To my good friend F. L. Annable
from L M Klauber

BULLETINS

OF THE

Zoological Society of San Diego

« »

No. 8

A Statistical Survey of the Snakes of the Southern Border of California

By
L. M. KLAUBER
Curator of Reptiles
Zoological Society of San Diego

San Diego, California
JUNE 20, 1931

OFFICERS OF THE ZOOLOGICAL SOCIETY OF SAN DIEGO

THE PURPOSES OF THE SOCIETY

1. To advance science and the scientific study of nature.
2. To foster and stimulate interest in the conservation of wild life.
3. To maintain a permanent Zoological Exhibit in San Diego.
4. To stimulate public interest in the building and maintenance of a Zoological Hospital.
5. To provide for the delivery of lectures, the exhibition of pictures and the publication of literature dealing with natural history and science.
6. To operate a society for the mutual benefit of its members for non-lucrative purposes.

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INTRODUCTION

I first became interested in the work of the San Diego Zoological Society in the autumn of 1922, when the reptile house was opened to the public, and thus renewed an acquaintance with reptiles which, as a boy many years before, had taken the form of a rather casual and entirely non-technical familiarity with the snakes of San Diego County.

The reptile house began to engage the attention of the public soon after opening, and specimens in growing numbers were brought in for identification and as donations to the exhibit. Most of these were from San Diego County; often they were of species which, from scanty data in the literature, might be deemed quite rare. It was at once apparent that here was an opportunity to accumulate some novel and useful information touching such matters as relative rarity, zonal and chronological distribution, etc. Therefore records of the incoming specimens were kept with care, the date and locality of collection being secured from each donor. Later collecting was stimulated by offering annual prizes, both for numbers of specimens and the rarest brought in; the prize for numbers was modified, after a time, on a basis whereby the infrequent forms scored more points than the commoner. This further increased interest, as amateur naturalists brought in specimens for identification, in the hope of having secured something of unusual rarity.

In addition to the records of donations to the Zoo, the writer has had the duty of recording the accessions of the San Diego Society of Natural History, and has been in touch with the several field workers from such institutions as the California Academy of Sciences, the University of Kansas and others who have visited our county during the same period. My own field trips have added to the record.

Thus, from these various sources there have been accumulated during the past eight years, distributional records of 6231 specimens of snakes from San Diego County, of twenty-nine species and subspecies, and it would appear that the time is opportune to publish a discussion of some of the conclusions which may be deduced from this census.

This does not purport to be a descriptive treatise of the snakes of this area; it is merely a presentation of the statistics gathered and an attempt to interpret them in general terms of distribution, habitat and habit. A few incidental field notes are included.

It will be noted that the numerical tables apply primarily to San Diego County. We have had many specimens sent in from Imperial County, Lower California, Arizona and other adjacent areas; these have afforded interesting locality records, but the collections have not been sufficiently comprehensive and evenly distributed to permit statistical interpretations. Imperial County is, however, treated at some length in the habitat survey in order to complete a Southern California cross-section.

That part of the present paper dealing with automobiles, their effect on the snake fauna and on collecting in general, represents a separate but related investigation. The road specimen tables cover a seven-year period, instead of eight as in the county census; for although I began field work in the spring of 1923, several trips had been made before the significance of the snakes found run over on the highway was appreciated, and as the records for the first year were incomplete, they were omitted entirely. Thus the statistical record of the auto trips herein described, covers the period, January 1, 1924, to December 31, 1930, while the census begins a year before. It should be understood also that the tables which constitute the county census likewise include the auto trip specimens, whether those noted were dead or alive.

Our eight year study has increased the number of species of snakes known to occur in San Diego County from 21[1] to 29. One new species (*Trimorphodon vandenburghi*) and one subspecies new to California (*Masticophis piceus*) were discovered. The other six, new to the county only, are as follows:

Phyllorhynchus decurtatus
Pituophis catenifer deserticola
Sonora episcopa
Thamnophis sirtalis infernalis
Thamnophis ordinoides elegans
Crotalus atrox

Naturally our studies have greatly increased the definite locality records within San Diego County. These now vary from 146 in the case of such a common and widespread species as *Pituophis catenifer annectens,* to a single record in the case of a species like *Crotalus atrox,* which barely crosses the county boundary. The number of locality records available has been multiplied over tenfold beyond those hitherto published;[2] their enumeration would be quite beyond the scope of this paper, and in fact would be of little interest except in a work of monographic character on individual species.

Throughout the present paper abbreviations in technical names are used to conserve space; only in the first schedule, that of ranges (page 9), are the names given in full; thereafter initials only have been employed for generic names, and likewise for the names of species where the subspecific name is given in full. The same procedure has been followed in the tables, the full name of the species being given only in Table 1.

THE SOUTHERN BORDER COUNTIES OF CALIFORNIA

(Maps 1 to 3; Figs. 1 to 8)

Since these notes are primarily a discussion of snake ranges and habitats as affected by climate and topography, it will be advisable to

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[1] Twenty-two had previously been reported, but one was based on an incorrect identification.

[2] The most complete set of western records available is to be found in Van Denburgh, 1922.


CALIFORNIA
NEVADA
ARIZONA
NEW MEXICO
SAN DIEGO COUNTY
IMPERIAL COUNTY
UNITED STATES
MEXICO
PACIFIC OCEAN
LOWER CALIFORNIA
GULF OF CALIFORNIA
SONORA
CHIHUAHUA
SINALOA
SOUTHWESTERN UNITED STATES
AND
NORTHWESTERN MEXICO
SHOWING LOCATION
OF SAN DIEGO AND IMPERIAL COUNTIES,
CALIFORNIA
0 25 50 100 200
SCALE OF MILES
B3750-LMK

MAP 1

present a summary of the physical characteristics of the territory under consideration for the benefit of those unfamiliar with it.

The climate and topography of the two southern border counties of California lend interest to a study of reptile distribution, owing to the wide variations within comparatively short distances. The altitudes range from sea level on the Pacific shore line to a maximum of 6515 ft. at Cuyamaca Peak, thence downward again to 250 ft. below sea level in the Colorado Desert basin. Temperatures are mild both summer and winter along the coast, while in the interior the winters are colder and the summers warmer. Eastward of the divide the winters are mild but the summers are exceedingly hot.

As to rainfall, this varies from an annual precipitation of about ten inches along the coast (San Diego 9.7 in., Oceanside 12.9 in.) and fifteen inches in the interior valleys (El Cajon 13.6 in., Escondido 16.4 in.) to twenty or more inches in the foothills (Campo 19.8 in., Descanso 22.8 in.) and reaches a maximum of over fifty inches in the mountains (Palomar 50.3 in.). Thus, the rainfall increases about 7½ inches for each 1000 ft. gain in altitude. East of the divide the rainfall decreases rapidly, averaging less than three inches annually on the floor of the desert. Snowfall is usual in the mountains (Cuyamaca average 37.3 in.) not uncommon in the foothills, but rarely experienced elsewhere.

Over most of the area the summers are virtually rainless; 90 per cent of the annual precipitation occurs in the months of November to April, inclusive. However, summer showers are not uncommon in the mountains and some of the higher foothills.

The most conspicuous topographic feature of San Diego County is the mountain mass forming a part of the range known as the San Jacinto or Peninsula Range, including, in this county, such local mountain groups as Palomar, the Volcans, Cuyamacas and Lagunas. Between the ocean and the mountains there are three rather distinct areas: first, a coastal belt; then, a series of valleys and mesas; and finally, foothills which are rough in contour and with great granite outcrops. Eastward of the mountains the descent to the desert is usually precipitous and is characterized by irregular spurs of tumbled and barren masses of rock. (See Profile, Fig. 2).

Vegetation follows rainfall. Near the coast trees are restricted to the infrequent and usually dry water courses, and the mesas are covered with low brush. This increases to a dense chaparral in the foothills and to considerable forests, first of live oaks, then of conifers in the mountains. Beyond the ridge the vegetation changes with great rapidity, ending in a desert flora characterized by a sparse growth of cacti and thorny shrubs. (See Figs. 3-8).

In considering distribution in so restricted a district as San Diego County, it appears desirable to subdivide the main life zones, based on local conditions. In this area the coast and foothills are generally considered Upper Sonoran, while the inland valleys and the desert fall within the Lower Sonoran classification.

However well suited these life zones may be to general classification, in this limited case, they combine areas having dissimilar climates, vegetation and topography, and therefore the localities have been subdivided into the following six belts:

Coast—The fog and high fog belt. Mild winters and summers (principally Upper Sonoran).

Inland Valleys and Mesas—Mild winters, warm summers (principally Lower Sonoran).

Foothills (*Western Slope*)—Areas between 1,000 and 4,000 feet in altitude. Cool winters, warm summers (Upper Sonoran).

Mountains—Areas above 4,000 feet. Cold winters, mild summers (largely Transition).

Desert Foothills[3] (*Eastern Slope*)—Cool winters, hot summers (a narrow belt of Upper, but mostly Lower Sonoran).

Desert—Below 1,000 feet. Mild winters, exceedingly hot summers (Lower Sonoran).

Map 2 is prepared in accordance with this zonal scheme; Fig. 2, which includes a profile along a line northeasterly from the City of San Diego to Cuyamaca Peak, and thence eastward beyond the county boundary across Imperial County to Yuma, gives further life zone and meteorological data.

Agricultural activity in the county is largely restricted to the coast and the scattered valleys of the mesa and foothill zones. The area under cultivation includes about 300 out of a total of 4220 square miles. There are large sections which are almost inaccessible that will for a long time remain undisturbed, except along the road fringes, or unless reached by brush fires.

Of the population of slightly over 200,000, 75 per cent live in the City of San Diego, and about 85 per cent in the coastal area. The population has almost doubled in each decennium since 1900; necessarily this growth has affected natural conditions materially, and it is fortunate that the rough terrain will for a long time furnish some refuges and reservoirs of dispersal for the less conspicuous, non-game wild life.

San Diego County does not in itself constitute a natural faunal area but, taken together with Imperial County (which was once included within its borders), a complete profile across Southern California, from the Pacific to the important natural barrier of the Colorado River, is obtained. (See Map 1). This cross-section is rather typical of what would be found anywhere in Southern California or northern Lower California from Latitude 31 degrees to 34 degrees. Western San Diego County constitutes the approximate center of the so-called San Diegan subordinate faunal district. The mountains of the county, although not so high as

[3] Contain some isolated valleys which are typically desert.

those found in the same range to the north or south,[4] contain most of the known Transition forms. But to the eastward only a corner of the Colorado Desert area is contained within San Diego County and thus, to complete the picture, Imperial County must be included and is discussed in these notes, although the snake census statistics therefrom are fragmentary, compared with those from the area wherein our operations have necessarily centered.

To the herpetologist, Imperial County is of interest, first, on account of its desert character, and secondly, because of the material changes which have been made in certain areas within the past few years by the hand of man.

Imperial County is entirely Lower Sonoran, for although it includes within its borders several mountains of considerable altitude, these, being on the desert side of the Peninsula range, are Lower Sonoran to their peaks, for at no point is the crest of the range within the county. (See Map 3).

Across the northeastern section of the county are the Chocolate[5] Mountains, in reality a desert extension of the San Bernardinos. This barren range gradually diminishes in size and importance from northwest towards the southeast.

To the westward and paralleling the Chocolates are the Sand Hills, an area of shifting sand dunes some six to eight miles wide and sixty miles long. These consitute a typical desert picture for those who consider desert and sand synonymous, and have often been used as a Saharan background by Hollywood.

Between the Chocolate and the Peninsula Ranges lies the low flat basin rather loosely termed the "Colorado Desert." This area was once the upper end of the Gulf of California. Subsequently cut off from the Gulf by the spreading delta of the Colorado, it became, first an inland sea, and, later, the site of a great lake known to geologists as Lake Cahuila, which through several complete cycles of filling and evaporation was either entirely fresh or slightly brackish. This lake may have existed to almost its full extent within a thousand years. Its ancient beach line is even today quite clearly defined along much of both its eastern and western borders, the shore line being some 50 feet above the present sea level.

When white men came upon the scene, Lake Cahuila had shrunk to a salt marsh in the vicinity of Salton, Riverside County, and the basin between the Chocolate Mountains and the Peninsula Range had become one of the most forbidding deserts in North America. This area, characterized by low rainfall, infrequent water holes and high temperatures, became one of the great barriers to travel, and its history is replete with tragedy. Much of the ancient lake bed lies below sea level and therefore considerably below the level of the Colorado River to the eastward.

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[4] To the north, Mt. San Jacinto, 10,805 ft.; to the south, San Pedro Martír, 10,126 ft.

[5] Pronounced as in Spanish, Cho-co-lá-te.

The river, in its annual summer floods, usually spread out across its delta at the head of the Gulf of California, and there turned northward into the Salton basin, from its several branches in the delta region, two river channels known as the Alamo and New Rivers. These, during the summer overflow, often carried a small quantity of water into the Salton sink, and likewise filled, from time to time, several shallow lakes, such as Blue, Pelican, Badger, and Mesquite Lakes.

It was early recognized by travelers that the ancient lake bed, consisting of finely compacted silt, might be made fruitful, nothwithstanding its seeming barrenness, if water were supplied, and various schemes were proposed to bring Colorado River water continuously into this area. Finally, in 1900, this was actually done, and partly through artificial canals, partly through the use of the Alamo River, water was brought to the Lake Cahuila bed, and the agricultural development known as the Imperial Valley was begun.

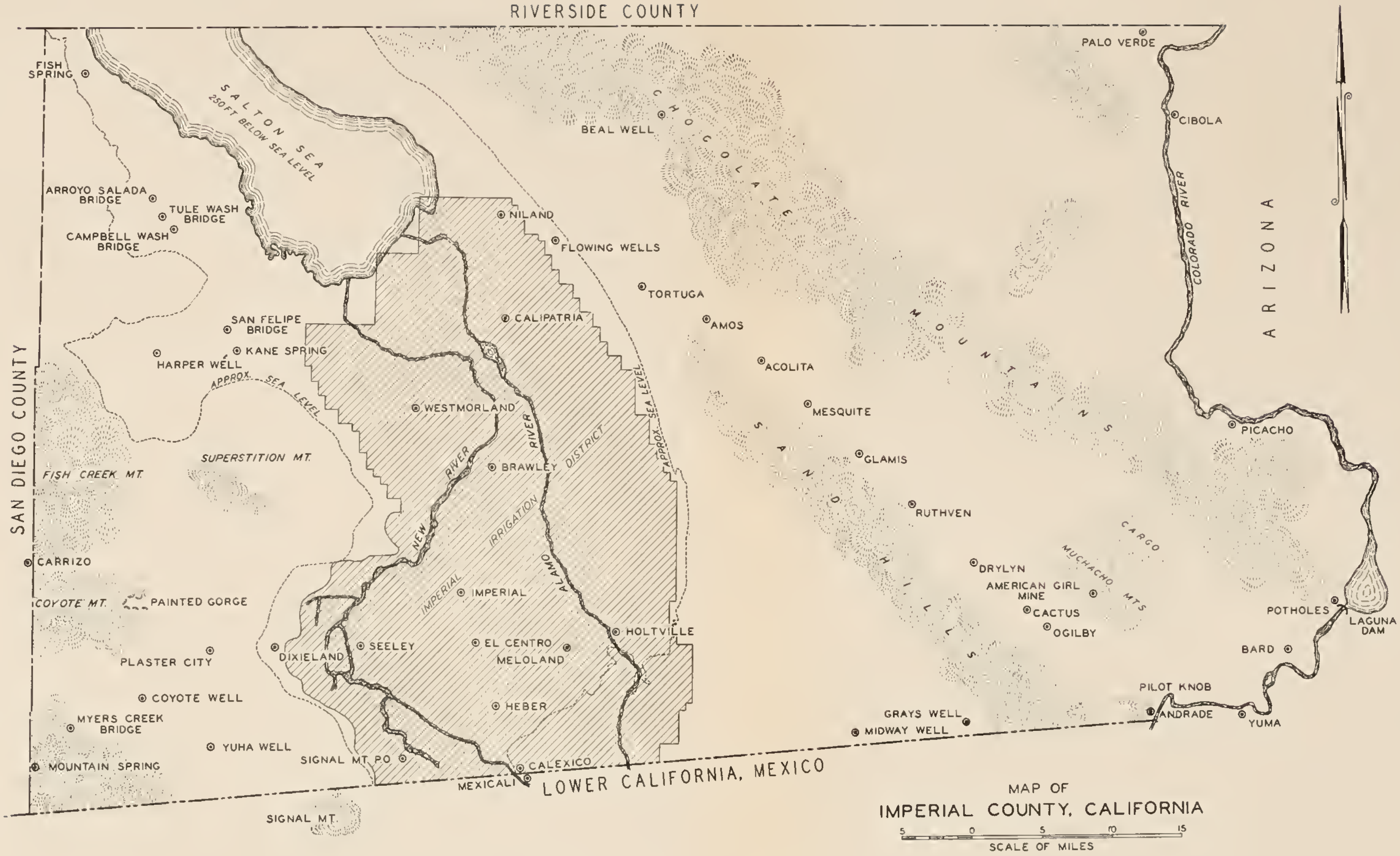
From the first the venture was moderately successful, since the deep beds of silt were very rich, and the climate permitted the production of off-season crops. In 1905, however, an unusual flood of the river washed away the diversion head-works. Without going into engineering detail, it may be said that subsequent control was extremely difficult, and within a short time the entire Colorado River discharge, instead of passing into the Gulf, was flowing via the New and Alamo Rivers into the ancient Salton sink, which from a restricted marsh, rapidly grew into a great inland, brackish lake. Finally, late in 1906, the Southern Pacific Company, with the co-operation of the United States Government, succeeded in closing the break at a cost in excess of $2,000,000. It is obvious that had the break not been closed, Lake Cahuila would have been completely restored and the agricultural development in the Imperial Valley would have disappeared.

Today the inland lake, known as Salton Sea, covers an area of 300 square miles and with a surface at minus 250 ft. has approximately reached a balance, the level being maintained by irrigation drainage via the New and Alamo Rivers, and likewise by occasional flood waters from the Peninsula Range, these together being sufficient to maintain the level against the very high evaporation losses. The Imperial Valley, though subject to the vicissitudes which seem to follow all agriculture, nevertheless is one of the most successful as well as one of the largest of all the irrigation developments in the United States. Thus, we have in what was recently a desert in every sense of the word, a lake of considerable size and an area given over to the most intensive irrigation and cultivation.

Beyond the Chocolate Range in the northeastern corner of the county lies yet another desert area, which may be considered a portion of the Colorado Desert or of the Mohave, depending on the ideas of the geographer, for the two terms "Colorado Desert" and "Mohave Desert" seem to be without exact definition.

The population of Imperial County, about 61,000, is almost exclusively contained in the irrigated areas of Imperial Valley.


PACIFIC OCEAN
RIVERSIDE COUNTY
ORANGE COUNTY
IMPERIAL COUNTY
FOOTHILLS
DESERT FOOTHILLS
DESERT
EASTERN SLOPE
CALIFORNIA
BAJA CALIFORNIA
UNITED STATES
MEXICO
SAN DIEGO
SAN DIEGO BAY
NORTH ISLAND
CORONADO
N
San Diego County, California
SHOWING LIFE ZONES
5 0 5 10 15
Miles
SAN ONOFRE
AGRA
SANTA MARGARITA
LAS FLORES
STUART
SAN LUIS REY
OCEANSIDE
CARLSBAD
HEDIONDA
LA COSTA
LEUCADIA
ENCINITAS
CARDIFF
SOLANA BEACH
DEL MAR
TORREY PINES
SORRENTO
LA JOLLA
PACIFIC BEACH
OCEAN BEACH
PT. LOMA
DE LUZ
FALLBROOK
RED MOUNTAIN
RAINBOW
MONSERATE
BONSALL
PALA
LILAC
MOOSA
VISTA
BUENA
TWIN OAKS
SAN MARCOS
RICHLAND
ESCONDIDO
SAN PASQUAL
VALLEY CENTER
WOHLFORD DAM
BERNARDO
HODGES DAM
LUSARDI
OLIVENHAIN
RANCHO SANTA FE
POWAY
MIRAMAR
LINDA VISTA
ROSE CANYON
ROSEDALE
MISSION VALLEY
MISSION GORGE
GRANTVILLE
LA MESA
LEMON GROVE
ENCANTO
NATIONAL CITY
CHULA VISTA
PALM CITY
OTAY
IMPERIAL BEACH
NESTOR
ONEONTA
SAN YSIDRO
TIA JUANA
MONUMENT
AGUA TIBIA
PAUMA
PALOMAR
PALOMAR PEAK
OAK GROVE
MENDENHALLS
AMAGO
RINCON
HENSHAW DAM
MORETTIS
MESA GRANDE
VINEYARD
PAMO
SANTA YSABEL
SUTHERLAND
WYNOLA
WITCH CREEK
BALLENA
RAMONA
SAN VICENTE
WILDWOOD
SHADY DELL
PADRE BARONA
MUSSEY
EL CAPITAN
FOSTER
EL MONTE
LAKESIDE
RIVERVIEW
SANTEE
BOSTONIA
EL CAJON
GROSSMONT
DEHESA
JAMACHA
SPRING VALLEY
LA PRESA
SUNNYSIDE
BONITA
OTAY DAM
OTAY MT.
JAMUL
BRATTAN VALLEY
DULZURA
BARRETT DAM
DEERHORN FLAT
HONEY SPRINGS
LEE VALLEY
LYONS VALLEY
SKYE VALLEY
JAPATUL
GLEN LONELY
LAWSON VALLEY
ALPINE
HARBISON CANYON
FLYNN SPRINGS
VIEJAS
DESCANSO
GUATAY
PINE VALLEY
CORTE MADERA
BUCKMAN'S
LAGUNA (RESORT P.O.)
MONUMENT PEAK
OAK ZANITA
GREEN VALLEY
CUYAMACA
CUYAMACA PEAK
TULE SPRING
BOULDER CREEK
EAGLE PEAK
PINE HILLS
JULIAN
BANNER
STUART SPRING
SAN FELIPE VALLEY
VOLCAN PEAK
GRAPEVINE SPRING
MONTEZUMA
WARNERS RANCH
WARNER'S HOT SPRINGS
EAGLES NEST
HOT SPRINGS PEAK
SAN IGNACIO
COMBS CAMP
CHIHUAHUA VALLEY
THOUSAND PALM CANYON
COLLINS VALLEY
BEATTY'S
BORREGO PALM CANYON
CLARK VALLEY
SANTA ROSA MTS.
SEVENTEEN PALMS
BORREGO SPRINGS
BARREL SPRING
VERRUGA
YAQUI WELL
THE NARROWS
SENTENAC CANYON
BOREGO (TOWN SITE)
BOX CANYON
LA PUERTA
VALLECITO
PALM SPRING
CARRIZO
CANE BRAKE CANYON
DOS CABEZAS
CARRIZO GORGE
LA POSTA
LIVE OAK SPRINGS
NEWTOWN
CLOVER FLAT
BOULEVARD
MOUNTAIN SPRING
JACUMBA
HIPASS
CAMPO
BINGVILLE
POTRERO
COTTONWOOD
TECATE
MORENA DAM


RIVERSIDE COUNTY
SAN DIEGO COUNTY
ARIZONA
LOWER CALIFORNIA, MEXICO
SALTON SEA
250 FT BELOW SEA LEVEL
FISH SPRING
ARROYO SALADA BRIDGE
TULE WASH BRIDGE
CAMPBELL WASH BRIDGE
SAN FELIPE BRIDGE
KANE SPRING
HARPER WELL
APPROX. SEA LEVEL
SUPERSTITION MT.
FISH CREEK MT.
CARRIZO
COYOTE MT.
PAINTED GORGE
PLASTER CITY
COYOTE WELL
MYERS CREEK BRIDGE
YUHA WELL
MOUNTAIN SPRING
SIGNAL MT. P.O.
SIGNAL MT.
DIXIELAND
SEELEY
EL CENTRO
MELOLAND
HEBER
CALEXICO
MEXICALI
IMPERIAL
HOLTVILLE
WESTMORLAND
BRAWLEY
CALIPATRIA
NILAND
FLOWING WELLS
NEW RIVER
ALAMO RIVER
IMPERIAL IRRIGATION DISTRICT
APPROX. SEA LEVEL
BEAL WELL
TORTUGA
AMOS
ACOLITA
MESQUITE
GLAMIS
RUTHVEN
CHOCOLATE MOUNTAINS
SAND HILLS
DRYLYN
AMERICAN GIRL MINE
CACTUS
OGILBY
CARGO MUCHACHO MTS
GRAYS WELL
MIDWAY WELL
PILOT KNOB
ANDRADE
YUMA
BARD
POTHOLES
LAGUNA DAM
PICACHO
CIBOLA
PALO VERDE
COLORADO RIVER
MAP OF
IMPERIAL COUNTY, CALIFORNIA
5 0 5 10 15
SCALE OF MILES

LIST OF SPECIES, WITH GENERAL RANGES

The following schedule lists the species, thirty-two in number, which comprise the group discussed herein; these being the twenty-nine known to occur in San Diego County, and three additional species, found in Imperial County, but not in San Diego County. Their general ranges are given in broad terms as they are known today; the more detailed ranges in the two border counties are discussed under Zonal Distribution, and are listed in Appendix 3.

Western Worm Snake **Leptotyphlops humilis** (Baird and Girard). Western Texas, southern Arizona, northwestern Mexico, and the Californias from Death Valley south to the Cape region of Lower California.

California Boa **Lichanura roseofusca roseofusca** (Cope). Southern and Lower California west of the desert from Los Angeles County south to San José (Lat. 31 deg.).

San Diegan Ring-neck Snake **Diadophis amabilis similis** Blanchard. Southern and Lower California west of the desert from southwestern San Bernardino County south to the San Pedro Martír Mountains.

Western Yellow-bellied Racer **Coluber constrictor mormon** (Baird and Girard). The Pacific Coast from southern British Columbia south to San Diego County, with an eastern extension into southern Idaho, northern Nevada and the Salt Lake region of Utah.

Red Racer **Masticophis flagellum frenatus** (Stejneger). From central California, southern Nevada and southwestern Utah south to the Cape region of Lower California, and through Arizona and Sonora to northern Sinaloa.

Black Whip Snake **Masticophis piceus** (Cope). From southern San Diego County, California, south to the Cape region of Lower California; also southeastern Arizona.

California Striped Racer **Masticophis lateralis** (Hallowell). California and Lower California (west of the Sierras and the desert) from Shasta County south to Mulegé.

Western Patch-nosed Snake **Salvadora grahamiae hexalepis** (Cope). From western New Mexico to the Pacific Coast, across Arizona, southern Utah, Nevada, eastern and southern California; thence south throughout Lower California; also northwestern Mexico.

Lower California Leaf-nosed Snake **Phyllorhynchus decurtatus** (Cope). The California deserts from Inyo County, California, south to the Cape region of Lower California; also southwestern Arizona.

Western Faded Snake **Arizona elegans occidentalis** Blanchard. From southeastern Arizona west to the coast of southern California and northern Lower California.

San Diegan Gopher Snake **Pituophis catenifer annectens** (Baird and Girard). The coastal region of southern California and northern Lower California from Santa Barbara County, California, south to the San Pedro Martír Mountains.

