P

BULLETINS

OF THE

Zoological Society of San Diego

No. 22

Classification and Ranges
of the Gopher Snakes of the Genus *Pituophis*
in the Western United States

By L. M. KLAUBER

Consulting Curator of Reptiles, Zoological Society of San Diego

SAN DIEGO, CALIFORNIA

May 15, 1947

Zoological Society of San Diego

Founded October 6, 1916

* * *

BOARD OF DIRECTORS

C. L. COTANT, *President*

L. M. KLAUBER, *First Vice-President*

JOHN P. SCRIPPS, *Second Vice-President*

FRED KUNZEL, *Secretary*

ROBERT J. SULLIVAN, *Treasurer*

F. L. ANNABLE, DR. T. O. BURGER, GORDON GRAY

L. T. OLMSTEAD, T. M. RUSSELL

MILTON G. WEGEFORTH

* * *

STAFF OF ZOOLOGICAL GARDEN

EXECUTIVE SECRETARY, MRS. BELLE J. BENCHLEY

GENERAL SUPERINTENDENT, RALPH J. VIRDEN

VETERINARIAN, DR. ARTHUR L. KELLY

SUPERVISORS:

Grounds, B. E. HELMS

Birds, KARL KOCH

Reptiles, C. B. PERKINS

Mammals, HOWARD T. LEE

Curator of Publications, KEN STOTT, JR.

Education, MRS. JACQUELINE SCHERMERHORN

Food Concessions, LISLE VINLAND

Purchasing Agent, CHARLES W. KERN

BULLETINS
OF THE
ZOOLOGICAL SOCIETY OF SAN DIEGO

No. 22

CLASSIFICATION AND RANGES
OF THE GOPHER SNAKES OF THE GENUS *PITUOPHIS*
IN THE WESTERN UNITED STATES

BY L. M. KLAUBER
Consulting Curator of Reptiles
Zoological Society of San Diego

SAN DIEGO, CALIFORNIA

MAY 15, 1947

Digitized by the Internet Archive
in 2017 with funding from
IMLS LG-70-15-0138-15

TABLE OF CONTENTS

	<i>Page</i>
Introduction	7
Variability in <i>Pituophis</i>	7
<i>Pituophis</i> Scale Peculiarities	10
Classification of Western Subspecies.....	11
<i>Pituophis catenifer catenifer</i> (Blainville)	12
<i>Pituophis catenifer annectens</i> Baird and Girard.....	21
<i>Pituophis catenifer deserticola</i> Stejneger.....	27
<i>Pituophis catenifer affinis</i> Hallowell.....	39
Ecological and Field Notes.....	48
Ecological Preferences	48
Seasonal and Daily Activity.....	51
Refuges	53
Temperament	54
Food	54
Enemies	56
Reproduction	57
Aberrant Specimens	59
Scale-Count Synopsis	62
Phylogeny	66
Keys	69
Acknowledgments	74
Summary	74
Bibliography	75

Fig. 1. Map Showing the Ranges of the Subspecies of *Pituophis catenifer*.

CLASSIFICATION AND RANGES OF THE GOPHER SNAKES
OF THE GENUS *PITUOPHIS*,
IN THE WESTERN UNITED STATES

By LAURENCE M. KLAUBER,
Consulting Curator of Reptiles, Zoological Society
of San Diego

INTRODUCTION

Recently, in surveying the gopher snakes of the genus *Pituophis* in Baja California and the coastal islands, I had occasion once more to consider the distribution and nomenclature of our western forms. Notwithstanding the revisions of Van Denburgh and Slevin (1919), Van Denburgh (1920, 1922), and Miss Stull (1932, 1940), certain problems of the validity of subspecies, and their differentiation and ranges, have remained unsettled. Upon these questions new accessions of specimens from critical areas have shed some light, and the conclusions which follow have been based on these expanded collections. I shall discuss nomenclatorial and systematic problems; the variability and trends within each subspecies; the differentiation from, and relationship with, adjacent subspecies; and ranges and areas of intergradation. I shall touch *sayi* only incidentally. Our California collections of this subspecies are limited, and I did not wish to undertake an extensive borrowing campaign, nor have I had any field experience with it.

VARIABILITY IN *Pituophis*

Anyone who hopes to devise a key which will always segregate these western gopher snakes properly, is doomed to disappointment. They seem to be particularly difficult to fit into nomenclatorial pigeonholes. We have the usual failure of characters to change simultaneously, so that the boundary between two subspecies will fall in one location if based on one character, but is shifted considerably if based on another. Yet we must employ these summations of characters, otherwise the key will too often fail. These difficulties are accentuated by the fact that, although ecological gradients in this area are likely to be steep—which should lead to sharp lines of differentiation—there is considerable ecological interweaving. This tends to break a population up into noncontiguous groups of similar characteristics, or at least sufficiently alike so as to prevent a nomenclatorial recognition of the smaller divisions.

In general, *Pituophis* exhibits a lack of plasticity in squamation but has considerable variability in pattern. Scale changes—in ventrals, for example—follow clines so gradually that the usual variability within any homogeneous local population tends to obscure intersubspecific differences. Scale

rows, ventrals, and subcaudals, as well as labials, oculars, and other head scales, while occasionally affording distinguishing characters which are applicable in terms of averages, often fail with respect to individuals, and are thus seldom useful in keys. The same is true of blotch counts and blotch conformation—aberrant specimens are to be found in nearly every local population. Differences in tail length, while important, are often inconclusive in allocating individuals (Klauber, 1943, p. 40). These are not arguments against the recognition of subspecies which, at their centers of dispersal, are definitely different and readily identifiable with respect to the great majority of individuals, but they do make necessary the use of localities as a part of the operation of a key; ignoring geography results in such wide overlaps in ranges that the definitions become of little practical interest. For example, Miss Stull (1940), in rigidly following her key, locates specimens of *annectens* as far north as the Pit River in northeastern California, and correspondingly carries *catenifer catenifer* as far south as San Diego. This makes an overlap of 650 miles in the ranges of these two subspecies and leaves a pure *annectens* range only 180 miles in length, all in Baja California.

Hence, I deem it more practical to deal with populations as units, without too much attention to the few individuals that stray from the mode. Boundaries between subspecies are located by finding where the majority of specimens change from one form to the other.

To gain some insight into the variability of *Pituophis* I have calculated the statistics of the largest homogeneous series available, a collection of *annectens* from western San Diego County. These data, which are set forth in Table 1, show that the variability in such a *Pituophis* population is substantially similar to other snake populations. Ventrals, as usual, with a coefficient of variation of about 2 per cent, comprise the most stable character.

The coefficients of sexual divergence in per cent (Klauber, 1943, p. 11), as calculated from these statistics are as follows:

Scale rows at mid-body.....	- 2.62
Ventrals	- 2.74
Subcaudals	9.29
Body blotches	0.93
Tail spots	9.12

Negative figures indicate that the female counts are higher than the male. All of these divergences are found to be significant, with the exception of that of the body blotches; there is no proof of a real sexual difference in this character. Since the body blotches, unlike the tail spots, show no significant sexual difference, I have used this character—rather than the total of body plus tail—in the discussion of species differences and

TABLE 1
Statistics of San Diego County *P. c. annectens*

	Number of counts	Mean	Standard Deviation	Coeffi- cient of Variation, Per cent
Scale rows at mid-body				
males	158	32.41	1.368	4.22
females	154	33.27	1.378	4.14
sexes combined....	316	32.83	1.456	4.44
Scale rows at neck.....	100	30.32	1.341	4.42
Scale rows at base of tail..	100	24.07	1.283	5.33
Scale rows at mid-tail.....	100	9.03	1.053	11.66
Ventrals males	158	227.57	4.305	1.89
females	154	233.90	4.735	2.03
Subcaudals males	136	77.84	3.948	5.07
females	133	70.93	4.037	5.69
Supralabials	648	8.28	0.528	6.38
Infralabials	646	12.85	0.723	5.63
Preoculars	647	1.70	0.507	29.88
Postoculars	648	3.60	0.718	19.93
First temporals	555	3.55	0.831	23.39
Second temporals	436	4.01	0.573	14.30
Body blotches males.....	142	77.12	5.706	7.40
females..	136	76.41	6.611	8.65
Tail spots males	142	25.11	2.673	10.65
females	136	22.92	2.229	9.73

in the key; this simplifies differentiation and has the further advantage of securing useful data from specimens with incomplete tails.

The adult coefficient of sexual dimorphism in tail length in this *annectens* series was found to be 11.8 per cent (*loc. cit.*, p. 47).

For comparison with these statistics of a homogeneous series, there are presented in Table 2 the coefficients of variation derived from all the specimens of each subspecies available to me. As might be expected, these, because of the effect of intrasubspecific variation, are usually somewhat higher, for each character, than in the San Diego series of *annectens*. It will be observed that there is a considerable character uniformity in the values of the coefficients.

In this, and the following studies, I have not separated the sexes in considering the tail spots, although there is some sexual dimorphism as has been shown in the *annectens* example.

TABLE 2
Coefficients of Variation in Per Cent
in *Pituophis catenifer* Subspecies

	<i>Catenifer</i>	<i>Annectens</i>	<i>Deserticola</i>	<i>Affinis</i>
Scale rows	4.38	4.49	5.07	4.65
Ventrals males	2.07	2.09	3.09	3.10
females	3.01	2.37	3.28	2.94
Subcaudals males	6.70	4.91	4.97	5.24
females	6.80	5.51	6.25	5.74
Supralabials	6.12	6.23	6.45	5.94
Infralabials	6.31	5.88	7.17	6.63
Preoculars	17.82	28.78	25.96	31.96
Postoculars	17.58	19.22	18.93	17.23
Body blotches	15.14	8.69	11.33	12.72
Tail spots	17.64	11.93	14.30	16.91

The coefficients of sexual divergence in per cent in these series are as follows:

	Ventrals	Subcaudals
<i>Catenifer</i>	— 2.47	10.29
<i>Annectens</i>	— 2.34	9.49
<i>Deserticola</i>	— 2.20	10.87
<i>Affinis</i>	— 2.11	11.15

A consistency in the sexual differences will be noted. It is my opinion that the true differences between the sexes are probably slightly greater than here shown, since every error in sexing a specimen reduces the apparent difference. Undoubtedly some errors of this kind have crept in, particularly in the case of juveniles.

Pituophis SCALE PECULIARITIES

The genus *Pituophis* differs from most colubrid genera in several particulars. The dorsal scale rows are relatively high in number (usually 31 to 35) and irregular in arrangement. Rows approaching suppression are frequently dropped and then reappear for a few scales. An even number of rows at mid-body is not unusual. Sexual dimorphism in tail length and subcaudals is low. There is a considerable variability in the prefrontal scales, which, in our United States species, usually number 4, instead of 2 as in most colubrids. These 4 may be fused or divided in a number of ways; not infrequently the outer two are transversely divided to form scales which may be counted as additional loreals, although I rather prefer to

consider them as increasing the prefrontals to 6. An azygos scale may be present at the posterior ends of the prefrontals; sometimes even this is subdivided into two or three. The parietals are usually quite irregular. An extra subloreal is sometimes present; I have considered any extra scale a loreal which contacts the regular loreal, except the outer end of a prefrontal. Sometimes—particularly in western Mojave Desert specimens of *deserticola*—there is an extra scale between the upper preocular and the labials, which, as it does not touch the orbit, cannot be considered an ocular, nor does it contact the regular loreal and therefore should not be counted as an extra loreal.

Usually one labial contacts the eye; in a few specimens two make this contact. In the Coronados Island form *coronalis*, there is generally a complete row of scales between the supralabials and orbit, and this arrangement is not uncommon in *deserticola* in some areas. In these cases, although true suboculars are present, no attempt is made to segregate them from postoculars, all being considered the latter. I have not been able to find any consistency in the contact, or lack of contact, between the upper postocular and the adjacent parietal.

The temporals are usually so irregular in size and arrangement in *Pituophis* that they are difficult to count—the second row particularly—without setting out rather elaborate rules. They seem of little value in classification.

CLASSIFICATION OF WESTERN SUBSPECIES

The following discussion, by subspecies, summarizes my views as to the classification, relationships, and ranges of our western forms.

In the descriptions of the several subspecies which follow, I have given some statistics of the scale and blotch variability within each subspecies. This ignores the valid criticism that, where there are territorial clines, the calculated mean and dispersion of any character in a subspecies taken as a whole will obviously depend largely on the territorial distribution of the sample. I have subsequently mentioned some of the more important of these territorial differences.

With respect to the more variable counts (ventrals, subcaudals, body blotches, and tail spots) I have in most instances, when stating the range of variation, deliberately omitted mentioning the limiting specimens, which, when large series are dealt with, are too often freaks or the results of a worker's errors. Instead, I have given the calculated interquartile range and also the range that will include all except those which seem to me quite likely aberrants or intergrades. The first spread should include about half the specimens in a population; the second, which I have called the normal range, about 95 per cent. I think these limits are more useful to the student than the absolute range of the particular sample available to me, for the rare aberrants unnecessarily widen the overlaps.

The reasons why all of the forms included in this paper are considered subspecies of a single species, *Pituophis catenifer* (Blainville), 1835, will

be apparent from the discussions, it being pointed out that each intergrades with one or more of the others. The Baja California and island subspecies have been covered in previous papers (Klauber, 1945a, 1945b). Subspecies of *catenifer* are the only *Pituophis* found in the western United States; *deppei*, contrary to the opinion expressed by Miss Stull, does not occur in this area (Klauber, 1941, p. 58).

Burt (1935, p. 381) has suggested that there may be intergradation between *Pituophis catenifer sayi* and *Pituophis melanoleucus rithveni* in eastern Texas, although the evidence is considered inadequate by Miss Stull (1940, p. 76). I have no new material bearing on this problem, but it should be noted that if such intergradation be eventually demonstrated, the older name *melanoleucus* (Daudin), 1803, will supplant *catenifer* (Blainville), 1835, as the specific name of all the forms which are the subject of the present paper.

It is not impossible that intergradation may eventually be shown to exist between *sayi* and *jani*. It may be significant that the most southerly available specimen of *sayi* (Carnegie Museum 9511, 3/4 mi. inland from Tamesi River, in Veracruz or Tamaulipas) has two labials in contact with the orbit, although it has 4 prefrontals.

***Pituophis catenifer catenifer* (Blainville)**

PACIFIC GOPHER SNAKE

Figure 3

- 1835. *Coluber catenifer* Blainville, Nouv. Ann. Mus. Hist. Nat. Paris, vol. 4, p. 290. Type locality "Californie"; type specimen in Paris Museum of Natural History.
- 1853. *Pituophis catenifer*, Baird and Girard, Cat. N. Amer. Rept., part 1, p. 69.
- 1853. *Pituophis Wilkesii* Baird and Girard, Cat. N. Amer. Rept., part 1, p. 71. Type locality Puget Sound, Ore. [=Wash.; validity of locality doubtful]; type specimen USNM 5471.
- 1853. *Pityophis Heermanni* Hallowell, Proc. Acad. Nat. Sci. Phila., vol. 6, p. 236. Type locality Cosumnes River, California; type specimen unknown.
- 1859. *Pityophis catenifer* Hallowell, Report on Reptiles of Route, in: Explor. and Surv. for Railroad Route, etc., vol. 10, part 4, p. 24.
- 1901. *Pityophis catenifer catenifer* Brown, Proc. Acad. Nat. Sci. Phila., vol. 53, p. 53.
- 1917. *Pitnophis catenifer catenifer* Grinnell and Camp, Univ. Calif. Pubs. Zool., vol. 17, No. 10, p. 193.
- 1920. *Pitnophis catenifer heermanni* Van Denburgh, Proc. Cal. Acad. Sci., ser. 4, vol. 10, no. 1, p. 16.

Diagnosis.—A subspecies having a proportionately longer tail than any other except *annectens* and its island derivatives. It has more blotches than the subspecies further inland, and has a characteristic suffusion of grayish punctations on the sides and under the tail, which *deserticola* and *affinis* lack. From *annectens* it differs in having fewer ventral scales, on the average, and more regularly formed and better-separated anterior blotches. In most areas it has fewer blotches than *annectens*, and these are more often brown anteriorly, as compared to black in *annectens*. It usually lacks the twin subcaudal stripes of *fuliginatus*, the complete ring of ocular scales of *coronalis*, and averages more scale rows than *pumilus*.

Material.—Pattern data have been available on about 500 specimens, and scale counts on 350.

