted Flicker	San Diego Wren

The results of a brief study of a more mature stand of Coulter Pine on the range provide interesting data for purposes of comparison. Plot IV is located near the center of section No. 36, township No. 5, S., range No. 6, W., about 100 yards west of a dirt base road known as the Main Divide Truck Trail, and at an elevation of 4100 feet.

The vegetation on this plot is dominated by Coulter Pines that are the oldest and largest trees of this species found on the range. The average age of the tree was found to be 110 years. Although very limited in area, this forest probably represents a climax stand of this pine. Many of the trees are scarred from previous fires, undoubtedly being injuries received from the fire that swept through the area in 1923.

This pine forms an open forest with ground areas covered with a sparse mat of pine needles. A few scrub oaks and a few isolated patches of chaparral plants are scattered along a shallow ravine that parallels the eastern border of the plot. A few fallen trees in various stages of decay are strewn across the eastern half of the plot. Only two animals were taken far from these logs or restricted clumps of chaparral plants.

Plot IV was trapped for three nights beginning June 11 and ending June 13, 1940.

The rodents taken from this one-acre plot are as follows:

	MALE	FEMALE	TOTAL
Peromyscus truei martirensis	3	3	6
Peromyscus californicus insignis	0	1	1
Peromyscus boylii rowleyi	1	0	1
Perognathus californicus dispar	0	1	1
Neotoma fuscipes macrotis	0	1	1
	4	6	10

It is clear from comparisons of this list with those from other plots that this community does not offer the proper environmental conditions for small mammals. This is emphasized particularly by notations that one-half of the total number of mammals was taken in association with the fallen trees, and the other half was associated with the isolated patches of chaparral plants found on the floor of the forest.

Peromyscus truei reaches its maximum numbers in this open forest, but only where there are logs or tangles of fallen branches. This is substantiated by data from Plot II, which show that the *truei* here were taken mainly on the eastern portion of the plot supporting the scattered chaparral plants.

It is suggested that the other species, with the exception of *Peromyscus boylii,* sought out the available niches on the forest floor, only because of population pressure in the surrounding chaparral. Here, as elsewhere, *boylii* was taken in association with the oaks.

The following birds were observed on the plot:

Olive-sided Flycatcher	Ash-throated Flycatcher
Pigmy Nuthatch	Western Marten
Cabanis Woodpecker	Western Gnatcatcher
Cassin Vireo	California Jay
Western Tanager	Bailey Mountain Chickadee

From the above-cited evidence, it is clear that the destruction of this type of forest by fire will produce changes in the fauna equally as distinctive as those wrought on the flora. It may well be true that the effects of this reduction of environmental niches are not important when referring to birds and mammals in general. But when a species has a close affinity for a particular niche and when that niche is of limited extent in the region under discussion, it means that competition for available space in the remaining favorable niches will be heightened. As was pointed out elsewhere in this report, the number of forest areas, both arid and semi-mesophytic, is small and each is of small size so that their complete or partial destruction may mean the elimination of certain species from the fauna of the range. Obviously a region such as this where forest communities reach minimal ecologic values is well suited to emphasize the critical nature of the ratio between population size and area of habitat, since the effects of destruction may well be absolute and not relative.

In general one might postulate that approximately one hundred years are necessary for the pine forest of this region to return from the chaparral-pine complex that develops after fire, as at Plot II, to the open forest found on Plot IV. Because of its altitudinal

position, which carries a complement of edaphic factors that control the nature of the vegetation, the mixed chaparral-pine succession shows a closer faunal relationship to the upper association of chaparral, even 56 years after the fire when the pines are dominant in the sense that they are beginning to crowd the chaparral plants out, than it does to either the open pine forest or the lower chaparral association.

In a region outside the Santa Ana Mountains, where more extensive forests occur, returns from a careful study of this kind should prove valuable in determining just what relative frequencies of certain plants are necessary before particular species of birds and mammals begin to reinvade the community.

A compendium of all the facts gained from trapping rodents at many points on the Santa Ana Mountains would seem to justify the following observations and conclusions:

1). No single rodent species was taken on all of the measured plots—a fact that is not surprising in view of the diversity of vegetation types represented.