Desert Gopher Snake **Pituophis catenifer deserticola** Stejneger. The desert areas of eastern California and northeastern Lower California; the southern San Joaquin Valley; also Nevada and Utah.

California King Snake **Lampropeltis californiae** (Blainville). California, west of the desert, from Fresno County south to the northern Lower California border.

Boyle's King Snake **Lampropeltis getulus boylii** (Baird and Girard). California from Shasta County south to the San Pedro Martír Mountains of Lower California; also southern Nevada, southwestern Utah and northwestern Arizona.

Desert King Snake **Lampropeltis getulus yumensis** Blanchard. Southern Arizona and northwestern Sonora; also California and Lower California in the bottom lands on the west bank of the Colorado River.

Coral King Snake **Lampropeltis multicincta** (Yarrow). The Transition areas of California on both sides of the Great Valley from Siskiyou County south to the Mexican border.

Long-nosed Snake **Rhinocheilus lecontei** Baird and Girard. Western Kansas and central Texas west to the Pacific Coast with an extension northward through Utah to southern Idaho; along the Pacific Coast from Mendocino County, California, south to Magdalena Bay, Lower California; also northwestern Mexico.

Shovel-nosed Ground Snake **Sonora occipitalis** (Hallowell). Western Arizona and the desert regions of eastern California from Inyo County south into northeastern Lower California.

Striped Ground Snake **Sonora episcopa** (Kennicott). Central Oklahoma and Texas, west to the desert areas of California; also northward into southern Idaho and south to southern Lower California.

Banded Burrowing Snake **Chilomeniscus cinctus** Cope. Eastern California, southern Arizona, northwestern Mexico, and Lower California south to the Cape region.

Spotted Night Snake **Hypsiglena ochrorhynchus** Cope. Central Texas and Mexico westward to the coast; Contra Costa County, California, south to the Cape region of Lower California.

Pacific Garter Snake **Thamnophis sirtalis infernalis** (Blainville). From southern Oregon to northern San Diego County, including western Nevada, but excluding the northwestern coastal area of California and the southeastern deserts.

California Garter Snake **Thamnophis ordinoides hammondii** (Kennicott). The Californias west of the desert from San Luis Obispo County, California, south to central Lower California.

Mountain Garter Snake **Thamnophis ordinoides elegans** (Baird and Girard). The Sierra Nevada and San Bernardino Mountains from Butte County south to San Diego County, California; also Nevada in the vicinity of Lake Tahoe.

Marcy's Garter Snake **Thamnophis marcianus** (Baird and Girard). Oklahoma and Texas west to the Imperial Valley in California; also northern Mexico.

California Tantilla **Tantilla eiseni** Stejneger. The Californias from Fresno and Ventura Counties south to Socorro, Lower California.

California Lyre Snake **Trimorphodon vandenburghi** Klauber. California from Kern County south to the Mexican border.

Desert Diamond Rattlesnake **Crotalus atrox** Baird and Girard. From western Arkansas and the Trinity River in Texas, westward to the Colorado desert in California and Lower California, but excluding the plateau areas of northwestern New Mexico and northeastern Arizona; also Mexico from Tamaulipas to Sonora.

Sidewinder **Crotalus cerastes** Hallowell. The desert areas of central and southwestern Utah, southern Nevada, western Arizona, northwestern Sonora, and southeastern California from Mono County to the San Felipe desert in northeastern Lower California.

Red Diamond Rattlesnake **Crotalus ruber** (Cope). Coastal California and Lower California from southern Los Angeles County south to Lat. 27 deg., including the Gulf of California coast, south of Lat. 30 deg.

Bleached Rattlesnake **Crotalus confluentus mitchellii** (Cope). The desert mountains and coastal foothills of California from San Bernardino County south to the Cape region of Lower California. Also southwestern Arizona.

Pacific Rattlesnake **Crotalus confluentus oreganus** (Holbrook). From southern British Columbia and northwestern Idaho, south through Washington, western Oregon, and California west of the desert, to the San Pedro Martír Mountains in Lower California, except the coastal fringe of Washington, Oregon and northeastern California. Also the plateaus and mountains of south-central Arizona and northern Sonora.

STATISTICAL TABLES AND THEIR DERIVATION

(Tables 1 to 8).

I do not consider San Diego County a particularly fruitful snake collecting territory. While the number of species compares favorably with other districts of similar size, it is only because there are really several quite different habitat areas under consideration. For instance, there are six forms restricted entirely to the desert side of the mountains, and eight coastal forms which, while they cross the mountains, never invade the desert proper.

In numbers of individuals our snake fauna seems to compare unfavorably with other areas along the southern border of the United States. Lack of water limits both the mammal and amphibian population, and this in turn holds in check the snakes which feed upon them. Our statistics indicate that a wayfarer along the roads will ordinarily come upon a live snake in every 223 miles of travel at the peak of the season (May), and a dead snake every 25 miles. On the average throughout the year he will find a live snake every 585 miles, and a dead specimen every 66 miles. This, I think, would compare unfavorably with records in other areas.

There is, in this area, little opportunity for collecting snakes in groups, and one can never be sure of a single snake, even in the best collecting month, except possibly *Thamnophis ordinoides hammondii* along the banks of a few streams and reservoirs. Large spring catches of other forms are not made. Although in the mountain area the snakes may hibernate in dens, as they are known to do in many localities elsewhere, such haunts in our county have not yet been located, and in the more temperate portions probably do not exist. Thus no group collections (even of *T. o. hammondii*) have been sufficiently large to distort our census statistics.

Table 1 presents the results of the eight year statistical record, showing the distribution of 6231 snakes by species and month of collection. As has been stated, the specimens upon which this table is based are primarily those brought to the San Diego Zoological Society by volunteer collectors such as auto picnickers, ranchers, campers, and amateur naturalists generally, supplemented by the accessions of the Natural History Society and various field collectors, including my own trips. The identifications are believed to have been made with accuracy. No hearsay evidence has been accepted except from herpetologists, such as J. R. Slevin, E. H. Taylor and others.

Table 1P gives the same data in percentage form, but from this table there have been eliminated all species of which less than 150 individuals were available in the eight year period; it is believed chronological distribution would not be fairly indicated with a lesser number, being too much affected by the activities of particular collectors, or accidental finds. Table 1P, which permits a comparison between the monthly distributions of the different species independent of relative numbers collected, is more readily interpreted than the previous table.

Space does not permit, nor does scientific interest warrant, showing separately the eight annual tables comprised in Table 1. However, in Table 2 the annual totals are given, repeated in Table 2P on a percentage basis. Table 2P is of more use than Table 2 for comparing monthly distribution between years, being independent of the gradually increasing interest in the collections which has resulted in a growing supply of specimens.

Table 3 shows the distribution of the same specimens by zones, and Table 3P, as usual, gives the same data on a percentage basis. Table 3Q presents a list of approximate zonal and habitat preferences.

In presenting these three tables it is necessary to state at the outset that certain factors difficult of evaluation affect the zonal distribution unequally. These factors of relative areas of zones, population, road mileage, accessibility, etc., all tend to distort the figures, so that it cannot be presumed that comparable snake populations in the several zones are indicated in these two tables. Some of the factors affecting zonal totals are approximately evaluated in Table 4.

Likewise, comparisons between different species in the same zone are not to be made without proper allowances for such characteristics as size, brilliancy of color, secretiveness, habitat, speed of movement, and other

TABLE 1

EIGHT YEAR CENSUS OF SNAKES OF SAN DIEGO COUNTY

Distribution by Months

	Species	January	February	March	April	May	June	July	August	September	October	November	December	Total	Per Cent of Total	Rank
1.	Western Worm Snake **Leptotyphlops humilis** (Baird and Girard)			2	4	13	10	4	3			1	1	38	0.6	15
2.	California Boa **Lichanura roseofusca** (Cope)		1	11	42	53	66	17	6	5	8	3	1	213	3.4	9
3.	San Diegan Ring-neck Snake **Diadophis amabilis similis** Blanchard	9	26	42	44	48	28	21	13	15	14	9	5	274	4.4	8
4.	Western Yellow-bellied Racer **Coluber constrictor mormon** (Baird and Girard)			1	4	8	10	4	2					29	0.5	18
5.	Red Racer **Masticophis flagellum frenatus** (Stejneger)		1	3	16	59	49	15	6	8	2	1		160	2.6	11
6.	Black Whip Snake **Masticophis piceus** (Cope)						1			1				2	0.0	26
7.	California Striped Racer **Masticophis lateralis** (Hallowell)		3	13	62	83	45	30	18	18	7	3	3	285	4.6	7
8.	Western Patch-nosed Snake **Salvadora grahamiae hexalepis** (Cope)			2	15	21	22	14	4	4	1		1	84	1.3	13
9.	Lower California Leaf-nosed Snake **Phyllorhynchus decurtatus** (Cope)					2		1	1					4	0.1	24
10.	Western Faded Snake **Arizona elegans occidentalis** Blanchard		1	1	5	8	11	2	3	3				34	0.5	16
11.	San Diegan Gopher Snake **Pituophis catenifer annectens** (Baird and Girard)	7	30	104	240	393	280	85	41	43	49	21	16	1309	21.0	1
12.	Desert Gopher Snake **Pituophis catenifer deserticola** Stejneger				1									1	0.0	28
13.	California King Snake **Lampropeltis californiae** (Blainville)	1	4	10	49	96	101	51	26	19	3	2	2	364	5.8	6
14.	Boyle's King Snake **Lampropeltis getulus boylii** (Baird and Girard)	1	3	10	50	149	112	87	41	26	8	6		493	7.9	5
15.	Coral King Snake **Lampropeltis multicincta** (Yarrow)					4	8	1	3					16	0.3	22
16.	Long-nosed Snake **Rhinocheilus lecontei** Baird and Girard	2	1	4	13	70	30	23	9	5	1		1	159	2.6	12
17.	Shovel-nosed Ground Snake **Sonora occipitalis** (Hallowell)	3		2	5	12	1				1	1		25	0.4	20
18.	Striped Ground Snake **Sonora episcopa** (Kennicott)				1									1	0.0	28
19.	Spotted Night Snake **Hypsiglena ochrorhynchus** Cope		3	11	13	10	9	6	11	5	2	3	2	75	1.2	14
20.	Pacific Garter Snake **Thamnophis sirtalis infernalis** (Blainville)			1		7	1		1					10	0.2	23
21.	California Garter Snake **Thamnophis ordinoides hammondii** (Kennicott)	4	14	65	190	265	295	262	58	38	11	11	1	1214	19.5	2
22.	Mountain Garter Snake **Thamnophis ordinoides elegans** (Baird and Girard)							1			2	1		4	0.1	24
23.	California Tantilla **Tantilla eiseni** Stejneger		2	1	1	7	6	4	1	2		1	1	26	0.4	19
24.	California Lyre Snake **Trimorphodon vandenburghi** Klauber			3	4	5	2	2	1	1				18	0.3	21
25.	Desert Diamond Rattlesnake **Crotalus atrox** Baird and Girard				2									2	0.0	26
26.	Sidewinder **Crotalus cerastes** Hallowell		1	1	14	8	2			4		1		31	0.5	17
27.	Red Diamond Rattlesnake **Crotalus ruber** (Cope)	4	13	57	134	108	73	41	48	29	28	11	2	548	8.8	4
28.	Bleached Rattlesnake **Crotalus confluentus mitchellii** (Cope)		1	5	28	44	47	24	30	13			1	193	3.1	10
29.	Pacific Rattlesnake **Crotalus confluentus oreganus** (Holbrook)	3	11	52	108	120	88	66	59	47	44	12	9	619	9.9	3
	Total	34	115	401	1045	1593	1297	761	385	286	181	87	46	6231	100.0	
	Per Cent of Total	0.6	1.8	6.4	16.8	25.6	20.8	12.2	6.2	4.6	2.9	1.4	0.7	100.0		

traits which affect the number of individuals coming into a collection.

For the more accurate representation of zonal distribution, Fig. 2 has been prepared. This presents Table 3P in graphic form, amended by these factors to such an extent as seems proper based on judgment and experience. It also extends the presentation to cover Imperial County. The figure illustrates certain topographic and climatic features of the territory to complete the pictorial survey. It must be emphasized, with reference to this figure, that the relative widths of the legends representing the several species are to be taken only as indicating variations of distribution of a single species between zones, and not as between different species in the same zone. Attention should also be called to the fact that the widths of the three desert zones have been shortened, as will be noted from the mileage figures on the profile.

As a general discussion of the tables presented in connection with the county census would be facilitated by considering, at the same time, the tabulation of the results of my own auto trips segregated from the main census, I digress at this point to present the tabular results of my

TABLE 1P

PER CENT VARIATION IN MONTHLY DISTRIBUTION

(Species of which over 150 specimens are available)

	L. r. roseofusca	D. a. similis	M. f. frenatus	M. lateralis	P. c. annectens	L. californiae	L. g. boylii	R. lecontei	T. o. hammondii	C. ruber	C. c. mitchellii	C. c. oreganus	Normal (all species)
Jan.	0.0	3.3	0.0	0.0	0.5	0.3	0.2	1.3	0.3	0.7	0.0	0.5	0.6
Feb.	0.4	9.5	0.6	1.1	2.3	1.1	0.6	0.6	1.2	2.4	0.5	1.8	1.8
Mar.	5.2	15.3	1.9	4.5	8.0	2.8	2.0	2.5	5.4	10.4	2.6	8.4	6.4
Apr.	19.7	16.1	10.0	21.7	18.3	13.5	10.1	8.2	15.6	24.4	14.5	17.4	16.8
May	24.9	17.5	36.9	29.1	30.0	26.4	30.2	44.0	21.8	19.7	22.8	19.4	25.6
June	31.0	10.2	30.6	15.8	21.4	27.8	22.8	18.9	24.3	13.3	24.4	14.2	20.8
July	8.0	7.7	9.4	10.5	6.5	14.0	17.7	14.5	21.6	7.5	12.4	10.7	12.2
Aug.	2.8	4.7	3.7	6.3	3.1	7.1	8.3	5.7	4.8	8.8	15.6	9.5	6.2
Sept.	2.4	5.5	5.0	6.3	3.3	5.2	5.3	3.1	3.1	5.3	6.7	7.6	4.6
Oct.	3.8	5.1	1.3	2.5	3.8	0.8	1.6	0.6	0.9	5.1	0.0	7.1	2.9
Nov.	1.4	3.3	0.6	1.1	1.6	0.5	1.2	0.0	0.9	2.0	0.0	1.9	1.4
Dec.	0.4	1.8	0.0	1.1	1.2	0.5	0.0	0.6	0.1	0.4	0.5	1.5	0.7

roadside experiences. As I have stated, this investigation covers the seven year period terminating December 31, 1930, a year less than the time covered by the preceding tables.

In general, it has been my practice during this period to keep a record of all snakes found on the highway, whether alive or dead, whenever the conditions of travel or business engagements have permitted stopping to make accurate identifications. It was early found that certain other rules had to be set in order to secure a uniform record. First, travel within built-up municipalities must be excluded, for this would involve many miles of travel in which the finding of specimens could not be expected. Secondly, night travel had to be eliminated, since it was observed that even with the best of headlights, or spot-lights, specimens could be seen only with difficulty, and as many would be missed, the statistics would thereby be rendered inaccurate. Thirdly, it was decided to limit the scope of the inquiry primarily to San Diego County, in order that the results might be compared with the general county census. For this reason San Diego County trips were listed separately, and although some useful notes have been accumulated resulting from travel elsewhere in California and in Arizona, these are not incorporated in the tables (except Tables 6A and 7). Trips also were excluded unless the writer occupied the front

TABLE 2

VARIATIONS IN MONTHLY DISTRIBUTION

OF SPECIMENS COLLECTED

	1923	1924	1925	1926	1927	1928	1929	1930	Total	Ave.	Per Cent
Jan.	8	1	4	3	7	6	2	3	34	5	0.6
Feb.	10	22	10	24	10	7	6	26	115	16	1.8
Mar.	19	29	59	107	39	63	50	35	401	57	6.4
Apr.	61	73	79	92	153	232	141	214	1045	149	16.8
May	129	144	165	236	251	197	290	181	1593	228	25.6
June	78	92	123	172	271	128	152	281	1297	185	20.8
July	96	40	109	99	135	107	67	108	761	109	12.2
Aug.	37	18	46	32	63	51	40	98	385	55	6.2
Sept.	25	10	38	44	49	15	46	59	286	41	4.6
Oct.	12	10	46	15	30	12	21	35	181	26	2.9
Nov.	2	4	11	13	23	5	8	21	87	12	1.4
Dec.			13	4	4	2	10	13	46	7	0.7
Total	477	443	703	841	1035	825	833	1074	6231	890	100.0

seat of the automobile, since under other circumstances an accurate survey of the road is impossible. Likewise, all trips wherein business engagements prevented a more or less careful observation have been omitted. Allowing for these limitations, I am able to report, for the seven year period, upon the result of 28,813 miles[6] of travel on San Diego County highways, during which time I have recorded 755 snakes found dead upon the road, and 97 observed alive, or a total of 852 specimens.

Table 5 presents the distribution of these results between species, while Table 6 gives the data on a mileage and chronological basis. Table 6A presents the results of some unusually fruitful trips.

In the preparation of the statistics, accurate identifications were deemed essential and where these were impossible the snake was listed as indeterminate. All of the identifications in connection with these automobile trips were made personally by the writer, and were made by backing up to the dead snake and dismounting from the car when necessary, this being done invariably in the case of small or inconspicuous specimens. As specimens are often passed at considerable speeds, this has meant backing up or retracing one's course in the aggregate for many miles.

TABLE 2P

VARIATIONS IN MONTHLY DISTRIBUTION

in Per Cent of the Annual Collection

	1923	1924	1925	1926	1927	1928	1929	1930	Total Period
Jan.	1.7	0.2	0.6	0.4	0.7	0.7	0.2	0.3	0.6
Feb.	2.1	5.0	1.4	2.9	1.0	0.9	0.7	2.4	1.8
Mar.	4.0	6.5	8.4	12.7	3.8	7.6	6.0	3.3	6.4
Apr.	12.8	16.5	11.2	10.9	14.8	28.1	17.0	19.9	16.8
May	27.0	32.5	23.4	28.1	24.2	23.9	34.8	16.8	25.6
June	16.4	20.7	17.5	20.4	26.2	15.5	18.3	26.2	20.8
July	20.2	9.0	15.5	11.8	13.0	13.0	8.0	10.0	12.2
Aug.	7.7	4.1	6.6	3.8	6.1	6.2	4.8	9.1	6.2
Sept.	5.2	2.3	5.4	5.2	4.7	1.8	5.5	5.5	4.6
Oct.	2.5	2.3	6.6	1.8	2.9	1.5	2.5	3.3	2.9
Nov.	0.4	0.9	1.6	1.5	2.2	0.6	1.0	2.0	1.4
Dec.	0.0	0.0	1.8	0.5	0.4	0.2	1.2	1.2	0.7

[6] The total mileage during this period, without deduction because of these restrictions, was somewhat over 75,000.

TABLE 3

EIGHT YEAR CENSUS OF SNAKES OF SAN DIEGO COUNTY

DISTRIBUTION BY ZONES

	Coast	Inland Valleys	Foot-hills	Moun-tains	Desert Foot-hills	Desert	Unde-term-ined	Total
L. humilis	11	12	6	2	6	1		38
L. r. roseofusca	29	74	86		24			213
D. a. similis	226	29	14	1			4	274
C. c. mormon	4	10	10	4	1			29
M. f. frenatus	66	40	11		41	2		160
M. piceus			2					2
M. lateralis	85	68	105	6	16		5	285
S. g. hexalepis	6	18	52	2	5		1	84
P. decurtatus					4			4
A. e. occidentalis	20	3	4		6	1		34
P. c. annectens	572	316	341	29	36		15	1309
P. c. deserticola						1		1
L. californiae	173	103	78	8	2			364
L. g. boylii	228	144	90	8	15	2	6	493
L. multicincta			1	15				16
R. lecontei	76	39	31		8	2	3	159
S. occipitalis					13	12		25
S. episcopa						1		1
H. ochrorhynchus	37	6	20		10		2	75
T. s. infernalis	3	7						10
T. o. hammondii	258	272	559	109	10	2	4	1214
T. o. elegans				3	1			4
T. eiseni	15	4	4		3			26
T. vandenburghi	1	3	12		2			18
C. atrox						2		2
C. cerastes					4	27		31
C. ruber	192	159	155	3	35	1	3	548
C. c. mitchellii	1	26	126	6	34			193
C. c. oreganus	239	146	138	34	43		19	619
Total	2242	1479	1845	230	319	54	62	6231
Per Cent of Total	36.0	23.7	29.6	3.7	5.1	0.9	1.0	100.0

TABLE 3P

EIGHT YEAR CENSUS

PER CENT DISTRIBUTION BY ZONES

	Coast	Inland Valleys	Foothills	Mountains	Desert Foothills	Desert	Undetermined
L. humilis	28.9	31.6	15.8	5.3	15.8	2.6	
L. r. roseofusca	13.6	34.7	40.4		11.3		
D. a. similis	82.4	10.6	5.1	0.4			1.5
C. c. mormon	13.8	34.5	34.5	13.8	3.4		
M. f. frenatus	41.2	25.0	6.9		25.6	1.3	
M. piceus			100.0				
M. lateralis	29.8	23.8	36.9	2.1	5.6		1.8
S. g. hexalepis	7.1	21.4	61.9	2.4	6.0		1.2
P. decurtatus					100.0		
A. e. occidentalis	58.8	8.8	11.8		17.7	2.9	
P. c. annectens	43.7	24.1	26.1	2.2	2.8		1.1
P. c. deserticola						100.0	
L. californiae	47.5	28.3	21.4	2.2	0.6		
L. g. boylii	46.3	29.2	18.3	1.6	3.0	0.4	1.2
L. multicincta			6.3	93.7			
R. lecontei	47.8	24.5	19.5		5.0	1.3	1.9
S. occipitalis					52.0	48.0	
S. episcopa						100.0	
H. ochrorhynchus	49.3	8.0	26.7		13.3		2.7
T. s. infernalis	30.0	70.0					
T. o. hammondii	21.2	22.4	46.1	9.0	0.8	0.2	0.3
T. o. elegans				75.0	25.0		
T. eiseni	57.7	15.4	15.4		11.5		
T. vandenburghi	5.5	16.7	66.7		11.1		
C. atrox						100.0	
C. cerastes					12.9	87.1	
C. ruber	35.1	29.0	28.3	0.5	6.4	0.2	0.5
C. c. mitchellii	0.5	13.5	65.3	3.1	17.6		
C. c. oreganus	38.6	23.6	22.3	5.5	6.9		3.1
Total	36.0	23.7	29.6	3.7	5.1	0.9	1.0

TABLE 3Q

ZONAL AND HABITAT PREFERENCES

	Classification	Major Activity	Preferred Zone	Territorial Character	Habitat Preference
L. humilis	Subt.		Son.		Rocky Soil
L. r. roseofusca	Terr.	Crep.	U.S.	Foothills	Rocks
D. a. similis	Burr.	Day	U.S.	Coast	Gardens
C. c. mormon	Terr.	Day	U.S.	Foothills	Grass, Fields
M. f. frenatus	Terr.	Day	L.S.	Valleys	Fields
M. piceus	Terr.	Day	L.S.	Foothills	Brush
M. lateralis	Terr.	Day	U.S.	Foothills	Brush
S. g. hexalepis	Terr.	Day	Son.	Foothills	Brush
P. decurtatus	Terr.	Night	L.S.	Desert	Sand
A. e. occidentalis	Terr.	Crep.	Son.	Desert	Sand
P. c. annectens	Terr.	Day	U.S.	C-F.	Fields, Brush
P. c. deserticola	Terr.	Crep.	L.S.	Desert	Desert Oasis
L. californiae	Terr.	Day	U.S.	C-F.	Brush
L. g. boylii	Terr.	Day	U.S.	C-F.	Brush
L. g. yumensis	Terr.	Crep.	L.S.	Desert	River Bank
L. multicincta	Terr.	Day	Trans.	Mountains	Forest
R. lecontei	Terr.	Crep.	Son.	C-F.	Brush
S. occipitalis	Terr.	Night	L.S.	Desert	Sand
S. episcopa	Terr.	Night	L.S.	Desert	Sand, Fields
C. cinctus	Burr.		L.S.	Desert	Rocks
H. ochrorhynchus	Terr.	Night	Son.	C-F.	Rocks
T. s. infernalis	Water	Day	U.S.	Valleys	Creeks, Ponds
T. o. hammondii	Water	Day	U.S.	C-M.	Creeks, Ponds
T. o. elegans	Water	Day	Trans.	Mountains	Mt. Stream
T. marcianus	Water	Day	L.S.	Desert	Irr. Ditch
T. eiseni	Burr.	Night	Son.	C-F.	Rocky Soil
T. vandenburghi	Terr.	Night	Son.	Foothills	Rocks
C. atrox	Terr.	Night	L.S.	Desert	Sand
C. cerastes	Terr.	Night	L.S.	Desert	Sand
C. ruber	Terr.	Day	U.S.	Foothills	Brush, Rocks
C. c. mitchellii	Terr.	Day	L.S.	Foothills	Rocks
C. c. oreganus	Terr.	Day	U.S.	C-F.	Fields, Brush

Abbreviations—

Subt.	Subterranean	U. S.	Upper Sonoran
Burr.	Burrowing	L. S.	Lower Sonoran
Terr.	Terrestrial	Trans.	Transition
Crep.	Crepuscular	C-F.	Coast to Foothills inclusive
Son.	Sonoran	C-M.	Coast to Mountains inclusive

While it has been an interesting field sport to make flying identifications, and some amusingly accurate guesses of rare species have been made, these were not depended on in the tabulations.

Additional notes on the destruction of snakes by automobiles will be found in a subsequent section of this paper.

Table 8 comprises a reference summary of scale count and tail length ratio data. These are partly original and partly derived from such authorities as Van Denburgh, Blanchard and Ortenburger.

We now proceed to a discussion of some of the conclusions which may be premised on these several tables.

CHRONOLOGICAL DISTRIBUTION OF SNAKES

(Tables 1, 1P, 2, 2P; Fig. 1)

The chronological distribution of the specimens which constitute the general census is presented in tabular form in Tables 1 and 2 and the corresponding percentage Tables 1P and 2P. Parts of these data are illustrated graphically in Fig. 1. The chronological results of the road trips are contained in Tables 6 and 6A, the latter covering especially successful, rather than average, trips.

A few general facts are at once evident from Tables 1 and 1P. It is shown that in this area spring is consistently the peak of the snake season and that May is usually the high point, not only of the species collectively (as shown in Tables 2 and 2P), but also of the individual species as indicated in Table 1P.

In view of the prominence of this spring peak, it is rather surprising

TABLE 4

PERCENTAGE FACTORS AFFECTING INTERPRETATION OF LIFE ZONE TABLES

FACTOR	Per Cent in Each Zone					
	Coast	Inland Valleys and Mesas	Foot-hills	Mount-ains	Desert Foot-hills	Desert
Human Population	84.63	13.17	1.61	0.23	0.32	0.04
Area	9.4	18.6	34.2	10.2	20.6	7.0
Road Mileage	23.2	29.1	31.4	5.6	5.9	4.8
Accessibility*	30	20	17	13	11	9

* Reciprocal of distance of center of area from San Diego City.