Nomenclatorial and Systematic Problems.—Some doubt exists as to whether de Blainville's type specimen of *catenifer* came from central or southern California. The original description is quite inadequate and the figure poor; and unfortunately Bocourt, in his study of the specimens in the Paris Museum (1888, p. 670), gave more attention to newly acquired material collected by de Cessac than to de Blainville's type. Baird and Girard (1853, p. 69) were the first to differentiate the two coastal California subspecies. They assigned de Blainville's name *catenifer* to the northern and the new name *annectens* to the southern form. There are some indications that de Blainville's specimen came from southern California, but they are not sufficient to warrant upsetting a nomenclatorial usage of such long standing. If the name *catenifer* were assigned to the southern coastal subspecies, *wilkesii* Baird and Girard, 1853, would be available for the northern, although the type locality, given as Puget Sound, Ore. (= Wash.) is probably erroneous, since gopher snakes evidently do not range that far north on the coastal side of the Cascades. But the description and the figure in Girard's atlas (plate 9, 1858) show that the type was what we now call *catenifer*, rather than *deserticola*.

The most important question in the classification of the gopher snakes of central and northern California is the desirability of segregating a coastal from an inland subspecies. Van Denburgh (1920, p. 16) revived the name *beermanni* Hallowell, 1853, type locality Cosumnes River, for the snakes of the Klamath, Sacramento, western Sierra, and northern San Joaquin areas. He segregated them from *catenifer* of the coast based on their fewer dorsal blotches—48 to 70, with a mean of 57.6, as compared to 56 to 93, with a mean of 70 in *catenifer*. Miss Stull (1932, p. 5; 1940, p. 141), finding much overlapping between the two, deemed the differentiation to be unwarranted. New material, which has only recently become available, indicates that there is a significant difference between the coastal and the inland snakes, but not in accordance with the territorial division suggested by Van Denburgh; for the snakes with the high blotch counts are found to occupy a much narrower coastal belt than he

suggested. We have the following data on the numbers of body blotches, given in terms of the mean and its standard error, for several areas:

Area	Number of Specimens	Mean Body Blotches
Coastal San Luis Obispo and Monterey counties.....	21	79.45 ± 1.93
Inland San Luis Obispo and Monterey counties	29	65.81 ± 1.55
Santa Cruz County (coastal)	8	74.00 ± 2.52
Santa Clara County (inland)	54	66.06 ± 0.90
San Mateo County (inland specimens only)	38	63.34 ± 0.90
North Bay (Marin, Napa, Sonoma, and Lake counties)	58	75.05 ± 1.16
East Bay (Contra Costa and Alameda counties)	63	61.74 ± 0.96
Sacramento Valley	32	61.50 ± 1.16
Central San Joaquin Valley.....	22	54.14 ± 1.23
Southern San Joaquin Valley.....	101	58.54 ± 0.66
Sierra Foothills	19	57.66 ± 1.22

It will be observed that the snakes with the high average counts (above 70) are restricted to areas closely contiguous to the ocean—to what might be termed the fog belt. There is a greater reduction in blotch counts in crossing the mountain ranges which border the ocean—the Santa Lucia and Santa Cruz mountains, for example—than in crossing the Coast Range itself. Thus, if *catenifer* be subdivided, even the snakes from the vicinities of Palo Alto and Berkeley would fall into the *beermanni* classification.

I find that the standard deviations of the blotch counts of these groups run from $5\frac{1}{2}$ to $8\frac{1}{2}$ blotches, the coefficient of variation being from $8\frac{1}{2}$ to 12 per cent, with an average of 10.8 per cent. Populations whose means are separated by about two standard deviations might well be recognized as subspecies, for in such cases the overlapping, that is, the per cent of each population falling within the range more properly belonging to the other, would be about 16 per cent. But as a practical matter in the present instance, we have the further complication of an interweaving of ecological areas. For example, even at the upper end of Carmel Valley, although on the coastal side of the Santa Lucias, the snakes have inland characteristics. Others from further inland, but higher altitudes, are more like coastal specimens. Thus the practical difficulties of assigning territorial limits to two subspecies would be great, one having a very long, narrow, and ill-defined range, and the segregation of individual specimens too often confusing. I therefore concur with Miss Stull in the non-recognition of *beermanni*.

It might be thought feasible to assign the coastal snakes averaging above 70 blotches to *annectens*, this being justified, not only by their high blotch counts, but the color of their anterior blotches, which are generally black, as compared to the customary brown of the inland specimens. However, the lower ventral scale counts and the more complete separation of the anterior blotches in these northern specimens, as compared to the true *annectens* of southern California, makes this undesirable.

It will be recalled that both Van Denburgh and Miss Stull assigned the snakes of the southern San Joaquin Valley to *deserticola* rather than *catenifer* (or *beermanni*). It is true that they have somewhat higher ventral counts than those from farther north, or westward across the mountains, but there is no place in the Valley where one can suggest a consistent subspecific dividing line, the change being very gradual. I prefer to classify on a basis of pattern, assigning to *deserticola* the areas where the adults normally have black anterior blotches, which form a longitudinal band enclosing the light interspaces; whereas *catenifer* has brown anterior blotches which are not usually confluent. This throws all of the San Joaquin Valley snakes, together with those of the Tehachapi Mountains, into *catenifer*, the intergrades being on the desert slope of the mountains.

Also, in the northwest, I concur with Cowan (1936, p. K21) that all of the snakes of British Columbia should be assigned to *deserticola*. The only Washington records of *Pituophis* west of the Cascades—Puget Sound, Fort Steilacoom, and Sumas (on the Canadian border)—are all highly doubtful, for they were made in the days when museum specimens were credited to points of shipment rather than collection, the latter being usually unknown. Prof. J. R. Slater writes me that, while he has some circumstantial evidence of the existence of gopher snakes in the area south of Olympia, he has so far been unable to obtain one, nor does he know of any recent specimen of unquestioned locality from west of the mountains in Washington. Until new valid records from cismontane Washington are available, I think that only *deserticola* should be included in the fauna of the state, since the snakes found east of the Cascades, while showing local divergences and variations, are more like *deserticola* than *catenifer*.

In Oregon *catenifer* does occur along the coast. It may be segregated from trans-Cascade *deserticola* by its higher blotch counts, fewer ventrals, brown anterior blotches, and the gray suffusion in the ground color, particularly on the sides of the body and the underside of the tail. In this state there is a broad zone of intergradation between *catenifer* and *deserticola*, and the snakes from this region are difficult to allocate.

Description of the Subspecies.—The scale rows at mid-body are usually 31 or 33, the former predominating in the ratio of about 3 to 2. Occasionally they number 29 or 35, and in one case 37. Specimens with even numbers of rows are not unusual. The dorsal rows are strongly keeled, but gradually become smooth on the sides; from 6 to 8 of the lowest lateral rows are generally smooth. Paired apical scale pits are evident.

The ventrals in the males average $219.11 \pm .31$; the interquartile range is 216.0 to 222.2.* All but a few specimens fall between 207 and 236. The female mean is $224.60 \pm .55$, with an interquartile range of 220.0 to 229.2. Most specimens fall between 212 and 241. The anal is undivided. The subcaudals in the males average $69.20 \pm .33$; the interquartile range is from 66.0 to 72.4; the normal range is 59 to 79. The mean in the females is $62.38 \pm .36$; interquartile range 59.5 to 65.3; almost all specimens fall between 54 and 69.

The supralabials most often number 8, but nearly 30 per cent of the specimens have 9. Specimens with 7 or 10 have been observed, but are rare. Usually the fourth touches the orbit (or the fifth if there are 9), although rarely a complete row of oculars intervenes. The next to the last supralabial is the largest of the series. The infralabials are most often 13 (53 per cent), 12 (26 per cent), or 14 (12 per cent); the over-all range is 10 to 15. The largest is usually the seventh, followed by the sixth. The initial pair meet on the median line. Behind come first a large pair of genials, medianly in contact, followed by a smaller divergent pair with 2 or 3 rows of gulars between.

The rostral is generally somewhat wider than high, although the dimensions may be equal. Viewed from above it is slightly convex, giving the snout a blunt appearance; it is not raised above the surrounding scales. Its upper point separates the internasals for about half their depth. Most specimens have four prefrontals, two outer and two inner; however, these may be fused or divided irregularly so that the total varies from 2 to 7. An azygos scale is present in about one-fourth of the specimens; occasionally this also is split. The supraoculars, which usually contact the outer prefrontals, are widest posteriorly. The frontal is wedge-shaped and widest anteriorly: it penetrates between the parietals to about a fourth of their depths. The parietals are subtriangular in shape, quite irregular, and with roughened surfaces. The nasals are subequal; they meet on a suture which is shorter than their outer edges. There is a trapezoidal loreal on either side; its lower edge is the longer of two parallel sides, forming a point which indents the upper preocular. Occasionally there is a small subloreal. The preoculars may be single or paired; 87 per cent of the specimens have two on a side. Where there are two the upper is always much the larger. The postoculars, which are subequal, may number from 2 to 5; about 59 per cent of the specimens have 3, followed by 35 per cent with 4. The temporals are irregular in size and arrangement; those in the first row number from 2 to 6, and in the second from 3 to 6.

The largest specimen I have measured was 1718 mm. long. Mr. Weldon D. Woodson has informed me of a specimen collected near O'Neals, Madera County, which measured 1854 mm. (6 ft. 1 in.), and weighed $4\frac{1}{4}$ lbs. The length at birth is normally about 370 mm. The ratio of the length of the tail to the length over-all averages about .157 in adult males and

* The figure following the sign $\pm$ is the standard, not the probable, error of the mean.

.143 in the females, thus falling between *annectens* and *deserticola*. There is some territorial variation.

Catenifer is essentially a brown-blotched snake, with much incidental streaking and stippling in the areas between blotches, so that they are not strongly contrasting, much less so than in most *deserticola* and *affinis*. The main dorsal blotches are usually medium-brown anteriorly, although often edged with black or dark-brown. Anteriorly they are relatively small, and somewhat irregular, although they seldom touch the secondary series at more than a few points, being more completely separated from each other and from the interspaces than in *annectens*. The anterior interspaces are from 1 to 2 scales wide (along the snake). The blotches of the main series increase in size posteriorly, and become more distinct and in greater contrast with the ground color. The blotches may be round or square. There are usually 4 series of auxiliary, alternating blotches on each side. One of these secondary series often comprises attenuated streaks on the neck, although they are seldom as long as in *deserticola*. The lowest series occupies the outer edges of the ventrals. These auxiliary series are usually darkest anteriorly.

The ground color is buff, clay, or light-brown, but throughout the spaces between blotches it is much stippled and suffused with gray or brown. While some of this superimposed color is applied to the scale keels, it is by no means restricted to them, especially on the sides, where there is little contrast between blotches and the spaces between. The ventral color is cream or yellow, with some blotches forward, and increasingly prevalent gray punctations toward the tail, on the underside of which some blotches may also be present. The grayish suffusion, laterally on the body and on the underside of the tail, is characteristic of this subspecies and *annectens*, and will often serve to distinguish them from *deserticola* and *affinis*.

The head is usually brown above, and buff on the sides and below. The customary *Pituophis* cross-stripe, which follows the suture between the frontal and prefrontals, is sometimes evident as a broad, brown band, but is often obscured by the general brown color of the head. The postocular stripe to the angle of the mouth is also brown. The sutures between labials are less often dark in this subspecies than the others; the one below the eye is, as usual, accentuated.

The body blotches in *catenifer* average $64.76 \pm .45$; the interquartile range is 58.1 to 71.4; most specimens fall between 47 and 90, although the over-all range is 41 to 99. The extreme specimens are from territories near where intergradation takes place with *deserticola* on the one hand or *annectens* on the other. The tail spots have a mean value of $20.47 \pm .17$; an interquartile range of 18.0 to 23.0; and a normal range of 14 to 31. The extreme range is 12 to 36.

Intraspecific Trends.—The non-recognition of *beermanni*, which I have already discussed, renders *catenifer* more comprehensive and therefore the more subject to intraspecific variation.

Among the coastal snakes there is a moderate decrease in ventrals from south to north, continuing the tendency noted in *annectens*. It is probable that the drop from San Luis Obispo County to coastal Oregon is about 12 scales or more. However, the snakes with the highest ventral counts are those from the southern end of the San Joaquin Valley, where the influence of *deserticola* is evident. The same effect is noted in scale rows, the San Joaquin Valley being the only section of the range where 33 or more rows predominate over 31 or less. A contrary trend is observable in the subcaudal scales, for the San Joaquin Valley snakes are low; this is explained by the fact that *deserticola* is a shorter-tailed subspecies, with fewer subcaudals, than *catenifer*.

No important trends are observable in labials or oculars. *Catenifer* has a slightly higher percentage of paired preoculars than *annectens*, but has a lower percentage of specimens with 4 postoculars (instead of 3).

I have already pointed out, in discussing the *heermanni* problem, that the number of body blotches in *catenifer* declines considerably in proceeding inland from the coast, the lowest counts being met in the San Joaquin Valley, again a *deserticola* influence. That this is a matter of such an influence, rather than a simple ecological effect produced by the similarity of conditions in the western Mojave Desert and the arid southern San Joaquin Valley, is shown by the fact that the snakes of the intervening Tehachapi Mountains also have low counts, notwithstanding this is Upper Sonoran or Transition territory. The highest numbers are reached in the fog belt, particularly to the north of San Francisco Bay. A reduction is again evident further north in Oregon.

The coastal specimens also have black anterior blotches more frequently than those from the interior, and in other details of pattern show a closer affinity to *annectens*. Black blotches likewise are often seen in those areas where intergradation with *deserticola* occurs. In the coastal specimens the anterior interspaces between blotches are usually quite narrow, measured along the snake; they are generally wider in the inland snakes. The blotches are more nearly square toward the coast; in some Sierra areas they are quite round. The anterior side blotches tend to be longer in inland specimens. But none of these differences is consistent enough to warrant segregating *heermanni* as a subspecies.

In *catenifer* the youngest specimens are generally the darkest, a contrary condition from that existing in *deserticola*; however, in some coastal areas the adults of *catenifer* are darker than the young.

Relationships and Intergradation.—Intergradation with *annectens* will be discussed under the latter subspecies.

Catenifer intergrades with *deserticola* in two areas. The first is along the desert slope of the Tehachapi Mountains and the Sierra Nevada at least as far north as Walker Pass. North of here the mountains may be too high for the gopher snakes to cross.

The second is in the Lassen-Modoc area and from there northward into the Klamath district. This latter zone of intergradation is probably not continuous, but is effective through the mountain passes and saddles. It is a rather broad contact, and, until more specimens are available, it is impossible to define an exact boundary line.

Catenifer appears to me to be derived from *deserticola*, and in turn, became ancestral to *annectens*, although *annectens* now intergrades directly with *deserticola* in the Antelope, Apple, and Lucerne valleys at the desert foot of the San Gabriel-San Bernardino ranges. *Catenifer* is intermediate between the two in several important characters.

The island form, *pumilus*, is also an off-shoot of *catenifer*.

Range and Locality Records.—*Pituophis c. catenifer* occurs in Oregon, west of the Cascade Mountains, from Yamhill and Multnomah counties southward, and throughout California, west of the Sierra Nevada, as far south as the northern boundary of Santa Barbara County and the desert slope of the Tehachapi Mountains. It prefers the Lower Sonoran and Upper Sonoran Life Zones, and is not plentiful in the Transition Zone. While there are several old records from western Washington, its presence there is to be considered unverified.

Definite locality records are as follows:

OREGON: *Curry County*—3 mi. n. of Illahe, Solitude Bar, near Gold Beach; *Douglas County*—Roseburg, Camas Mts., Tiller (South Umqua River), 2 mi. w. of Drain; *Jackson County*—1½ mi. e. of Squaw Lake, 5 mi. e. of Ashland, 3 mi. w. of Phoenix, 2 mi. e. of Dark Hollow, Rogue River; *Josephine County*—Store Gulch, Grants Pass, Raine Falls (Rogue River); *Multnomah County*; *Yamhill County*—7 mi. n. of Sheridan.