2). The sagebrush community is the most favorable for the largest number of rodent species. Furthermore, the *Eriogonum-Rhus laurina* association will yield the largest number of rodent species and the largest total of individuals per unit area of any vegetational unit found here. In some instances as many as 84 individuals of 8 species were removed from the equivalent of one acre of this association. It should be noted that no adjustments have been made for the influence that the peripheral row of traps may exert beyond the limits of the plot. Since most plots were handled in essentially the same manner, however, it would seem that comparative but not absolute values might be adduced.

3). Chaparral in general is the second most favorable community for rodent species, despite the fact that the *Arctostaphylos-Garrya* association supports only two rodent species. Grassland follows chaparral very closely. The major part of the chaparral community, speaking in terms of area found on this range, yields a larger number of species with a lesser number of individuals, while grassland supports a larger number of individuals of few species. From another point of view, since chaparral covers many times the acreage of both grassland and sagebrush, it may well be elevated to first rank so far as the total number of rodents dependent upon it is concerned.

4). The mature Coulter Pine forest community is the least favorable for rodents, there being an average of only nine individuals of four species per acre here. Nonetheless, it is apparently the favored community of *Peromyscus truei* on this range. It is the least common of the five species of this genus.

5). Several facts indicate that rodents have individual preferences for plant species. It is suggested that a variable minimum number of plants of a given species must be present before they form a niche suitable for residence by the rodent.

6). *Reithrodontomys megalotis* and *Microtus californicus* form an association as characteristic of grassland as its plant species. In pure grassland microtus is more abundant, but with the invasion of sagebrush, particularly *Artemisia californicus,* reithrodontomys is present in superior numbers.

7). *Perognathus fallax* and *Peromyscus eremicus* are characteristic rodents of the sagebrush community. If the vegetation is composed principally of *Eriogonum fasciculatum* and *Salvia apiana,* perognathus will be more abundant; but where eriogonum and *Salvia mellifera* predominate peromyscus is more abundant; while if artemisia predominates, reithrodontomys will either supersede the others or appear in superior numbers.

8). *Peromyscus californicus, Neotoma fuscipes* and *Perognathus californicus* are characteristic rodents of the chaparral community.

9). *Peromyscus boylii* is characteristic of the woodland community.

10). *Peromyscus truei* is characteristic of the forest community.

11). From my records *Peromyscus maniculatus gambeli* is not the most abundant rodent on this range. It is confined almost entirely to the sagebrush community, both successional and climactic.

12). *Dipodomys stephensi* is undoubtedly the least common of the native rodents of this region, since only two specimens were taken. It is apparently restricted to sagebrush, in particular the *Eriogonum-Artemisia* association, where it occurs with *Dipodomys agilis.* This latter species, however, is very common in chaparral.

13). *Mus musculus* is apparently not able to invade the native vegetation to any great extent. It was taken on one plot only. This was located near human habitation.

14). The Beechey Ground Squirrel is not common on the range. Where found it is associated with disturbed conditions.

15). Pocket gophers may be encountered in almost any vegetational complex, but grassland would appear to be its favored type.

16). In several instances these observations are not in accord with those obtained from the records of others making surveys in similar regions. The important discrepancies reside with differences in the actual species of rodents or their frequency relative to other forms in a given vegetational type. These differences may be resolved in part at least by remembering that a trapper trying to reveal the rodents of an area for systematic or zoogeographic studies will set traps in all conceivable niches, while my plots were placed in what was considered to be homogeneous samples of each vegetation unit.

The methods employed in this study were not devised to shed light on the absolute numbers of individuals of various rodent species on a measured area of habitat. But it would seem that certain comparisons from fairly uniform methods would be justified. A few notations for those rodent species for which sufficient data were collected to permit comparisons are listed below.

17). Twenty-six microtus per acre represents the largest number of individuals of a single species brought to light in this report. This number is followed closely by reithrodontomys for which an average of twenty-four individuals were removed from one acre covered uniformly with ninety-nine traps. It is interesting to note, however, that microtus averages only 5 per acre in vegetational types outside its optimum, as compared with 10.75 for Reithrodontomys.

18). *Peromyscus californicus insignis* averaged 10.75 per acre in chaparral and only 3.75 in other vegetational units. *Neotoma fuscipes macrotis* parallels this very closely with 10 and 4 per acre for chaparral and other niches, respectively. Since chaparral is the most widespread vegetation and since *Peromyscus californicus* was found in all communities except grassland, I am confident that it is the most abundant rodent on this range. A conservative estimate would place the census of this rodent within the forest boundaries at approximately 500,000 individuals.

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