TABLE 5

SNAKES ENCOUNTERED ON THE ROADS
IN SAN DIEGO COUNTY, CALIFORNIA
402 Trips Totalling 28,813 Miles of Travel

	Caught Alive	Escaped Alive	Total Alive	Dead on Road	Total on Road	% Dead Snakes of all Reported*	% Juveniles among the Dead
L. humilis				2	2	5.3	0
L. r. roseofusca	3		3	15	18	7.0	36
D. a. similis				1	1	.4	0
C. c. mormon	1	1	2	8	10	27.6	0
M. f. frenatus	1	1	2	42	44	26.2	13
M. piceus				‡		0.0	
M. lateralis	2	18	20	73	93	25.6	5
S. g. hexalepis		2	2	25	27	29.8	18
P. decurtatus				1	1	25.0	0
A. e. occidentalis				12	12	35.3	18
P. c. annectens	21	6	27	273	300	20.8	50
P. c. deserticola				§		0.0	
L. californiae	5		5	33	38	9.1	25
L. g. boylii	7		7	45	52	9.1	21
L. multicincta						0.0	
R. lecontei				70	70	44.0	4
S. occipitalis				§		0.0	
S. episcopa				§		0.0	
H. ochrorhynchus				4	4	5.3	0
T. s. infernalis				4	4	40.0	0
T. o. hammondii	8	1	9	57	66	4.7	9
T. o. elegans						0.0	
T. eiseni						0.0	
T. vandenburghi				6	6	33.3	0
C. atrox				§		0.0	
C. cerastes				§		0.0	
C. ruber	4		4	19	23	3.5	6
C. c. mitchellii	1		1	6	7	3.1	17
C. c. oreganus	7		7	40	47	6.5	62
Unidentified		8	8	19	27	†	
Total or Average	60	37	97	755	852	11.8	15

* That is, ratio of snakes found dead on the road to total reported from all sources as shown in total column of Table 1 which is not here repeated.

† Not listed in Table 1.

‡ The only known specimens from San Diego County were found run over on the road, but not by the writer and therefore are not reported in this table.

§ No specimens reported from within San Diego County because of the absence of heavily travelled desert highways within this county. These species are frequently found dead on the Imperial County highways (see table 7).

to note how universal is the popular idea that snakes are to be found (and, of course, feared) almost exclusively during the summer months. The public is decidedly more snake conscious in July and August than at other times of the year; yet annually enough people notice the prevalence of snakes in April and May to cause newspaper comment on the supposed fact that snakes are out especially early.

Probably the primary reason why people believe the summer to be the center of, if not the sole snake season, is the exaggerated popular idea concerning the ophidian desire for heat. In a general way it is thought

TABLE 6

RESULTS OF SAN DIEGO COUNTY ROAD TRIPS

JAN. 1, 1924—JAN. 1, 1931

	Miles Traveled	Live Snakes Encountered	Run-over Snakes	Total Snakes Alive and Dead	Miles per Live Snake	Miles per Dead Snake	Miles per Snake Alive or Dead	Snakes per Mile, Alive†	Snakes per Mile, Dead†	Snakes per Mile, Alive or Dead†	Per Cent Distribution of all Species
Jan.	602		2	2	∞	301	301	0	3.32	3.32	1.6
Feb.	1,132		6	6	∞	189	189	0	5.29	5.29	2.6
Mar.	3,661	9	56	65	407	65	56	2.46	15.28	17.74	8.7
Apr.	5,304	30	169	199	177	31	27	5.65	31.80	37.45	18.5
May	7,136	32	290	322	223	25	22	4.48	40.60	45.08	22.2
June	4,295	20	159	179	215	27	24	4.66	37.10	41.76	20.6
July	2,704	3	42	45	901	64	60	1.11	15.52	16.63	8.2
Aug.	1,415	3	10	13	472	142	109	2.12	7.07	9.19	4.5
Sept.	888		14	14	∞	63	63	0	15.76	15.76	7.8
Oct.	838		5	5	∞	168	168	0	5.96	5.96	2.9
Nov.	464		1	1	∞	464	464	0	2.16	2.16	1.1
Dec.	374		1	1	∞	374	374	0	2.67	2.67	1.3
Total or Ave.	28,813	97	755	852	297	38	34	1.71*	15.21*	16.92*	100.0

* These results give equal weights to each month and therefore are not influenced by the fact that more miles were traveled in the most productive months. Assuming uniform monthly travel the average miles per live snake would be 585, per dead snake 66 and per snake of either kind 59. These figures are of greater importance than those at the foot of columns 5 to 7 above, since the latter are low owing to the high travel in the spring months compared with less fruitful periods.

† Multiplied by 1000.

that no climatic condition is too hot for snakes, and few people realize that even the sidewinder (probably the most specialized of all our desert forms) cannot stand the direct heat of the desert sun at mid-day in the summer for more than a brief time without fatal results, as has been shown experimentally on several occasions.

The spring peak may be attributed to various causes, such as the desire of the snakes, while the ground is still cold, to take advantage of the spring sun (quite a different matter from the summer sun), the appetite for food after the long hibernation, and the mating instinct; for our field notes show that in this area at least, snakes usually mate in April and May. Probably all three of these factors are of considerable weight, and all three would be such as to cause the snakes to range more in the open and to be less careful of concealment.

One fact indicates rather definitely that it is not excess heat alone that makes them less in evidence after May, since a frequency curve based entirely on coastal specimens shows the same sharp peak as does Table 1. (See Fig. 1) The coastal snakes show an earlier activity than is noted in other areas, for there were taken in March 10.7 per cent of the coastal

TABLE 6A

SELECTED SERIES OF SUCCESSFUL ROAD TRIPS

Date	Miles	Snakes on Road			Miles per Snake
		Alive	Dead	Total	
Apr. 3, 1926	108	1	10	11	9.8
Apr. 5, 1931	127	3	18	21	6.0
Apr. 12, 1928	231	3	14	17	13.6
Apr. 12, 1930	195	4	18	22	8.9
Apr. 17, 1925	178	2	16	18	9.9
Apr. 24, 1927	162	1	11	12	13.5
May 5, 1929	230		18	18	12.8
May 7, 1928	147	2	17	19	7.7
May 11, 1930	166	1	11	12	13.8
May 20, 1928	117		9	9	13.0
May 22, 1926	105	5	2	7	15.0
May 24, 1930	258	3	19	22	11.7
May 25, 1930	159		14	14	11.4
June 3, 1928	142		15	15	9.5
June 5, 1927	164	3	8	11	14.9

snakes as against 6.4 per cent of specimens from all zones. On the other hand, the falling off after May, not only takes place amongst the coastal snakes, but is even sharper than in those from the back country, for 17.6 per cent of the coastal snakes were captured in June compared with 20.8 from all zones, and 8.3 per cent were taken in July as compared with 12.2 per cent of the general average. The point is that the early summer decline cannot be attributed to heat, for along the coast the weather is virtually never hot. For instance, at San Diego during the eight year period covered by Table 1, there were during the months of June, July, and August only 35 out of 736 days (or 4.8 per cent) in which the maximum temperature exceeded 80 deg. F. and on only two days did it exceed 90 deg. F. The mean maximum daily temperature at San Diego for these three months is 69.2, 72.3 and 73.6 deg. F. It will be readily agreed that these temperatures are not sufficiently high to cause snakes to become nocturnal, and thus we may conclude, either that they are acting

TABLE 7

RESULTS OF DESERT ROAD TRIPS

(Not Restricted to San Diego County)

	Dead on Road	Alive on Road	Total	Per Cent of Total
Masticophis flagellum frenatus	5	2	7	5.3
Salvadora grahamiae hexalepis	2		2	1.5
Phyllorhynchus decurtatus	6	1	7	5.3
Arizona elegans occidentalis	13	2	15	11.3
Pituophis catenifer deserticola	33	2	35	26.3
Lampropeltis getulus boylii	1		1	0.7
Lampropeltis getulus yumensis				
Rhinochelus lecontei	3		3	2.3
Sonora occipitalis	14	2	16	12.0
Sonora episcopa	2		2	1.5
Chilomeniscus cinctus				
Thamnophis marcianus	2	1	3	2.3
Trimorphodon vandenburghi	1		1	0.7
Crotalus atrox	1		1	0.7
Crotalus cerastes	31	9	40	30.1
Total	114	19	133	100.0

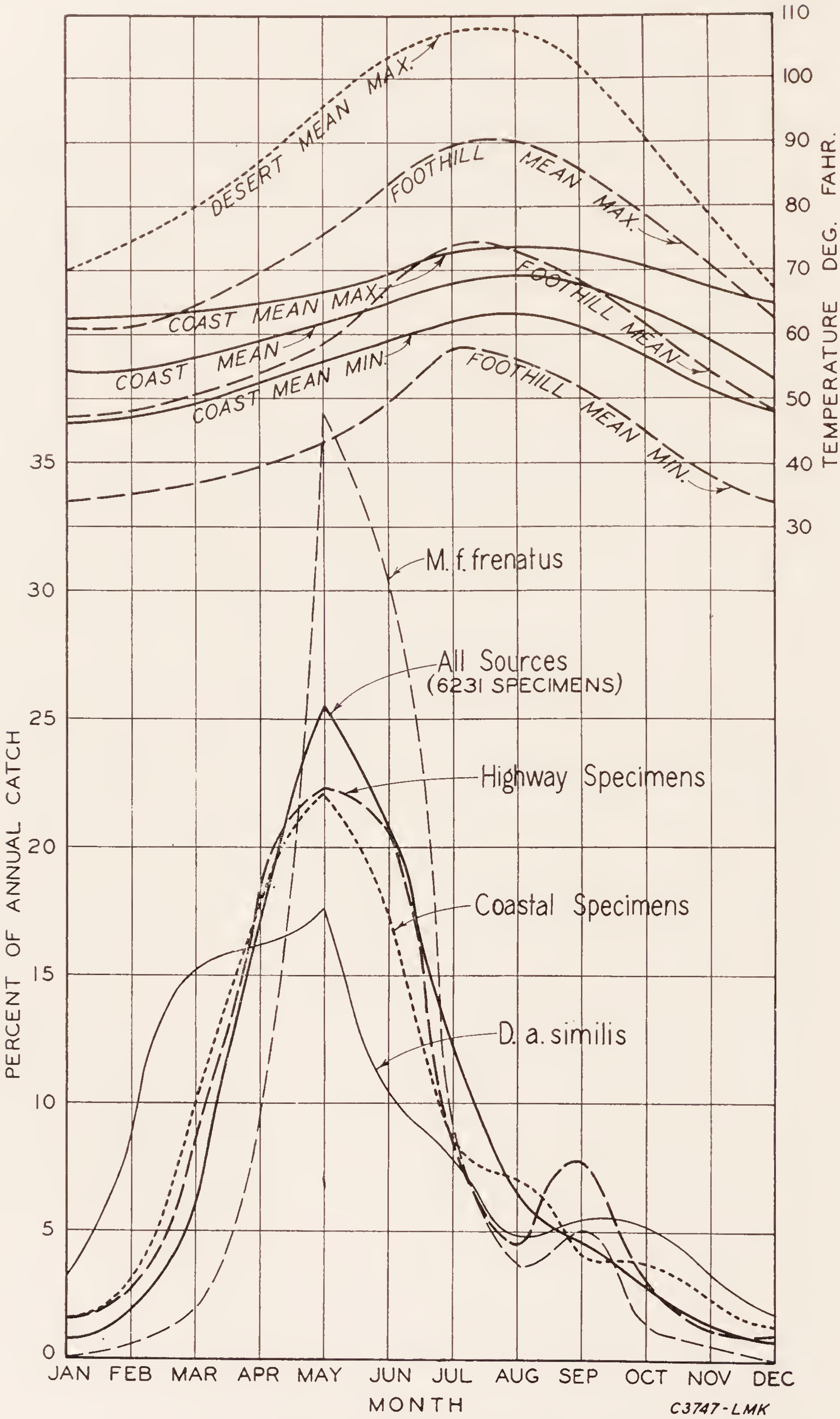


FIG. 1. MONTHLY DISTRIBUTION OF SPECIMENS
(Also Temperature Curves)

TABLE 8 SCUTELLATION

(Where Parentheses Are Used, the Extreme Range, Rather Than the Normal or Usual Range, is Indicated)

SPECIES	Scale Rows	Ventrals	Anal	Caudals†	Supralabials	Infralabials	Loreals	Preoculars	Postoculars	Temporals‡	Ratio Tail/Total Length	No. Specs.	Authority	Part of Range‡‡
L. humilis	14	263-301*	Ent.			4(5)					.04-.06	25	L M K	S. D. Co.
L. r. roseofusca	(35-)39-43	221-244	Ent.	39-51	(12)13-14(15)	(13)14-16(17)	(2)3**	(7-)9-10††			.10-.15	38	L M K	Entire
D. a. similis	15(17)	190-210	Div.	46-65	7	(7)8	(0)1	2	2	1+1	.15-.20	10	L M K	S. D. Co.
C. c. mormon	17	163-184	Div.	72-104	(6)7-8	(7)8-9(-11)	1	(1)2	2	2+2	.20-.35	203	A I O	Entire
M. f. frenatus	17	185-212	Div.	97-125	(7)8-9	(9)10-11(12)	1	2	2	2+2	.23-.28	188	A I O	Entire
M. piceus	17	187-207	Div.	101-124	8(9)	(9)10(11)	1	2	2	2+2	.23-.30	32	A I O	Entire
M. lateralis	17	183-204	Div.	115-137	(7)8(9)	(8)9(10)	1	2	2(3)	2+2	.26-.32	81	A I O	Entire
S. g. hexalepis	17	187-202	Div.	73-99	(6-)9(10)	(9)10(11)	(1)2(3)	2-3(4)	2(3)	2+3	.20-.24	25	L M K	S. D. & Imp. Cos.
P. decurtatus	19	161-193	Ent.	26-40	6(7)	8-9	(1)2(3)	2(3)	2-3	3+3	.08-.15	23	L M K	Entire
A. e. occidentalis	(25)27-29	193-236	Ent.	37-56	(7)8(9)	(11)12-13(-15)	1	1(2)	2	2+4	.10-.16	44	B & K	Entire
P. c. annectens	(29-)33(35)	217-243	* Ent.	62-85	8(9)	(10-)12-14(15)	1	2(3)	(2)3(-5)	4+4	.14-.17	69	J V D	Entire
P. c. deserticola	(29)31-33(-37)	223-263	Ent.	50-72	8(-10)	(12)13(14)	1	(1)2	3(4)	4+4	.11-.15	28	J V D	Entire
L. californiae	23(25)	226-241	Ent.	47-60	7(8)	(8)9-10	(0)1	1	(1)2(3)	2+3	.11-.14	27	B & V D	Entire
L. g. boylii	23(25)	206-254	Ent.	41-62	7(8)	(8)9(10)	(0)1	1	(1)2	2+3	.11-.15	69	B & V D	Entire
L. g. yumensis	23(25)	212-248	Ent.	44-57	7(8)	9(10)	1	1	(1)2	2+3	.12-.13	9	B & V D	Entire
L. multicincta	(21)23(25)	198-222	Ent.	45-61	(6)7(8)	(8)9(10)	(0)1	1(2)	2	2+3	.13-.16	49	B & V D	Entire
R. lecontei	23(25)	186-216	Ent.	40-55	(7)8(9)	8-10	1	1(2)	2(3)	2+3	.12-.15		J V D	Entire
S. occipitalis	15	147-170	Div.	33-55	(6)7	7(8)	(0)1(2)	1(2)	2	1+2	.15-.22	46	L M K	Entire
S. episcopa	15	164-182	Div.	38-56	(6)7	6-7	1	1	2	1+2	.17-.21	14	L M K	S. D. & Imp. Cos.
C. cinctus	13	108-125	Div.	21-29	7	(6-)8(9)	0(1)	1	2	1+1	.10-.14		J V D	Entire
H. ochrorhynchus	21(23)	160-191	Div.	38-66	(7)8(9)	(9)10	1	(1)2(3)	2	1+2	.13-.18		J V D	Entire
T. s. infernalis	19(21)	156-175	Ent.	74-97	7(-9)	(8-)10(11)	1	1(2)	(2)3(4)	1+2	.22-.27	135	J V D	Entire
T. o. hammondii	(19)21	156-173	Ent.	67-88	8(9)	(9)10(11)	1	1-3	(2)3(4)	1+2	.20-.24	75	J V D	Entire
T. o. elegans	19-21	151-179	Ent.	70-101	(6-)8(9)	(8-)10(11)	1	1(2)	(2)3(4)	1+2	.19-.26	97	J V D	Entire
T. marcianus	21(23)	149-163	Ent.	63-79	(7)8	10(11)	1	1(2)	3-4	1+2	.19-.26		J V D	Entire
T. eiseni	15	166-190	Div.	56-71	(6)7	(6)7	0	1	2	1+2	.21-.26	18	L M K	S. D. Co.
T. vandenburghi	21-23	220-242	Ent. §	66-80	8-9(10)	11-12(13)	(2)3§§	(2)3	2	2+3	.14-.17	15	L M K	Entire
C. atrox	(23)25-27	173-195	Ent.	16-30	(13)14-17(18)	(14)15-18(-20)	(0)1(2)	2(3)			.05-.09	222	L M K	Entire
C. cerastes	(19)21-23(25)	134-153	Ent.	13-27	(11)12-14	(11)12-14(-16)	1	2(3)			.05-.09	100	L M K	Entire
C. ruber	27-29(31)	185-205	Ent.	16-29	(13-)15-18(19)	(14-)16-19(20)	1-2	2(3)			.05-.08	105	L M K	Entire
C. c. mitchellii	23-25(27)	163-187	Ent.	16-28	(13-)15-17(-19)	(13)14-17(-19)		2(3)			.05-.09	104	L M K	Entire
C. c. oreganus	(23)25(27)	167-184	Ent.	17-28	(13)14-16(17)	(13-)15-17(-19)	1(2)	2(3)			.05-.09	100	L M K	So. Calif.

ABBREVIATIONS
B—F. N. Blanchard
AIO—A. I. Ortenburger
JVN—J. Van Denburgh

FOOTNOTES
* Dorsals from head to tail (referring only to this species).
† All are paired except:
L. humilis and **L. r. roseofusca**, entire.
R. lecontei, usually single anteriorly, divided posteriorly.
Crotalus, usually entire, but may have a few paired, especially posteriorly.
‡ Because of variability only the most common formula is given.
§ Rarely divided.
** Also 1 to 3 subloreals.
†† Total scales in ocular ring (referring only to this subspecies).
‡‡ Indicating the part of the known range of the species or subspecies producing the specimens tabulated. "Entire" indicates that specimens from all parts of the range were included.
§§ Usually a subloreal also present.

through habits acquired in warmer areas; or else, their early spring desires for warmth, food, and mating have been satisfied, they become more cautious and secretive, and thus are less often seen in the day time, if in fact most of them do not become entirely crepuscular or nocturnal.

One might expect a secondary autumn peak, when presumably the snakes would again be in search of food to build up a winter reserve of fat, and to take advantage of the autumn sun before finally going into hibernation. Such a peak, of minor quality compared with the spring peak, is in evidence in several species such as *L. r. roseofusca, M. f. frenatus* and *P. c. annectens.* For all species combined this secondary peak appears rather as a leveling out of the curve before the decline to the minimum in winter.

It is possible that the general curve would show an even sharper drop in late spring than it does, were it not for the fact that the mountain snakes are experiencing a maximum activity at that time, and are therefore brought in largely during the months of June and July. For obvious reasons their season is delayed for a month or six weeks as compared to the foothill and valley snakes.

The secondary peak must in part result from the presence of the young newly born in the autumn, these being evident in sufficient numbers amongst some of the species, as for instance *P. c. annectens and C. c. oreganus,* to affect the general curve. These inexperienced specimens are both captured and run over in considerable numbers. (See also page 59) and last column, Table 5).

Taking the species listed in Table 1P, which includes those represented by series large enough to constitute a representative picture, that is, species of which over 150 individuals have been available in the eight year period, it is interesting to note which have earlier and which have later peaks than the general average. Two divergent theories might be advanced to account for the evident difference between species. First, it might be thought that a species whose principal habitat zone is cooler and moister than San Diego County, might come out earlier in the spring, being more accustomed to the moisture and coolness of that season as compared to others from drier areas. Or, on the other hand, it might be argued that this character of species should come out later, being, in its more normal habitat, used to a shorter season. In other words, is the chronological distribution of a species dependent on something inherent in the species, or is it modified in different areas to meet the climatic conditions there encountered? Two species which may be investigated as examples are *Diadophis amabilis,* which in San Diego County finds a more arid and warmer area than that to which it is accustomed in the greater part of its range, and *Masticophis flagellum frenatus* which meets in San Diego County a more humid and cooler district than is usual elsewhere in the wide territory where it occurs. The conclusion deduced from these two favors the theory of adapability, rather than that of inflexible season length, for in San Diego County we find that *Diadophis* is early, while

M. f. frenatus is late (as shown in Fig. 1) ; thus the former has a longer and the latter a shorter season in San Diego County than obtain over most of their ranges.

It will be of interest to divide the species listed in Table 1P into two groups, those which are earlier and those which are later than the general average:

Early	**Late**
D. a. similis	*L. r. roseofusca*
M. lateralis	*M. f. frenatus*
P. c. annectens	*L. californiae*
C. ruber	*L. g. boylii*
C. c. oreganus	*R. lecontei*
	T. o. hammondii
	C. c. mitchellii

We find that the early group includes most of the forms primarily Upper Sonoran in their tendencies, while the late group includes all the essentially Lower Sonoran species. The king snakes and the garter snake are exceptions. The garter snake distribution can be explained by the number collected in the mountains, this having distorted, somewhat, the curve for this species; but the king snake distribution I am unable to explain.

Of the species not listed in Table 1P a few are worthy of comment. The essentially mountain species, *L. multicinta* and *T. o. elegans,* are late, although the record does not include sufficient specimens to be conclusive. In this case the simple explanation of a late season in the mountains is available.

Species which range both on the floor of the desert and along the coast are likely to have later distribution curves than those restricted entirely to the truly desert areas. This is shown by a comparison of *S. g. hexalepis* and *A. e. occidentalis* on the one hand with *C. cerastes* and *S. occipitalis* on the other.

The comparison first made, between *D. a. similis* and *M. f. frenatus,* may be thought inconclusive because so large a proportion of the ring-necked snakes were taken in the early opening coastal zone. But such zonal distribution does not entirely explain these chronological differences between species. For instance, 66 per cent of *M. f. frenatus* were taken in the early coast and valley zones while only 54 per cent of *M. lateralis* were found in these zones; nevertheless *M. lateralis* showns an average peak of activity about a month earlier than the red racer. The conclusion is inevitable that *M. lateralis,* which is essentially Upper Sonoran, becomes active as soon as Upper Sonoran weather is available, while *M. f. frenatus,* accustomed over most of its range to a warmer climate, waits until drier conditions prevail. Thus we find that species ranging into somewhat composite or borderline habitat areas retain a preference for the conditions more nearly approximating those in their centers of activity.

It is probable that in the coastal area true hibernation does not occur. The finding of specimens of some of the commoner Upper Sonoran forms in every month of the year indicates that instead of taking refuge in deep holes and crevices they probably hide under stones, in wood-rat nests, gopher holes and similar places, and then take advantage of the occasional warm (and even hot) days to roam about.[7] No doubt in the Transition areas the more usual form of hibernation occurs.

Brimley, in his discussion of seasonal distribution at Raleigh, N. C., divided the snakes of that area into four classes: garter and water snakes; small burrowing and ground snakes; terrestrial snakes and pit vipers. He found a peak for the first two classes in April, the peak for the third in May and for the last (represented only by the copperhead) in June. A strong secondary autumn peak was noted in all groups.[8]

I have tried a similar arrangement, but did not find a conspicuous group or class difference in the San Diego County chronological distribution. The zonal factors seem to be of greater weight.

The probability that sex has some effect on chronological distribution is indicated by the fact that the males range abroad more carelessly. Not only are they the pursuers in the mating season, but probably the females remain in concealment when heavy with eggs. I have noted the greater prevalence of males in most rattlesnake collections, the ratio running as high as 60 to 40. For instance, in a collection of over 200 *C. atrox* from a variety of sources, the ratio was 61 to 39; and in a group of 100 *C. ruber* there were 59 males and 41 females. This is not the result of any normal discrepancy in the numbers of the sexes, for a collection of 153 *C. c. confluentus* from a single locality taken just prior to hibernation, when all sex activities might be considered at an end, showed equal division between the sexes.

In connection with Table 1 it should be stated that there may be a slight lag between true time and the chronology of the table, for a few specimens were no doubt retained by the collectors for several days before being presented to the Zoo; however it is not believed that this is of major importance.

Table 5, which gives the chronology of the writer's automobile road trips, in some ways produces a more accurate chronological result than Table 1. The type of time lag above mentioned does not exist, and, furthermore, allowance has been made for the relative seasonal activity of the collector. This is impossible in Table 1, since the factors which should be used to compensate for the greater prevalence of picnic parties in the valleys and foothills in the spring (while the snake barren beaches are more frequented by picnickers in the summer) cannot be determined. But Table 6 refers only to the writer's trips, and in the last column has been reduced to a unit travel basis. It should also be remembered that the road specimen curve is more truly representative of the crepuscular

[7] L. H. Cook found a *P. c annectens* under a flat stone in the lower foothills, Feb. 8, 1931, which had eaten a mouse within a few days. This is merely an example and is not to be considered unusual.

[8] Brimley, 1925.

and nocturnal species than is the general curve. This trip curve is incorporated in Fig. 1, and is observed to be flatter, with a less pronounced May peak, than the curve for all specimens. A secondary September peak is quite definitely in evidence.

Even this curve is not entirely independent of the effect of picnics and similar spring activities, since the dead roadside specimens are found, not only because of the activities of the collector and recorder, but likewise the traffic which causes the casualties. This is no doubt heavier in spring, but the difference is largely restricted to week-ends. It is partly compensated by the summer vacation traffic.

A possible source of the variability in the unit mileage statistics of the highway trips is found in the uncertain effect of a return trip on the same highway in the same day. Necessarily this leads to some slight inaccuracy; it would not be fair to eliminate such mileage entirely, since snakes are often found on the return trip which were not present on the outgoing. Not infrequently the same specimen is seen twice, and is, of course, not counted on the return trip, thus somewhat reducing the fair mileage per snake seen.

It will be noted (Table 6) that the density of live and dead snakes per thousand miles of travel reaches a maximum of 45 in May or, expressed in the reciprocal relation, one should come upon a snake every 22 miles. It may be of interest to give the figures for some of the best trips the writer has ever taken to illustrate the results of especially fruitful, rather than average days. Taking into consideration only trips exceeding 100 miles, fifteen of the best have been selected and are listed in Table 6A. From the standpoint of snakes observed, the best trip ever experienced by the writer occurred on April 5, 1931 with 21 snakes seen in 127 miles, or one snake every 6.0 miles. Trips better than one snake every ten miles are to be considered quite unusual. They are likely to occur any time between the first of April and the first week of June, with the greatest probability early in May, this being without doubt (in the average climatic year) the peak of the season in all zones except the mountain.