CALIFORNIA: *Alameda County*—Sunol, Greenville, Altamont, Berkeley, Berkeley Hills, Leona Heights, Grizzly Peak, Strawberry Canyon, Oakland, Piedmont, Tassajero Creek (6 mi. nw. of Livermore), Livermore (also 6 mi. e., 6½ mi. ne., and 9 mi. se.), Mocha Creek (7 mi. se. of Livermore), Corral Hollow, Alameda, San Leandro, Hayward, Calaveras Reservoir, Mission Peak; *Amador County*—10 mi. wsw. of Plymouth; *Butte County*—Butte Creek, bet. Live Oak and Gridley, 1 mi. w. of Oroville, Gridley, Chico; *Colusa County*—Colusa (also 13 mi. e.), Arbuckle (also 9 mi. w. and 9 mi. nw.), Maxwell; *Contra Costa County*—Rodeo, Clayton, 5 mi. w. of Pittsburgh, Walnut Creek (also 2 mi. e. and 2 mi. sw.), Mt. Diablo, San Pablo Valley, Antioch, Moraga Valley, Richmond, Nortonville, Lafayette, Shoal Point, Black Hills (near Mt. Diablo), Kellogg Creek (near Byron), Marsh Creek (near Byron), Byron (also 3 mi. nnw.), Pine Canyon (Mt. Diablo), Orinda; *Del Norte County*—East Fork of Illinois River, Indian Creek; *El Dorado County*—Fyffe, Riverton, Placerville (also 4 and 12 mi. n.); *Fresno County*—Laton, Malaga, Bowles, Conejo (also 3 mi. w.), Herndon, Selma, Calwa, Fowler, Oilfields, Kings River Hatchery, Junction of North and South Forks of Kings River, Dunlap, Mercey Hot Springs, 6½ mi. ne. of Clovis, Coalinga (also 1 mi. w., 2 mi. e., and 9 mi. nw.),

Shell Camp (10 mi. ne. of Coalinga), 1 mi. e. of Big Creek, Trimmer (Kings River), Kings Ranch (24 mi. s. of Fresno), Fresno, Hammond, Dubbs Creek (s. Fork Kings River), Pitman Creek; *Glenn County*—Fruto, Winslow (5 mi. w. of Fruto); *Humboldt County*—Garberville, 4 mi. sw. of Coyote Peak, Humboldt Bay; *Kern County*—Ilmon (also 2 mi. s.), Weed Patch, Greenfield (also 4 and 5 mi. s.), Wheeler Ridge P.O. (also 4 and 5 mi. n.), Old River, Elk Hills, Wible, Gosford, Stevens (also 6 mi. sw.), Tupman, Strand, Bena, McKittrick, (also 2 mi. s.), Fellows, De-longha Hot Springs, Democrat Springs, Bealville (also 4 mi. w.), Maricopa (also 12 mi. e.), Lost Hills (also 4 mi. e.), Kernville, Reed Station, Slater, Weldon, Bodfish, Midoil, 3 mi. sw. of Caliente, Rosedale, Rowen, Saco, McFarland, Fort Tejon, Lebec, Stonybrook Retreat, Tehachapi, Monolith, Bakersfield (also 8 mi. ne.), Marcel, Walker Pass, Edison, Buttonwillow, Isabella, Delano, Thompson Canyon (Walker Basin), 3 mi. nw. of Blackwells Corner, Caliente Creek Wash (12 mi. e. of Bakersfield), Mt. Pinos, Rose Station; *Kings County*—Corcoran (also 5 mi. w.), Guernsey, Hanford, Stratford, Kettleman City, Tulare Lake; *Lake County*—Kelseyville, Lower Lake, Middletown, Cobb Valley, Hills nw. Rattlesnake Island (Clear Lake), Borax Lake; *Lassen County*—Petes Valley (*deserticola* intergrades); *Madera County*—Califa (also 5 mi. w.), Oakhurst, Berenda, Bisset's Ranch, Coarse Gold, Belleview, Raymond, Madera (also 3½ mi. ne.), O'Neals, San Joaquin Experimental Range (25 mi. e. of Madera); *Marin County*—Mailliard, Manzanita Station, San Anselmo, Inverness, ridge between Mill Valley and Muir Woods, Lagunitas, Point Reyes Station, Mill Valley, ½ mi. se. of Tocaloma (Lagunitas Creek), Nicasio, Fort Barry, Sausalito, Millerton Gulch (2¼ mi. ne. of Inverness); *Mariposa County*—El Portal, Wawona, Coulterville, between Kinsley and McCauleys Station, Pleasant Valley, Pohono Bridge (Yosemite Valley); *Mendocino County*—Hopland, Willits (also 10 mi. s.), Ukiah, 7 mi. n. of Branscomb, Cahto; *Merced County*—Los Banos (also 5 and 9 mi. w., and 5½ and 10 mi. e.), Santa Rita Park (also 3 mi. e.), Atwater, Snelling, Merced, Merced Falls; *Modoc County*—Canby, between Alturas and Davis Creek, Goose Lake Meadows (*deserticola* intergrade), Sugar Hill (*deserticola* intergrade), Dry Creek (Warner Mountains) (*deserticola* intergrade); *Monterey County*—Big Sur (also 15 mi. n.), Workfield, Bradley, Nacimiento, San Ardo, Santa Lucia, King City (also 14 mi. ne.), Wunpost, Chalk Peak, San Lucas, Carmel, Metz, Welby, Coburn, Soledad, Carmel Valley (also upper valley) Big Pines, Turner Creek (1 mi. w. of Devils Peak), Prattco, Marina, 3 mi. e. of Gigling Station, sw. slope of Junipero Serra Peak, Monterey, (also 4 and 10 mi. ne.), Mission San Antonio, 4½ mi. n. of Jolon, Carmel Cove, Mound Meadow (Point Lobos Reserve); *Napa County*—Napa (also 14 mi. n., 4½ mi. ne., 2 mi. sw., 14 mi. w.), Calistoga, Gordon Valley; *Placer County*—1 mi. e. of Newcastle, Applegate, Lander (near Colfax), ½ mi. ne. of Dutch Flat; *Sacramento County*—Rio Linda, Sacramento, 4 mi. se. of Folsom; *San Benito County*—San Juan, 3 mi. s. of Hollister, 6 mi. ene. of San Benito, 15 mi. s. of Paicines, Pinnacles Nat. Mon., 5 mi. se. of Indria, 8 mi. n. of Pinnacles; *San Francisco County*—San Francisco;

San Joaquin County—Mossdale Junction, Nilegarden, Manteca, Tracy (also 4 mi. w.), Dry Creek (n. of Lodi), Stockton; *San Luis Obispo County*—La Panza, Arroyo Grande, Simmler (also 5 mi. s. and 7 mi. se.), Edna, Pozo, Pismo, San Miguel, Palo Prieto Canyon, source of Salinas River, San Juan River, Indian Creek, Shandon (also 7 mi. se.), Creston; *San Mateo County*—Atherton, Burlingame (also 1 and 3 mi. w.), San Mateo, San Mateo Park, Pescadero, Millbrae, Millbrae Highlands, Woodside, Redwood City, Menlo Park, near Searsville Lake, Beresford; *Santa Clara County*—San Felipe Lake, San Martin, Palo Alto, East Palo Alto, Mayfield, Stanford University, Milpitas, Sargent, Gilroy, Pacheco Pass, Alma, Alum Rock Park, Coyote Creek, Stevens Creek Canyon, Coyote, Los Gatos, San Jose, Sunnyvale; *Santa Cruz County*—Santa Cruz, Soquel, Corralitos, Zayante Park; *Shasta County*—Baird, Fort Reading (= Redding), bank of Pit River, McCloud River; *Siskiyou County*—Fort Jones, Callahan, Shasta River (1 mi. above the mouth), 1 mi. e. of Grenada, Little Shasta River (10 mi. e. of Montague), west fork Cottonwood River (3 mi. sw. of Hilt), Fort Crook, Klamath Hot Springs (Beswick), Mount Shasta; *Solano County*—Soda Springs Creek, Tremont, Buddha Canyon, East Grizzly Island, Vacaville (also 3 mi. sw.), Montezuma; *Sonoma County*—Camp Royaneh (near Cazadero), Monte Rio, Guerneville, Petaluma, Duncans Mills, 1½ mi. n. of Quarries, Santa Rosa, Freestone, Cotati, 3 mi. e. of Jenner; *Stanislaus County*—Modesto, Newman (also 5 mi. w.); *Sutter County*—Butte Slough (West Butte); *Tehama County*—Tehama, Dales (Paynes Creek), Red Bluff (also 9 mi. se.), Lyonsville, Manton, Canes, Blue Tent Creek, Mill Creek; *Trinity County*—8 mi. e. of South Yolla Bolly Mt., 1 and 3 mi. e. of Mad River Bridge, 1 mi. s. of Norgaars Ranch, Horse Ridge (se. of Ruth), Hayford; *Tulare County*—Pixley, Ash Mountain Checking Station, Lemoncove, Lindsay, Exeter, Visalia, Richgrove, Tagus Ranch, Cross, Matchin, Tipton, Terminus, Sequoia National Park (near Headquarters), near Crystal Cave (Sequoia National Park); *Tuolumne County*—2 mi. s. of Mather, 8 mi. e. of Sonora; *Yolo County*—10 mi. w. of Woodland, Grand Island (w. of Knights Landing), 7 mi. nw. of Knights Landing, 10 mi. ne. of Knights Landing, Putah Creek (8 mi. w. of Winters).

***Pituophis catenifer annectens* Baird and Girard**

SAN DIEGAN GOPHER SNAKE

Figure 4

1853. *Pituophis annectens* Baird and Girard, Cat. N. Amer. Rept., part 1, p. 72. Type specimen USNM 1839; type locality San Diego, California.
1859. *Pityophis annectens* Baird, Reptiles, in: Explor. and Surv. for Railroad Route, etc., vol. 10, part 3, p. 15.
1919. *Pituophis catenifer annectens* (part) Van Denburgh and Slevin, Proc. Cal. Acad. Sci., ser. 4, vol. 19, no. 6, p. 216.

1920. *Pituophis catenifer annectens* Van Denburgh, Proc. Cal. Acad. Sci., ser. 4, vol. 10, no. 1, p. 17.

Diagnosis.—A subspecies particularly notable for its high blotch counts and relatively long tail, and for the grayish suffusions in the ground color laterally and subcaudally, which characters will adequately separate it from all except *catenifer* and the related island forms. It has more blotches and ventral scales, on the average, than *catenifer*, and its anterior blotches are more often irregular and confluent; also, they are more frequently black. From *fuliginatus* it differs in lacking the paired subcaudal dark stripes characteristic of that island form. *Annectens* has more scale rows than *pumilus*, and usually lacks the subocular scales of *coronalis*.

Material.—Data have been available on over 550 specimens of this subspecies, of which 340 are from San Diego County.

Nomenclatorial and Systematic Problems.—Unless a study of de Blainville's type specimen of *catenifer* should indicate that it came from southern, rather than central or northern California, there is no question that the name *annectens*, founded on a specimen from San Diego, may properly be applied to the snakes of coastal southern California and northern Baja California.

Annectens, having the most limited range of the mainland subspecies, is the least variable in character. The principal problem to be considered, in connection with this subspecies, is the allocation of the specimens in the coastal fog belt of central California, as discussed under *catenifer*.

Description of the Subspecies.—The scale rows at mid-body are most often 33, nearly half the total (45 per cent) having that number. Next in frequency comes 31 (26 per cent), followed by 35 and 29. Snakes with even-numbered rows are not unusual. The over-all range is 29 to 38. The central dorsal rows have conspicuous keels; these become less marked laterally and the lowest 5 to 7 rows are smooth. The 3 lowest rows are considerably larger than those of the middorsal series. Paired apical scale pits are present, often accentuated by dark dots.

The ventrals in the males normally range from 216 to 239; the interquartile range is 224.1 to 230.6; the mean $227.36 \pm .28$. The corresponding counts in the females are 219 to 247; interquartile range 229.0 to 236.5; mean $232.76 \pm .36$. The anal is entire. The subcaudals in the males vary from 69 to 89; interquartile range 75.2 to 80.4; mean $77.78 \pm .23$. In the females the normal range is 62 to 79; interquartile range 68.0 to 73.3; mean $70.69 \pm .26$.

The supralabials most often number 8; about four-tenths as many have 9, and rarely there may be 7 or 10. The next to the last is the largest. Usually the fourth enters the eye, although if there are 9 it is generally the fifth. Rarely there is a complete ring of oculars, so that no supralabial touches the eye, while in a few cases two labials make this contact. The infralabials most often number 13, about 57 per cent having this number,

followed by 24 per cent with 12, and 14 per cent with 14. The complete range is from 10 to 15. The seventh is the largest; the first pair meet on the median line. Behind these there is a pair of large chin shields, followed by a smaller divergent pair, the latter being separated by 2 or 3 rows of gulars.

The rostral is as wide as high, or slightly wider. It is flush with the adjoining scales. Viewed from above the front edge is quite flat, giving the snout a blunt appearance. The internasals are posteriorly divergent; anteriorly the rostral separates them for about half their depths. While there are normally 4 prefrontals, they may be either fused or split in a variety of ways, so that the total varies from 2 to 9. An azygos scale is sometimes present. The supraoculars are widest behind, and the frontals anteriorly. The supraoculars normally touch the outer prefrontals. The parietals are quite irregular. The nasals are subequal, with the nostril at the upper end of the separating suture. The loreal is longer than high, and is trapezoidal, with a lower posterior point. Occasionally there is an extra loreal either above or below the regular loreal. About two-thirds of the specimens have 2 preoculars, most of the rest one, although rarely a specimen has 3. When there are 2 the upper is much the larger. The postoculars number 3 somewhat more often than 4 (51 against 39 per cent); the maximum range is from 2 to 6. The temporals, which are highly irregular in size and arrangement, number from 2+3 to 6+6; 3+4 or 4+4 predominate.

The longest specimen I have seen (a female) measured 1862 mm.; other large specimens noted were 1844 and 1785 mm. A large female full of eggs weighed 4½ lb. Judging from broods hatched in captivity, the normal length at birth is about 380 mm. This is the slimmest and longest-tailed of all the mainland gopher snakes; adult males have a tail to length over-all ratio of about .170 and the females .155.

In pattern, *annectens* is somewhat drab, lacking the bright and contrasting colors evident in the inland subspecies. The dorsal blotches are usually black anteriorly and posteriorly; they may be black throughout, but more often are brown or red-brown at mid-body. When the anterior blotches are brown they are bordered with black, or each scale may have a brown center with a black edge. Brown anterior blotches are most often found in juveniles; some ontogenetic color change is often to be noted in *Pituophis*. Non-black posterior blotches are more frequent than anterior; such blotches may have gray or brown scales with black edges.

Anteriorly the dorsal blotches are quite irregular and indefinite; they are often partially confluent with each other and with the first lateral series. They are usually longer than wide. The interspaces comprise rows or streaks of yellow scales. Posteriorly the blotches become wider and rounder; the interspaces are buff or gray, streaked with brown, the contrast remaining imperfect. In some specimens the interspaces are red-brown, especially toward the tail. Finally toward the tail the blotches become more regular and distinct, the interspaces being lighter and wider. Anteriorly there are

usually 4 rows of alternating lateral spots on each side. The sides between blotches are so suffused with gray or brown punctations, or streaks on individual scales, that it is difficult to assign a color to the background. This suffusion is characteristic of the subspecies, being evident only in one other mainland subspecies, *catenifer*. The lower surfaces are buff or yellow, spotted with black or stippled with gray. The outer edges of the ventrals are often marked by the lowest series of secondary blotches. The underside of the tail is usually punctated with gray, and is sometimes blotched with black. Occasionally these spots comprise a double row of triangles, the analogues of the twin stripes in *fuliginatus*.

The body blotches average $76.36 \pm .30$; interquartile range 71.8 to 80.9; over-all range 56 to 102. The tail spots average $23.71 \pm .13$; interquartile range 21.7 to 25.7; maximum range 16 to 33.

The head is brown above, sometimes mottled in the parietal region with darker-brown or black. There is usually a sharp contrast between the first black blotch on the neck and the brown of the head. There is often a dark-brown streak across the anterior ends of the supraoculars and the frontal. A postocular dark streak, ending at the angle of the mouth, is sometimes in evidence, but this characteristic *Pituophis* mark is less prominent in this than in most other subspecies. The dark streaks in the labial sutures, another *Pituophis* feature, are generally present, particularly that immediately below the eye. The head is buff on the sides, and, except for the darkened labial sutures, is immaculate cream below.

Young specimens are usually brighter than adults, with clearer spots and more color contrast.

Intraspecific Trends.—In *annectens* there is a reduction in the ventrals from south to north, probably involving an average difference of about 8 scales from Baja California to Santa Barbara County. A slight difference in the subcaudals in the same direction may be noted. In scale rows the highest average is also reached at the southern end of the range; in Santa Barbara County, as would be expected as the territory of *catenifer* is approached, specimens having 31 rows begin to exceed those having 33 or more. No conspicuous trends in labials are noted; 8 supralabials and 13 infralabials being the mode in all areas. Similarly 2 preoculars and 4 postoculars predominate throughout.

In average body blotches and tail spots there is no notable trend within the subspecies, although a somewhat greater regularity of the anterior blotches is observed in the northerly specimens. There is a rather sharp reduction in the number of blotches in the territory where intergradation with *deserticola* begins.

Relationships and Intergradation.—*Annectens* is obviously derived from *catenifer*, with which it intergrades, and which is intermediate between it and the desert subspecies, *affinis* and *deserticola*, in the characters in which *annectens* is most widely separated from them, such as the long tail, high subcaudal scale counts, high number of body blotches, and

the gray suffusion in the ground color. Of the island subspecies, *coronalis* and *fuliginatus* are derivatives of *annectens*, which, except for these, is a terminal form.

Tentatively I should fix the dividing line between *annectens* and *catenifer* as the Santa Maria-Cuyama River, the boundary line between San Luis Obispo and Santa Barbara counties. From this statement one should not assume a sharp character change at this point, for such is not the case; I am merely suggesting that this represents the approximate locality where a preponderance of characters in most of the specimens has changed from the one to the other, but the overlapping in any case is considerable. In fact, there is little difference from *annectens* in specimens of *catenifer* collected immediately contiguous to the coast in San Luis Obispo and Monterey counties, to the north of the boundary I have specified.

Later collecting may demonstrate that the snakes of the Santa Ynez and Santa Maria valleys should be assigned to *catenifer*. Inland I should expect the Los Padres National Forest to be inhabited by fairly typical *annectens*, changing to *catenifer* along the south edge of the Cuyama Valley. The snakes of the Carrizo Plain are certainly *catenifer*.

Annectens intergrades with *deserticola* along the northerly edge of the San Gabriel Mountains. In fact, the *annectens* influence is carried well out into the Antelope Valley, so that, in Los Angeles County, true *deserticola* occurs only in the extreme northeastern corner. Similarly intergradation between *annectens* and *deserticola*, at the foot of the San Bernardino Mountains, takes place well out on the alluvial fans; even as far out as Apple Valley and Lucerne Valley, the snakes show a marked *annectens* influence. The anterior blotches are often brown and the number relatively high.

The question of the intergradation of *annectens* with *affinis* I shall discuss under the latter subspecies. As I have stated elsewhere (Klauber, 1946a, pp. 11 and 27) intergradation with *bimaris* is to be considered doubtful.

Range and Locality Records.—*Annectens* is found in California, from northern Santa Barbara County and the desert slopes of the San Gabriel and San Bernardino ranges, south to the Rosario River (Lat. 30° N.) in Baja California. Within this strip it ranges from the coast through the inland valleys and mesas, and across the mountains to the foot of their desert slopes, but not out on the desert itself. It is equally at home in the Lower and Upper Sonoran Life Zones, and somewhat less so in the Transition, although it is found to an altitude of at least 7400 ft., and probably higher.

The following locality records are available:

CALIFORNIA: *Los Angeles County*—Oak Flat (Ridge Route), Paradise Ranch (Ridge Route), Castaic, Olive View, Saugus (also 6 mi. e.), Bouquet Canyon (near Saugus), Whittier, Montebello, Claremont, Live Oak Dam (near Claremont), Palos Verdes Hills, Torrance, Bixby Slough, Hynes,

Seal Beach, Spadra, Monrovia Canyon, Big Pine Park (San Gabriel Mountains), Placerita Canyon, Pomona (also 3 mi. w.), Sandbergs, Los Angeles, Pasadena, mouth of San Gabriel Canyon (near Azusa), Sierra Madre (also 1½ mi. n.), Old Mt. Wilson Trail, Griffith Park, Hollywood (also 2 mi. n.), Glendale (also 1½ mi. s.), Coldwater Canyon, La Crescenta, Charter Oak, San Pedro, Baker Canyon, Elizabeth Lake, Inglewood, Baldwin Hills, West Los Angeles, Harold, Verdugo Canyon, Little Tujunga Canyon, Santa Catalina Island; *Orange County*—Newport Beach, Corona del Mar, Emerald Bay, Dana Point, Fullerton, Anaheim, Tustin, Esperanza, Santa Ana Canyon, Olive (also 1 mi. e. and 1 mi. n.), Irvine (also 3 mi. w., 3 mi. s., and 6 mi. s.), El Toro (also 2½ mi. n. and 3 and 4 mi. ne.), Galivan, San Juan Capistrano (also 2 and 7 mi. n.), Serra (=Doheny Park), San Clemente, mouth of Black Star Canyon, Aliso Creek, Laguna Beach, La Habra, Brea; *Riverside County*—Riverside (also 2 mi. se.), Highgrove, Box Spring, Calimesa, Arlington, Beaumont (also 1 mi. n.), Banning (also 2 mi. e.), Cabazon, Fingal, Moreno, Camp Haan, March Field (also 1 mi. e.), Alessandro, Val Verde (also 2 mi. s.), Andersons, Perris (also 1 mi. n., 3 mi. e., 4 mi. s.), Corona, Tinmine Canyon (3 mi. sw. of Corona), Egan, Elsinore, North Elsinore, Rome Hill, Wildomar, Murrieta, Temecula (also 2 mi. s. and 6 mi. n.), Dripping Spring (also 5 mi. w.), Aguanga, Coahuila, Coahuila Valley, Anza, Eden Hot Springs, Gilman Hot Springs (also 4 mi. nw.), Hemet, Hemet Valley, Winchester, Domenigoni Valley, Elsinore Mountains, Burnt Valley, Snow Creek, Sedco, Nightingales, Los Alamos Valley, Vandeventer Flat, Pershing, Sage, Prado, Kenworthy, San Jacinto, Old Idyllwild Grade, 4 mi. w. of Mountain Center, Pinyon Flat, 1 and 5 mi. w. of Ribbonwood, Rangers Cabin (San Jacinto Mountains), Shains Ranch, Strawberry Valley; *San Bernardino County*—San Bernardino, Colton, Cajon P. O. (also 1 and 3 mi. nw. and 5 mi. n.), Cajon Pass, Cozy Dell, Devore, Muscoy, Chino, Redlands (also 2 mi. e.), Millers Corner, Barton Flats, Lake Arrowhead, Santa Ana River (San Bernardino Mts.), Ontario, Shandin Hills, Sheep Creek (San Gabriel Mts.), Seeley Flats, Mountain Home Canyon, Seven Oaks, Bluff Lake; *San Diego County*—San Diego (type locality), San Mateo Creek, San Onofre, Agra, Don, Las Flores, Sycamore Canyon, Stuart, Oceanside, Carlsbad, Hedionda, La Costa, Merle, Leucadia, Encinitas, Cardiff, San Luis Rey, Rancho Santa Fe, San Dieguito Valley, Solana Beach, Del Mar, Torrey Pines, Sorrento, Seven Points, Camp Callan, Linda Vista, La Jolla, Mt. Soledad, Rose Canyon (=Ladrillo), Murphy Canyon, Rosedale, Pacific Beach, Grantville (=Orcutt), Mission Valley, Ocean Beach, Chollas Heights, Loma Portal, Point Loma, Encanto, Paradise Valley, National City, Bonita, Chula Vista, Imperial Beach, Coronado, North Island (=Naval Air Station), Otay, Oneonta, San Ysidro, Tia Juana, Monument, De Luz, Fallbrook, Pala, Monserate, Bonsall, Lilac, Ronsees, Moosa Canyon, Vista, Buena, San Marcos, Richland, Escondido, San Pasqual, Bernardo, Lake Hodges, Poway, Miramar, Mussey, Foster, El Monte, Lakeside, Riverview, Flinn Springs, Lakeview (=Johnstown), Mission Gorge, Bostonia, Fletcher Hills, El Cajon, Murray Lake, Santee, Dehesa, Hillsdale, Grossmont, Helix, Spring Valley,

La Mesa, Lemon Grove, Jamacha, Sweetwater Lake, Upper Otay Dam, Lower Otay Dam, Otay Mesa, Rainbow, Pauma, Palomar Mt., Cuca Mesa, Amago, Rincon, Valley Center, Henshaw Dam, Warners Hot Springs (=Agua Caliente), Warners Ranch (=Warners Pass), Morettis, Lake Wohlford (=Bear Valley Dam), Mesa Grande, Santa Ysabel, Sutherland, Wynola, Witch Creek, Ballena, Ramona, Rock Haven Spring, Mt. Woodson, San Vicente, Shady Dell, Boulder Creek, Padre Barona, El Capitan, Tule Spring, Viejas, Descanso, Los Terrenitos, Guatay, Pine Valley, Harbison Canyon, Japatul, Glen Lonely, Lawson Valley, Lees Valley, Suncrest, Jamul, Mt. San Miguel, Dulzura, Marron Valley, Cottonwood, Tecate, Potrero, Honey Springs, Deerhorn Flat, Barrett Dam, Bingville, Campo, Morena Dam, Buckmans, La Posta, Clover Flat, Hipass, Live Oak Spring, Julian, Pine Hills, Pine Hills Junction, Green Valley, Rattlesnake Peak, Rattlesnake Valley (=Harpers Ranch), Oakzanita, Laguna Mt., Montezuma (also 3 mi. e.), Verruga, Stuart Spring, San Felipe Valley, Banner, near La Puerta, Newtown, Boulevard, Manzanita, Jacumba, Culp Valley; *Santa Barbara County*—Santa Barbara, Buellton (also 5 and 9 mi. n.), Los Alamos, 6 mi. n. of Elwood, Schoolhouse Canyon (Cuyama Valley), Mono Flats (8 mi. ne. of Santa Barbara), Bluff Camp; *Ventura County*—Pine Creek, Mt. Pinos, 1 mi. n. of Fillmore, 2 mi. e. of Frazier Borax Mine (Lockwood Valley).

BAJA CALIFORNIA: Tijuana, Rosarita Beach, Redondo (S.D. and A.E.Ry), Lindero (S.D. and A.E.Ry), halfway between Tijuana and Tecate, Tecate, Zacatosa, Descanso Point (also 1 mi. n.), San Miguel Mission, 6 mi. s. of Jatay, Mesquite Point, El Tigre Grade, Ensenada (also 3, 8, 10, 12, 15, and 23 mi. n., and 7 mi. and 15 mi. s.), Guadalupe Valley, Laguna Hanson, Sierra Juárez, 8 mi. n. of Alamo, Santo Tomás, San Antonio del Mar (=Johnsons Ranch, also 10 mi. n.), Johnson Canyon (n. of San Antonio del Mar), Valle de la Trinidad (*affinis* intergrade?), San José (=Rancho San Jose, Lat. 31° N.), Rancho Buena Vista (7 mi. nw. of San José), Socorro Mine, La Encantada, San Pedro (Mártir) Mt., San Quintín, mouth of Rosario River (Lat. 30° N.).

***Pituophis catenifer deserticola* Stejneger**

GREAT BASIN GOPHER SNAKE

Figure 5

1872. *Pityophis bellona* Cope, Ann. Rep. U. S. Geol. Surv. Terr. for 1871, p. 468.
1875. *Pityophis sayi bellona* Cope, Bull. U. S. Nat. Mus., no. 1, p. 39.
1884. *Pityophis catenifer bellona* Garman, Bull. Essex Inst., vol. 16, p. 27.
1893. *Pituophis catenifer deserticola* Stejneger, North Am. Fauna, no. 7, p. 206. Type specimen USNM 18070; type locality Beaverdam Mountain, Washington County, Utah.

1920. *Pituophis catenifer stejnegeri* Van Denburgh, Proc. Cal. Acad. Sci., ser. 4, vol. 10, no. 1, p. 21. Type specimen CAS 14203; type locality Fort Douglas, Salt Lake County, Utah.

Diagnosis.—A subspecies having a shorter tail than *catenifer*, *annectens*, or their island offshoots—*pumilus*, *coronalis*, and *fuliginatus*; also it has fewer body blotches on the average. It generally has black anterior blotches, whereas *vertebralis* has red, and *affinis* and inland *catenifer* have brown. *Deserticola* has more blotches than *bimaris*, and usually has clearly defined frontal, postocular, and subocular dark marks, which are generally absent in *insulanus*. *Deserticola* may be segregated from *sayi* by its blunter snout and wider rostral.

Material.—Data have been available on about 475 specimens of this subspecies.

Nomenclatorial and Systematic Problems.—Stejneger (1893, p. 206) was the first to point out that the name *bellona* was not applicable to the snakes of the western deserts, for reasons which I shall outline under *affinis*. He therefore proposed for them the new name *deserticola*, the applicability of which, for the Great Basin gopher snakes, is unquestioned, although he merely indicated the type specimens by museum number and locality of collection without describing them.

The major question with respect to *deserticola* is the propriety of splitting off a section as an additional subspecies, *stejnegeri*. This subspecies was set up by Van Denburgh (1920, p. 21) to include the snakes of northwestern Utah. He did not propose a major division of *deserticola*, but seems to have visualized a limited population surrounding the type locality (Fort Douglas). The segregation was made primarily on the prevalence in that area of snakes having 29 scale rows and single preoculars. It was subsequently shown by Miss Stull (1932, p. 5; 1940 p. 167), and W. W. Tanner (1939, p. 107) that Van Denburgh's criteria fail to hold in many snakes from northern Utah, and they therefore considered *stejnegeri* invalid. As to the inadequacy of Van Denburgh's segregative characters, I concur. He sought to combine the two items in the following key:

Scale rows + preoculars usually 32 or less; usually	
1 preocular	<i>stejnegeri</i>
Scale rows + preoculars usually 33 or more; usually	
2 preoculars	<i>deserticola</i>

I recently rechecked a series of 23 specimens from Fort Douglas. I find the scale rows distributed as follows: 28 (2), 29 (14), 30 (1), 31 (6). This is a lower average than is the rule throughout *deserticola* territory, but not conspicuously so, for snakes with 29 rows are occasionally found in the Mojave Desert and southern Utah. But the preocular character fails conspicuously, the counts being: 1 (10), 2 (33), 3 (1). When we combine the characters as suggested by Van Denburgh, only 6 specimens out of 22 from the type locality key out properly. As a matter of fact, the out-

standing peculiarity of the Fort Douglas snakes is the high prevalence of specimens lacking a contact between the supralabials and the orbit, for 24 counts out of 43 lack this contact, a higher percentage than I have noted in any other mainland area. I should not, however, consider this anomaly alone, in the proportion found, to warrant subspecific recognition.

But while *stejnegeri* cannot be considered valid on the scale characters suggested by Van Denburgh, it is by no means certain that *deserticola* should not be split into a northern and southern subspecies by reason of differences in pattern, in which case the name *stejnegeri* could properly be applied to the northern race, although Fort Douglas is considerably south of where the most divergent northerners are to be found. The northern snakes, particularly those of eastern Washington and southwestern Idaho, are much darker than those of the western Mojave Desert, which are at the other end of the scale. The difference lies not so much in ground color, although some divergence is present, as in the extent of the pigmentation of the superimposed marks. In the northern specimens the head marks, particularly the transverse frontal, postocular, and subocular are black and heavy, while in the Mojave specimens, they are thinner and often brown. The same is true of the interblotch streaking—the darkened scale ridges which are characteristic of *deserticola*. These dark streaks are more numerous and more often black in the northern than in the southern specimens, and the dark mottling is carried further down the sides. The ventral surface is more frequently and heavily blotched in the northern specimens.

I think there would be little difficulty in segregating most specimens in eastern Washington and Idaho from those of the Mojave Desert; but other areas in Nevada, Inyo and Mono counties, California, and northern Arizona, would be more of a problem, large sections being populated by snakes difficult of allocation, and resulting in much overlapping. I have therefore decided not to make this segregation of *deserticola*, and consequently do not recognize *stejnegeri*. It should be mentioned that in any case the differences in pattern between *stejnegeri* and *deserticola* as represented at the type localities—Fort Douglas and Beaverdam Mountain*—are not as extreme as those between the specimens from eastern Washington and the western Mojave; however, this incidental feature of nomenclature

* Stejneger, 1893, p. 208, although pointing out certain differences from *sayi* and *catenifer*, did not describe *deserticola* in detail. He merely listed several cotypes, five from the area westward of Death Valley, and one, USNM 18070, from the east slope of Beaverdam Mountain, Washington County, Utah. Grinnell and Camp (1917, p. 194), and Miss Stull (1932, p. 5; 1940, p. 167) have stated that USNM 18070 is the type of *deserticola*. Cowan (1936, p. K21) assumes the first-named cotype (USNM 18065) to fix the type locality at Jackass Spring, Panamint Mountains. Stejneger and Barbour, in the five editions of their check list, have always given the type locality of *deserticola* as "the Great Basin and southwestern deserts," thus indicating that no particular cotype had been selected as holotype. I am unable to find a reference definitely settling this question of selection. To avoid future confusion, if adequate action is not deemed already to have been taken, I name USNM 18070, east slope of Beaverdam Mountain, as the lectotype of *deserticola* Stejneger, 1893. I adhere to the first selection by Grinnell and Camp, although it might have been

has not affected my decision. Nor do I consider this decision to be a final one; I am of the opinion that when really adequate material shall have become available from all areas now embraced within the range of *deserticola*, including especially eastern Utah, at least two, and possibly three, subspecies will warrant recognition.

In segregating *deserticola* from *catenifer* and *affinis*, I have leaned more heavily on pattern than on scale-count criteria. This, I find, leads to a more logical territorial arrangement, somewhat reducing the overlapping visualized by Van Denburgh and Miss Stull.

Van Denburgh (1922, p. 706) employed the following key characters:

<i>Deserticola</i>	<i>Rutilus (=Affinis)</i>
Caudal blotches + total preoculars >16	Caudal blotches + total preoculars <16
Usually 2 preoculars	Usually 1 preocular
Posterior dorsal blotches not distinctly reddish	Posterior dorsal blotches often reddish or reddish-brown.

He had available only one specimen from San Diego or Imperial counties; this he classified as *deserticola*.