While this survey has probably covered a sufficient period to give a fairly accurate indication of monthly distribution, it has not continued long enough to afford an idea of annual fluctuations. It is no doubt reasonable to assume that in a territory such as this, where biological development is so dependent on a variable and capricious rainfall, the snake crop might be co-ordinated with the seasonal precipitation. Heavy rains should mean more amphibians, mammals and lizards and, later, more snakes. But eight years involve too short a time and the interference of extraneous factors is too difficult to eliminate, to permit a picture of cause and effect. 1923 and 1924 were low snake years, not because of any climatic or food variations, but because the public had not yet become interested in our activities. Whether the variations in the other years were in any way related to rainfall I cannot say. Precipitation was above normal in the rainy seasons of 1921-2, 1925-6, and 1926-7, practically normal in 1929-30 and subnormal in the intervening years.

I have heard it said that sidewinders are particularly in evidence on the desert following the rare spring showers, but there is evidence that our local snakes do not like our spring rains and the cold weather which generally accompanies them. A year in which there was an unusually heavy fall of rain in April was characterized by a subnormal percentage (of that year's snakes) taken in that month. Another year with heavy rain in March and May (1930) produced a subnormal May catch and transferred the peak to June. 1928, characterized by a particularly heavy percentage of the annual catch in April, was notable for subnormal rainfall—less than an inch fell in the coastal belt in any month subsequent to December of the previous year—and an average daily temperature excess in every spring month. An early season was therefore to be expected.

I have checked the percentage of normal rainfall for each month against the percentage of normal snake catch for the same month, this being done for the 96 months in the eight year period. I find a significant correlation only in the critical months of April and May. For a mutual effect between rainfall and the incidence of snakes, the winter months have too few snakes and the summer months too low a rainfall; that is, the rainfall in those months in any case is but a fraction of an inch and therefore without effect on the snake catch. But of 8 Aprils the snake catch is of opposite sign to the rainfall in 7 cases and in May is of opposite sign in 6 out of 8 years. So we may conclude that in these months of maximum snake activity and considerable rainfall expectancy, rainy weather does affect the snake season. Heavy spring rains mean a late activity and vice versa.

Few species of which there are sufficient specimens available to be really conclusive, have their absolute peaks (to a prominent degree) in any month but May. Considering only those species of which at least 100 specimens have been available, and only those in which the peak month exceeds the next highest by at least 10 per cent, we find the only exceptions to be *C. ruber* with a peak in April and *L. r. roseofusca* and *T. o. hammondii* with high points in June.

ZONAL DISTRIBUTION OF SNAKES

(Tables 3, 3P, 3Q, 4 and 7; Fig. 2).

Tables 3, 3P, 3Q, 4 and 7 and Fig. 2 are presented in an endeavor to elucidate the zonal and habitat preferences of the thirty-two species and subspecies of snakes known to be present along the southern border of California. Generalities are more difficult to deduce than in the chronological presentation, since each species seems to act as a separate unit.

I have pointed out elsewhere that the various sources and methods of collection of the specimens upon which Table 3 is based lead to errors. The supply of certain species is unfavorably affected by such factors as inaccessibility of range, small size, secretiveness or nocturnal habit.

It must be remembered with reference to Table 3, which includes San Diego County only, that some of the zones, particularly the mountain and desert, are not equally accessible to roads, nor so thoroughly networked, and thus automatically the numbers of specimens brought in from such territories, or found dead on the road, are proportionately decreased. In fact, in San Diego County, desert roads of primary character are not to be found; the main San Diego-Imperial highway does not reach the desert until within Imperial County. Therefore the desert area is especially penalized, and it should be emphatically stated that neither Table 3 nor 3P gives an accurate summary of the frequency of occurence of desert forms, territorially or by species. For this reason the special record contained in Table 7 has been prepared, giving the results of a number of exploration trips within the Colorado Desert, made both by day and night. These trips were primarily within the Imperial Valley and the adjacent level floor of the Colorado Desert, the surrounding desert foothills being definitely excluded. The limits of the area considered in preparing the table were as follows: San Diego-Yuma highway (U. S. 80), from the Colorado River on the east to Myers' Creek Bridge on the west; Imperial Valley-Los Angeles highway (U. S. 99), from Calexico on the south to Whitewater on the north; Julian-Kane Springs highway, from The Narrows on the west to Kane Springs on the east; Mecca-Blythe highway, from Mecca on the west to the Colorado River on the east; Old Butterfield stage road, from Vallecito on the west, to the intersection with U. S. 80 on the east. This area should give a fairly accurate survey of conditions on what might be called the floor of the desert.

While it has seemed best to eliminate night travel from the mileage record of the San Diego County results, the special desert tabulation (Table 7) is based very largely on night collecting, for in that territory night collecting is particularly fruitful. (See for example Appendix 2, under May 4, 1930).

In an endeavor to offset the factors which unfavorably affect the outer zones and the nocturnal and secretive species, Tables 3 and 3P have been modified into Fig. 2. These statistics and the field notes, of the character illustrated in Appendix 2, have been employed in the preparation of Table 3Q.

Table 3Q is intended only as a rather general indication of zonal and habitat preferences. Few definite lines may be drawn; seldom do snakes adhere so rigidly to a single zone and habitat that their characteristics can be covered so succinctly. Dogmatic statements are always subject to upsets.

I learned this lesson in 1923 while on a trip with the late Dr. J. Van Denburgh. He was anxious to procure specimens of *L. r. roseofusca,* a species not then well represented in the California Academy collection. After a long trip through promising boa country amongst granite and brush without seeing a specimen, we came down near the coast and drove between cultivated fields. Here I discoursed at length upon the impossibility of finding a boa in such territory and the necessity of trying the foothills again on another day. Dr. Van Denburgh's amused smile when the next snake picked up on the road proved to be *Lichanura* was to be long remembered.

Thus I make no claim to universal application of the data assembled in Table 3Q. The classification given in the first column is loose. No sharp line can be drawn between burrowing and terrestrial species; the burrowers of the day become terrestrial at night and the diurnal or crepuscular snakes of the early spring become nocturnal in summer. But I have attempted to indicate the habit of the snake at the time of its maximum (spring) activity.

Similarly, in the statement of life zone and habitat preference, only a general indication is to be assumed. Almost all seem to break over their normal bounds occasionally, and some are so catholic in taste that narrow preferences cannot be indicated.

It may be asked why so much stress has been given to zonal differentiation across the mountains with none parallel thereto. This is done because the life zones or belts in southern California and northern Lower California all run in a northwesterly and southeasterly direction, as do the coast and the main mountain range. All the main life habitats, with the exception of the mountain, extend in a series of parallel belts for considerable distances virtually unbroken from Los Angeles to Santo Domingo or below. In these strips changes are gradual and few species are affected. For instance, out of the 21 species and subspecies which are relatively plentiful in the foothill area 17, or 81 per cent, range at least from Lat. 34 deg. to 31 deg. N. The other four seem to reach the ends of their ranges in, or close to, San Diego County; they are *C. c. mormon, L. californiae* and *T. s. infernalis* coming down from the north, and *M. piceus* entering the edge of the county from the south. Of these same 21, 15, or 71 per cent, do not go eastward beyond the margin of the desert, although three reappear beyond the Colorado River in Arizona. Thus we see how much more important and effective are the climatic and habitat changes from east to west as compared to the north-south modifications.

The mountain zone presents a somewhat different situation. The Peninsula Range is not continuous, from the San Gabriels on the north to the San Pedro Martírs on the south. On the contrary, between the several mountain groups there exist low altitude passes, such as San Felipe, San Gorgonio and Cajon, all of which dip into the Lower Sonoran zone. These passes must constitute real barriers to the Transition forms which inhabit the mountains, and probably for a long time such species as *Ensatina croceater croceater, Rana boylii muscosa* and *Sceloporus graciosus vandenburgianus* have been separated into a series of biological island groups. Transition forms amongst the snakes are few. *Charina bottae* has been taken as far south as San Jacinto Mountain; it has not yet been found in San Diego County. The two conspicuous examples within our territory are *L. multicincta* and *T. o. elegans*; the first seems to occur on every mountain, the second thus far has been found only on Laguna or its flanks. Farther south, on San Pedro Martír, these two become modified to *L. agalma* and *T. o. hueyi* respectively. By these independent islands, and the beginning of a definite differentiation, a former more extended Transition area is indicated.

The real effectiveness of the parallel belts may best be realized by reference to Fig. 2, showing how many species vary in distribution as the boundaries are crossed.

In consulting this chart it must be remembered that the width of a line is not presumed to indicate relative rarity as between species; it is only intended to suggest approximate variations within a species. Again, it must be remembered that the mountains do not constitute such a barrier between the desert and the coast as the profile suggests, since between the mountain groups there are the low passes previously mentioned; and through these passes Lower Sonoran forms might filter without entering Transition areas, or, in fact, going above the lower fringes of Upper Sonoran. In Fig. 2 it will be observed that some species are indicated by the dotted lines as going around (through passes) rather than over the mountains. But if specimens have been taken in the mountain zone, they are shown as if going over, although they are not to be assumed as occurring on the highest peaks. In the same way *T. marcianus* has followed the irrigation canal or the New River into the Imperial Valley, instead of crossing that part of the desert shown in the profile.

Aside from the mountain species which have been mentioned, few forms seem to be seriously perturbed by any variation in conditions found on the coastal side of the range. Their frequency of occurrence may be considerably affected by local habitat preferences (as for instance rocks, brush, grass, etc.) but, in general, it may be said that, if on the coast side of the ridge at all, they are likely to be found to a moderate extent in every belt from the foothills to the coast. Eliminating *T. s. infernalis* and *M. piceus* which barely enter the county, the one from the north, the other from the south, and are represented by only a few stragglers, we find only a single species which has a definite range line between the mountains and the sea. This is *C. c. mitchellii,* which stops along the edge of the granite-chaparral line at the western edge of the foothills. It is true that a few specimens have been found beyond this line but they seem to have been washed down the San Diego and San Luis Rey rivers by floods. Thus, on the coastal side of the mountains, only one species out of nineteen has a range limit paralleling the coast.

East of the mountains the change is more sharp and a considerable number of the forms terminate their ranges in one direction or the other. Most of these range limits will be found between the top and bottom of the desert foothills, for the desert forms sometimes ascend for a little way into the isolated desert valleys, while the coastal species follow down the eastbound streams until these disappear into the desert sand.

FIG. 2. ZONAL DISTRIBUTION OF SPECIES

The following list will show how these changes are effected. In this list the western foothills and the desert basin are considered the two typically representative areas on the opposite sides of the range; however, the two mountain species which barely enter the foothills are included in the statement.

(A) Species at home in both areas.

1. *M. f. frenatus*
2. *S. g. hexalepis*
3. *A. e. occidentalis*

(B) Species found on both sides of the desert basin but not in the basin itself.

1. *L. humilis*
2. *M. piceus*
3. *R. lecontei*
4. *H. ochrorhynchus*
5. *C. c. mitchellii*
6. *C. c. oreganus*

(C) Foothill species with closely related species or subspecies in the desert basin.

1. *P. c. annectens*..........*P. c. deserticola*
2. *L. g. boylii*..........*L. g. yumensis*
3. *T. o. hammondii*..........*T. marcianus*
4. *C. ruber*..........*C. atrox*

(D) Foothill species with related forms in southern Arizona.

1. *L. r. roseofusca*..........*L. r. gracia*
2. *D. a. similis*..........*D. regalis arizonae*
3. *M. lateralis*..........*M. semilineatus*
4. *L. multicincta*..........*L. pyromelana*
5. *T. s. infernalis*..........*T. eques*
6. *T. eiseni*..........*T. nigriceps*
7. *T. vandenburghi*..........*T. lyrophanes*

(E) Foothill species without related forms in the desert or southern Arizona.

1. *C. c. mormon*
2. *L. californiae*
3. *T. o. elegans*

(F) Desert basin forms not occurring in the foothills.

1. *P. decurtatus*
2. *S. occipitalis*
3. *S. episcopa*
4. *C. cinctus*
5. *C. cerastes*

It will be observed that, of the 23 forms found on the western slope, only three, or 13 per cent, are contained in Group "A" and are really at home on the floor of the desert.

Concerning Group "B" there is some uncertainty. This group is largely Lower Sonoran in tendency, and some species may actually occur in the desert basin.

L. r. roseofusca in Group "D" is often considered a desert species and specimens labelled "Colorado Desert" are to be found in the National Museum. However, one of these (the type of *orcutti*), is now known to have been taken near Jacumba; the others are no doubt from the same area, and thus there is no specimen definitely known to be from the Colorado basin. A related subspecies, *L. r. gracia,* does occur in the Mohave Desert and in western Arizona, but probably in the scattered mountains rather than between.

The discussion of this species brings out the differences between the Colorado Desert and the Mohave, and, likewise, the Western Arizona or Yuma Desert. The two latter are higher and, although containing great barren stretches, are broken by frequent isolated mountain groups. These, with their foothills, constitute strongholds for such rock inhabiting forms as *L. humilis, L. r. gracia, H. ochrorhynchus* and *C. c. mitchellii;* and thus such species are to be found in southern Arizona and parts of the Mohave, whereas they seem absent from the basin constituting the bed of ancient Lake Cahuila, which apparently exercises a more restrictive effect than a rocky, or mountainous, desert area interspersed with sandy plains.

I am of the opinion that *R. lecontei* does occur in the Imperial Valley; I have had it from near the center of Borego Valley. However, no specimens or authentic records being at hand, it is, for the present, placed in Group "B".

C. c. mitchellii may occur in the basin. It is widespread in the Mohave, there is an authentic record on the west bank of the Colorado River at Picacho, and doubtful records from Seeley and Coyote Wells.

C. c. oreganus is in a rather different class from others of this group, being the only typically Upper Sonoran form contained therein. While present in Arizona, it is found only in Upper Sonoran and Transition areas. There appears to be no possible existing bridge between the Arizona and California ranges; the Arizona individuals may constitute a separate subspecies, for certain differences are noted.

With reference to Group "C," I have elsewhere stated that neither the gopher snake subspecies nor the king snakes intergrade in this area. (See page 49). There is probably a considerable territorial separation between the king snake ranges; the gopher snakes may overlap.

M. lateralis and *C. c. mormon* have both been reported from southeastern Arizona but I doubt the authenticity of these records. It is, I think, significant that both records are based on specimens taken many years ago at Fort Buchanan. Those familiar with collecting conditions in the days of the Indian wars and the railroad surveys state that there was always a possibility of an occasional shipment received from one locality, but collected in another, being credited to the first rather than the second.

As a group, the "D" species seem to be related to the Arizona forms via southern Utah or northern Arizona and thence southward, rather than straight across the desert basin; that is, there are indications, through variations within species in the case of several of this group, that the southern Utah specimens are intermediate between those from the coast and those from southern Arizona.

Groups "E" and "F," being restricted to single zones and without relatives on the opposite side of the range, require no comment.

If we regroup the snakes of the southern border, based on the direction from San Diego of the centers of range (which may or may not be the equivalent of center of dispersal), we have the following:

North	**East**	**South**
D. a. similis	*L. humilis*	*M. piceus*
C. c. mormon	*M. f. frenatus*	*P. decurtatus*
M. lateralis	*S. g. hexalepis*	*C. cinctus*
P. c. annectens	*A. e. occidentalis*	*C. ruber*
L. g. boylii	*P. c. deserticola*	
L. multicincta	*L. g. yumensis*	**San Diegan**
T. s. infernalis	*R. lecontei*	*L. r. roseofusca*
T. o. hammondii	*S. occipitalis*	*L. californiae*
T. o. elegans	*S. episcopa*	*T. eiseni*
C. c. oreganus	*H. ochrorhynchus*	*T. vandenburghi*
	T. marcianus	
	C. atrox	
	C. cerastes	
	C. c. mitchellii	

In the last column headed "San Diegan" I have placed those species which apparently reach their greatest abundance in the San Diegan subordinate faunal district.

In making these distributions I have been guided, not only by the subspecies under consideration, but likewise by the nearest related subspecies, particularly where the differentiation is not considerable. Thus *P. c. annectens* is obviously more closely related to *P. c. catenifer* than to *P. c. deserticola.* Similarly *D. a. similis* differs little from the other subspecies of *D. amabilis* to the north.

It will be noted at once that from the north have come the typically Upper Sonoran and Transition forms, while from the east, as might be expected, have emigrated those which prefer a Lower Sonoran habitat, or those, like *L. humilis, R. lecontei* and *H. ochrorhynchus,* which seem to be at home in either Sonoran zone.

I have shown *M. piceus, P. decurtatus* and *C. cinctus* in the South column, for while all three are found in Arizona as well, they seem to be more common, so far as we now know, in Lower California. *C. ruber* no doubt came from the south, since it does not occur in Arizona and does not range north of the San Diegan area.

The species listed in the last group include some entailing the most interesting of the problems of relationship in this area.

With the separation of *L. roseofusca* into two subspecies the typical, or coastal form is restricted exclusively to the San Diego district.

L. californiae is a species almost exclusively restricted to the San Diegan area, although a few specimens have been taken near Fresno in the San Joaquin Valley. The status of this species and its relationship with *L. g. boylii* continues to be a puzzle. Are these two forms, one of which has longitudinal stripes and the other transverse rings, really separate species, or merely two freely interbreeding varieties of the same species? Are the mixed specimens, having the characteristics of both forms, and which constitute about two per cent of the total of both, hybrids? Only the hatching of batches of eggs will be really pertinent on this point and thus far we have been unsuccessful in securing such material.

I can offer no important contribution to the solution of this problem based on the chronological and zonal tables, for it will be noted how closely the two resemble each other in habits and habitat. *L. g. boylii* does seem to range further down on the desert side of the mountains than *L. californiae* and, likewise, further into Lower California; it is well known also that the more common snake ranges further to the north. From these considerations separate species are indicated, the mixed specimens being considered hybrids.

It will be observed that I do not follow Blanchard[9] in the use of the trinomial for the California king snake. While the close relationship of *L. californiae* with *L. nitida* is not questioned, I would point out that, notwithstanding some rather extensive collecting at a number of Lower California points, as, for instance, San José and San Ignacio, no longitudinally striped king snake has yet been reported between the Cape region and a point but a few miles south of the American border. Thus a distance of about 800 miles, including considerable areas of a character probably unsuited to the king snake, intervene between the known ranges of the two forms, and it therefore appears that they should be considered separate species, using Blanchard's definition of subspecies.[10]

The range of *T. eiseni* may not center in the San Diegan region, but so few specimens have come to light from beyond the county limits that it is tentatively placed herein. We do not yet know whether its relationship is nearest the Cape or Arizona species.

Much the same statement can be made concerning *T. vandenburghi*. Ultimately it may be shown to be in territorial contact and intergrading with *T. lyrophanes*, either in Lower California, or in Arizona via the Mohave Desert and Utah. Most of the specimens available to date are from the San Diegan area.

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[9] 1921, p. 94.
[10] 1925, p. X.

In summary we note that, on the desert side of the mountains, we have a Lower Sonoran fauna which seems to have entered the territory largely from the eastward, although two species, *P. decurtatus* and *C. cinctus,* may have come from the south.

On the coastal side of the mountains we have more of an assortment, as the territory itself is, within narrow limits, a mixture of Upper Sonoran, Lower Sonoran and Transition. We have first a group of species of Upper Sonoran or Transition preferences which have entered the territory from the north. Next we have a group which prefers Lower Sonoran conditions; such species have either crossed the desert directly from the east or entered via the desert mountains of the Mohave. On reaching the coastal side of the Peninsula range they have not only occupied such Lower Sonoran areas as were available but have become more or less acclimated to Upper Sonoran conditions and so secured a wider range.

Lastly, we have a smaller group, whose affinities are more with the Cape region of Lower California, and these include the three species most localized and typical of the San Diegan area, *i. e., C. ruber, L. r. roseofusca* and *L. californiae.*

While touching the subject of problems of relationship such as that between *L. g. boylii* and *L. californiae,* it is deemed desirable to mention two others having to do with snakes of this area, upon which decisions are necessary in order to determine the nomenclature to be employed. The first is the proper name to use for the black whip snake, the second for the striped ground snake.

Van Denburgh[11] reached the conclusion that the black whip snake was but a melanistic phase of the red racer and, as the two forms occupy the same territory, a single species was indicated. Ortenburger,[12] with additional material, discussed the situation very fully and came to the conclusion that the black whip snake is a valid species, separate from the red racer. His reasons need not be here repeated; they are no doubt of great weight, but they fail to explain one phase of the situation, namely, the finding of what appear to be hybrids or intergrades, not only rather frequently in northern Lower California, but occasionally in parts of Arizona as well. As a result we have three possible courses none of which is entirely satisfactory:

1. We may consider the two forms as a single species. This is unsatisfactory because it does not explain why the two forms remain pure in some parts of their overlapping territories, or why the ranges are not co-extensive, for the red form occupies a large territory from which no black snake has ever been reported.

2. Consider the two as separate species. This fails to explain the intergrades.

3. Consider the two as separate subspecies. This is contrary to the

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[11] 1922, p. 669.
[12] 1928, p. 125.

usual definition of subspecies.[13] Also it fails to explain why the two forms have certain consistent differences besides that of color, as pointed out by Ortenburger, and why they do not intergrade in all areas.

On the whole I think it will be most logical, for the present, to follow Ortenburger and consider the species distinct. But the problem is not finally settled. A number of additional specimens have lately come to hand, and it is hoped that eventually this puzzling situation can be cleared up.

Almost the same predicament exists with reference to the ground snakes, *Sonora semiannulata* and *S. episcopa*. Ortenburger[14] has stated that a complete series of intergrades has been found at Ardmore, Okla., between the cross banded form (*semiannulata*) and the longitudinally striped or unicolor snakes (*episcopa*). Erwin[15] found the two forms together in Idaho but without intergrades. I have seen both forms, but no intergrades, from central Arizona; the locality data were not sufficiently definite to determine whether they were found together. From Imperial and San Diego Counties in California, and particularly from the Imperial Valley, I have seen at least twenty-five specimens. All were pure *episcopa*, and all distinctly striped, not unicolor, neither intergrades nor *semiannulata* specimens having yet come to light. The chances are therefore rather strong that the cross ringed form does not occur in this territory. Also in the western part of the range the two forms have differences in scutellation as well as pattern. So we have here the same alternatives considered under the black-red racer situation. To be consistent the same decision as that made in the racer problem should be adopted, and I have, therefore, decided to refer to *S. episcopa* in these notes as a valid species.

We finally come to the question which is so often asked: Where, in these two counties, are snakes most plentiful? If we depend entirely on Table 3 for the answer it would seem that the greatest density of snake population would be found in the coastal zone. But again we must refer to Table 4, showing the unequal effects of certain factors upon which the totals in Table 3 depend.

If we note from Fig. 2 the distribution of full width sections, which indicate maximum population for each species (there may be two or more equal maximums for a single species), we have the following:

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[13] The situation is not comparable to that which exists amongst the subspecies of *Crotalus confluentus*, for there intergradations take place successively over a circular route, until two quite different and non-intergrading subspecies occupy the same territory (See Klauber 1930a, p. 132).

I admit an inconsistency in the treatment of the garter snakes I have referred to *T. o. elegans* in this paper. There is something queer about these specimens, which only additional material will clear up. The garter snakes are so variable that opinions based on few specimens are valueless; in any case these mountain specimens are certainly not *hammondii*.

[14] Copeia No. 120, p. 79, 1923.

[15] Copeia No. 138, p. 6, 1925.

Coast	11
Inland Valleys and Mesas	12
Foothills	16
Mountains	4
Desert Foothills	2
Desert	4
Desert (irrigated)	6

This indicates that more species reach their maximum populations in the foothill zone than any other. Furthermore, we find that the particular species which have their maximums either exclusively in this zone, or share them with others, are species which are the most plentiful, such as *P. c. annectens, T. o. hammondii, C. c. oreganus, C. ruber,* etc. My conclusion is that the western slope foothill section, particularly the chaparral-granite areas between the 1200 and 3500 ft. contours, offers the best snake collecting field in these two counties, followed by the other two zones toward the coast. Next comes the desert foothill zone, then the desert, with the mountains last.

The desert always constitutes a great disappointment to the collector who tries the daylight, even in the spring, for snakes seem to be so scarce as to be virtually absent. But night collecting under favorable conditions, preferably along the road, will often yield many pleasant surprises.

RARITY OF REPTILES

(Tables 1 and 7).

One cannot discuss the zonal distribution of reptiles in a variable area such as the southern border of California without touching on the general subject of rarity. The question arises whether such forms are ever really rare in the sense that there is no center of population in which they are comparatively plentiful, or whether the term "rare" only means that they are infrequently discovered or are relatively scarce in collections. Could a species be rare and still survive, or is true rarity only found along the edge of the range of a species, or when such species is actually approaching extinction?

One might picture the permanence of a species as being comparable with the stake of a gambler at the roulette table. Even assuming that on the wheel there be no zero or double zero, and therefore that the chances are equal between the player and the bank, the latter must eventually win if it has a relatively inexhaustible capital compared to the former. Necessarily the player's reserve at any given time will fluctuate above and below a mean in a series of cycles, but let the cycle once run low enough to consume the player's reserve and he is wiped out beyond chance of recovery, for he cannot again resume play. So, in connection with the life of a species, it would seem that there must be cyclic fluctuations in the numbers of individuals resulting from variations in food supply, the prevalence of enemies, climatic changes and similar conditions which affect the race; but there must be a minimum margin below which the form cannot go without final extinction; that is, a point from which recovery is no longer possible. There must always be a reservoir of numbers to safeguard the species.

As we look back over the history of herpetological collecting in this area, we note a gradual decrease in the number of species considered rare, as additional knowledge and more intensive collecting have rendered our survey of the territory and the species contained therein more complete. For instance, 40 or 50 years ago when San Diego County was a relatively isolated and sparsely settled area, such localized forms as *C. ruber* and *L. californiae,* were represented by few specimens in collections and were therefore considered rare. It is now known, of course, that they are quite plentiful in this territory and thus we have two species which were considered rare only because of the inaccessibility of the area from which they came. The same must be true even today of some of the forms found in Lower California.

Again, we have the rarity which results from the particular habits or habitat of the form under consideration. Of this *T. eiseni* is a good example. Subsequent to Eisen's original specimens sent to the National Museum from Fresno in 1879, no additional specimens seem to have reached museums in the next twenty years, and as late as 1920 probably less than fifteen specimens had been reported. It is now known that this form is quite plentiful all through this area, but its secretive, subterranean habit, and its quickness when its concealment is discovered, have resulted in few specimens reaching herpetological collections.

Other examples of this form of rarity are *Xantusia vigilis* and *X. henshawi,* both of which were once thought to be extremely rare, but on the contrary are now known to be quite plentiful. Dr. J. Van Denburgh found an easy way to collect the former in 1894 when he discovered that they secreted themselves in broken yucca stems. Similarly in 1923, he and J. R. Slevin, working at Mountain Spring, found that *X. henshawi* could be taken in considerable numbers by prying off granite flakes, and in a single day collected several times the number which, in all previous years, had been brought to the museums of the world.

Another form of rarity must be that which conceals a moderately differentiated species behind a plentiful one when the two are found together. Thus, in the desert mountains of San Diego County, *Uta stansburiana hesperis,* or the subspecies *stejnegeri,* are the most common of lizards, and in the same areas occurs *U. microscutata,* unrecognized as being present in the United States until 1929.[16] Naturally in cataloguing a collection of utas from these areas, one might not be too careful in their identification; thus the rarer form, which is not particularly uncommon,

[16] Copeia No. 170, p. 16, 1929.

but is not conspicuously differentiated from the better known, would be filed in a collection with an incorrect identification.

Sometimes no effort is made to collect a very common form and another more unusual species interspersed with it thus escapes capture. This is the only way in which I can explain the discovery of *Bufo californicus* being delayed until Camp first described it in 1915, and the fact that only two specimens were known as recently as 1923. This species in many areas in San Diego County is extremely plentiful, and while it is true that the adults are rather secretive and not easily found, the juveniles occur in great numbers about many ponds and marshy areas in the spring, and may be collected in this season whenever desired. The early collectors must have seen these little toads, but probably ignored them on the supposition that they were the common *B. canagicus halophilus,* and the same may have been true of the few adults which reached collections.

The discovery of a subspecies is usually of a different nature from the examples above cited, for this is a matter of accumulating large numbers of specimens and noting consistent differences for separate geographical groups.

There is, no doubt, a true rarity where a species reaches the border of its range, either of the total area which it covers, or some local habitat zone. Thus, *M. piceus* is no doubt really rare in San Diego County, as it apparently barely enters the county from the south, although it seems to be quite plentiful near Ensenada, about 70 miles away. Similarly, *T. s. infernalis* is rare in northern San Diego County, and has never been taken along the southern border; but further to the north in other southern California areas it is known to be quite common. Even *P. decurtatus,* long believed to be one of the rarest species in California, is moderately common in the sandy areas of the desert, but this does not mean that it is easy to collect. In the daytime it may be located by turning over stones, as the first California specimen was found by Miss S. Atsatt,[17] but this is at best a tedious and uncertain procedure. At night, hunting with a flash light will discover an occasional specimen, but the pattern and coloration render it difficult to see. I think the paved highway at night affords the best means of collection; in this way I once found three specimens within a few miles of each other.

These considerations of species on the edge of their ranges (including biological island remnants), and habitat or habit difficulties, explain the ostensible rarity of every species of snake thus far reported from the southern border of California. None is known to be rare here which has not a more populous center elsewhere. *L. g. yumensis* and *C. cinctus,* of the first of which I have had but one, and of the second no California specimens, are merely range edge forms. I have had little access to the Colorado River valley where the king snake is found. *C. cinctus* seems

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[17] Copeia No. 96, p. 38, 1921.

to be quite common in the vicinity of San Ignacio, Lower California and probably in some Arizona localities as well.

It will take years of collecting to determine if any of these species is really migrating; whether advancing, retreating or stationary; and these must be years of intensive collecting, since desultory investigations will hardly prove the point. Naturally the definite limits of the range of a species are never known with accuracy, unless the area be intensively investigated. We do not yet know whether *T. s. infernalis* is slowly coming southward; in view of its discovery in the county, first in the San Luis Rey Valley, and then in the more southerly San Dieguito watershed, such is indicated but not proved. But if, after a number of years of continuous collecting, it is finally found in the watershed of the San Diego River which has long been quite thoroughly collected, the inference may be drawn that the progression is not a matter of chance in collecting, but that the species is really moving toward the south.

In the case of some species, an occasional aberrant specimen will be discovered which seems to be entirely beyond the limits of the normal range, but may be explained by other peculiarities of the locality. Thus, the finding of a specimen of *L. multicincta* at Dulzura indicates a final remnant of the mountain form in that area, rather than a stray from its general range, for certain mountain botanical forms are likewise present there.

Some of these wanderers seem to be beyond explanation until further collecting is done. Thus, a single specimen of *Sonora occipitalis* in the National Museum from the San Diego River near Santee has never been duplicated on the coastal side of the mountains. Similarly, *Ensatina croceater eschscholtzii* is found in considerable numbers in the Sequoia Mine near Dulzura, yet has never been taken elsewhere within a hundred miles, so far as I am aware. Are these strays from the normal range? May a few individuals have been planted at this mine in some material or equipment from another area? Are they scouts pushing out into new territory, or remnants left by a receding tide?

Inaccurate locality records occasionally are the solutions of these problems, and one is never safe in placing too much importance on these wanderers until additional fully authenticated individuals have come to light. Such has been the case, for instance, in the Sequoia Mine salamanders, for a collector sent out to verify the locality had no difficulty in securing additional specimens.

The biological island forms must invariably represent the remains of a more extensive range; an advancing body must be in touch with its center of dispersal, but a declining population will be the more readily isolated, by changing habitat conditions, into a discontinuous series of groups.

I need hardly point out these notes on rarity are addressed exclusively to reptiles and amphibians. I do not know whether they are in any way applicable to other vertebrates.

PATTERN AND COLOR VARIATIONS

This paper, being essentially a statistical study, makes no attempt at complete descriptions of the several forms found in the California border countries. However, if we undertake a schedule containing a brief summary of the colors and patterns of the species, we find that some interesting conclusions may be drawn.

The following table affords a rather rough characterization of such colors and patterns. Naturally, only the most usual or common form of each species in this territory can be described so briefly; some species are quite variable, with color and pattern modifications not in accordance with this table.

It will be observed that the species may be quite definitely segregated into five pattern groups; i. e., unicolor, striped, ringed, blotched and mottled (nondescript).

A—UNICOLOR

L. humilis: Silver-brown with a lighter lacework of scale borders.
D. a. similis: Olive-green; head darker; an orange cross-ring on the neck.
C. c. mormon:Olive-green or olive-brown (the young are blotched).
M. f. frenatus: Pink or tan. The head and neck are usually darker, being often dark brown or black, with or without light cross-rings.
M. piceus: Black.
T. o. hammondii: Olive-brown. Indefinite lateral yellow stripes are often present.
T. eiseni: Black head, faint white ring on the neck, pink-brown body.

B—LONGITUDINAL STRIPES

M. lateralis:Dark brown (almost black) with a thin yellow or white line down each side.
S. g. hexalepis: A tan mid-dorsal stripe on a black or gray-brown ground color.
L. californiae: A yellow mid-dorsal stripe on a chocolate brown ground color.
S. episcopa: A red mid-dorsal stripe on a light brown ground color.
T. s. infernalis: A yellow or blue mid-dorsal line on a black or red spotted ground color. Secondary yellow stripes are in evidence on the sides.
T. o. elegans: A mid-dorsal yellow or orange stripe on a black or dark brown ground color.
T. marcianus: A light gray mid-dorsal stripe on a gray-brown (mottled with black) ground color.

C—TRANSVERSE RINGS

L. g. boylii: About 25 to 40 white or yellow rings alternating with dark brown. (The numbers indicate bands exclusive of those on the tail).

L. g. yumensis: About 35 light brown rings alternating with dark brown.

L. multicincta: Alternating white and black rings (about 25 to 45 of each), the black being split with complete or half bands of brilliant red.

R. lecontei: Alternating red and black half-rings to the number of 20 to 35 on a white or cream background. Both red and black are sprinkled with white scales. The red may be absent.

S. occipitalis: Black or dark brown rings or half-rings numbering from 20 to 40 on a cream or white background. Between the dark rings there is usually a secondary series of red or orange bands.

C. cinctus: About 25 black or dark brown rings (or half-rings) on a pinkish ground color.

D—BLOTCHES

P. decurtatus: A dorsal series of from 30 to 47 rectangular brown blotches on a cream or pink ground color.

A. e. occidentalis: A dorsal series of about 75 dark brown blotches (rectangular or elliptical) on a tan or light brown ground.

P. c. annectens: A dorsal series of about 75 black or dark brown blotches, highly irregular in shape and often confluent, on a brown or yellow ground color.

P. c. deserticola: A dorsal series of about 55 brown or red-brown blotches on a yellow or tan ground color.

H. ochrorhynchus: A series of irregular circular dark brown blotches on a light brown ground color. A large dark brown spot on each side of the neck.

T. vandenburghi: A dorsal series of from 30 to 42 hexagonal chocolate brown blotches on a light brown background. The blotches are usually split transversely by light brown bands.

C. atrox: A dorsal series of from 30 to 40 punctated dark brown diamonds with light edges on a gray or tan ground color. The tail is ringed with alternate black and ash-gray.

C. cerastes: A dorsal series of from 30 to 45 square dark brown blotches on a tan background.

C. ruber: A dorsal series of about 35 red-brown diamonds with pink or straw edges. The tail is ringed with alternate black and ash-gray.

C. c. mitchellii: A dorsal series of from 27 to 40 highly irregular and indefinitely outlined brown or gray-brown blotches on a gray or pinkish ground color.

C. c. oreganus: A dorsal series of from 29 to 43 black or dark brown hexagons on a mottled gray background. The blotches degenerate into rings posteriorly.

E—MOTTLED

L. r. roseofusca: An irregular pattern of dark red-brown on a leaden-gray ground. The pattern may approach a trio of jagged, ill defined, longitudinal stripes, or the two colors may blend (particularly in the adults) to produce a unicolor effect.

That there is a definite interrelation between body form, pattern and degree of activity is indicated by the following classification:

Active			Moderate			Slow		
C. c. mormon	U	.26	*D. a. similis*	U	.17	*L. humilis*	U	.05
M. f. frenatus	U	.25	*L. californiae*	S	.13	*C. cinctus*	R	.12
M. piceus	U	.25	*S. episcopa*	S	.19	*P. decurtatus*	B	.11
T. eiseni	U	.23	*R. lecontei*	R	.13	*C. atrox*	B	.07
T. o. hammondii	U	.22	*L. g. boylii*	R	.13	*C. cerastes*	B	.07
M. lateralis	S	.30	*L. g. yumensis*	R	.13	*C. ruber*	B	.06
S. g. hexalepis	S	.22	*L. multicincta*	R	.15	*C. c. mitchellii*	B	.07
T. s. infernalis	S	.24	*S. occipitalis*	B	.18	*C. c. oreganus*	B	.07
T. o. elegans	S	.22	*A. e. occidentalis*	B	.13	*L. r. roseofusca*	M	.12
T. marcianus	S	.22	*P. c. annectens*	B	.15			
			P. c. deserticola	B	.13			
			T. vandenburghi	B	.15			
			H. ochrorhynchus	B	.15			

In this schedule the letters indicate the pattern (by the initial letter of the pattern group), while the figures show the average ratio of tail length to total body length. An arbitrary division has been made at tail ratios .20 and .12. Having done this capriciously, it is found that the species have been quite fairly divided into three groups; an active, a moderate and a slow group, this arbitrary segregation having resulted quite as accurately as would an individual consideration of each form.

Into the first column have fallen the speedy racers, the garters, the racer-like patch-nose and *T. eiseni,* by far the most active of the local subterranean species. The last group includes the heavy bodied rattlers, the boa, worm snake and the two slowest desert forms.

In showing that the slim, long-tailed snakes are faster than the short-tailed species, we are only emphasizing a self-evident fact, namely that slimness and a relatively long tail are aids to progression. But the relation between pattern and progression may be more unexpected. Summarizing this relationship from the previous schedule, we have:

	Active	Moderate	Slow
Unicolor	5	1	1
Striped	5	2	
Ringed		5	1
Blotched		5	6
Mottled			1
	10	13	9

Unquestionably, the fast snakes, that is, those whose defense is primarily speed, are the snakes which are usually without discrete markings, while the slow forms are camouflaged by broken color areas.

The effect of color continuity and its value in escape can be best observed by attempting to follow with the eye such a snake as *M. lateralis* traveling amongst brush or rocks. Try as you will to follow the head, your eye will become anchored to what appears to be a stationary section of the body, in a striking contrast of black with the two bright yellow stripes. But this stationary section is in reality a flowing body; curiously, without apparent longitudinal motion, it seems to diminish in width, the tail flashes by and it has vanished, before the eye can be advanced to another section.

Similarly, in hunting with a flashlight on the desert at night it is curious to note how the fallen dry twigs, with their alternating branch points, have a spotted effect, so that many look like blotched snakes. Amongst these, the distinctly marked *S. occipitalis* and *P. decurtatus* are very difficult to see. The night snakes seem to run rather strongly to rings and blotches as shown by *T. vandenburghi, H. ochrorhynchus, A. e. occidentalis, C. cerastes,* etc. *T. eiseni* and *S. episcopa* are exceptions to this rule.

COLOR VARIATION WITH HABITAT

Another type of color study relates to variation within species. Whatever be the cause and the mechanism whereby desert reptiles achieve their light colors, the fact remains that these forms usually are lighter than their prototypes from more humid regions. The obvious reason may be presumed to lie in the benefits of protective coloration, or in the advantages of greater reflecting power and therefore reduced internal heat absorption. However, the explanation may be by no means so simple; the fact remains that such color variations do exist and are evident to a marked degree in the territory along the southern border of California.

Aside from sexual differences, color changes may be of two general kinds: First, temporary changes in the shade or color of an individual, resulting from variations in temperature, light, humidity, nervous excitement, or such causes; and secondly, zonal or habitat variations within a species, genus or larger group.

Well known examples of the first form are the marked and beautiful color changes in *Hyla regilla* and *Anolis carolinensis.* Of our local lizards *Xantusia henshawi* and the several species of *Phrynosoma* have this power to a conspicuous degree.

Amongst the snakes this power is by no means as marked and is, in fact, doubted by some, although my experience leads me to believe it unquestionably exists in certain forms to the extent of permitting changes in shade, if not in color. *Crotalus cerastes* and *C. confluentus oreganus* are the two local forms having this power most definitely; in these it has been observed on many occasions.

The second form of color variation, that is, a permanent change in a group rather than an ephemeral one in an individual, is well illustrated by several species which inhabit our two border counties.

On the desert, light colored lizards (some almost white) are so much in the majority as to attract immediate attention. *Dipsosaurus dorsalis dorsalis, Callisaurus ventralis gabbii* and *Uma notata* are the most conspicuous, for none of our coast or mountain species are as light as these. Equally common is *Uta stansburiana stejnegeri;* this latter form is lighter than the coast subspecies, *U. s. hesperis,* although both possess to some extent the power of individual color change, which renders a comparison between subspecies rather inconclusive. The coast horned toad, *P. b. blainvillii* is darker than the desert forms, *P. m'callii* and *P. platyrhinos. Crotaphytus wislizenii* as found on the desert, is lighter than the few individuals which stray to the coastal side of the ridge. *Cnemidophorus tessellatus stejnegeri* of the coast is darker and more distinctly marked than its prototype, *C. t. tessellatus* of the desert.

The shrub inhabiting species, *Uta graciosa* and *Sceloporus magister,* are not especially light, although the former possessess the property of individual color change to a considerable degree.

It may be pointed out that the typical desert foothill, rock inhabiting forms, *Sauromalus obesus, Uta mearnsi, Uta microscutata* and *Sceloporus orcutti,* are conspicuously dark forms rather than light; this is an argument in favor of the protective coloration rather than the radiation theory as a basis of beneficial selection, for the rocks are hot but usually dark in color. However, it must be remembered that the foothill forms are less often out in the heat of the summer day, as compared with such forms as *Dipsosaurus, Callisaurus* and *Uma,* and also, in the boulder masses, have more opportunity for shade.

Coming to the snakes, amongst which individual color control is probably limited to a few forms, it will be of interest to present the results of our survey in scheduled form, listing in order the 32 species and subspecies known from the area under consideration, to see whether zonal color variations are sufficiently definite and constant to be more than accidental.

L. humilis: The color difference is so strong between the coast and desert forms that a separate subspecies is indicated. The coast form has (when preserved) a deep brown back and a light ventral surface while the desert border specimens have little difference in color between the two surfaces.

L. r. roseofusca: There is a quite definite difference in the species between the coast and desert foothill forms, particularly those of the latter from the lower altitudes. In these, the stripes (which reach their maximum prominence in *L. trivirgata*) are irregularly in evidence in brown against a lighter background of gray. The same stripes are occasionally to be seen in the coast specimens, but here the gray is so dark that there is little or no contrast. In the desert edge forms, the contrast is sufficient so that the stripes are to be clearly seen. It is not to be understood that this desert form, as it occurs in the eastern edge of the San Diego County, has stripes with the even and regular longitudinal edges of *trivirgata,* or the subspecies *gracia* from Arizona and the Mohave Desert, but there is an approach toward the latter.

D. a. similis: This form does not cross the ridge of the mountains, so far as available material indicates, and therefore no conclusions as to color changes are to be deduced.

C. c. mormon: Only one specimen is available from beyond the divide, and this is from Boulevard, only a short distance within the desert foothill zone. Here no color variation is to be expected and none is found.

M. f. frenatus: This highly variable subspecies is a difficult one upon which to draw conclusions for several reasons, amongst which may be mentioned the variability itself, not only of color but of pattern, the rapid fading of the red or pink, which takes place even with the most careful preservation methods, and lastly, the uncertain relationship with *piceus.* Comparing a considerable number of coastal and desert specimens we find the following differences: The western specimens have more black in the pattern; excluding those which have some *piceus* characteristics, the pure *frenatus* specimens have considerably more black on the head and neck when from western San Diego County and are of a deeper red than the desert representatives. Those from the desert foothills are intermediate, but more closely resemble the coast than the desert specimens. Thus the desert specimens do average lighter in color.

M. piceus: This species enters the southern border counties only in one zone, and but two specimens are known; therefore no conclusions may be drawn on color variations.

M. lateralis: This snake, characteristic of the coastal areas, crosses the ridge but a short distance into desert foothill territory. No color modifications are evident, nor could they be expected.

S. g. hexalepis: In this form there is a definite change from the coast to the desert, specimens from the latter area being considerably lighter. Not only are the colors lighter in the eastern individuals, both in ground color and brown longitudinal stripes, but the width of the light dorsal line is increased and the secondary lines on the sides are more pronounced, thus hightening the contrast by increasing the light and decreasing the dark areas. An occasional lighter specimen is found amongst the coastal individuals, but the average difference is extensive.

P. decurtatus: This is exclusively a Lower Sonoran form.

A. e. occidentalis: In this subspecies a color change from desert to coast is quite definite and fairly uniform. It takes the form, not only of a general darkening of the ground color, particularly on the sides, but also there is a longitudinal widening and darkening of the dorsal blotches. Specimens from such desert foothill localities as San Felipe, La Puerta and Mountain Spring are intermediate between the coastal and the desert basin specimens.

P. c. annectens-deserticola: From the first I have naturally been desirous of determining the area of intergradation of these two forms, if such an area exists. Therefore, all border specimens coming into my hands have been examined with care, and I have been surprised to find that there is apparently no intergradation. I do not know, as yet, whether the ranges of the two subspecies overlap, but at least it is evident that they closely approach each other. I have had specimens of *annectens* from a number of desert foothill localities, including Stuart Spring, Yaqui Well, La Puerta, Carrizo, Jacumba and Mountain Spring. Strange as it may seem, these specimens appear to average rather darker and with a higher number of dorsal blotches than is usual in *annectens;* thus showing a tendency away from, rather than toward, *deserticola.* It is true that an occasional specimen, light in color and with few spots, will come to hand, which will fall between *deserticola* and *annectens* according to the key, but these are quite as likely to be found in the coastal zone as elsewhere and seem to be conspicuous by their absence in the desert foothill area. A single typical *deserticola* has been taken within San Diego County at Carrizo and further eastward the subspecies becomes relatively common. Here it is quite uniform in coloration and distinct from *annectens.* Thus we have in the place of a single changing form, two separate subspecies which have not been shown to intergrade in this region, although they may elsewhere, or through a third member of the species.

L. californiae: Although this king snake has been taken as far east as Mountain Spring, it seems to be rather unusual beyond the ridge and absent from the desert proper. Within its range the color variation is extensive. The brown dorsal stripes change in depth of tone and, in addition, the yellow or white on the sides may terminate on the ventrals or extend high up on the sides in the form of spots of light color in the center of each scale. Also the mid-dorsal line varies in width. Thus, there are light and dark California kings, but these variations seem to be quite independent of the zone in which the specimen is found.

L. g. boylii-yumensis: Variations in color in this species may be produced by modifications in shade of either the light (yellow or white) or dark (brown) color elements, or by the relative widths of the light and dark rings. Again, each white scale may contain a basal brown spot. A considerable degree of all these changes is to be found in the San Diego County specimens of *boylii,* but the variations appear to be without regard to zone. Although this subspecies ranges farther eastward than the California king snake, and specimens have been taken at the bottom of the foothills on the edge of the desert basin, even the most easterly of the specimens which have yet come to hand show no tendency toward *yumensis.* I rather doubt the present intergradation of *boylii* and *yumensis* across the territory included in this survey; it may take place to the northeast where *boylii* occurs in Arizona. But in California *boylii* has not been reported beyond the base of the Peninsula Range, while *yumensis* on its part, except for one specimen reported by Van Denburgh from near Coachella,[18] has never been taken more than a few miles from the Colorado River, and never beyond the inundated, or irrigated, section. Between these two lies a desert area in which I doubt *Lampropeltis* could exist.

Thus we have, in this genus, the same condition found in *Pituophis,* except that the present separation of the subspecies is much wider. As to color, we have here a case in which the desert form is decidedly darker than the coastal.

L. multicincta: This form is too restricted in its range to come within the scope of this color variation survey.

R. lecontei: Specimens of this snake from the desert edge (I have seen none from the central desert basin) are definitely lighter than the western slope individuals. This change in general appearance is not secured by reduction in the width (along the body) of the primary black rings, but rather by a clearing up of the spaces between, which are left quite white and immaculate. Not only does the usual red of the coastal specimens practically disappear in these spaces, but likewise the black dots, which tend to stray over the borders into the light rings, are kept out of these areas in the desert specimens, so that a general pattern not greatly different from *L. g. boylii* is produced.

These remarks apply only to the snakes found on the edge of the Colorado Desert; some, which I have seen from the edge of the Mohave, differed less in color from the coast form.

S. occipitalis: This form, except for a single doubtful specimen, has never been taken outside of the Lower Sonoran zone and is almost exclusively a desert dweller. Color changes of the type under discussion are therefore not to be expected. Nevertheless, it is exceedingly variable in details of color and pattern, although fundamentally remaining always a ringed snake. The dark rings may be black or brown, and may terminate on the sides, or completely encircle the body. Sometimes they are complete on a part of the body only. The ground color may be white, yellow or cream. The dorsal interspaces may, or may not, contain a secondary series of scarlet or orange rings or blotches. I formerly thought the absence of these reddish rings indicated faded specimens, but have since seen numbers of live specimens in which there were no secondary red rings. The popular name of "Tricolor Ground Snake" is therefore untenable for this form; I think "Shovel-nosed Ground Snake" is to be preferred.

Sonora episcopa: The snakes of the Imperial Valley and adjacent desert seem to be always of the *episcopa* rather than the *semiannulata* form. As they occur only in a single zone, no color modifications varying

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[18] Van Denburgh, 1922, p. 760. Through the courtesy of Mr. J. R. Slevin, I recently had the opportunity of examining the specimen on which this locality was based. It was taken at the foot of the Santa Rosa Mts. opposite Coachella. While the bases of some scales are marked with brown, I do not find this more prevalent than in a number of specimens from the coastal side of the divide. I would therefore consider it *boylii,* the differences from typical *yumensis* being quite marked.

with zones are to be expected.

C. cinctus: As far as I am aware, but one specimen of this form has ever been taken in this territory.

H. ochrorhynchus: I have had none of this species from Imperial County, although it may be expected there in rocky areas. Specimens from such desert edge localities as Yaqui Well, Box Canyon and The Narrows, show the Lower Sonoran individuals to be noticeably lighter than those from the coast. The color difference is mostly in the ground color, which, in the eastern specimens, is lighter, tending toward tan rather than brown. As a result the primary brown blotches of the desert specimens are in sharper contrast, and more clearly defined, than in the others.

T. s. infernalis: Found only on the coast side of the mountains, it need not be considered here.

T. o. hammondii: Although this species is found at certain isolated water holes and springs at the edge of the desert (as for instance at Carrizo and Sentenac) no consistent difference from coastal individuals is evident. This might well be due to its restricting its activities to a particular habitat, reminiscent of the usual conditions to which it is accustomed elsewhere. As it spends much of its time in the water, the full effect of the desert could hardly be expected.

T. o. elegans: Found only in a restricted range.

T. marcianus: Found only in the desert basin.

T. eiseni: No specimens are available from the desert proper, but from such semi-desert localities in the foothills as Yaqui Well and La Puerta, specimens are definitely lighter than those from the coast side of the mountains. The dorsal color becomes less brown and more tan. The ventral red seems unchanged in tone, but engages a narrower strip of the ventral plates.

T. vandenburghi: Specimens from the foot of Mountain Spring grade and The Narrows, both of which are just within the true desert area, are lighter, grayer and with more sharply defined dorsal blotches than are the Upper Sonoran specimens. The same is true of specimens seen from near Palm Springs, Riverside County, and Red Rock Canyon, Kern County. In this variation the desert forms show a tendency toward *T. lyrophanes*.

C. atrox: Although this species ascends to considerable altitudes in some parts of its range, in this region it seems to be restricted entirely to the lower levels of the basin; it is entirely Lower Sonoran and, consequently, without the type of color change into which we are inquiring.[10]

C. cerastes: This also is exclusively a desert form.

C. ruber: This snake exhibits a rather marked difference in the color of its desert foothill representatives as compared with the coastal individuals. In the former the ground color is lighter; the bordering scales are

[10] Klauber, 1930, p. 17.

white rather than straw, and the lateral series of blotches are smaller, thus rendering the general color lighter and brighter.[20]

C. c. mitchellii: Of this highly variable form I have had several specimens from the lower reaches of the desert foothills and the edge of the basin. These show a softer and milder coloration, with less distinct blotches than those from the higher altitudes. The color change continues on into Arizona, where still lighter specimens are to be found.

C. c. oreganus: Few specimens from the desert foothills have been available to me; one lately taken at San Felipe was definitely lighter than the coastal specimens both in blotches and ground color. Others from La Puerta and Mountain Spring showed the same condition. In the lower end of the San Joaquin Valley there is to be found a decidedly lighter form than that of the adjacent mountains.

Summarizing the variations of color with zones, we have the following: Of the thirty-two forms found within the two border counties, sixteen range from the coast across the mountains and far enough down on the desert side to come in contact with such typically desert forms as *C. cerastes* and *S. occipitalis* and to experience truly desert conditions. Of these sixteen, twelve, or 75 per cent are definitely known to become modified to a lighter color under desert influence. These are:

L. humilis	*H. ochrorhynchus*
L. r. roseofusca	*T. eiseni*
M. f. frenatus	*T. vandenburghi*
S. g. hexalepis	*C. ruber*
A. e. occidentalis	*C. c. mitchellii*
R. lecontei	*C. c. oreganus*

Of the other four, one probably does not go far enough; *L. californiae* has been taken only at Mountain Spring, and I think it significant that F. Stephens in his long experience of collecting at La Puerta, failed to find it there. If we eliminate this, the positive percentage becomes 80.

The other three are exceptions with modifying circumstances. *T. o. hammondii* manufactures its own habitat conditions by restricting its operations entirely to water holes. *P. c. annectens* is represented on the desert by a lighter subspecies, *P. c. deserticola*, with which, however, it apparently does not intergrade in this area (if it did it would join the majority). *L. g. boylii* is the most peculiar of all. Not only does it fail to change as it approaches the desert, but it is represented (at least on the other side of the basin) by a *darker* subspecies with which it may intergrade at some other point of contact.