In application these criteria will be found often in conflict, particularly between the first pair and the last. Excluding the color criterion, the scale counts will result in an overlap all the way from San Diego County, California, to Tucson, Arizona. Many of the snakes in the latter area, even though it is the type locality of Van Denburgh's *rutilus* (= *affinis*), would come out *deserticola* by his key.

Miss Stull (1940) used the following key:

<i>Deserticola</i>	<i>Affinis</i>
Rostral rarely longer than broad	Rostral longer than broad
Ventrals + caudals + dorsal spots on body and tail > 360	Ventrals + caudals + dorsal spots on body and tail < 360

She had only two specimens from Imperial County, one of which she classified as *affinis*, the other as *deserticola*.

Miss Stull's rostral criterion is rather unsatisfactory in application, except between two forms which are markedly different—*sayi* and *annec-*

better originally to have selected either the Shepherd Canyon or the Haway (= Haiwee) specimen, as being more representative of the Mojave Desert section of the subspecies.

It is probable that Stejneger's informal diagnosis of *deserticola*, by mentioning differences from other subspecies, complies with the requirements of Article 25 of the Code, as amended by Opinion 1, although the mere listing of a series of types would not. (Opinions and Declarations Rendered by the International Commission on Zoological Nomenclature, vol. 1, part 10, pp. 73-86, July 1944.)

tens for example. Such a sharp contrast is not evident between *deserticola* and the western representatives of *affinis*. The application of Miss Stull's scale-and-blotch-count criterion would throw most of the specimens from Maricopa County, Arizona, westward, into *deserticola*; however, the resulting overlap would be very broad.

Using either the Van Denburgh or Stull keys there are difficulties elsewhere, especially in the western Mojave Desert, where many of the specimens will key out as *vertebralis* under Miss Stull's key; or in the southern San Joaquin Valley where Van Denburgh finds *heermanni* contacting *deserticola*, while Miss Stull, who does not recognize *heermanni*, has a long overlap between *deserticola* and *catenifer*.

I think it simplest to segregate *deserticola* from either *affinis*, or *catenifer* (which includes *heermanni*), by the color of the blotches on the neck, *deserticola* being black and the others brown. This will work in the great majority of cases, although not too well with some *deserticola* juveniles; upon these some auxiliary criteria may be employed. This will throw all the San Joaquin Valley snakes into *catenifer*. The snakes of the Tehachapi Mountains will also key out as *catenifer*, for the *deserticola*-*catenifer* intergrades occur in the desert foothills of these mountains, just as the *deserticola*-*annectens* intergrades occur in the desert foothills of the San Gabriel and San Bernardino ranges.

Another character which can often be used to advantage in segregating *deserticola* from *affinis*, or *catenifer*, is the merging of the anterior dark blotches of *deserticola* with each other, and with the first lateral series, to form a sort of black longitudinal band or ribbon on the neck, in which the light interspaces appear as isolated light blotches. The scales within these light blotches generally have characteristic dark streaks on their keels. This pattern arrangement will be useful in classifying *deserticola* juveniles, which are often gray or brown anteriorly, instead of black as are the great majority of adults. These isolated light areas are rarely found in either *affinis* or the snakes of the San Joaquin Valley. In young *deserticola*, if the anterior blotches have not yet turned black, it will usually be noted that each gray or brown scale is edged with black, whereas in *affinis* the blotch, as a whole, is edged with darker, rather than each scale.

Description of the Subspecies.—The scale rows are most often 31 (44 per cent) but frequently are 29 or 33 (about 21 per cent of each). The entire range is 27 to 35; about 12 per cent have even numbers of scale rows. The central dorsal scales are relatively small and are strongly keeled. The lowest 6 to 8 rows on the sides are smooth. The row touching the ventrals is considerably larger than the next above. Paired apical scale pits are present but are not conspicuous.

The ventrals in the males average $234.51 \pm .45$; the interquartile range is 229.6 to 239.4; the range 220 to 249 includes all but a few aberrant specimens. In the females the mean is $239.72 \pm .56$; the interquartile range 234.4 to 245.0; the normal range is 224 to 254. The anal is entire.

The mean of the subcaudal scales in the males is $66.75 \pm .21$; the interquartile range is 64.5 to 69.0; and the normal range 60 to 75. In the females the corresponding figures are: mean $59.87 \pm .27$; interquartile range 57.3 to 62.4; normal range 53 to 68.

The supralabials usually number 8 (68 per cent) or 9 (29 per cent); rarely there are 7, 10, or 11. The fourth touches the eye if there are 8, or the fifth if 9. The next to the last is the largest of the series. Occasionally (quite frequently in the Salt Lake area) a complete series of oculars is interposed between the supralabials and the orbit. The infralabials most often number 13 (44 per cent), 12 (33 per cent), or 11 (12 per cent); the over-all range is 10 to 15. The eighth is usually the largest, although it may be the seventh or even the sixth. The first infralabials meet on the median line; these are followed by a pair of large chin shields medianly in contact, followed by a smaller divergent pair separated by from 2 or 3 rows of gulars.

The rostral may be a little higher than wide, but the dimensions are usually about equal. Viewed from above it is somewhat convex in front, and may be raised slightly above the surrounding scales. The internasals are small and posteriorly divergent; anteriorly they are separated by the point of the rostral for about half their depths. Specimens having 4 prefrontals are greatly in the majority; however, these scales may be fused or split in a variety of ways so that the prefrontals range from 2 to 9. One or two azygos scales are occasionally present. The frontal is widest forward, the supraoculars posteriorly. The parietals are rather irregular and wrinkled. The nasals are subequal, with the nostril toward the top of the suture between them. The loreal is longer than high, with a posterior point at the lower edge of the upper preocular. A small subloreal is sometimes present. Some specimens have, below the upper preocular, a small extra scale that is not itself an ocular since it does not touch the orbit.

The preoculars are usually 2 (74 per cent), but may be single (25 per cent), or 3 (one per cent). Where there are two or more, the upper greatly exceeds the others in size. The postoculars, which are subequal in size, vary from 2 to 6, 3 (51 per cent) or 4 (40 per cent) predominating. The temporals, irregular in size and arrangement, vary from 2 to 6 in the first row, and 3 to 6 in the second.

The longest specimen I have measured was 1719 mm. over-all. This was from the western Mojave Desert, where I think it reaches its largest size. However, Mr. E. D. McKee has reported one from Indian Gardens, Grand Canyon National Park, which measured 6 ft. 1 in. (1854 mm.). The length at birth is about 370 mm. The adult tail length ratio (tail to length over-all) averages about .148 in males and .136 in females.

Deserticola is primarily a black-blotched snake, with rather sharply contrasting colors. The main dorsal series of blotches is almost always black anteriorly and posteriorly, and brown at mid-body. In the young the anterior blotches have scales with grayish centers and black borders.

Characteristically, in this subspecies, the anterior dark blotches are short middorsally and long laterally; and usually these lateral wings coalesce to form a continuous black ribbon, thus separating and isolating the light spots which would normally be the interspaces. This blotch arrangement will serve to diagnose the great majority of specimens of *deserticola* from the other subspecies, although not, of course, in regions where intergradation with other subspecies occurs. This merging of blotches occurs only on the neck; posteriorly the dark blotches are increasingly well separated. They are usually square. The first blotch on the neck is generally Y-shaped, with the two branches of the Y pointing toward the head. Laterally there are four series of auxiliary blotches on either side; the lowest, always black, engages the outer edges of the ventral scutes. Anteriorly the second of these series comprises a set of black bars on either side; these are often joined to form elongated black streaks. The ground color varies from whitish, through buff or yellow, to clay. However, the interspaces, both dorsally and laterally, are much marked by dark streaks on the keels of the scales. While this keel-streaking is characteristic of all western *Pituophis* in the United States, it is accentuated in this subspecies, since the streaks are usually black anteriorly and posteriorly (although brown at mid-body), and contrast sharply with the ground color on the periphery of each scale. The streaking is less evident in the young. This black streaking within the isolated anterior interspaces is highly characteristic of this subspecies throughout the Great Basin; it is sometimes absent in the lighter-colored specimens from the western Mojave Desert. The interblotch streaking is less evident on the tail. The color below is white, cream, or yellow, with rows of black spots on the outer edges of the ventrals. Subcaudally there are usually a number of black spots, sometimes suggesting the double lines of *fuliginatus*, or the single stripe characteristic of *bimaris* and *vertebralis*.

The head is usually brown above, often mottled with darker-brown or black in the parietal region. In addition, the three typical head marks of western *Pituophis* are, in this subspecies, usually black and sharply outlined; these are a transverse bar across the anterior edge of the frontal, a post-ocular stripe to the angle of the mouth, and a bar or triangle below the eye. The labial sutures are usually darkened, otherwise the head is unmarked below.

The body blotches in *deserticola* have a mean count of $56.39 \pm .29$; an interquartile range of 52.1 to 60.7; and an over-all range of 40 to 75. All but a few specimens fall between 43 and 71. The tail spots average $16.15 \pm .11$; interquartile range 14.6 to 17.7; over-all range 10 to 23. All but 6 specimens fall between 12 and 22.

Intraspecific Trends.—In ventral scales there is a decrease from the Mojave Desert in California, northward through Nevada to a low in eastern Oregon and Washington. Idaho specimens average lower than Utah. Specimens with high counts occur in northern Arizona. The same trends are evident in the subcaudals, but not nearly so marked.

In scale rows there is a rather marked subspecific variation, as was pointed out by Van Denburgh in describing *stejnegeri*. A majority of specimens from the Mojave Desert have 33 or more rows, while from other parts of the range 31 or less predominate. In the Salt Lake area 29 rows are slightly in the majority.

The supralabials average somewhat higher in the southern part of the range; that is, there is a higher proportion of snakes with 9 instead of 8. There is a similar change in the infralabials which is more marked; in Idaho, Oregon, and Washington, 12 or less predominate, while to the south 13 or more are in the majority. The same situation exists in the postoculars; 3 or less predominating in the northern section, 4 or more in the south. The line of division in this character seems to be south of that of the infralabials, probably in southern Utah. Two preoculars predominate in all areas except in northern Arizona. The specimens in the Salt Lake area have a higher proportion lacking contact between the supralabials and the eye than any other mainland subspecies.

There are no conspicuous trends in body blotches, although a slight increase in number toward Idaho may be noted.

In color there is a considerable difference between the average specimens in the north and south, even if we compare areas inhabited only by pure *deserticola* uncontaminated by intergrades. Thus if we compare specimens from eastern Washington and southwestern Idaho, with a series from the Mojave Desert in California, we find the former conspicuously darker. The color difference is not entirely in the shade of the ground color, although this is evident also; it lies particularly in the extent of the superimposed pigment. In the northern specimens the dark head marks characteristic of western *Pituophis* are usually both wider and darker than in the southern specimens. A higher proportion of the main dorsal series of blotches is black. The secondary lateral blotches are more prominent and extend lower down on the sides. But more conspicuous even than these are the dark streaks which are usually present on the keels of the scales in this subspecies, both in the dorsal interspaces and in the lateral light areas. These are more often black, are heavier, and are present in greater numbers in the northern specimens. In some southern specimens they are not present anteriorly at all. The northern specimens are also more heavily mottled with black below.

Taking these differences of pattern, together with the average scale differences already mentioned, I am of the opinion that a subspecific distinction between the northern and southern individuals might be warranted, were it not for the wide and interweaving territory of intergradation, and the complications of non-conformity in certain of the side areas. Additional material will probably clear up some of these inconsistencies so a further splitting of *deserticola* will no doubt be justified eventually.

Specimens from west-central Utah and east-central Nevada are notable for the whiteness of the ground color; they seem to lack yellow and brown in their composition, all blotches and streaks being black.

Relationships and Intergradation.—*Deserticola* is intermediate between *affinis* and *catenifer* in the important character of tail proportion, and was probably derived in part from the former. However, although I have no evidence as yet of a present interconnection between *sayi* and *deserticola*, certain pattern likenesses suggest that a direct infusion from *sayi* across the northern Rockies may have affected the latter.

The areas of contact between *deserticola* and *catenifer* have already been mentioned. In California *deserticola* intergrades with *affinis* across the desert, approximately along the line separating San Bernardino and Riverside counties, or slightly to the south. The snakes of the Palm Springs and Coachella Valley areas, although allocated to *affinis*, show some *deserticola* influence, compared to the purer *affinis* further south in San Diego and Imperial counties. The same is true of the snakes at Desert Center, Riverside County. On the other hand the snakes of the Lone Star-Twenty-nine Palms area are *deserticola*. There is no physical barrier between these populations; additional collecting should determine an exact zone of intergradation. In eastern Riverside County it is known that the snakes in the vicinity of Blythe are *affinis*, while those from Essex, San Bernardino County, are *deserticola*. Here also more specimens will be required to define the boundary between the two.

In northern Arizona the south rim of the Grand Canyon divides these subspecies, the snakes within the Canyon being *deserticola* with particularly high ventral counts. Where the Colorado River occupies Marble and Glen canyons, *deserticola* occurs east of the river, being found along a line from Cedar Ridge to Kayenta. Southward, at US 66, the snakes are pure *affinis*, although darker than those from southern Arizona. I believe the area of intergradation to be in the vicinity of the Hopi villages and eastward toward Canyon de Chelly. The Hopi Indians, with their habit of bringing in snakes from considerable distances for use in the Snake Dance, and then releasing them, may conceivably have had some part in mixing the subspecies in this area.

I am still uncertain whether there is direct intergradation between *deserticola* and *sayi*. *Deserticola* occurs along the upper reaches of the Green River in Wyoming and may contact *sayi* along Bitter Creek toward Wamsutter. Another possible contact is across the Bitter Root Mountains between the Lemhi Valley in Idaho (where *deserticola* is known to occur) and the Beaverhead Valley in Montana. *Crotalus viridis viridis* crosses this range and intergrades with *C. v. oreganus* down the Salmon River to the west, and *Pituophis* may do the same, although in this case the Lemhi snakes belong to the western form, whereas in the rattlers they are nearer the eastern.

Range and Locality Records.—*Deserticola* is found from the Kamloops-Okanagan area of British Columbia, southward and eastward throughout the Great Basin, to the northern edge of the Colorado Desert and northern Arizona, including trans-Cascade Washington and Oregon; California east of the Sierra Nevada, together with the Mojave Desert south to the

northern boundary of Riverside County; Nevada; central and southern Idaho; the Green River drainage area of southwestern Wyoming; Utah; western and southwestern Colorado; the northeastern corner of New Mexico; and Arizona north of the Colorado River, the Hopi villages, and Canyon de Chelly.

The following are specific locality records: BRITISH COLUMBIA: Okanagan Falls, Okanagan Lake, Okanagan Landing (also 3 mi. sw.), Okanagan Valley, Vernon, Kamloops, Cascade, Lillooet, Osoyoos, Similkameen Valley, Fraser Valley, Vaseaux Lake, Keremeos, Green Lake, Kaleden.

WASHINGTON: *Asotin County*—Asotin; *Benton County*—Paterson, Kennewick; *Chelan County*—Meadow Creek, Peshatin Creek, 5 mi. n. of Wenatchee; *Douglas County*—Brewster; *Franklin County*—5 mi. ene. of Pasco; *Grant County*—Coulee, 3 mi. se. of Grand Coulee Dam, Trinidad (also 3 mi. e.), 10 mi. w. of Neppel; *Kittitas County*—Cle Elum; *Klickitat County*—Maryhill; *Okanogan County*—Osoyoos Lake (1 mi. s. of Canadian Border), 5 mi. w. of Tonasket, Omak Lake; *Spokane County*—Marshall; *Stevens County*—Colville (also 5 mi. n.); *Walla Walla County*—Walla Walla (also 15 mi. w.), Fort Walla Walla, Wallula, south bank of Snake River 1 mi. above mouth, Prescott, Atolia, Touchet River (1 mi. w. of Lamar); *Whitman County*—Pine City, Almota, Wawawai, Pullman, St. John, Rock Creek; *Yakima County*—Wenas Creek, Toppenish, 1 3/4 mi. ne. of Moxee. The following Washington records (of *catenifer*) are to be considered doubtful: Puget Sound, Fort Steilacoom (Pierce County), and Sumas (Whatcom County).

OREGON: *Baker County*—near Baker; *Gilliam County*—Willows, Deschutes River (at mouth of John Day River); *Harney County*—south end of Lake Alvord, Burns, Blitzen River Valley; *Klamath County*—Klamath Falls, Keno, Langell Valley (6 mi. n. of Calif. Line); *Lake County*—Summer Lake, 8 mi. s. of Lakewood, 20 mile Creek (9 mi. s. of Abel); *Malheur County*—1 mi. sw. of Ironsides, 8 mi. w. of Jordan Valley, Rome, Juntura; *Morrow County*—Heppner; *Sherman County*—6 mi. w. of Shaniko, Columbia River at mouth of Deschutes River; *Umatilla County*—Umatilla, Pendleton, 8 mi. e. of Pilot Rock, John Day River (and Valley), near Hermiston; *Wallowa County*—Cache Creek; *Wasco County*—The Dalles, Mill Creek (10 mi. sw. of the Dalles), Sherars Bridge, Maupin (also 2 mi. se. and 5 mi. w.); *Wheeler County*—Mitchell.