In the species which are subject to color modification, it is noted that the change is usually accomplished by lightening and clearing the ground color, rather than by a lighter tone of the marks consituting the pattern.

Of the species which are entirely Lower Sonoran, and therefore

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[20] Klauber, 1930 c, Plate 4.

without possibility of the type of color modification which we have discussed, it may be noted that a majority are light in color. *P. decurtatus, S. occipitalis, C. cinctus* and *C. cerastes,* with large areas of white, cream or sandy ground-color, are conspicuously lighter than almost any species restricted to Upper Sonoran or Transition areas.

SNAKE DESTRUCTION BY AUTOMOBILES

(Tables 5 to 7).

No one who is interested in natural history, and travels to any extent upon our highways and secondary roads, can have failed to observe the large numbers of animals which are destroyed, either wilfully, or accidentally, by motorists. This does not refer to the obvious effect that the automobile has had upon the activities of the sportsman by enormously increasing his range, but to the animals which are unfortunately destroyed by the car itself upon the highway. Some statistics have already been published upon this subject,[21] but I do not believe that there has yet appeared an interpretation of the results of such observations in terms of the habitats and ranges of the species observed, nor a discussion of the effect of the automobile upon the faunal investigation of a limited area.

With reference to my own observations, the detailed statistics of frequency of occurrence have been restricted entirely to snakes. I have observed and recorded lizards and amphibians merely to increase my collection of locality and habitat records.

In general, it has been my belief that mammals are the principal sufferers, possibly not on a basis of relative population, but at least in total quantity of individuals destroyed upon the highway. Rabbits of several forms, including jack rabbits and cottontails, ground squirrels and the various species of rats and mice are certainly to be found in greater profusion upon our roads than snakes. Larger animals are not infrequent casualties. Some dead birds are seen, but by no means approaching the mammals in numbers. Amphibians, particularly toads, are in some areas to be found in relatively large numbers, especially near irrigated fields or after rainstorms. Upon one occasion along a broad suburban boulevard in the vicinity of San Diego, so many adult toads were crushed by automobiles on the night of the first rain of the wet season in October, as to cause newspaper comment; and on the following night, the rain continuing, large numbers of *Bufo canagicus halophilus,* and *Scaphiopus hammondii,* together with a few *Hyla regilla* were collected, especially along the curb, over which they seemed able to progress with difficulty. This migration appeared to have no counterpart in subsequent years, for some unknown reason, as investigations on the first rainy night of two successive seasons, under what appeared to be similar conditions, disclosed either no specimens or very few.

Even in the day time is has been noted during rain storms that toads,

[21] Stoner, 1925, 1929; Grant, 1926; Flint, 1926; White, 1927; Gander, 1927; Robinson, 1930; Conant, 1930.

especially *Scaphiopus hammondii,* unexpectedly appear in relatively dry areas, and at such times casualties from autos are many.

Lizards, because of their high degree of activity, seem to suffer less than other animals from automobile destruction, especially having in mind the great numbers in which they are present in some localities. Although seen in profusion scampering across the roads, dead specimens are infrequently found. This may be somewhat qualified by stating that, on the desert, their curiosity often gets the better of them, and they stop to observe an on-coming car, this being true especially of *Callisaurus ventralis. Uma notata* and *Crotaphytus wislizenii. Coleonyx variegatus, Sauromalus obesus* and the horned toads also suffer somewhat, the first particularly at night. In the coastal area *Gerrhonotus* is found run over more frequently than any other lizard, although horned toads are occasionally discovered.

Desert tortoises often travel along the deep ruts which are to be expected on unsurfaced roads, and thus are crushed in numbers, notwithstanding the light traffic.

Obviously, the destruction of animals by automobiles must depend upon the relative coincidence of the animals and the motor cars. There are urban areas where traffic density is exceedingly heavy, yet where a dead snake will seldom be found because of the rareness of snakes. On the other hand, in some foothill areas along side roads, snakes must be relatively numerous, as is shown by the number of crossing tracks, yet on such roads dead specimens may be almost absent because of the lack of autos, their reduced speed by reason of the character of the road, or both. In order to permit comparisons with other areas, it may be stated that San Diego County with a population of 209,487 (1930), of which approximately 85 per cent is urban, has 74,430 registered motor cars and 2950 trucks, a total of 77,380. In addition, large numbers of cars visit the county over the week-ends from the Los Angeles area, both in summer and winter, and still further numbers (about 60,000 per annum) come in from other states. Traffic density on the most traveled interurban highways varies from 3000 to 10,000 cars per day on the heaviest days over holiday week-ends, but is normally much less. In contrast, on some of the remote roads in the mountains and desert, hardly a car a day may pass. San Diego County has 360 miles of primary (paved) and 2400 miles of secondary highway, outside of urban communities, the zonal distribution of which is shown in Table 4. This will serve as a general picture of the automobile traffic in its relation to wild life in this county.

The frequency with which animals are discovered dead upon the road depends, not only upon the actual number so destroyed, but likewise upon the length of time which the remains continue in evidence, and this in turn is contingent upon a number of factors. Referring primarily to herpetological specimens, it may be noted that amphibians disappear very quickly after a rain storm. On an early morning trip to Riverside, approximately 120 miles, during a heavy rain, large numbers of toads were noted along the way which had been run over by previous machines. A business engagement prevented stopping for records or identifications, it being expected that specimens and localities could be checked on the return trip in the afternoon. But by that time, the weather having cleared, practically none of the dead specimens remained. Lizards also, particularly the smaller species, seem to be quickly dessicated and ground into bits, or blown away. Snakes, however, appear to be more lasting. Unless they are taken off the road when fresh by buzzards, crows, etc. (as has been observed upon occasion), they will probably endure for several days at least. In extremely heavy traffic they may become so worn and dried as to be blown off the road; in other cases, particularly where an asphalt covering has been softened by heat, they may be pressed into the surface and remain for weeks. On unsurfaced roads specimens may be ground into the earth and thus disappear; on the other hand they sometimes last for long periods, merely because of lack of traffic. Once having become thoroughly dried and no longer of interest to scavenging mammals, birds or insects, specimens are likely to endure for some time.

Not all of the specimens fatally injured die on the highway. On two occasions I observed large gopher snakes run over, once on an earth road and once on pavement, and saw the victims struggle to the side and disappear in the grass or brush, almost certainly to succumb within a short time. No doubt many tragedies of this kind occur, no telltale results being left upon the highway.

It is probable, on account of the involuntary movements of a snake's body after it has been fatally injured, that an exaggerated idea has become widespread that snakes are difficult to kill. Our experience in the reptile house of the Zoological Society leads us to believe that they are relatively delicate animals, and often succumb to rather slight injuries. On the other hand, I have secured two rattlesnakes which had unquestionably been "killed" at one time, but had made a complete recovery. The head of each showed a large scar, while others were noted at mid-body; the rattles had been completely cut off, thus rendering the evidence conclusive that the damage had been done by man. All of these scars had healed and the snakes appeared to be in normal condition when captured.

In an area where one is relatively familiar with the character of the fauna, identifications may be quite easily and accurately made on badly deteriorated specimens, or even parts of specimens. Some will have become so thoroughly dried they cannot be identified in the field, but color and pattern can be brought out by soaking the remains in water.

My own experience in pointing out snakes on the highway to fellow occupants of the front seat, leads me to believe that most of the destruction of snakes or other wild life is quite unpremeditated. People do not ordinarily watch the road with sufficient care to see a snake of moderate size, or any of the less conspicuous species, at least in time to prevent its being run over. Occasionally, however, one hears a driver boasting of having run over a large snake, usually of course, described as a rattler, but in all probability having been either a gopher snake, a king snake or some other harmless and useful species. Incidentally, it might be stated that some persons endeavor to run over rattlers, while others are afraid to do so on account of reports that snakes so run over may be thrown into the machine. It is difficult to see how this could be accomplished, with the usual automobile fenders; however, such occurrences were undoubtedly authentic with the slower moving, unprotected wheels of the horse and buggy days.

Actual occurrences of the intentional running over of harmless snakes have been noted from time to time. For instance, on an unsurfaced road bordering a vineyard, it was clearly evident from the tracks that a traveler had turned deliberately off to the side of the road to run over a large gopher snake. By so doing he was certainly not befriending the adjacent rancher.

One soon becomes accustomed, in driving, to be on the lookout for specimens, and, as is the case in the field, a certain skill in locating them is developed with practice. For this reason it is believed that comparatively few specimens are missed; however, the exact number cannot of course be known. It will be observed from Table 5 that species as small as ring-necks and worm snakes are found. It is true that occasionally, when dismounting to identify one snake, a second will be unexpectedly found nearby, which indicates that some must be overlooked. Where specimens have been found together they were usually not of the same species, so giving no indication of traveling in pairs.

There are certain times when, unfortunately, it is impossible either to stop or identify a snake. Sometimes identification is prevented by the necessity of maintaining business engagements; at other times it is impossible to stop on account of the condition of the road or the traffic, as, for instance, on narrow mountain grades or on blind curves. Again, when one has just passed a car going in the same direction at a high rate of speed, often after a dusty battle with a road hog, it is obviously impossible to stop and check a dead snake. As will be observed from Table 5, records have been kept of dead snakes of which identification was not made, to improve the accuracy of the snake—mileage ratio, as further developed in Table 6.

The chance of a snake's escaping traffic on the highway depends upon a number of factors; the character and size of the snake, the swiftness of its normal movements, the density of traffic, the quality of the road surface, all have an important bearing upon the result. Under some circumstances, it must be evident that no snake crossing a paved road can possibly escape, the mortality being 100 per cent. I was once returning on a heavily traveled highway in the Sunday afternoon traffic, and noted a large *R. lecontei* just entering the pavement. This snake was run over by five cars before I could bring my own machine to a standstill at the roadside.

Under certain circumstances snakes prefer to sun themselves in the road, particularly in spring; for instance on the desert they seem to appreciate the surfaced highways in the early months of the year. At other times they apparently shun the highways, especially when the traffic is dense enough to cause sufficient noise to frighten them. Surfaced roads, having a lubricating oil coating from passing cars, do not seem to be pleasant to the snakes; it has been observed that a freshly oiled berm is quite likely to keep them off the road entirely for a time. A curb by the roadside which seemingly snakes might climb with ease, often causes their crawling along the road, instead of taking the shortest means of egress. The same situation effects tortoises and toads.

The chance of a snake escaping is, of course, seriously interferred with upon surfaced roads when smooth or oily. Under such circumstances their most violent efforts to escape only produce a surprisingly slow actual progression; occasionally they hardly get forward at all. This no doubt causes heavy casualties amongst snakes as compared with other animals having more effective means of traction.

I have had it in mind to make studies of the time required by snakes to cross roads of different types, and likewise to make dynamometer tests on the tractive efforts of snakes on different surfaces, but thus far have had no opportunity to do so. Dynamometer tests should be particularly interesting on rattlers, on account of their relatively heavy bodies and the secure point of attachment for the scale which the rattle would provide.

The length of the snake is only one of the many factors which may affect comparative mortality. Certainly alertness, normal speed of movement, dislike of spaces affording no cover, sinuousness of normal crawling position, road surface, and similar qualities and conditions are all of importance, many probably more so than length. However, it is interesting to note that, assuming these conditions constant, the zone of danger to a snake varies directly with its body length, if we assume further, as appears reasonable, that an automobile wheel will invariably inflict a fatal injury to a snake if run over anywhere between head and vent. Above a length equal to the guage of the average machine, that is over 56 ½ inches, the danger zone instead of increasing directly with the length, increases less rapidly, owning to the overlapping of the danger zones of the two wheels. The same is true on two track highways, where the separation of the inside tracks is less than the length of the snake. But for most of the specimens found in our area it will be fairly true to state that the danger is proportionate to the length. This should be taken into account in considering the relative mortality of some of the smaller species and the juveniles of the larger. (Table 5, last column).

A comparison of the snakes seen alive on the road with the number found run over on the same trips is of interest. In general, as will be noted from the third and fourth columns of Table 5, about 8¼ times as many dead snakes were seen as live snakes, using only the identified specimens in the calculations. In some the ratio of dead to live snakes is conspicuously above the average; in others it is below. Eliminating the species of which less than ten specimens were found on the road, we have the following:

More than Average Alive	**Less than Average Alive**
L. r. roseofusca	*M. f. frenatus*
M. lateralis	*S. g. hexalepis*
L. californiae	*A. e. occidentalis*
L. g. boylii	*P. c. annectens*
T. o. hammondii	*R. lecontei*
C. ruber	
C. c. oreganus	

The slower moving diurnal snakes should have about the average ratio, and this is found to be the case. The night snakes should be run over much more frequently than the proportionate number seen in daylight hours, and this holds true conspicuously for *A. e. occidentalis* and *R. lecontei.* I rather think that this theory also accounts for the few live *M. f. frenatus* seen—only two, compared with 42 dead specimens.

In the other group only one snake has a notably large proportion of live specimens, compared with the number of dead; this is *M. lateralis*, the most active and wary of all the snakes in the territory, and no doubt these very qualities permit so many to cross the road unscathed.

Of the snakes which I have observed on the highway, 38 per cent escaped, usually because of the impossibility of stopping and getting out quickly enough to secure them. The rattlers, king snakes and other slowly moving species are nearly always caught without difficulty but, on the other hand, the racers and similar active forms are often lost. Of specimens of *M. lateralis* seen on the road, no less than 18 out of 20, or 90 per cent, escaped. (See Table 5, column 2).

In the field, afoot, and therefore better prepared for action, fewer specimens escape; however, I find that under these circumstances 19 per cent of all specimens seen have got away. Here the number is swelled, not only by the racers, but by the garter snakes, which escape into the water and hide in the weeds. With such species, the experienced collector who is securing museum series, will use a shot pistol at once.

I have made calculations on the total number of snakes run over on the highways of San Diego County, assuming that the average specimen killed remains on the road three days, and that half the number killed are actually noted, the others being overlooked or dying off the road. Making such assumptions, we find that 2300 snakes are run over in the month of May each year, and the total number destroyed in the county per annum by automobiles exceeds 10,000.

It is believed that tables of frequency of occurrence are likely to be more accurate, when based on specimens found run over on the road, than when entirely premised upon data secured from other forms of collecting, since by this means the nocturnal or crepuscular species will be more accurately represented. Thus, we find that the crepuscular *R. lecontei* and *A. e. occidentalis* are represented in larger proportion, amongst the snakes found dead on the road (Table 5), than in the general census (Table 1) showing acquisitions from all sources, the ratio being shown in the sixth column of Table 5. Similarly, one-third of the trimorphodons recorded were found dead on the road, whereas the general average for all species is but one-eighth. *Hypsiglena* is a night snake of a different type. It seems to travel about less than *Trimorphodon,* no doubt remaining closely adjacent to rock piles and, being a small snake, is found less frequently.

We would further expect that snakes difficult to capture on account of speed or temperament, as for instance, the racers, which are both rapid and vicious, would be more prominently represented among the dead snakes than in the census of snakes from all sources, and this is found to be the case, for over one-fourth of the recorded specimens of the three common racers, that is to say, *C. c. mormon, M. f. frenatus* and *M. lateralis* were found dead on the highway. The red racer is especially vicious and, when caught, often proves such an unpleasant surprise to the amateur naturalist that it is allowed to escape. *Salvadora,* while not vicious, is a shy and retiring snake and, being almost as speedy as a racer, is represented by a high percentage found dead on the road. The only two black whip snakes, *M. piceus,* ever reported in this territory, were found run over on the road.

The rattlesnakes are represented by dead specimens much less frequently than is the average for all species. This probably results from the fact that our Zoological Society publicity has stressed the desirability of bringing in rattlesnakes to aid in venom collection for the Antivenin Institute, which has increased the number from sources other than road trips. The high ratio of specimens of *C. c. oreganus* found run over, as compared to *C. ruber,* is due to the large number of juveniles of the former species that are found killed on the road. While these two snakes are approximately equal in number in our country, judging from Table 1, more than twice as many Pacific rattlesnakes are run over as red rattlers. There must be something definitely different in the habits of the young Pacifics, causing them to roam more widely; this is an example of the character of information that the automobile investigation produces.

The common garter snake of this area (*T. o. hammondii*) is seldom found run over, compared to its actual numbers in the territory; evidently it does not usually stray far from its preferred moist habitat. On the other hand a very high percentage of all the specimens of *T. s. infernalis* were dead highway specimens, so that we may infer that they travel about more freely than the other garter snakes.

Some comparative records have been kept of large and small specimens found on the road. Juvenile specimens are the chief casualties with some species, particularly at certain times of the year. For instance, juveniles of *P. c. annectens* constitute a large percentage of all individuals of this species found run over, amounting to 50 per cent for the year and reaching 73 per cent in March. On one trip in early April, out of 21 snakes seen, 8 were *P. c. annectens,* all yearlings. *C. c. oreganus* likewise has a large proportion of juveniles, with 62 per cent on the average and reaching 80 per cent of yearlings in May.

Juveniles of the king snakes are less frequently found, the figure being 25 per cent for both the California and Boyle's kings. Other snakes have still lower ratios; for instance of the racers, *M. f. frenatus* has 13 per cent, and *M. lateralis* only 5 per cent of juveniles. *R. lecontei,* 4 per cent, *T. o. hammondii,* 9 per cent, and *C. ruber,* 6 per cent, are others having low ratios of juvenile fatalities. Whatever it is that causes the young and inexperienced gopher snakes and Pacific rattlers to range carelessly abroad in search of food, particularly in the spring, does not seem to be so effective amongst the other snakes.

There is evidence that snakes have certain definite ranges over which they travel. I judge this from having noted that when a short-line highway is opened through a district, and thus heavy traffic is introduced over a route hitherto infrequently traveled, the snake mortality for a time is out of proportion to what might normally be expected.

I have considered checking the statistics of the unimproved as against paved highways, but have found that conditions of travel, particularly relative speed, traffic density and the fact that unimproved highways usually traverse more primitive areas, would render the results comparatively useless.

One advantage of traveling unsurfaced highways is the opportunity to catch snakes by following up their crossing tracks, and this has been done successfully on a number of occasions, although the majority lead to failure.

It has previously been stated that, in the collection of the statistical data, night traveling has been omitted. It may be mentioned, however, that probably the most fruitful way of collecting at night in the desert section is to motor on the highway, rather than travel afoot on the sand. As the desert forms are light in color (many of them white or cream, especially in side view), they may be readily seen at a considerable distance against the black background of the highway, and this renders night motoring on the desert a most interesting experience for the collector. The enormously greater area which thus comes under the collector's eye, as compared with hunting afoot by the roadside, probably more than compensates for any aversion the snakes may have for the open road. (See Table 7).

On the coastal side of the mountains, the situation is somewhat different. While it is to be presumed, and all evidence indicates, that, in the hot summer months, sufficiently back from the coast to be beyond the influence of the cooling ocean breezes, practically all species become nocturnal, nevertheless, I have, while traveling at night in this area, seen few live snakes.

Several gopher snakes have been found just after sunset. One *L. g. boylii* was noted crossing the road in the moonlight at 9:30. But on the whole the experience is disappointing. It is probable that the darker colors of the coastal belt snakes render them difficult to see at night. Certainly there must be many night casualties, as shown by the mortality record of the known crepuscular and nocturnal forms.

THE AUTOMOBILE AND THE COLLECTOR

Much as the herpetologist may deplore the high, but probably unavoidable, snake mortality from motor cars, he cannot overlook the greatly increased scope the automobile has given his activities.

That there has resulted a great change in the collecting methods of the herpetologist, goes without saying. Today he can make trips, within the space of a few hours, which, in former times, would have consumed as many days. He can verify locality records and ecological conditions in a brief time, which before would have been impossible. Naturally, this is due, not only to the more rapid means of travel, but to the highway network which has been a concurrent result. Thus, one should be able to make a rather complete faunal survey of a given district within a time quite impossible under the old conditions.

Such a survey will be greatly aided by a check of the specimens found dead upon the road, if there be any traveled highways in the area, and this means should not be neglected. Indeed it is often difficult to tell whether continuous travel upon the highway will not produce more specimens in the long run than more strenuous efforts afoot in the field. In the latter case, it is true by turning over rocks, logs, etc., one has a better chance of securing some of the more secretive forms; but, on the other hand, on the highway the greatly increased area observed tends to multiply the bag, to say nothing of the fact that all other drivers on the route become unwitting assistants. For, if the object of the collection be primarily preserved specimens for a museum, rather than live specimens for a zoo, the catch can be notably increased by utilizing freshly killed specimens found on the road; these will often be either perfect, or with so few blemishes, as to be quite satisfactory for preservation. When it comes to the rarer forms, one will be only too glad to save even the badly crushed specimens, for with them it will be possible to verify at least some of the scale counts and other data of interest.

It might be questioned whether these crushed individuals will not lead to inaccurate locality records by reason of specimens having been carried on autos for a time and then dropped by the roadside. This may occur occasionally, especially in the case of rattlesnakes carried as souvenirs and later abandoned. However, such specimens can usually be recognized by their having strings attached. As a matter of fact, this is no more serious than the occurrences, reported from time to time, of live animals which have evidently been carried by tourists far from their natural ranges. I am quite sure, for instance, that a live *Heloderma suspectum* which was sent to me from Jacumba Mountain in eastern San Diego County, was left there by some Arizona visitor who had tired of his pet, or it might have been placed in a box-car by a practical joker, and escaped. At any rate, if the gila monster were indigenous to so suitable a locality as Jacumba, the species would have been reported in numbers long ago.[22]

The automobile has not only modified travel and thus changed collecting conditions, but likewise everywhere on the roads will be found adequate accommodations; a different picture from that with which the collector of former years had to contend; for not only was transportation a serious problem with him, but he must likewise carry with him all necessary food, supplies and shelter. Today a collector, with a few moments preparation, can leave for even so remote and desolate an area as Death Valley, assured of finding entirely adequate accommodations along the way and at the terminus. Another important advantage of the modern collector is the greater capacity of the automobile for carrying collecting appliances and supplies. Preservatives can be made available in sufficient quantities for long trips, and accessible running-board boxes with special receptacles make it easy to give specimens adequate attention and thus improve specimen quality. Subdivided compartments avoid breakage of delicate parts, such as the tails of lizards.

The presence of the speedometer on the automobile will have a considerable effect on the locality records of the future. It will probably be desirable not to make these unnecessarily accurate, on account of the duplications in the literature that will follow; judgment will have to be used in this matter. In territories in which habitat conditions change rapidly within a few miles, it is definitely of great interest to know whether a snake was taken two, three or five miles west of a given town. On the other hand if the habitat conditions be more uniform, then the name of the town itself will be sufficiently accurate for all localities in the vicinity, and the literature should not be encumbered with a long list of "Four miles west of Blank," "Three miles north of Blank," etc. In some areas, counties constitute sufficiently definite locality areas, whereas, in other states, where there are both large counties and rapidly changing topographic conditions, non-specific county records are valueless. A glance at an outline map of the United States, which shows county boundaries only, is fairly illustrative of one of these points; a good contour map will show the other.

To illustrate how important a check of dead roadway specimens may be, in developing a complete faunal list of an area, our San Diego County experience will be of interest. We have, as previously noted, raised the number of species known from this county from 21 to 29. Of the 8 additions, one (*M. piceus*)[23] is still known only from run over specimens, and two others (*P. decurtatus* and *T. s. infernalis*) were first discovered in this form and later verified by live specimens. *T. vandenburghi* is so often found run over that its discovery in this manner would certainly

[22] English, 1927; Vorhies, 1928.

[23] Not listed in Table 5, since I was not the finder of these specimens. Both were brought in for examination and were in a condition good enough for preservation.

have soon occurred, although the writer found the first recorded California specimen alive under a rock. As to the three new desert forms, *C. atrox, P. c. deserticola* and *S. episcopa,* although not found run over, the reason is lack of traveled desert highways within San Diego County. Being common in Imperial County, they were found there at an early date. The eighth of the previously unrecorded species, *T. o. elegans,* is, in this area, restricted to remote mountain regions.

Taking San Diego and Imperial County as a faunal unit (in order to be fair to the desert forms), it is interesting to note that, in the course of seven years, the identification of dead road specimens would have discovered all but five[24] of the 32 forms occurring in the area, and nearly all of the identified 27 would have been found the first year. Had we not possessed in San Diego the rather unique situation of the donation of hundreds of live snakes annually to the Zoo, the auto trips would have been of relatively greater importance in our studies. Certainly a check list of crushed specimens will be found most useful in any newly investigated area having considerable auto traffic. This has been further demonstrated by range extensions we have developed, based on dead specimens, in areas less thoroughly collected than the counties here under consideration.

One may make a study of habitat preferences from records of specimens found dead upon the road, if the character of the roadside surroundings be noted. Thus, we observe the preference of *M. lateralis, S. g. hexalepis* and *L. r. roseofusca* for chaparral, while *M. f. frenatus* and *C. c. mormon* prefer grassy fields. *C. c. mitchellii* is partial to rocky areas. The preference, hereafter mentioned, of *M. f. frenatus* and *P. c. deserticola* for the newly irrigated desert sections, which are correspondingly shunned by *C. cerastes* and *S. occipitalis,* has also been verified largely by observations of dead specimens on the road.

Stomach contents are occasionally in evidence. Thus a specimen of *L. californiae* was found which had recently swallowed a *M. lateralis* longer than itself. A specimen of *L. g. boylii* was found containing a young Pacific rattler.

During the eight years of this census, only two albino snakes have come to light from San Diego County. Both were juveniles; one a *P. c. annectens,* and the other *L. californiae.*[25] They were taken in the first two years of this census, and therefore gave us, at first, a somewhat inaccurate idea of the frequency of occurrence of albinos.

No two-headed snakes have been found in this area. A two-headed garter snake from southern Oregon is the only live specimen brought to our attention.

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[24] The missing species are the two mountain forms, *L. multicincta* and *T. o. elegans*; the desert forms *C. cinctus* and *L. g. yumensis;* and, lastly, *T. eiseni,* which is probably lacking because of its small size and subterranean habit.

[25] Klauber, 1924, Figs. 4 and 5.

SNAKE POPULATION AND CONTROL

We have no accurate statistics as to the present snake population compared with the past. There are those who believe that destructive agencies, including brush fires, the conversion of land to agricultural use, poison campaigns against rodents[26] and last, but by no means least, automobiles, have greatly decreased the snake population. On the other hand, there are some who feel that the increase in rodents, which has followed agricultural development in certain areas, has likewise led to an increased number of snakes. Possibly both are true in some places, but I rather agree with Mr. Frank Stephens in believing that they are somewhat less common today than before. Methods of travel are so different that a determination cannot definitely be made. In evaluating the number of snakes seen, both time and space must be taken into consideration. As I have lived in this county all my life, and have done considerable traveling by both means, I may perhaps hazard an opinion. In the old days when 30 miles, by team or stage, represented a tedious and tiring day's work, I was often on the lookout for snakes. I remember that two or three per day were rather more than the average to be seen, even in the spring. Dead individuals were found rarely indeed, unless someone had stopped to kill a rattler. Now, at the peak of the spring season, one may see more snakes, but while the time of observation has not changed, being limited to about twelve daylight hours, the space covered, that is to say, the area under observation, has been multiplied by approximately ten, which greatly affects the result.