CALIFORNIA: *Inyo County*—Coso Station, Coso Valley, Cartago (also 5 mi. n.), Aberdeen, Dunmovin, Narka, Bishop (also 3 mi. w., 8 mi. nw., and 3 1/2 mi. ese.), Big Pine (also 4 mi. n.), Cowan Station, Owens Valley, Haway (=Haiwee) meadows (10 mi. s. of Owens Lake), Haiwee, Shoshone (also 4 1/2 mi. s.), Bruce Canyon (Argus Mts.), Mountain Springs Canyon (Argus Mts.), Shepherd Canyon (Argus Mts.), Lone Pine, Mesquite Springs, Olancho (also 5 mi. sw.), Wild Rose Spring, Lone Willow Spring, Jackass Spring (Panamint Mts.), Surprise Canyon (Panamint Mts.), Cow Creek (100 ft. below sea level, Death Valley), Texas Spring (Death Valley), Hells Gate, 1/2 way between Stovepipe Wells and Emigrant

Ranger Station, Emigrant Junction (=Lone Pine Checking Station); *Lassen County*—Doyle, Sage Mountain (2 mi. e. of Doyle), Smoke Creek, Warm Springs (9 mi. e. of Amedee), Petes Valley (*catenifer* intergrade); *Los Angeles County*—Llano (also 9 m. e.), Devils Punch Bowl, Neenach, 4 mi. w. of Fairmount, Lovejoy Springs, Oban, 15 mi. e. of Palmdale, near Valyermo, near Lancaster, 20 mi. w. of Lancaster; (all these Los Angeles County records are of *annectens* intergrades except Lovejoy Springs and Oban); *Kern County*—Freeman Junction (also 3 mi. nw.), Inyokern (also 4 mi. w. and 12 mi. e.), Terese, between Johannesburg and Mojave, Trescape (*catenifer* intergrade), Mojave (also 3, 11, 14, 15, and 16 mi. e., some of which are *catenifer* intergrades); *Mono County*—Coleville, Little Round Valley, Fales Hot Springs, Mammoth, Mammoth Creek, 7 mi. ne. of Benton Crossing, 2 mi. n. of Convict Lake, Benton, 5 mi. n. of Benton Station, Topaz Lake; *San Bernardino County*—Kramer, Kramer Junction (also 2, 8, 9, and 11 mi. n., 3 and 4 mi. e., and 1, 2, 3, 4, 11, 13, 14 and 15 mi. s.), Kramer Hills (also 18 mi. s.), Adelanto (also 8, 10, 11, 12, 15, and 19 mi. n., 3 mi. e., 4 and 10 mi. s., 1 mi. w., and 7 mi. sw.), Atolia (also 5 and 8 mi. s.), Barstow (also 2 mi. nw.), Hinckley, Jimgrey, Hawes, Mace, Bryman, Victorville (also 5 mi. s.), Red Mountain (also 6 mi. n.), Mountain Pass Station, Yucca Grove, Halloran Spring, Essex, Twentynine Palms, Lone Star, Rabbit Dry Lake, Morongo (*annectens* intergrade), Morongo Valley, Oro Grande, Stoddard Well, Wild, Yermo, Hodge, Deadmans Point, Beacon, 3 mi. n. of Cedar Canyon (Providence Mts.), Rock Springs (Providence Mts.), Government Holes (Providence Mts.), Lanfair, 1 mi. e. of Leach Lake, 3 mi. e. of Cima, n. side Clark Mountain, Granite Well (Granite Mts.), Millers Corner (*annectens* intergrade), Lucerne Valley (also 5 and 6 mi. w., some being *annectens* intergrades), Hesperia (*annectens* intergrade), Roxbury Ranch (*annectens* intergrade), Apple Valley (*annectens* intergrade), Apple Valley School, 1 mi. s. of Phelan (*annectens* intergrade).

NEVADA: *Churchill County*—Fallon (also 3 mi. s.), Alcorn Ranch (4 mi. w. of Fallon); *Clark County*—State Line Wells, Erie, Jean, Borax, Las Vegas (also 9 mi. sw.), Glendale (also 5 mi. sw.), Boulder City, 10 and 14½ mi. e. of Charleston Park, 1 mi. s. of Rogers Spring, across Colorado River from Fort Mohave (Ariz.); *Douglas County*—Gardnerville, 1 mi. se. of Minden; *Elko County*—Tuscarora, Carlin, 5 mi. sw. of Whiterock, Humboldt Park (18 mi. w. of Elko), west side of Ruby Lake, 3 mi. e. of Harrison Pass, Goose Creek, Elko (also 3 mi. n., 14 mi. w., and 22 mi. e.), James Canyon, Maggie Canyon, Moleen Canyon, South Fork of Humboldt River; *Esmeralda County*—Palmetto Mountains, Fish Lake, 2 mi. n. of Goldfield, 22 mi. se. of Mina, 13 mi. s. of Tonopah; *Eureka County*—Dunphy (also 5 mi. e.), 15 mi. nne. of Tenabo (Lander Co.), 1 mi. e. of Palisade; *Humboldt County*—Virgin Valley, Big Creek (Pine Forest Mts.), Virgin Creek (Pine Forest Mts.), Virgin River, Winnemucca (also 12 mi. e.), Thousand Creek Flat, 12 mi. e. and 1 mi. n. of Jungo, Golconda Pass (6 mi. se. of Golconda), 7 mi. ne. of Golconda, 5 mi. n. of Paradise Valley, Martin Creek Ranger Station (Santa Rosa Mts.), Paradise

Valley; *Lander County*—Mozel, Austin (also 30 mi. n.), Kingston Creek, 2 mi. n. of Birch Creek Ranch, 10 mi. nne. of Tenabo, Battle Mountain (also 20 mi. e. and 10 mi. ne.); *Lincoln County*—Hiko, 2 mi. nw. and 10 mi. w. of Caliente, 20 mi. e. of Crystal Spring, 12 mi. se. of Groom Baldy, Alamo (Pahranagat Valley); *Lyon County*—Fernley (also 6 mi. sw.), Wellington, between Wellington and Yerington, 10 mi. nw. of Walker Lake; *Nye County*—Amargosa, e. side of Pahrump Valley, Round Mountain, 4 mi. e. of Skeleton Hills, Spectre Mountains, Troy Creek, Haws Canyon (15 mi. se. of Clarks Station), 5 mi. se. of Millett (Smoky Valley) 2 mi. se. of Oak Spring, 5 mi. w. of White Rock Spring (Belted Range), 2 mi. s. of Yucca Pass, 6 mi. s. of Stone Cabin, 6½ mi. n. of Hot Creek (Hot Creek Valley), 15 mi. wsw. of Sunnyside (White River Valley), 3 mi. w. of Millers Valley, 19½ mi. w. of Indian Springs, 6 mi. se. of Carrara, Peavine Creek (Toyabe Range); *Ormsby County*—Carson City; *Pershing County*—Fanning (West Humboldt Range); *Storey County*—Camp 12 (Truckee River); *Washoe County*—Reno (also 3 and 12 mi. e), 11 mi. e. of Sparks, Derby, Pyramid Lake (also se. shore and n. end), Nixon, Wadsworth, 5 mi. w. of Geiger Pass, Flanigan (also 3 mi. and 5 mi. w., and 3½ mi. nw.), Smoke Creek, Deephole, Twelvemile Creek, Sutcliffe, Peavine Mountain (nw. of Reno); *White Pine County*—Pyrmont, Smith Creek Cave (Mt. Moriah), Hendry Creek (8 mi. se. of Mt. Moriah), 3 mi. se. and 5 mi. nw. of Baker, Willard Creek (Spring Valley), Water Canyon (8 mi. n. of Lund), 8 mi. ne. of Midas.

IDAHO: *Ada County*—Boise (also 6 and 10 mi. n., 6 and 15 mi. s., 6 mi. sw., and 2 mi. w.), Tenmile Creek (s. of Boise), Kuna, Melba, Regena; *Adams County*—Indian Valley; *Bannock County*—Portneuf, Inkom, Oxford, Swan Lake, Pocatello; *Bear Lake County*—east side Bear Lake; *Bonneville County*—Lava Beds (17 mi. w. of Idaho Falls); *Boise County*—Moore Creek; *Butte County*—Arco, Big Butte; *Camas County*—Fairfield; *Canyon County*—Fort Boise, near Parma, south of Nampa; *Casia County*—8 mi. n. of Elba; *Elmore County*—Regena, Indian Creek, Cleft (also 4 and 5 mi. s.), Hammett; *Franklin County*—Preston; *Jerome County*—5 mi. s. of Jerome; *Lemhi County*—Salmon River (21 mi. below Salmon), Colsom Creek (Salmon River); *Nez Perce County*—Lewiston; *Oneida County*—Preston; *Owyhee County*—Snake River (west of Bruneau River), mouth of Bruneau River, Jump Creek; *Twin Falls County*—Blue Lakes, 2 mi. e. of Hagerman, 4 mi. e. of Rogerson; *Washington County*—Crane Creek (15 mi. e. of Midvale), 12 mi. n. of Weiser.

WYOMING: *Sweetwater County*—30 mi. e. of Point of Rocks, Black Rock Butte.

UTAH: *Beaver County*—Sulphurdale, Beaver Creek Hills, Beaver; *Box Elder County*—Mantua (also 4 and 5 mi. n.); *Cache County*—Logan, Smithfield; *Carbon County*—Price, Columbia Junction, Sunnyside, Castle Gate, Hiawatha, Standardville; *Emery County*—Castle Dale; *Garfield County*—Tropic, Escalante; *Grand County*—Thompson, Green River (town), San Rafael River (2½ mi. e. of Green River), Moab, below Cisco;

Iron County—Kanarraville, Luna, Rush Lake, 2 mi. s. of Parowan; *Juab County*—Starr, 4 mi. s. of Nephi, Silver City, near Eureka, Levan, 10 mi. n. Lynndyl; *Kane County*—2 mi. s. of Glendale, Orderville, Wahweap Creek, Willow Spring Tank; *Millard County*—Delta (also 30 mi. n., 8 mi. ne., and 8, 10, and 20 mi. nw.), Scipio, Holden, Kanosh (also 10 mi. sw. and 7 mi. s.), 1 mi. se. of Gandy, 6 mi. n. of Robinson Ranch (Snake Valley), Fillmore, Fillmore Canyon, Milford; *Salt Lake County*—Red Butte, Red Butte Canyon, Emigration Canyon, Millcreek, Bell, Fort Douglas, Salt Lake City, Dry Canyon, Sandy; *San Juan County*—Bluff; *Sanpete County*—Mount Pleasant, Sterling Reservoir; *Sevier County*—Sevier, Sevier Dam, Sevier Bridge Reservoir, Marysvale Canyon, Monroe; *Tooele County*—Tooele, Mills Junction, Timpie, Low, 6 mi. e. of Knolls, Orrs Ranch (Skull Valley); *Uintah County*—Green River (15 mi. sw. of Ouray), 6 mi. sw. and 20 mi. se. of Jensen, near Jensen, Ouray Agency, White River, west of Dragon; *Utah County*—Provo, Pleasant Grove, Thistle Canyon, Chimney Rock Pass (4 mi. w. of Lehi); *Wasatch County*—Wasatch Mts., Provo Canyon; *Washington County*—Zion National Park, Emerald Pool (Zion Canyon), Saint George, 3 mi. s. of Enterprise, Rockville, Oak Grove, Pine Valley, Leeds, Beaverdam Mountain (type locality), ½ mi. e. of Ash Creek Bridge (n. of Pintura), Springdale; *Wayne County*—Fruita, Torrey; *Weber County*—Ogden.

COLORADO: *Archuteta County*—Pagosa; *Mesa County*—Grand Junction, Fruita; *Montezuma County*—Mesa Verde National Park; *Montrose County*—Naturita.

NEW MEXICO: *San Juan County*—Aztec.

ARIZONA: *Apache County*—Canyon del Muerto; *Coconino County*—Indian Gardens (Grand Canyon), Bright Angel Trail (Grand Canyon), Tonto Platform (Grand Canyon), 3 mi. w. of Lees Ferry Bridge, Cedar Ridge, Marble Canyon, Kaibab Forest (north rim), Farview Point (north rim), Pasture Canyon (2 mi. ne. of Tuba City), El Tovar (*affinis* intergrade); *Navajo County*—Water Lily Canyon (Tsegi Canyon), mouth of Keet Leel, Betatakin Canyon, Kayenta (also 2, 3, and 18 mi. w., and 12 mi. sw.), above Bat Woman Cave, Marsh Pass, 5 mi. e. of Shonto Canyon, Long Canyon, Bubbling Springs Canyon, Oraibi (*affinis* intergrade), Mishongnovi (*affinis* intergrade), Shongopovi (*affinis* intergrade).

***Pituophis catenifer affinis* Hallowell**

SONORAN GOPHER SNAKE

Figure 6

1852. *Pityophis affinis* Hallowell, Proc. Acad. Nat. Sci. Phila., vol. 6, p. 181. No type specimen mentioned; type locality New Mexico, later (1854, p. 146) stated to be the Zuni River, New Mexico (which included Arizona).
1920. *Pituophis catenifer rutilus* Van Denburgh, Proc. Cal. Acad. Sci., ser. 4., vol. 10, no. 1, p. 24. Type specimen CAS 33869; type locality Tucson, Pima County, Arizona.

1932. *Pituophis sayi affinis* Stull, Occ. Papers Mus. Zool., Univ. Mich., no. 250, p. 4.
1943. *Pituophis catenifer affinis* Smith and Mittleman, Trans. Kans. Acad. Sci., vol. 46, p. 248.

Diagnosis.—A subspecies which can be distinguished from *catenifer*, *annectens*, *fuliginatus*, *coronalis*, and *pumilus* by its proportionately shorter tail and fewer body blotches. It can be segregated from *deserticola*, *bimaris*, and *insulanus* by its brown anterior blotches compared with black in the others. It may be separated from *vertebralis* since it lacks the black subcaudal stripe which characterizes the latter; also, *vertebralis* has black dorsal blotches at the base of the tail, while those of *affinis* are brown or dark-brown. *Affinis* has a rostral which is relatively wider and not so prominently raised above the surrounding scales as in *sayi*; also, when the rostral is viewed from above the anterior curve is flatter in *affinis* than in *sayi*.

Material.—I have data available on somewhat over 400 specimens of this subspecies.

Nomenclatorial and Systematic Problems.—For a long time the gopher snakes of our southwestern deserts were referred to *bellona*, described by Baird and Girard (1852, p. 350) as *Churchillia bellona*, the type having been collected by Gen. S. Churchill, presumably on the left bank of the Río Grande near Presidio del Norte in 1846.* This was the only specimen mentioned by Baird and Girard (that is, mentioned by reference to a locality) in the original publication; subsequently (1853, p. 68) five other specimens were listed in redescribing the species. It may be mentioned that in this second publication the length of the Churchill specimen is in error, that of the first Graham specimen being repeated. The Churchill specimen is considerably shorter (about 21 in.).

Stejneger (1893, p. 206) stated that in his opinion *bellona* was a synonym of *sayi* Schlegel, 1837, basing this on the fact that, although he thought the type lost, there was available another specimen, USNM 1542, from the identical locality and this had the narrow rostral characteristic of *sayi*. He therefore considered the name *bellona* inapplicable to the snakes of the Great Basin and the southwestern deserts, and proposed the name *deserticola* for them. Subsequently Miss Stull (1940, table 10, top line, p. 114) correctly listed USNM 1519 as the type of *bellona*, this specimen being still available. There seems no question as to the accuracy of Miss Stull's conclusion, as the catalogue entry includes the principal scale counts, as was customary in 1858 with respect to types.

Recent collections have shown that *affinis* occurs farther east in northern Chihuahua and in Coahuila than was previously thought to be the case,

* The type specimen is USNM 1519, the catalogue entry being "S. Ant. W. of R. G.," for which information I am grateful to Dr. Doris M. Cochran. The catalogue entry was made in 1858.

and it is by no means impossible that the snakes now to be found in the vicinity of Presidio del Norte are *affinis* rather than *sayi*. However, this is not important in view of the indefiniteness of the stated type locality, and the frequent inaccuracies of the old localities of collection. The essential fact is that the type is to be allocated to *sayi*, thus invalidating *bellona* as a proper name for the western subspecies. *Sayi* may ultimately be split into north and south sections, based on the color of the anterior blotches and other differences, in which case *bellona* will be available as the name of the southern form.

Van Denburgh in 1920, finding differences between the snakes of the Great Basin and Mojave Desert, to which Stejneger had applied the name *deserticola*, and those of southern Arizona, proposed for the latter the name *rutilus*, type locality Tucson. Later Miss Stull (1932, 1940), although confirming this segregation between the snakes of the Great Basin and Sonoran areas, revived for the latter a much earlier, but long-neglected name, *affinis* Hallowell, 1852.* The type locality of *affinis*, first given as New Mexico (Hallowell, 1852, p. 181), was later stated to be near the Zuni River, New Mexico, which then included Arizona (Hallowell, 1854, p. 146). The type specimen is lost. The Zuni River is a relatively short stream arising in McKinley County, New Mexico, and flowing into the Little Colorado in Apache County, Arizona. This fixes the type locality within rather narrow limits, at least into a single ecological area. A number of specimens are now available from this immediate vicinity. Although these dark-colored, high-plateau snakes are found to be somewhat different from the light-brown or red-brown inhabitants of the deserts of southern Arizona and the lower Colorado River basin, I do not think a further north-to-south subspecific segregation is warranted. Thus Miss Stull was correct in assigning the southern Arizona snakes to *affinis*, and placing *rutilus* in its synonymy. It is unfortunate that, as is so often the case, the type locality of *affinis* is at one corner, rather than near the center, of its range. If a further subdivision of *affinis* is found desirable in the future I have no doubt it will involve the separation of the two extremes in Coahuila and southern California, which differ significantly in several particulars, as I shall subsequently point out. It would then become a problem to determine to which the name *affinis* should be applied, since the type locality falls in intermediate territory.

The snakes of the Salton or Cahuilla Basin considered by Van Denburgh to be *deserticola*, and by Miss Stull to belong to both subspecies, *deserticola* and *affinis*, I assign entirely to the latter category. In my own previous papers I have allocated the snakes of the desert areas of Riverside, San Diego, and Imperial counties to *deserticola*. This is an error; *deserticola*, as now defined, does not enter either of the southern counties, although it may be found along the northern border of central Riverside County.

* Van Denburgh (1924, p. 220) suggested that the name *affinis* might be applicable to the snakes of New Mexico, as a subspecies of *sayi*.

Description of the Subspecies.—The scale rows at mid-body are most often 31, although these exceed only slightly those with 33 rows. The over-all range is 28 to 35. The scales are strongly keeled dorsally, but less so on the sides; from 5 to 7 of the lowest lateral rows are generally smooth. Paired apical scale pits are evident, particularly at the posterior end of the body; some are accentuated by dark spots. The ventrals in the males have a mean of $233.64 \pm .53$; interquartile range 228.7 to 238.5; normal specimens fall between 220 and 245. In the females the mean is $238.63 \pm .54$; interquartile range 233.9 to 243.4; normal range 226 to 251. The anal is undivided. The male subcaudals have a mean of $64.50 \pm .25$; interquartile range 62.7 to 66.8; normal range 56 to 71. The mean of the female subcaudals is $57.63 \pm .25$; interquartile range 55.4 to 59.9; normal range 50 to 64. The supralabials usually number 8 (77 per cent), but are occasionally 9 (about 21 per cent), and, rarely, 6, 7, or 10. Usually the fourth touches the orbit and the next to the last is the largest. The infralabials generally number 13 (46 per cent), but are not infrequently 12 (32 per cent), or 14 (14 per cent), and rarely 11, 15, or even 16. The seventh is the largest. The first pair meet on the median line; they are followed, first by a pair of large genials in contact, and then by a smaller divergent pair which are separated by two or three rows of gulars.

The rostral may be somewhat higher than wide or the dimensions may be equal. Viewed from above it is convex, the snout being sharper than in *annectens*. Occasionally it is slightly raised above the surrounding scales. It indents the internasals for about half their depths. Most specimens have four prefrontals, although in some specimens an outer and an inner may be fused. Occasionally the outer prefrontals are transversely divided. The supraoculars are narrowest anteriorly; they usually contact the outer prefrontals. The parietals are triangular and have irregular outer edges, particularly because of the invasion of a scale behind the upper postoculars. The anterior nasal is slightly larger than the posterior. The loreals, of which there is usually only one on each side, are longer than high. The preoculars are most often 2-2, with the lower quite small compared to the upper; in 43 per cent of the counts there is a single preocular; very rarely there are three. The postoculars are subequal; there are usually 3 (50 per cent) or 4 (44 per cent) on a side; rarely there are 2, 5, or 6. The temporals are highly irregular in shape; they vary from 2 to 6 in the first row, and 3 to 6 in the second. Most common are 3+4 or 4+5.

I have no accurate measurements on unusually long specimens of *affinis*. This snake grows to a large size in some sections of Arizona, probably well exceeding 2000 mm. Jackson (1945, p. 76) mentions one 7 feet, 8 inches long (2337 mm.), although it is not clear that it belonged to this subspecies. In a brood of 11 from Yuma, Arizona, the shortest was 356 mm., the longest 412 mm., and the average length 393 mm. The ratio of the length of the tail to the length over-all in the adults is about .136 in the

males and .125 in the females.* It is a short-tailed snake compared with *deserticola*, or, especially, with *annectens*.

Affinis is primarily a brown-blotched snake with much dark streaking of individual scales in the interspaces. The main dorsal series is usually light-brown anteriorly, becoming darker toward the tail, until, at the end, the blotches may be almost black. In some regions there is much red in the coloration, the main blotches being conspicuously reddish-brown. The anterior blotches are often outlined with dark-brown and sometimes even with black. The anterior blotches are not saddle-shaped, but the interspaces frequently are. The latter are usually buff, but within them there are many scales which are conspicuously darkened by brown streaks on their keels; this is particularly evident laterally, the dorsal interspaces being often clear. There are usually four series of auxiliary and alternating blotches on the sides. Posteriorly, both the main series and the auxiliaries tend to become more widely separated, more regular in shape, and more clearly outlined. The color below is cream or yellow, with some spotting on the outer edges of the ventrals. The subcaudal surface is usually spotted; rarely these spots may form longitudinal lines.

The head is light-brown or buff above, and lighter on the sides. There is usually a wide dark-brown line across the fronts of the supraoculars and the frontal. Back of this line there are dark-brown spots scattered in the frontal and parietal areas. There is generally a dark-brown line from the eye toward the angle of the mouth, with a vertical termination between the last two supralabials. There are the usual *Pituophis* streaks which follow the labial sutures, the one under the eye being widened and accentuated. The head is unspotted below.

The body blotches, in the specimens of *affinis* of which I have had counts, average $48.01 \pm .32$; interquartile range 43.8 to 52.2; normal range 34 to 63. The mean of the tail spots is $13.60 \pm .12$; interquartile range 12.0 to 15.2; extreme range 9 to 21.

Intraspecific Trends.—The clines in this subspecies are greater than in the others, probably because the range is primarily east-and-west, rather than north-and-south as in the other three, thus involving a greater ecological variety.

The ventrals increase from New Mexico and Chihuahua westward to California, the difference in the averages probably approaching 15 scales. The subcaudals show a similar, although less extensive, increase, and there is a corresponding increase in tail proportionality. The snakes with 31 or fewer scale rows exceed those with 33 or more in New Mexico and central Arizona, while in southern Arizona and California the reverse is the case.

* This refers to western specimens; the tails of those from farther east are proportionately shorter. The figures given are derived from the previous paper on tail length (Klauber, 1943, p. 41, and table 13), but it should be noted that the series referred to as *P. c. deserticola* I, Imperial County, should be called *P. c. affinis*.

There are no important trends in the labials, but the oculars show an increase from east to west. Single preoculars greatly outnumber the pairs in the east, whereas, beginning in the vicinity of Casa Grande and Phoenix, Arizona, and thence westward, the snakes with two preoculars are in the majority. The snakes of the central mountain area of Arizona conform to the eastern phase. The same type of change takes place in the postoculars, which more often number 3 or fewer in the east and 4 or more in the west; however, this change does not take place until California is reached. The snakes of western Riverside County average particularly high in postoculars. As might be expected, there is an average change in the shape of the rostral; in the east, near the area of intergradation with *sayi*, the rostral is more pointed, narrower, and is often raised above the surrounding scales, as compared with the western snakes. The entire snout is more pointed.

The number of body blotches increases from Chihuahua westward to California, the average in the body blotches probably increasing by 10 (from about 42 to 52) and the tail spots by 3 or 4. This is an important change, but the variability is such that the overlap between the terminal groups in summation remains considerable.

In color the most divergent snakes are those of the Flagstaff-Gallup area, not far from the type locality of *affinis*. Here many of the specimens are very dark, often as dark anteriorly as *deserticola*, although without the isolated anterior light interspaces of the latter; they also usually have lower ventral counts, so that they remain nearer *affinis* than *deserticola*.

It will be observed that western specimens of *affinis* average higher in scale rows, ventrals, subcaudals, preoculars, postoculars, body blotches, and tail spots. Under such circumstances it is possible to narrow the overlaps—that is, sharpen the differences between the easterners and the westerners—by combining characters. For example, one may take the sum of the ventrals and body blotches; when this is done there is almost no overlapping between the specimens from Coahuila and Chihuahua on the one hand, and those of southern California on the other. Thus if we set our dividing line at 280 ventrals plus body blotches for the males, and 285 for the females, few of the available specimens fail to key out correctly, the eastern snakes falling below and the western above these limits. However, this segregation applies only to the territorial extremes, the intervening areas being intermediate, as might be expected, and the zone of intergradation quite wide. But the available Mexican material is inadequate to make such a segregation with real assurance, in a genus as variable as *Pituophis*, and I have therefore decided not to split *affinis*, although I have no doubt such a procedure will eventually be warranted. When this is done a nomenclatorial problem will present itself, as the type localities of both *affinis* and *rutilus* fall in intermediate territory. I think both are nearer the eastern extreme, represented by the snakes of Chihuahua and Coahuila, so that a new name may be applicable to the western section, the best dividing line probably being in southwestern Maricopa County, Arizona.

Relationships and Intergradation.—*Affinis* falls between *deserticola* and *sayi*, both territorially and in characters.

The entry of *affinis* into California seems to have been a relatively late occurrence, since its range constitutes an intrusion between *deserticola* and *bimaris*, whose relationship is obviously close, although they are now separated territorially.

Affinis intergrades with *sayi* along a zone as yet ill-defined. In fact, it is probably relatively wide, for the change is gradual. It is my opinion that intergradation occurs approximately along the mountains forming the western boundary of the Pecos River basin in New Mexico, thence south, cutting off the westerly corner of Texas, to southeastern Coahuila. However, further collecting may prove that the snakes of the Rio Grande Valley in New Mexico are nearer *sayi* than *affinis*.

Intergradation with *deserticola* has already been discussed under that species. *Affinis* probably intergrades with *bimaris* in the vicinity of the fishing village of San Felipe, on the shore of the Gulf of California in Baja California; unfortunately no specimens are at hand from that area.

No direct evidence is yet available of any direct intergradation between *affinis* and *annectens*; in fact, they seem to be found together without intergradation along the San Felipe Wash in eastern San Diego County. As they are the most widely separated of the four western mainland subspecies in tail proportionality, subcaudal scales, and certain elements of pattern, one would not expect intergradation. Yet as I have discussed elsewhere (1946a, p. 27), there is possibility of intergradation in northern Baja California. Another place where there should be either intergradation or a definite overlap, is in the San Gorgonio Pass of Riverside County, since there is here no physical barrier to their meeting. Some intensive collecting should be undertaken between Banning and Whitewater, to decide this interesting question.

Range and Locality Records.—*Affinis* is found from the desert areas of southeastern California and northeastern Baja California eastward to eastern New Mexico and southeastern Coahuila, including eastern San Diego and Riverside counties, and Imperial County, California; extreme northeastern Lower California; Arizona south of the Grand Canyon, the Hopi villages, and Canyon de Chelly; Sonora; extreme northern Sinaloa; Chihuahua; and southern and western Coahuila.

The following are specific locality records: CALIFORNIA: *San Diego County*—Borego Valley, Borego P.O., Yaqui Well, $\frac{1}{4}$ mi. e. of The Narrows, Bensons Dry Lake, $\frac{1}{2}$ way between Box Canyon and Scissors Crossing, Carrizo Spring; *Imperial County*—Myers Creek Bridge (also $1\frac{1}{2}$ mi. e.), Coyote Well (also 4 mi. e.), Plaster City, Silsbee, 7 mi. e. of Bensons Dry Lake (San Diego County), Dixieland (also 1 and 2 mi. e., and 2 mi. w.), Bullshead Slough, Seeley, (also 1, 2, and 4 mi. e., 2, 3, 6, 10, and 18 mi. w., and 5 mi. s.), Mobile, El Centro (also 2, 3, 4, and 5 mi. e., and 3, 4, 5, 6, and 10 mi. w.), Calexico (also 3 mi. n., 5 mi. e., and 4 and 5

mi. w.), Bonds Corner (also 3 mi. e.), Holtville (also 2, 3, 4, 5, and 6 mi. e., and 1 mi. w.), Date City, Imperial (also 2 mi. n.), Trifolium, Brawley (also 2 mi. s.), Alamo Duck Preserve (8 mi. nw. of Calipatria), Calipatria (also 2 mi. n., 2 mi. w., and 3 mi. s.), Meloland (also 2 mi. e.), Rockwood, Estelle, Westmorland (also 1 mi. s. and 6 mi. w.), Heber, Keystone, Signal Mountain, Kane Spring (also 5 and 7 mi. nw.), Alamo, Midway Well (junction US 80 and Cal 98), Imperial Dam (also 3 mi. n. and 1 mi. s.), Bard, Winterhaven (also 2, 3, and 4 mi. w.), Pilot Knob, Andrade, MP 142 (S.D. & A.E.Rwy.); *Riverside County*—Palms to Pines Highway, Palm Springs RR Station, Palm Springs (also 5 mi. se.), Date Gardens, Indio (also 2, 7, and 8 mi. s.), La Quinta, Indian Wells (also 5 mi. w. and 4 mi. nw.), Coachella (also 4 mi. s. and 7 mi. se.), Thermal, Mecca, Oasis (also 2 mi. n. and 4 mi. nw.), Valerie (also 4 mi. se.), road northeast of Salton Sea, 17 mi. e. of Shavers Well, Desert Center (also 4 mi. e.), Hopkins Well, Blythe (also 2 mi. w.), Neighbors.

ARIZONA: *Apache County*—Navajo, Painted Desert (Petrified Forest National Monument), Agate Bridge (P.F.N.M.), Flattops (P.F.N.M.), Blue Forest (P.F.N.M.), Puerco River Checking Station (P.F.N.M.); *Cochise County*—Hereford, Willcox (also 10 mi. se. and 13 mi. ne.), 14 mi. w. of Don Luis, Saint David (also 7 mi. s. and 9 mi. se.), Benson (also 2 mi. e. and 10 mi. w.), Chiricahua RR Station, Light, White River Canyon, Fort Huachuca (also 5 mi. se. and 10 mi. e.), 2 mi. s. of Fairbank, Tombstone (also 13 mi. n.), Dos Cabezas (also 3 mi. w. and 12 mi. se.), mouth of Pinery Canyon (Chiricahua Mts.), Ramsey, Carr, Miller, and Ash Canyons (Huachuca Mts.); *Coconino County*—Turkey Tanks, Medicine Valley, Black Hills Park (San Francisco Peaks), Two Guns (also 7 mi. w.), Townsend (also 5 mi. e.), Pitt (also 1 mi. se.), Wupatki Pueblo, 2 mi. n. of Nelson (Yavapai County), 5 mi. w. of Cameron, 15 mi. w. of Winslow, Williams (also 5 mi. e.), Flagstaff, Ridge Ruins (e. of Flagstaff), Deadmans Flat, Castle Butte, Tuba City, 3 mi. e. of Wayside Museum (Grand Canyon National Park), El Tovar (*deserticola* intergrade), Oak Creek Canyon, Colorado Chiquito, Walnut, Canyon Diablo, 8 mi. w. of Sedona, 4 and 7 mi. e. of Ashfork (Yavapai County), Painted Desert, 3 mi. w. of Dennison, Winona; *Gila County*—Roosevelt Dam, Parker Creek (near Roosevelt Dam), Tonto Basin, 19 mi. ne. of Globe, Wheatfields, near Perkins Landing (Roosevelt Lake), 1 mi. nw. of Pine; *Graham County*—10 mi. s. of Safford, Camp Grant; *Greenlee County*—12 mi. sw. of Clifton, Eagle Creek; *Maricopa County*—Forepaugh, Marinette, Vekol Valley (25 mi. e. of Gila Bend), Phoenix (also 8, 9, and 19 mi. n., 12½ mi. ne., and 5 mi. e.), Theba, Morristown, Aguila (also 3 mi. w.), Sentinel, Glendale, Gila Bend, Mesa (also 7 mi. e.), 8 mi. e. of Burned Place Well, Cave Creek, Buckeye, Wickenburg; *Mohave County*—9 mi. e. of Kingman, Truxton, Antares, Walapai, Berry, Nixon Spring, Horse Tank, Hackberry (also 1 mi. e. and 15 mi. s.),