Of all the destructive agencies no doubt forest and brush fires are the most serious, even more so than the automobile and deliberate destruction by man. The annual destruction of great areas of chaparral is of material concern to the federal and state foresters, and conservationists in general. The network of roads in foothill and mountain areas, and the campers and motorists which they have brought in, have greatly increased the likelihood of fires starting. In addition, there are some ranchers who, in order to increase stock feed, burn extensive areas. Of course, with this increase in the number of fires, has likewise come an increase in the protective agencies for their control. Therefore, although the number of fires has grown, the damage may not be greatly on the increase. In former days it is true that fewer fires started, but occasionally a single fire, under favorable circumstances of wind and humidity, might sweep hundreds of miles of territory, for its advance would be practically unopposed, except in and about threatened towns, and there only inadequately. It is probable that natural causes for ages past have started sufficient fires so that, no attempt being made to stop them, the entire area was occasionally swept.

Certainly the fires are heavily destructive of reptile life; except for

[26] I have no definite data on the killing of snakes by poisoned rodents, but it is well known that snakes will occasionally eat dead mammals, so that some destruction may be assumed. *cf* Van Denburgh, 1922, p. 756.

the few individuals which have the good fortune to take refuge in deep ground holes, practically all are destroyed, and their food supply as well. Those which take refuge in shallow holes or in the cracks in rocks, although protected from actual contact with the flames, must be killed by the heat. Foresters have told me that snakes, especially rattlesnakes, are found burned quite frequently after a brush fire.

Subsequent to a brush fire, species must move into the devastated areas somewhat slowly. Lizards come first, as their food supply of insects is more quickly restored. I have found *U. S. hesperis, S. o. biseriatus* and *X. henshawi* on rocks in a fire swept area within a few weeks after the fire, and likewise under such circumstances one specimen of *C. ruber* was found. Two or three years after a fire has swept an area, it constitutes a rather good hunting ground for snakes, not presumably, because they have increased to their former numbers, but rather because such as there are available, are more easily located than they were before the thick brush was burned off.

It is surprising how small, secretive snakes are able to maintain themselves about human habitations. I have had specimens of *T. eiseni* from city blocks which have been paved on all four sides for many years, and in which most of the buildings were of a commercial rather than residential type, being without gardens. And even the larger species are sometimes unaccountably found in city gardens, distant from any unimproved territory. Given a city park with dense foliage, and all of the indigenous species seem to thrive, such being the case in Balboa Park, San Diego.

It may be interesting to note that as a boy, although having no scientific knowledge of snakes, I collected live specimens and well remember all of the commoner species, with the single exception of *D. a. similis*. This snake, while certainly native to San Diego County, and in fact widespread on the Pacific side of the mountains, nevertheless is common only in cultivated sections, particularly in city gardens, and I am satisfied that this form, at least, has greatly increased in numbers in the past 40 years in the garden and orchard areas close to the coast. For in that time the human population has multiplied by ten, and the character of what was once a semi-desert has been greatly changed by water storage and irrigation, in a manner favorable to this species at least.

That definite changes in habitat occur because of modifications brought about by irrigation must be unquestioned. The cultivation of the Imperial Valley has changed considerably the fauna of that area. The sidewinder and some of the ground snakes, which require a sandy habitat, have apparently been driven beyond the borders of the irrigated section; while other native species, such as the red racer and the desert gopher snake, thriving on the increased mammal prey, prefer the new conditions, and have no doubt grown in numbers.

Similarly, the amphibians have greatly increased in the Imperial Valley. The garter snakes represented by *T. marcianus,* have come in for the first time. It is interesting to note that the amphibians and the garter snake have followed the water; that is, they have come in from the Colorado River, rather than from the desert foothills of the Peninsula Range. In these desert foothills, coastal amphibian forms are present as far east as the streams run before they finally sink into the sand, this being as close to the Imperial Valley as the Colorado River is on the opposite side. Such species as *Batrachoseps attenuatus leucopus, Hyla regilla, H. arenicolor, Bufo canagicus halophilus* and *Rana aurora draytonii,* follow these streams toward the desert to such localities as Carrizo and Sentenac, and it is rather surprising that the occasional cloud-bursts have not carried them eastward into the Salton Basin, and given them a start in that area. However, to date they have not been found there, but, on the contrary, the Colorado River forms, *Rana pipiens, Bufo alvarius, B. woodhousii* and *B. cognatus* are, at present, the only known amphibians of the Imperial Valley and the Salton Basin. No tailed amphibian has yet been found in the Valley, nor has *B. punctatus* been collected there, although it has been taken both at the Colorado River, and at the foot of the mountains to the west.

While space does not permit a full discussion of the economics and possibilities of snake control, it may be mentioned that our scientific institutions are frequently in receipt of requests for advice on this subject. Householders in surburban districts desire to know how snakes may be eliminated from their gardens and orchards. We find that it is seldom useful to point out the advantages of snakes from the standpoint of rodent control, at least to such persons as have spent most of their lives in cities. They are usually not at all interested in the fact that snakes can be divided into different classes, some of which, such as the gopher snakes, being of distinct benefit and with no undesirable characteristics, except the one for which the snakes are not to blame, viz., that people have an unwarranted fear of them. Other snakes, such as the garter snakes, which destroy useful fish, toads and frogs, are probably economically disadvantageous. Still others, as for instance, the rattlers, while beneficial as rodent destroyers, have a single very objectionable characteristic, namely their venomous quality, and it is this characteristic that has given all snakes a bad name. It is unfortunate we cannot make people realize, that when they refuse to classify snakes into groups and use discrimination in their destruction, they are working against their own interests in two ways: first, because of the destruction of animals which are highly useful from the economic standpoint of rodent control; and secondly, because each time such a snake as a gopher snake, which is wholly beneficial, is destroyed, room is made for one more of that snake's economic competitors, which may be less desirable, namely a rattlesnake. More gopher snakes, king snakes and racers in a territory would ultimately mean fewer rattlers, and care upon the part of the public in distinguishing between snakes to be destroyed, would probably be the most effective means of venomous snake control. Admittedly, however, this is a difficult end to secure.

Records of attempted snake control, by such means as bounties and the importation of ophidian enemies like the mongoose, are available, but I know of no reference which indicates any great degree of success.[27] Snakes have a persistent and secretive way of maintaining themselves, even close to human habitations, which renders their complete extermination difficult.

The desirability of elimination, even of venomous species, is doubtful. For many years a round figure of 25,000 lives per year has been given as the human mortality from snake-bite in India. Accepting this large figure as correct, it may be questioned whether the average span of life in that country would be lengthened by the removal of the snakes, assuming such were possible. Even in a presumably civilized community, as California, where every dangerously venomous snake is conspicuously advertized by a peculiar tail appendage, the rattle, we are still only at the beginning of educating the public in differentiating between venomous and non-venomous snakes. How much more difficult would the situation be in teeming India, where a rather expert knowledge of herpetology is required to make such a classification, where many die annually from fear caused by the bites of harmless snakes,[28] and where it is contrary to the religion of a very considerable number to injure any living creature, venomous or otherwise. And even if such control were possible, would not the increased death rate from bubonic plague and other rodent carried diseases, far outweigh the death rate from venomous snakes? Can we agree with Dr. H. M. Diamond, who in commenting upon the injurious results on human communities, of superstitious and religious taboos, which prevent the destruction or control of dangerous animals, makes the following statement?

"The unfit survive. Men die that snakes may live, an outrageous inversion of the operation of natural selection. . . . . . Had these men regarded their noxious neighbors solely as physical in attribute, conquest would have been quick and decisive . . . . ."[29]

Possibly the unknown results of tampering with the balance of nature, may be more serious than the known danger from snakes.

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[27] Nicholson, 1874, pp. 157 and 161; Stejneger, 1895, p. 481.
[28] Wall, 1928, p. 69.
[29] Diamond, 1927.

APPENDIX 1.

FIELD NOTES

There follow, grouped by species, some observations made upon the snakes discussed in this paper. Most of these are based on notes made in the field, but a few, principally on mating and egg laying, have to do with captive specimens.

The experienced field collector will appreciate how rare are the occasions when an undisturbed snake will be observed to be doing something of interest. It is, in fact, quite out of the ordinary to witness an occurrence worthy of record, even when the snake has discovered the collector. Therefore, field notes are always few compared with the total number of specimens taken. With a large majority, only the locality of collection and the habitat conditions (which are available for every specimen) may be observed and recorded.

In a few instances, particularly of night or subterranean forms, the circumstances of collection are noted in this Appendix.

Leptotyphlops humilis

Oct. 4, 1922: Three were found in digging out the rotted butt of a fence post.
Jul. 8, 1923: Found a specimen in a crack, under a granite flake.
Mar. 20, 1926: One was discovered under a rock flake.
Mar. 28, 1926: Found a specimen under a flat rock; earth below, not another rock.
Apr. 20, 1927: Found one under a thick flake, leaning on a rock and touching the ground.

Lichanura roseofusca roseofusca

Apr. 15, 1923: A specimen was braced in a crack between granite boulders directly above, and evidently watching a wood rat's nest.
May 25, 1924: Found a specimen in a crack in a granite boulder.
Apr. 19, 1925: A large individual was located under a flat rock covering a small circular pocket in a large boulder.
Mar. 28, 1926: One was found with head and one-third of the body under a flat rock, the remainder of the body being in the open.
Apr. 11, 1926: Found one under a small flat rock.
Apr. 20, 1927: Located one in a crack in a granite boulder; fished it out with difficulty.

Diadophis amabilis similis

Jan. 11, 1925: A specimen was reported on reliable authority to have been plowed out. Identification by the writer.
Mar. 18, 1925: One was noted in captivity, which would lie on its back and play dead.
Mar. 27, 1925: Noted a specimen of unusual length, 460 mm. (18⅛ in.)
Feb. 27, 1927: A specimen was found coiled in a small depression under a tin sign.

Coluber constrictor mormon

Jun. 31, 1924: One crossing the road was particularly vicious when captured.

Masticophis flagellum frenatus

Jun. 11, 1923: A large specimen, driven toward a pond, took refuge in the reeds two or more feet above the water surface, showing a disinclination to take to water.
May 11, 1925: A pair was found mating.
May 12, 1925: Another pair mating.
Mar. 19, 1928: One was found on the desert, coiled under a board at an abandoned camp.
Apr. 9, 1928: A pair found mating.

May 7, 1928: A specimen was seen to capture its prey in the field. This snake was first spied by Dr. Tracy I. Storer at some distance from the point where we were standing. It seemed to be watching a bush intently. Suddenly a white footed mouse ran out of the bush and the snake went in pursuit. The mouse was overtaken within about ten feet. It was caught by the middle of the body and seemed to be killed by the pressure of the snake's jaws; there was no constriction nor was the body brought to bear upon the prey. After holding the mouse in its jaws for a few moments, the snake, with its head about six inches above the ground, glided to the shade of a juniper about 20 feet away, carrying the mouse still held at midbody. In the bush the snake rested in a U-shaped coil and, without using the body in any way, proceeded to work its jaws to the head of the mouse, after which it began to swallow. There was considerable trouble engulfing the head and hind quarters, especially the latter. There were long waits without movement. Even after the tail alone was protruding from the snake's mouth, there were pauses with the mouth open and no swallowing movements. Finally the tail disappeared and the victim was worked rapidly down the throat. The total elapsed time was 29 minutes from catching to completing the swallowing of the mouse. We then caught the snake.

Jun. 10, 1928: A specimen caught by the tail in a bush, twisted laterally with such violence that the tail was twisted off and the snake escaped.

May 27, 1929: A specimen contained the legs and feathers of a bird.

Feb. 24, 1930: One was found so stiffened with cold in the road that it appeared lifeless, but entirely recovered when warmed. This was in the desert foothills.

May 18, 1930: A specimen disgorged a gecko when caught.

Masticophis lateralis

Apr. 13, 1924: After being chased into a bush, a large specimen was found covertly watching the intruder from another bush nearby. This is a characteristic maneuver of this species.

Mar. 22, 1925: A specimen, pursued in heavy chaparral, proceeded through the branches instead of on the ground. After considerable searching it was located in an adjacent bush about three feet above ground. This specimen contained one large *Eumeces skiltonianus* and a *Sceloporus occidentalis biseriatus,* both swallowed head first.

Apr. 19, 1925: A juvenile was found under a flat rock, resting on a large boulder.

Apr. 25, 1925: One was noted in an open field without brush close by, a rather unusual place for this species.

May 10, 1925: A specimen caught by the tail rotated with such rapidity as to twist the tail off.

Jun. 7, 1925: A specimen was found in a crack in a granite boulder.

Jul. 29, 1925: Eight eggs were laid by a captive specimen.

Mar. 28, 1926: A specimen was discovered under a rock flake on a large boulder, nine feet above ground level.

Apr. 6, 1927: A specimen was found crawling along a low roadside curb and seemed hesitant to go over into the brush. When caught it bit violently and twisted laterally with great speed.

May 22, 1927: A specimen was lost in cactus and was later discovered ten feet away with head raised six inches out of a low bush, watching the hunt.

Jul. 30, 1927: A batch of eggs were measured having average dimensions of 54 mm. x 15 mm. ($2\frac{1}{8}$ in. x 21/32 in.).

Aug. 5, 1928: By following a road-crossing track, a large specimen was found coiled loosely in a bush three feet above ground.
May 19, 1929: A large specimen on the road raised its head and forebody about ten inches above ground to survey an approaching car.

Salvadora grahamiae hexalepis
Oct. 13, 1922: A very small specimen discovered, evidently just born.
Apr. 14, 1926: A pair mated in captivity.
May 2, 1927: A specimen 978 mm. (38½ in.) long was noted.

Arizona elegans occidentalis
Feb. 10, 1923: A specimen, said to have been plowed out, was identified.
May 2, 1927: A large specimen 958 mm. (37¾ in.) long was noted.
May 5, 1927: One was found run over on a cliff road immediately above the ocean surf.
Feb. 23, 1929: One was said to have been plowed out; identification by the writer.
Mar. 11, 1929: A specimen was found under a rock; it contained a *Uta stansburiana*.

Pituophis catenifer annectens
Jul. 3, 1924: One was observed coming out of a gopher hole at seven P. M.
Jun. 28, 1925: A specimen located by a road-crossing track was found in a manzanita bush one foot above ground.
Jul. 19, 1925: Eggs were laid by a specimen in captivity.
Apr. 14, 1926: Observed a very large specimen (for this subspecies), 1739 mm. (5 ft. 8½ in.) long.
Jun. 6, 1926: Found a large specimen on the margin of the San Luis Rey River, where it had either gone to drink, or had swam across.
Aug. 29, 1926: Eggs were laid by a captive specimen.
Oct. 15, 1926: A juvenile contained a full grown mouse.
Jun. 25, 1927: Noted a specimen on a concrete highway making almost no progress despite violent efforts.
Jul. 21, 1927: Eggs were laid in captivity.
Feb. 1, 1928: Found a small specimen under a piece of tin in a field.
Sep. 12, 1928: Noted in Schubach's collection an albino three feet long. Eyes pink. The normal yellow was straw; the normal black, brown and red were white. The parietals were distorted.
Apr. 10, 1929: Two unusually vicious specimens were noted. They struck fiercely and repeatedly.
May 14, 1929: A specimen, run over on the highway, had eaten two small rabbits.
Mar. 7, 1930: A buzzard was observed eating a large freshly killed specimen by the roadside.
Jun. 29, 1930: A specimen was caught crossing the road at 5:50 P. M.
Nov. 5, 1930: Noted a juvenile specimen which had eaten a large mouse.

Pituophis catenifer deserticola
Apr. 26, 1930: A specimen was found crossing the road just before seven P. M., it being quite dark at the time.

Lampropeltis californiae
Apr. 13, 1923: A large specimen, when captured, disgorged a mouse and a small gopher snake.
Apr. 6, 1924: A juvenile was found coiled under a flat stone resting on the ground.
May 22, 1924: A pair was found mating.
Jul. 19, 1925: A captive specimen laid eggs.
Apr. 24, 1927: A specimen, run over on the road, had swallowed a *M. lateralis* longer than itself. Three inches of the tail of the victim were still showing.

Jun. 2, 1929. Specimens in captivity were observed to take *Gerrhonotus* readily.
Jul. 14, 1929: A captive specimen was observed to kill a *Masticophis lateralis* by constriction.

Lampropeltis getulus boylii

Jun. 1, 1925: A pair mated in captivity.
Jul. 19, 1925: Nine eggs were laid by a specimen caught Jun. 28, 1925.
May 22, 1926: Found a specimen which struck wildly, even before an attempt was made to touch it.
Apr. 28, 1927: A newly caught specimen disgorged five crushed quail eggs.
Jul. 15, 1927: A freshly captured specimen disgorged a bird.
Mar. 6, 1928: A vicious specimen struck repeatedly and rattled its tail. This specimen (from Las Flores) was patterned somewhat like *L. g. yumensis.*
May 28, 1928: Observed a specimen 1206 mm. (47½ in.) long; unusually large for this subspecies.
Jul. 30, 1928: A captive specimen laid eggs.
Mar. 5, 1929: Found one containing a gopher snake.
May 18, 1929: A captive specimen placed in a sack, ate a *Uta stansburiana.*
Jun. 24, 1929: One specimen, lately collected, disgorged three juvenile *Crotalus confluentus oreganus;* and another, a *Masticophis lateralis* longer than itself.
Sep. 19, 1929: One, in captivity, was observed to eat another of the same species nearly as large as itself.
Apr. 12, 1930: To prevent the escape of a specimen found crossing the road, I stood between the snake and the brush. It rattled its tail, puffed up and came right at me, striking as it came.
Jun. 22, 1930: A specimen, found dead on the road, had eaten a *Crotalus confluentus oreganus* about half its own length.

Lampropeltis multicincta

Jul. 5, 1926: An unusually large specimen measured 844 mm. (33¼ in.) over all.

Rhinocheilus lecontei

Dec. 13, 1926: A specimen, identified by the writer, was said to have been plowed out.
Apr. 27, 1928: A specimen was caught on the Chula Vista Golf links at 5:30 P. M.
May 4, 1928: A specimen was observed to vibrate its tail when disturbed.

Sonora occipitalis

Apr. 30, 1927: A considerable party of searchers found three on the desert, mostly close to mesquite hummocks. The time was about 8:30 P. M.
Mar. 18, 1928: A juvenile was discovered under a cardboard sign.
Mar. 28, 1928: One was found under a stone.
Apr. 6, 1929: An unusually large specimen measured 425 mm. (16¾ in.) in total length.

Hypsiglena ochrorhynchus

Mar. 22, 1925: One was found under a rock (a chunk, not a flake) resting on another rock. This specimen ate a *Xantusia henshawi* while being carried home.
Mar. 25, 1925. Found a specimen under a rock resting on the ground. It was in a small hollow. It was observed to jump wildly when lightly touched on the head.
Mar. 19, 1927: Found a large specimen under one rock resting on another.
Feb. 14, 1929: A specimen was found under a rock.

Thamnophis ordinoides hammondii

Apr. 10, 1927: A large specimen, 943 mm. (37⅛ in.) long had swallowed a *Bufo canagicus halophilus* 200 mm. (8 in.) long.
Oct. 30, 1927: Twenty-five young were born in captivity.
Mar. 15, 1928: A yearling was found to contain a full-grown *Hyla regilla.*
Jul. 10, 1928: A specimen was found to contain a *Hyla regilla* and a worm.
Apr. 17, 1930: One was found hunting *Hyla regilla* in a marsh at 8:00 P. M.

Tantilla eiseni

Feb. 27, 1923: One was plowed out by a road making crew. Identification checked.
Aug. 23, 1925: One was taken in an excavation by a collector who stated there were four more which escaped.
May 16, 1926: Two specimens were found under a rock which was resting on the ground, not on another rock.
May 16, 1929: One was seen by a collector (not the writer, who, however, checked the identification) to be crawling about in the open at 1:30 A. M.

Trimorphodon vandenburghi

May 4, 1924: One was found under one rock resting on another.
May 1, 1926: Two were found in a crack between two large rocks, one being almost in the open. A cold, foggy day .
Apr. 8, 1927: A specimen was found under one rock resting on another. It vibrated its tail when caught.
Apr. 20, 1927: One was found under a cap rock, level and closely fitting.
May 21, 1929: One was observed in captivity to eat a *Xantusia henshawi.* The snake grasped the lizard by the center of the body with the upper jaw so placed that it engaged the lizard's ventral surface. (The same has been seen on other occasions and probably is not accidental). The jaws were widely extended so that the posterior teeth were effective. The snake, without the use of its body for constriction or holding, bit continuously with spasmodic movements of jaws and neck muscles. The biting movements were at approximately four second intervals. This was kept up for seven minutes. Here I ceased observations and, returning after ten minutes, found the snake swallowing the lizard head first. Upon being disturbed the lizard was dropped and seemed lifeless except for a twitching of the tail. The lizard was left in the cage and was eaten later. Much the same procedure was again noted on June 12, 1929.
Jul. 20, 1930: "On a dark night about 9:00 o'clock, my dog began to bark. I came out of the house and discovered the snake on a clear space close to rocky ground." Quoted from a letter from the donor. Identification by the writer.

Crotalus cerastes

May 4, 1929: Found a large specimen crawling about, notwithstanding the strong wind which usually blows on the desert about eight or nine P. M.
Apr. 27, 1930: A specimen contained a *Uma notata* and a caterpillar.

Crotalus ruber

Aug. 25, 1923: Embryo specimens were observed to be almost black.
Apr. 20, 1924: One on the move between two rock piles, made a hard fight to avoid capture. Two others found under rocks were more placid, as is usual in this species.
Apr. 13, 1924: A mating pair was found in the field.
Apr. 20, 1924: Another mating pair.

Apr. 27, 1927: One large specimen of a pair would not rattle even when roughly handled. These two were found two feet apart.
Mar. 13, 1926: One, found in a cactus patch, rattled when the observer was still eight or ten feet away—a rather unusual experience.
Mar. 27, 1926: A specimen was found which appeared sick. It died 12 days later.
May 23, 1926: One was found by following a road-crossing track. It was located in bushes 18 inches above the ground, and tried to escape by continuing at this level.
May 26, 1927: A large specimen was found under a flat rock exposed to the spring sun.
Oct. 9, 1929: A snake 900 mm. (35½ in.) long contained a large rat.

Crotalus confluentus mitchellii

Mar. 22, 1925: Found one resting in a cleft in a rock with head out.
Feb. 28, 1926: Discovered one in front of a rock hollow, into which it took refuge immediately as if the means of escape were known.
Mar. 26, 1927: Found one coiled under an overhanging flat rock with a retreat behind.
May 29, 1929: A specimen contained a mouse.

Crotalus confluentus oreganus

May 24, 1925: Found a juvenile under a log.
Jul. 25, 1925: Found three moderate sized specimens under a flat rock about fifteen inches in diameter.
Sep. 3, 1925: Young born in captivity.
Apr. 26, 1927: One was located on the ocean shore almost at the water's edge. This was a juvenile.
May 31, 1928: Found a juvenile 380 mm. (15 in.) long which had swallowed a mouse (*Perognathus f. fallax*), so large it appeared impossible to have engulfed it.
Jul. 5, 1928: Collected a juvenile at 6:15 P. M.
Jul. 12, 1928: Collected a juvenile at 5:45 P. M.
Mar. 27, 1929: A juvenile contained a mouse.
Apr. 10, 1929: A young specimen had eaten a large mouse.
Apr. 28, 1929: Found a crow fighting a young specimen. The bird was jumping on the snake, seizing it and then quickly dropping it to escape, and this notwithstanding the snake had been dead several days and was quite dried up.
Jun. 9, 1929: Several specimens from South Coronado Island contained *Gerrhonotus scincicauda webbii.* This lizard seems to be the regular food of these island snakes.
Aug. 6, 1929: Noted a specimen 1371 mm. (54 in.) long and weighing 2¾ lbs.
Oct. 18, 1930: 13 young were born in captivity all within a few minutes.
Oct. 20, 1930: A reliable observer reported to me as follows: While engaged in overturning some rocks two or three juveniles were discovered. Then, under a large flat rock, the mother with the balance of the brood was found. There were eleven young, including those first discovered. When the large rock was overturned, the mother seemed to try to protect the young, and did not attempt to escape until all had been killed. In my own experience, I have never noted a mother to take any notice of her young.
Nov. 5, 1930: A small snake contained a large mouse.
Mar. 24, 1931: A specimen from San Felipe contained two young jack rabbits.

APPENDIX 2

SAMPLE FIELD TRIPS

This paper contains such useful data on the snakes of the southern border counties and adjacent territory as have been accumulated in the course of some five hundred field trips covering a period of over eight years. It will, I think, be of some interest to give the diary records of a few random trips, some good, some bad, to indicate the kind of luck which the herpetologist may expect in this area, and the method of recording the field notes. The trips are given in monthly order (regardless of year), rather than chronologically, since this makes comparisons easier. Twenty-six trips are listed, three from May and from June, and two from each of the remaining months.

January 2, 1928

Drove to Pasadena and back with the family to see the Stanford-Pittsburgh game. Started at 8:45 A. M.; returned at 11:15 P. M. Total miles 281; miles in the county in daylight 66. A part cloudy but warm day.

No snakes seen alive or dead.

On the return trip heard *Hyla regilla* at many points, including San Mateo Creek, San Onofre, Las Flores, Stuart, Oceanside, Carlsbad, Del Mar and La Jolla.

January 15, 1930

Took the family out to Pine Valley to see the snow. A cool day; rain in the afternoon. 96 miles.

No snakes seen alive or dead.

February 1, 1928

Went to El Cajon at noon; a clear warm day; 35 miles. No snakes seen on the road. Hunted for a few moments near a pile of rocks NW of El Cajon. Found a yearling *P. c. annectens* coiled under a piece of sheet iron scrap. *Uta stansburiana* and *Sceloporus occidentalis biseriatus* were seen about.

February 29, 1928

Went to San Juan Capistrano at 8:30 this morning on business, returning at 5:45. A moderately warm, part-cloudy day. Miles in the county 118; total miles 185.

Hyla regilla was heard at San Clemente.

A juvenile *P. c. annectens* was found dead in the road at San Luis Rey.

March 23, 1930

In the afternoon, drove with the family to Ramona; out via San Pasqual; back via Fletcher Hills. Started at 1:45; returned at 5:15 P. M. A fine day, very warm; 88 miles.

No live snakes were seen.

Dead snakes were as follows:

P. c annectens	S,	DOR,[30]	Mission Valley	(grass)
T. o. hammondii	M,	DOR,	San Pasqual	(river)
T. o. hammondii	S,	DOR,	Shady Dell	(grass)

A *Gerrhonotus scincicauda webbii* was seen crossing the road at Shady Dell.

Stopped to hunt at one point only, a pile of rocks near San Pasqual battlefield. Found one *Hyla regilla* under a cap rock much as *H. arenicolor* is usually found.

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[30] L = Large. M = Medium. S = Small. DOR = Dead on the road.

Lizards were scarce. A number of crushed toads were seen, but too dried to be identified.

March 26, 1927

In the afternoon went to Dulzura with H. K. and E. E. K. A clear warm day; started at 2 P. M. returned at 6:30 P. M.; 66 miles.

No snakes were seen on the road alive or dead.

Hunted at Dulzura Summit. Got 8 *Xantusia henshawi* and lost several more; they were under flakes, as usual, and on the sunny side of the boulders.

Found one medium *C. ruber* coiled under a flat rock exposed to the sun. Could be seen from the side. Made no fight when captured.

Found one large *C. c. mitchellii* coiled, as usual, under an overhanging granite slab with a hollow behind. He retreated inside at once. Could be seen from the side. Was difficult to get, but finally landed him.

Saw several *Sceloporus orcutti.*

April 12, 1930

Started with the family for Indio at 2:30 P. M.; arrived at 8:10 P. M.; went via Elsinore, San Gorgonio Pass and Palm Springs. A clear cool day at the coast; very windy in the San Gorgonio Pass, as usual; moderately warm at Palm Springs; cooler and breezy at Indio.

Miles in the county 68; total miles to Indio 187; additional miles, evening trip 7½.

P. c. annectens	L,	DOR,	Mission Valley	(brush)
M. lateralis	L,	DOR,	Mission Valley	(brush)
C. c. oreganus	M,	DOR,	Poway	(brush)
L. g. boylii	L,	DOR,	Poway	(brush)
L. g. boylii	L,		Caught crossing road at Bonsall	(grass)
L. g. boylii	L,	DOR,	Bonsall	(grass)

Unknown, (probably *T. o. hammondii*) lost crossing road at Bonsall (grass)

P. c. annectens, juvenile caught crossing road at Rainbow. Fought viciously.

P. b. blainvillii		DOR,	Rainbow	(brush)
P. b. blainvillii		DOR,	San Diego-Riverside County Line.	
T. o. hammondii	L,	DOR,	Temecula, Riverside Co.	(marsh)
P. c. annectens	S,	DOR,	Temecula	(grass)
P. c. annectens	S,	DOR,	Wildomar	(brush)
P. c. annectens	S,	DOR,	Elsinore	(grass)
C. ruber	S,	DOR,	Elsinore	(brush)
P. c. annectens	S,	DOR,	Val Verde	(grass)
C. ruber	L,	DOR,	Morena Grade, near Eden Hot Springs	(brush)
P. c. annectens	L,	DOR,	Cabazon	
L. g. boylii	L,	DOR,	Indian Wells	(sandy)
C. cerastes	L,	DOR,	Indian Wells	(sandy)

In the evening at 8:30 went up the highway (U. S. 99) toward Dry Camp.

C. cerastes	L,	DOR,	Myoma	(sandy)
A. e. occidentalis	Caught a small specimen crossing the road at Edom			(sandy)
A. e. occidentalis	S,	DOR,	Dry Camp	(sandy)
A. e. occidentalis	S,	DOR,	Myoma	(sandy)

Hunted on the desert at two points with a flashlight but found nothing. It was cool and windy; hardly expected that sidewinders and faded snakes would be out.

On the return to Indio at 10 P. M. *Bufo woodhousii* was heard calling; found one dead on the pavement in the irrigated area. Truck traffic at night was heavy as usual.

Summary: 18 dead snakes; 3 live snakes caught; one lost, unidentified.

April 17, 1927

Went to Coyote Wells, Imperial Co. with Dr. C. F. Brooks and my family. Started at 9:15 A. M.; returned at 7:15 P. M. Miles in the county 175; outside 22. Weather clear at the coast; cloudy, cold and windy in the mountains. Part cloudy and comfortable on the desert. Went out via U. S. 80; returned via Campo.

While this was a fairly warm day (except in the mountains) it seemed to be too soon after cold and rainy weather; it had evidently rained at a number of points last night.

Only one snake was seen, a dead *P. c. annectens,* medium size, at Dulzura.

First stop was made at the top of the new Viejas grade. There were some fairly good flakes here. Secured 2 *Xantusia henshawi* and a young *Sceloporus orcutti.* Next stopped at the crest beyond La Posta; got a *Uta stansburiana* under a rock here. Cold and partly dormant.

Stopped for lunch at the foot of Mountain Spring Grade, on the edge of the rocky hills. There are fairly good flakes here. Found 2 *Phyllodactylus tuberculosus* under level heavy flakes and lost another; saw several *Uta mearnsi* and one *U. s. stejnegeri.* Did not see any *X. henshawi.* Hunted here about an hour. Left best .22 pistol resting on spare tires and so lost it.

Went on to Coyote Wells. Did not see lizards of any kind running on the desert, although it was about 75 deg. F. Stopped only at one point to pick ocotillo blossoms; found nothing here.

The geckos squeak. Both have vermilion mites.

May 3, 1929

Started home from Long Beach at 12 M.; reached San Diego at 3 P. M.; 120 miles; 66 in San Diego County. A warm day.

L. californiae	L,	DOR,	Opposite Balboa, Orange Co. (a queerly spotted specimen)	(grass)
M. lateralis	L,	DOR,	San Onofre	(brush)
L. r. roseofusca	L,	DOR,	5 miles S. of San Onofre	(brush)
L. g. boylii	L,	DOR,	Las Flores	(grass)
P. c. annectens	M,	DOR,	Stuart	(grass)
P. c. annectens	L,	DOR,	Solana Beach	(fields)

P. c. annectens—A large specimen was crossing the road at Rose Canyon; couldn't stop in time because of a narrow turn in the road, and he escaped in the brush.

May 24, 1930

Went to the desert with J. R. Slevin starting from San Diego at two P. M. and arriving at Banning at 12:30 A. M. It was cool at the coast and hot on the desert, but we did not reach El Centro junction until six P. M., when it was moderately cool. Route U. S. 80; then U. S. 99. Miles in San Diego County 86; total for the day 258. Did not hunt by the roadside anywhere. The wind was very bad between seven and nine P. M. and in San Gorgonio Pass.

P. c. annectens	M,	DOR,	Chollas Hts	(grass)
P. c. annectens	L,	DOR,	Alpine	(brush)

M. lateralis	M,	DOR,	Descanso	(brush)
A. e. occidentalis	L,	DOR,	Jacumba	(brush)

C. cerastes—A large specimen found on the road, unhurt. It was now dusk and windy. Desert surroundings; half way between Kane Springs and Westmoreland, Imperial Co.

C. cerastes	S,	DOR,	Arroyo Grande	(desert)
C. cerastes	S,	DOR,	Arroyo Grande (saved this specimen)	(desert)
C. cerastes	S,	DOR,	Tule Wash (very windy here)	(desert)

A white snake was seen on the road but escaped without identification.

C. cerastes	L,	DOR,	Arroyo Salada	(desert)
C. cerastes	M,	DOR,	Fish Spring Alive but hurt; died later.	(desert)
S. occipitalis	L,	DOR,	6 mi. S. of Coachella, Riverside County	(desert)
S. occipitalis	L,	DOR,	5 mi. S. of Coachella	(desert)
P. c. deserticola	S,	DOR,	4 mi. S. of Coachella	(desert)
S. occipitalis	L,	DOR,	Indian Wells	(desert)
S. occipitalis	L,	DOR,	10 mi. S.E. cf Palm Springs	(sand)
C. cerastes	S,	DOR,	Caught crossing the road 9 mi. S.E. of Palm Springs	(desert association)
P. decurtatus	L,	DOR,	8 mi. S.E. of Palm Springs (last seven specimens saved for collection)	(desert)
C. cerastes	S,	DOR,	4 mi. S.E. of Palm Springs	(desert)
A. e. occidentalis	M,	DOR,	2 mi. N.W. of Palm Springs	(desert)
A. e. occidentalis	L,	DOR,	Whitewater	(sand)
C. cerastes	M,	DOR,	5 mi. E. of Cabazon. (This must be near the range limit of this species in this pass).	

May 30, 1928

Today went to El Centro with C. Searl; out via Ramona, Julian, The Narrows, Kane Springs; returned via U. S. 80. Started at 8:40 A. M.; returned at 8:30 P. M. Cool and cloudy on the coast; warm and pleasant in the foothills; cold in the mountains; hot and windy in the desert. Total miles 273; miles in San Diego County 185; last 40 miles in darkness and not to be counted.

Hunted in the sandy and rocky wash beyond The Narrows for 40 minutes after lunch. Too hot; nothing seen but utas and they in the shade. Along the road from Yaqui Well to Borego we saw *Callisaurus* and *Dipsosaurus* perched on the rocks. The former stand high with stiff legs. Also saw *U. s. stejnegeri* and *Cnemidophorus t. tessellatus,* the latter not on rocks. Took several of all species.

Snakes were very disappointing.

P. c. annectens	M,	DOR,	Santee	(grass)
C. c. oreganus	S,	DOR,	Sutherland	(chaparral)

M. lateralis—Crossing the highway at Wynola. Lost him in the grass by the roadside, although we hunted carefully.

P. c. annectens	L,	DOR,	Wynola	(grass)
P. c. deserticola	L,	DOR,	Westmoreland	(cultivated fields)
A. e. occidentalis	S,	DOR,	Mountain Spring	(sand and rocks)
P. c. annectens	S,	DOR,	Boulevard	(fields and brush)
T. o. hammondii	M,	DOR,	La Posta	(stream and green grass)

June 8, 1929

Started for Yuma with P. M. K. at 2:15 P. M.; arrived at 9:45. 188 miles; 90 within San Diego County; Highway, U. S. 80. Cool at the coast; warm beyond.

P. c. annectens—A large specimen crossing the road at Grossmont, escaped into heavy brush before car could be stopped.

L. californiae	L,	DOR,	Viejas	(fields and dry grass)
P. c. annectens	S,	DOR,	Viejas	(fields and dry grass)
P. c. annectens	L,	DOR,	Viejas	(fields and dry grass)
C. c. mormon	L,	DOR,	Viejas	(fields and dry grass)
(via old grade; new grade closed for paving)				
T. o. hammondii	L,	DOR,	Buckman's	(brush)
R. lecontei	L,	DOR,	Mountain Spring	(rocks, sand)
C. cerastes	S,	DOR,	5 mi. E. of Coyote Wells, Imperial County	(desert sand)
P. c. deserticola	L,	DOR,	Seeley	(cultivated fields)

Stopped at El Centro for supper; started on for Yuma at 7:15; soon quite dark; some breeze but cool and comfortable.

C. cerastes—A small specimen caught crossing the road 26 miles west of Yuma.

C. cerastes—A medium specimen caught crossing the road 20 miles west of Yuma, where the Sand Hills begin. Another may have been seen; couldn't stop in time to be sure.

C. variegatus—Caught on the road 17 miles W. of Yuma and another lost.

The wind was now strengthening and sweeping sand over the road in a dense stream about a foot high; difficult to see the pavement. No sand lodges on the road. Have to drive carefully; one rear wheel off would mean a stop for the night.

P. c. deserticola	S,	DOR,	2 mi. W. of Yuma (saved this specimen)	(desert)

Hunted for 20 minutes, 12 miles west of Yuma with flashlights; no luck.

June 9, 1929

Left Yuma for home this morning at seven A. M. Clear and comfortably warm, as it was all through the desert; very cool for this time of year. Maximum temperature today at Yuma 94 deg. F.; hottest place Coyote Wells, probably under 100 deg. (3 P. M.). Reached home at 6:20 P. M. Total miles 186; within county, 89.

Not a live snake was seen today, but the lizard hunting was fairly good.

First stopped at the Sand Hills, 17 miles west of Yuma at eight A. M. Hunted until ten and then prepared specimens until 10:30 A. M. A fine cooling breeze was blowing. Saw many *Uma notata*; got two alive and shot 27; lost a few. Saw 6 *Uta graciosa* and got five, of which one was alive. No other lizards were seen in the sand hills.

From the tracks, I believe the umas run on their hind legs, but they are so fast I can't be sure. They will take to ground holes, where such holes are available, which is not often, as the sand drifts too much. But their usual method of escape is to run behind a bush, and dive into the sand, or continue on screened by the bush. It is difficult to see which they do, although the tracks often show. One was observed to jump out of a bush, where he seemed to have an observation post. The large specimens are wary and difficult to get.

The utas hang head downward on the greasewood bushes. They first hide by going around a branch like a squirrel; then, if pursuit continues, they take refuge in the roots of the bush. They change color notably; the one caught was dark gray on the branch, but changed to cream in the collecting sack.

Leaving the Sand Hills, many *Uma, Callisaurus* and *Dipsosaurus* were seen running about on the pavement, sometimes several together. Picked up a few. No *Uma* beyond the Sand Hills.

Stopped for half an hour 12 miles E. of Holtville, and collected *Callisaurus ventralis gabbii, U. graciosa* and *Dipsosaurus d. dorsalis.*

Next stopped eight miles E. of Holtville, just outside of the irrigated area. Collected *C. t. tessellatus.* Further on found a large *Crotaphytus wislizenii* DOR but worth saving.

Stopped at the foot of Mountain Spring grade to hunt *P. tuberculosus;* no luck. Got 3 *Uta mearnsi* and a *Sauromalus obesus.* The chuck was in a deep crack; had a hard tussle to get him out alive.

Stopped at two points near Boulder Park, at the top of the grade, but got nothing; it was too windy and cold. Left here at 3:40 P. M. for home.

Dead snakes were as follows:

P. c. deserticola	M,	DOR,	4 mi. W. of Yuma	(desert)
S. occipitalis	L,	DOR,	10 mi. W. of Yuma	(desert)
C. cerastes	M,	DOR,	Gray's Well	(desert)
T. marcianus	M,	DOR,	2½ mi. E. of Holtville	(irrigated fields both sides)
P. c. deserticola	M,	DOR,	6 mi. W. of El Centro	(irrigated fields)
P. c. deserticola	S,	DOR,	10 mi. W. of El Centro	(irrigated fields)
P. c. annectens	L,	DOR,	Guatay	(chaparral)
P. c. annectens	M,	DOR,	Descanso	(chaparral)
M. lateralis	L,	DOR,	Alpine (vineyard on one side, brush on the other)	

June 29, 1929

Went to Camp Fletcher this afternoon to get P. M. K. A moderately hot day in the valleys and foothills; cool in the mountains. Started at 12:45; returned at 5:15 P. M. 111 miles; no stops.

Few lizards were seen, mostly *U. s. hesperis* and *S. o. biseriatus.*

L. g. boylii	M,	DOR,	Fletcher Hills	(brush)
P. c. annectens	M,	DOR,	Riverview	(fields)

July 18, 1927

Drove in from Pine Valley Camp this morning between 6:30 and 8:30; a warm morning; 47 miles.

T. vandenburghi (saved this specimen)	M,	DOR,	Flynn Springs	(chaparral, rocks)
R. lecontei	L,	DOR,	La Mesa	(light brush)
R. lecontei	L,	DOR,	La Mesa (one was fresh, one dry)	(light brush)
S. g. hexalepis	M,	DOR,	La Mesa	(light brush)

July 21, 1928

Went to Pine Valley Camp this afternoon starting at two and arriving at three-thirty. A moderately cool day; 48 miles; nothing seen.

In the late afternoon drove to Cuyamaca; a few lizards were seen, no snakes; 42 miles.

In the evening found an adult *Bufo californicus* in the path near the Pine Valley cottage. Was about 2 ft. from a large trail of ants, on a dry, bare path.

Aug. 6, 1928

Had put up for the night at Bailey's, on Palomar Mountain, leaving the car in Doane Valley (the gas tank had been punctured the day before on a sharp stone in the center of the road, and had been sent back to San Diego for repairs).

Taylor, (Dr. E. H. of Kansas) was up at 5 A. M. and got two *Ensatina c. croceater* under the bark of logs.

After breakfast we walked back to the car in Doane Valley, about 3 miles. We made a good collection of lizards, *U. s. hesperis, Sceloporus occidentalis biseriatus, S. graciosus vandenburgianus* and *Eumeces skiltonianus.*

Saw a large *M. lateralis* in the brush but lost him. Farther on Wm. Lunceford and I found a fresh track and, following this up, spied a large *M. lateralis* in the brush coiled about 3 ft. above the ground and 10 ft. from the road. Shot him.

The car was repaired by 10:30 A. M. by mechanics from San Diego. We then went down Doane Creek, and got more lizards and a good series of *Rana boylii muscosa,* which had been discovered for the first time in San Diego County, the day before. One large *C. c. mormon* was seen and lost in the green grass. A large *T. o. hammondii* was caught in the creek. Altitude 4700 ft.

Started back to San Diego at 2:15 P. M., having hunted continuously from 8:30 to 1:15. Noted that *S. g. vandenburgianus* was not so plentiful as in the previous afternoon.

It was cool on the mountain, but hot from Warner's Ranch to Ramona. At Henshaw Dam, we picked up a large *T. o. hammondii* crossing the road; grass on both sides and mud from a spring.

We stopped on Mussey Grade to hunt for *Xantusia henshawi.* Saw two but got none. Shot one *Sceloporus orcutti.*

Reached home at 7:15 P. M.; mileage 101 today, but no dead snakes were seen on the road.

Aug. 23, 1930

Went out to Boulder Park on the edge of the county today to meet H. K. Gloyd and Hobart Smith. Started at 8:30 A. M. and reached there at 11:30. Hunted around Boulder Park and took *Xantusia henshawi, Uta stansburiana, Uta microscutata* and a brood of small *Sceloporus magister* (the latter all in one bush). While at Jacumba for lunch, there came on a hard shower with thunder. Returned to San Diego at 5:30; sultry weather, total miles 160, all but 2 in San Diego County.

P. c. annectens	S,	DOR,	Terrinitos	(brush)
C. c. oreganus	L,	DOR,	Live Oak Springs	(brush)
C. ruber	M,	DOR,	Jacumba	(light brush)

One snake was seen crossing the road at Flynn Springs. It was small, probably a garter, but escaped without identification.

Sept. 15, 1929

Drove from Gonzales to Fullerton today. Nothing seen. 380 miles, none in San Diego County.

Sept. 17, 1930

Started for San Francisco this afternoon driving as far as Los Angeles. A clear cool day. 134 miles; 61 in San Diego County.

P. c. annectens	S,	DOR,	Las Flores	(grass)
P. c. annectens	S,	DOR,	San Onofre	(fields)

Both were very small and certainly born this autumn.

Oct. 26, 1928

Went to Yuma with L. B. J., A. F. and C. G. A. Started at 2:30 P. M.;

arrived at 10:10 P. M. It was a moderately warm day, about 90 deg. F. in Imperial Valley. Miles in San Diego County 90; total miles 190.

No stops were made in the County, and no snakes were seen alive or dead along the road within this area.

Stopped for 15 minutes at Coyote Wells. Collected *U. s. stejnegeri*. Lost one *M. f. frenatus* (yellow phase) in the brush.

P. c. deserticola S, DOR, Meloland (irrigated fields)

C. cerastes—Caught a large specimen crossing the road (about 8:30 P. M.), 6 mi. E. of Holtville. It must have been hurt as it was dead the next morning.

C. cerastes S, DOR, 8 mi. E. of Holtville (desert)

Hunted carefully with flashlights near Pilot Knob but found nothing.

Oct. 27, 1926

Drove to Los Angeles in the morning; a fine clear day. 62 miles in the county; 132 total. No snakes were seen alive or dead.

Nov. 13, 1926

Drove to Santa Barbara starting in the morning; a fine clear day. 61 miles in the county; 237 total. Nothing seen.

Nov. 20, 1928

Started with family for San Francisco on business and to see the Stanford-U. C. game. A fine autumn day. Went via Golden State Highway. Stopped for the night in Modesto; miles in San Diego County 61; total for the day 467. No snakes seen alive or dead.

Dec. 4, 1928

This morning at 7:30 I started for Riverside on business, arriving at 10:40 A. M. Returned between 1:30 and 4:30 P. M. Total miles 248; miles in San Diego County, 140. Today was clear, but it had rained for two nights and one day previously.

Scaphiopus hammondii, Rainbow

P. c. annectens S, DOR, Rosedale (brush)
(a fresh specimen)

Dec. 18, 1927

This morning drove to Witch Creek and back with Dr. A. do Amaral. A clear cool day with snow in the mountains. Returned at noon so that he could catch a train. 84 miles; nothing seen.

APPENDIX 3.

FOR MAP MAKERS

Upon the completion of these notes I have come to realize that, notwithstanding their prolixity, I have given little information of the definite quality that is of service to those who wish to map, with accuracy, the range of a species. In the course of my excursions amongst the rattlers, I have had occasion to criticize mentally, some, who in their discussions of the subject, evidently had such information but failed to present it. So while it is impossible to publish a complete list of the locality records available to me, I give herewith certain notes, which, applied to Maps 2 and 3, will permit the ranges to be definitely outlined in our two southern border counties. In the cases of some of the more unusual forms all the available locality data are given, including a few points outside of San Diego and Imperial Counties. However, where zone limits are mentioned, it should be understood that these two border counties are referred to; the same lines may or may not hold beyond their boundaries.

The writer will deem it a privilege to furnish to any herpetologist, on request, maps of San Diego and Imperial Counties on which the known localities of collection of any desired species have been entered by appropriate legend.

L. humilis: From the coast line to the edge of the desert basin; also on the west bank of the Colorado River. Doubtful on the floor of the desert.

L. r. roseofusca: From the coast line to the lower edges of the desert foothills, excluding the mountains above 4500 ft.

D. a. similis: From the coast line to the top of the divide.

C. c. mormon: From the coast line to the divide and a few miles beyond. This being near the southerly limit of the species, which has not yet been taken in Lower California, the known San Diego County locality records are believed of interest. They are: La Jolla, Grantville (Orcutt), Mission Valley, Escondido, San Pasqual, Warner's Hot Springs, Miramar, La Mesa, Santa Ysabel, Wynola, Witch Creek, Ramona, Viejas, Deerhorn Flat, Campo, Palomar, Cuyamaca and Boulevard.

M. f. frenatus: From the coast to the Colorado River except the mountains above about 4000 ft. elevation.

M. piceus: Dulzura and Bingville are the only records to date. Evidently the species barely enters California from the south.

M. lateralis: From the coast line to the desert foothills; it descends only to about the 2700 ft. level on the east side of the divide.

S. g. hexalepis: The entire area except the mountains above 4000 ft. Through the courtesy of Mr. C. M. Bogert I received a specimen from Sespe Canyon, Ventura County, Calif., which constitutes, I think, a new northern record for the coastal region.

P. decurtatus: The desert and desert foothills from the Colorado River to an altitude of about 2500 ft. Probably absent from the irrigated areas of the Imperial Valley. The California localities known to me at present are as follows: San Felipe, La Puerta (San Diego Co.); 9 mi. N.W. of Kane Spring, 28 mi. S.E. of Oasis (=near Kane Spring), Arroyo Salada bridge on U. S. 99, 10 mi. W. of Yuma, Plaster City (Imperial Co.); Tahquitz Creek (=near Palm Springs), between Cabazon and Palm Springs, Palm Springs, 8 mi. S.E. of Palm Springs, 3 mi. S. of Coachella, 14 mi. W. of Blythe (Riverside Co.); 3 mi. S. of Needles, 4 mi. E. of Barstow (San Bernardino Co.); Inyokern (Kern Co.). The San Bernardino County records were received through the courtesy of C. M. Bogert.

A. e. occidentalis: From the coast line to the Colorado River, excepting the higher mountains.

P. c. annectens: From the coast to the lower reaches of the desert foothills.

P. c. deserticola: From the Colorado River westward to the edge of the desert foothills.

L. californiae: From the coast to the desert foothills stopping at about altitude 2500 ft. on the eastern slope.

L. g. boylii: From the coast to the edge of the desert; an occasional specimen is found in the sandy area a few miles from the foothills.

L. g. yumensis: I know of no authentic records from California except along the bank of the Colorado River in Imperial County. These are: Pilot Knob, 5 mi. N.E. of Fort Yuma, Fort Yuma, 3 mi. N. of Bard.

L. multicincta: The mountains above 4500 ft., with an occasional specimen from the higher foothills. San Diego County records are as follows: Palomar, Montezuma, Julian, Pine Hills, Cuyamaca, Cuyamaca Peak, Laguna, Guatay and Dulzura.

R. lecontei: From the coast to the western edge of the desert basin but excluding the mountains above about 4000 ft. elevation. It is quite likely to be found in the Imperial Valley.

S. occipitalis: From the Colorado River westward to the desert foothills at least to an altitude of 2500 ft. There is a doubtful locality record on the western side of the range.

S. episcopa: From the Colorado River to the lower fringe of the foothills. The following records are available: Heber, Seeley, Imperial, El Centro and Dixieland in Imperial County, and Carrizo on the eastern edge of San Diego County.

C. cinctus: I am unable to add new records to the two California localities hitherto reported: Fort Yuma, Imperial County; and Owens Valley, Inyo County.

H. ochrorhynchus: From the coast line to the lower edge of the foothills on the east slope. It is likely to occur in isolated rocky areas between the desert foothills and the Colorado River.

T. s. infernalis: The coast and valley areas in San Diego County as far south as the San Dieguito River. The following localities have been recorded: Mouth of the San Mateo River, Monserate, Bonsall, San Luis Rey, San Pasqual, and Rancho Santa Fe. In Riverside County I have taken it as far south as Temecula.

T. o. hammondii: From the coast to the fringe of the desert foothills as far down as permanent water is present. Carrizo is the most easterly point from which the species has been reported.

T. o. elegans: Has been found only in Kitchen Creek on Laguna Mountain. The classification is not final.

T. marcianus: The irrigated area in the Imperial Valley and the bank of the Colorado River. Definite localities are: Fort Yuma, 8 mi. E. of Picacho, Bard, Holtville, Seeley and Dixieland, all in Imperial County .

T. eiseni: From the coast to the desert foothills, at least as far down on the east slope as the 1500 ft. contour, but excluding the mountains above about 4000 ft. Definite San Diego County localities are: La Jolla, San Diego, Chollas Hts., Bonita, Poway, La Mesa, Spring Valley, Grossmont, Lyons Valley, Deerhorn Flat, Witch Creek, Descanso, Campo, La Puerta, Sentenac Canyon, and Yaqui Well. The Los Angeles Museum has specimens from Sespe Canyon, Ventura County, Calif.; and 2 miles north of Socorro Beach, Lower California. The latter constitutes a new southerly record. I have no records from Imperial County.

T. vandenburghi: From the coast to the westerly fringe of the desert, but excluding the mountains.

C. atrox: From the Colorado River to the lower fringes of the desert foothills.

C. cerastes: From the Colorado River to the desert foothills, including isolated sandy areas in the foothills at least to an altitude of 1900 ft. Probably scarce or absent in the irrigated section of the Imperial Valley.

C. ruber: From the coast to the westerly fringe of the desert but probably rare or absent from the mountains above 5000 ft.

C. c. mitchellii: From the westerly edge of the granite-chaparral area across the mountains to the westerly fringe of the desert. Also on the west bank of the Colorado. An occasional stray is found in the coast and valley zones.

C. c. oreganus: From the coast to the desert foothills down to an altitude of about 2000 ft. on the easterly slope including the highest mountain peaks in San Diego County.

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FIGURES 3 TO 8

Typical San Diego and Imperial County Associations and Habitats.

(See also Maps 2 and 3)

FIG. 3. INLAND VALLEYS AND MESAS

Fields and brush

(Top Right)

FIG. 4. FOOTHILLS

Granite and chaparral

(Bottom Right)

FIG. 5. MOUNTAINS

Forest

(Top Right)

FIG. 6. DESERT FOOTHILLS

Barren rocks

(Bottom Right)

FIG. 7. DESERT
Cacti and thorny shrubs
(Top Right)

FIG. 8. DESERT
The Sand Hills
(Bottom Right