Colorado River (above Bill Williams River), 15 mi. s. of Wolfhole, Fort Mohave; *Navajo County*—Winslow (also 2, 3, 4, and 14 mi. e.), Manila (also 3 mi. w.), Marcou Mesa (20 mi. n. of Holbrook), Headquarters of Petrified Forest National Monument, Rainbow Forest (P.F.N.M.), Joseph City; *Pima County*—Marana, Ajo Junction (1 mi. n., 5 mi. s., and 8 and 10 mi. w.), Sabino (Station), mouth of Sabino Canyon (east of Tucson) (also 5 mi. w.) Wrightstown, Fort Lowell, Santa Cruz River (near Tucson), Tucson (also 2, 5, 8, 9, 12, 14, 15 and 17 mi. n., 6 and 11 mi. s., and 4 and 5 mi. w.), Cañada del Oro, Steam Pump Ranch, San Xavier Mission (also 2 mi. n.), Xavier RR Station, Sahuarita, Rincon Ranch, Black Mountain (10 mi. sw. of Tucson), Spud Rock Ranger Station, Santa Rita Experimental Station, 4 mi. nw. of Rillito, Tortillita Mountains, Mt. Lemmon (Santa Catalina Mountains), 5 mi. w. of Gunsight Las Gijas, Ajo, Quitovaquita (Organ Pipe National Monument); *Pinal County*—Picacho (also 16 mi. e.), Randolph (also 7 mi. s.), Oracle Junction (also 2 and 8 mi. s., and 4 mi. ne.), Oracle, 28 mi. nw. of Tucson (Pima County), Florence Junction, Florence (also 6 mi. e.), Queen, Superior, Casa Grande (also 14 mi. w.), Casa Grande National Monument; *Santa Cruz County*—Nogales, Patagonia (also 2 and 6 mi. sw.), Tubac, Camp J. A. Rucker; *Yavapai County*—Congress Junction (also 5 mi. s.), 11 mi. n. of Wickenburg (Maricopa County), Yarnell (also 9 mi. n. and 9 mi. s.), Nelson, 4 mi. e. of Seligman, Crookton, Pineveta, Audley, Pica, Yampai, Peoples Valley, Kirkland Junction (also 4 mi. s.), near Kirkland, Hillside, Clarkdale, Ashfork (also 2 mi. e.), 4 mi. e. of Prescott, Granite Dells, Fort Whipple, Camp Verde (also 10 mi. s.); *Yuma County*—Yuma (also 2, 3, and 4 mi. s., 5 mi. w., 10 mi. sw., and 5 and 9 mi. e.), Somerton (also 5, 6, and 7 mi. n., and 4 mi. w.), Gadsden (also 2 mi. n. and 4 mi. s.), Dublin, Telegraph Pass (Gila Mts.), Dome, Wellton, Pembroke, Tacna, Mohawk, Stoval (also 3 mi. n.), Lechuguilla Desert (15 mi. s. of Wellton), Ehrenberg.

NEW MEXICO: *Bernalillo County*—Isleta; *Doña Ana County*—Las Cruces, w. of Ropes Spring, Jornada Experimental Range; *Grant County*—Santa Rita del Cobre, Redrock, Hachita, Fort Webster, Fort Bayard; *Hidalgo County*—2 mi. n. of Rodeo; *Lincoln County*—Ramon, Jicarilla Mts., 1 mi. w. of Carrizozo; *Luna County*—Mongolia, 9 mi. e. of Deming; *McKinley County*—Manuelito, Wingate, Fort Wingate, 17 mi. w. of Gallup; *Otero County*—Alamogordo, east of White Sands, southern Guadalupe Mts.; *Rio Arriba County*—Canjilon Creek Camp; *Sandoval County*—Bernalillo; *Santa Fe County*—Santa Fe (also 10 mi. se. and 9 mi. sw.), Rosario, 14 mi. e. of Stanley, San Ildefonso; *Socorro County*—Fort Conrad, San Mateo Mts.; *Valencia County*—Correo, Rito, 5 mi. e. of Laguna, Bluewater, Tajique, El Morro National Monument.

TEXAS: *El Paso County*—El Paso (also 3 and 24 mi. e.).

SONORA: 40 mi. sw. of Sonoyta, 18 mi. e. of Cajeme, Papago Tanks (Pinacate Mts.), Fronteras, 10 mi. n. of Pílares, San José de Guaymas, 7 mi. n. of Santa Rosa, 1 mi. w. of Altar, Guásima, between San Bernardino and Río San Pedro, Noria, Alamos, Guirocoba.

SINALOA: Ahome.

CHIHUAHUA: 9 mi. w. of Carrizal, Río Santa María (near Progreso), Río Station (near Progreso), 39 mi. e. of Carmen, San Blas Mts., San Diego, Ahumada, Chihuahua (City), Casas Grandes, near Batopilas, Pacheco, Madera, Colonia García.

COAHUILA: 21 mi. n. of Saltillo, Cuatro Ciénegas (*sayi* intergrade), Tanque del Lencko (6 mi. nw. of Conejo Station, Sierras del Carmen) (intergrade, nearer *sayi*).

ECOLOGICAL AND FIELD NOTES

Since the five western mainland subspecies of *Pituophis catenifer* have much in common in habits, I shall present, in combination, such life notes as I have accumulated. This will also permit comparing their somewhat divergent preferences with respect to habitats. I have little to offer on *sayi*.

Ecological Preferences.—Although the ecological conditions preferred by the several subspecies differ in important respects, they have this in common—each subspecies, in itself, shows a great adaptability, so that each lives under a wide variety of ecological conditions. Probably this adaptability is not unrelated to their frequency of occurrence, for in many parts of their ranges they are the commonest of snakes, although in others they are exceeded in numbers by the garter snakes about creeks and ponds, and some of the little secretive forms in the desert. No doubt it is this same adaptability which has resulted in the species covering so widespread a range.

Nowhere is this variability of habitat better illustrated than in San Diego County, where we find *annectens* the commonest snake in nearly every ecological niche, from the ocean, eastward across mountains exceeding 6000 ft. in altitude, and thence down to the foot of their desert slopes. The rainfall varies from 10 inches per annum at the coast, to about 50 inches in the mountains, and then declines again on the eastern slope to below 5 inches. There are rolling, coastal hills covered with low brush, grassy mesas, foothills with dense chaparral, oaks and pines in the mountains, and barren and rock-strewn desert foothills; and in all of these the San Diegan gopher snake makes its home. On the desert itself it is replaced by *affinis*.

For twenty-one years (1923-1943) I kept a census of the snakes of San Diego County, using methods described elsewhere (Klauber, 1931, 1939).

In this period the zonal distribution of the *P. c. annectens* which have been recorded was as follows:

	Number of gopher snakes	Per cent
Coast	1 274	42.1
Inland Valleys and Mesas.....	817	27.0
Foothills	766	25.3
Mountains	82	2.7
Desert Foothills	71	2.3
Desert	—	0.0
Uncertain	17	0.6
Total	3 027	100.0

Because of certain factors of area and accessibility which I have discussed elsewhere (1931, p. 19), these figures are not to be taken directly as indicating relative zonal frequency of occurrence, but they do show that the gopher snakes are quite prevalent from the coast to the foothills, that is, up to an altitude of about 4000 ft. Above this they are less common, but so are all snakes. In any case, they reach an altitude of at least 7400 ft. (outside of San Diego County) and probably somewhat higher. In the county they comprise 20 per cent of all the snakes recorded in the 21-year census.

Similarly we find *catenifer* from the redwood areas of the Santa Cruz Mountains, and further north along the coast in California and Oregon, eastward across the Coast Range and the Siskiyou into the Central Valley of California and well up the western slopes of the Sierra Nevada. The altitude reached is at least 6200 ft. The range also includes such arid areas as the Carrizo Plain and the southern end of the San Joaquin Valley.

Deserticola is primarily an intermountain or plateau form. So far as I am aware it has never been collected in the flats of Death Valley, the lowest point within its area. At any rate, it ranges from the floor of the Mojave Desert well up into the mountains that are interspersed throughout this desert and the Great Basin, at least to an altitude of 7150 ft. in Nevada, and probably higher along the north rim of the Grand Canyon.

Affinis is the subspecies whose range includes the most arid areas of the southwest. It seems to be able to live in any association except one which is exclusively sandy—I have yet to hear of one being found in the extensive sand-dune area some 18 miles west of Yuma. Elsewhere it occurs in our most extreme deserts—throughout the Salton Basin, and, on the Arizona side of the Colorado River, the Yuma Desert. Yet statistics show that it does welcome the improved conditions brought by irrigation, for in records which I have kept of snakes encountered alive or dead on the road (DOR), in trips on the floor of the desert in Imperial County, 137 specimens of *affinis* were observed in irrigated areas and only 12 in non-irrigated.

Reduced to a mileage basis, 6.1 gopher snakes were seen per 100 miles of travel in irrigated, and only .36 snake per 100 miles in primitive, arid territory, a frequency ratio of about 17 to 1. Somewhat the same proportion was observed in comparing the frequency of occurrence in the irrigated Yuma Mesa, with that in the Yuma Desert to the east. Probably the enhanced food supply resulting from irrigation permits the increased population. Yet other desert snakes, *Crotalus cerastes laterorepens* for example, are driven out by irrigation.

Elsewhere in Arizona we find *affinis* quite at home in a variety of associations, from the sparsely covered southern deserts, through the chaparral of the central foothills, the grassy plains of the northeast, the juniper and piñon associations of the middle north, to the pine forests around Flagstaff and the San Francisco Peaks, where it attains an altitude of at least 8000 ft. Further south in the Catalinas and some of the New Mexican mountains it reaches 9000 ft. or more. Here again we have an ecological range which includes the greatest variety of temperatures, rainfall, and vegetation.

TABLE 3
Ecological Conditions of Roadsides
Where Gopher Snakes Have Been Found

	<i>P. c. catenifer</i>	<i>P. c. annectens</i>	<i>P. c. deserticola</i>	<i>P. c. affinis</i>
Pond, creek, canal, river bank, marsh.....	2	13		3
Orchard, vineyard, garden.....	11	33	2	6
Cultivated field	41	107	9	152
Grass	47	258	16	25
Light brush	6	47	11	3
Heavy brush, chaparral	11	67	1	3
Trees, forest	6	33	1	1
Junipers				6
Joshua trees			2	
Mesquite				7
Rocks, boulders	6	19	7	3
Rocky desert			1	4
Brushy desert			67	25
Sandy desert			3	12
Barren desert			1	3
Total	130	577	121	253

For many years I have kept a record of the roadside borders where live and DOR *Pituophis* have been encountered by myself or my associates. Necessarily, in order to condense the data accumulated, it has been essential to generalize in describing the conditions met. The results are presented in Table 3. It is shown that cultivated fields, grass, or brush are especially favored. A contrast will be noted between *affinis* and *deserticola* with respect to the frequency of occurrence in cultivated fields, as compared with a brushy desert. This is partly because we have had access to no area in the Mojave Desert range of *deserticola* comparable to the Imperial Valley irrigated district in which *affinis* is found.

Seasonal and Daily Activity.—One may summarize the activity of the western gopher snakes by saying that while primarily diurnal, they are readily able to accommodate themselves to other hours of activity when required by climatic conditions to do so, as has been the case with *deserticola* and *affinis*.

The coastal forms, *catenifer* and *annectens*, are essentially diurnal in the spring, their season of greatest activity. In those inland territories where high temperatures are met in summer, such as the interior valleys of California, they become crepuscular, and even nocturnal, in mid-year. *Affinis* and *deserticola*, on the other hand, while frequently found active in the daytime or early evening, especially in the spring, and although largely diurnal or crepuscular throughout the year in the higher altitudes, are essentially nocturnal in the deserts, for here they encounter diurnal temperatures quite beyond the ability of any snake to withstand.

With respect to seasonal activity, the following monthly statistics, derived from the San Diego County census previously mentioned, will be of interest, these figures comprising only specimens of *annectens*:

Month	Number of specimens	Per cent
January	28	0.9
February	60	2.0
March	237	7.8
April	571	18.9
May	908	30.0
June	681	22.5
July	172	5.7
August	69	2.3
September	101	3.3
October	127	4.2
November	48	1.6
December	25	0.8
Total	3 027	100.0

Thus May is the peak month, closely followed by June and April. I have always attributed this spring activity to a combination of hunger after hibernation, and the mating season; the same peak is observable in all other species of snakes found in this area, although some are slightly earlier and others later (Klauber 1931, 1939). The resurgence in the fall is to be attributed to the advent of the newly hatched young, which are inexperienced and careless of concealment, and are killed in large numbers when crossing the traveled highways.

The table indicates a certain degree of activity throughout the year, the snakes coming out in winter whenever there is a warm spell. L. H. Cook found one under a stone near Jamul, San Diego County, on February 9th; it disgorged a mouse that had been eaten within a few days at most, showing that they feed in winter under favorable conditions.

I have no statistics of the other subspecies comparable to these on *annectens*; for while I have done considerable field collecting in their areas, this has been largely limited to the spring, which would bias any statistics I might present, the other seasons being inadequately represented. But sufficient data have been gathered to prove that there is a spring peak in all cases, a little earlier in the lower, warmer areas, a little later where spring is delayed. *Deserticola*, inhabiting the higher, cooler Mojave Desert, seems to reach a peak of activity about two weeks later than *affinis* in the Colorado Desert. However, the climatic conditions which gopher snakes must meet are not as extreme as those enforced upon the inherently nocturnal snakes—*Phyllorhynchus* and *Chionactis* for example—since the gophers can and do become active in daylight, when temperature conditions are satisfactory.

As to the time of activity within the day, I have the following data on *annectens*: 76 snakes have been observed alive on the road in the daytime, compared with only one in the late evening (just after sunset), and one in the dark of night. That this snake is essentially diurnal is thus fully demonstrated, for many thousands of miles have been traveled in the evening and at night with this meagre result.

Some specific times when *annectens* has been observed have been as follows: A.M. — 8:30, 8:35, 9:00, 10:10; P.M. — 12:35, 12:40, 1:00, 4:00, 4:30, 4:47, 5:00, 5:15, 5:20, 5:45, 5:50, 6:10, 6:15, 7:00, 7:05, 7:30. I have cause to regret that I did not make more complete records of these contacts.

My experience with *catenifer* has been less extensive but similar in trend. While principally diurnal, in the warmest areas, such as the southern San Joaquin Valley, it becomes crepuscular, and even nocturnal, in mid-summer.

With regard to the activities of *affinis* and *deserticola*, much depends on the season and temperature, and hence the altitude of the habitat. They certainly are not as nocturnal as some of the more typical nocturnal snakes of the desert—*Crotalus cerastes*, *Arizona elegans eburnata*, and *Phyllorhynchus decurtatus perkinsi*, for example. Evidently they adapt

themselves to the particular conditions which they encounter. I think in much of the territory which they inhabit they exercise a maximum activity in the early evening. I have encountered numbers of them just before or just after sunset. Night hunts show a higher ratio of DORs to live snakes than in the truly nocturnal species, thus indicating an earlier daily peak of activity. But that they do become truly nocturnal in late spring and summer there can be no question: I have records of *deserticola* as late as 10:42 P.M.; and of *affinis* at 10:15, 10:30, 11:00, 11:20 P.M., and 1:20 A.M. As to temperatures, I have the following night records of air temperatures in degrees Fahrenheit for *deserticola*: 66, 68, 71, 72, 77, 78, 82, 86; and for *affinis* 69, 78 (3), 80, 82, 84, 85, 86, 88 (2), 90, 91, 94, 96. On two occasions I have found *deserticola* active near Mojave, California, on very cold and windy nights. W. G. Abbott, of the Santa Barbara Museum told me of finding a *deserticola* crawling over a snow bank 7 miles northeast of Benton Crossing, Mono Co., Calif. This was in the daytime, and illustrates the extreme conditions met by this snake at the higher altitudes.

Refuges.—While the principal refuges of gopher snakes are no doubt mammal holes, from which they have been seen issuing on several occasions, and in which they must often catch their prey, they are also known to hide under rocks and logs. An *annectens* was found under an old piece of sheet iron. Near Patagonia, Arizona, Charles E. Shaw found an *affinis* under a rock, cold and lethargic, although the day was warm and clear. Another was found nearby under a rotten log in a pasture. I found one under a rock near Stanley, New Mexico; it was dormant with cold, for this was on a cold and windy day.

A. M. Jackley, of South Dakota, who has devised a method of trapping rattlers (*Crotalus v. viridis*) issuing from hibernation, writes me that *P. c. sayi* is often found in the traps, although in fewer numbers than the rattlers with which they have dened.

Gopher snakes at the zoo are occasionally observed digging, using a method which ought to be efficient enough to permit them to secure prey which has blocked itself off by bulkheading a tunnel with earth. They loosen the earth with the snout and then withdraw it by catching it in a loop of the neck and hooking it backwards. Miss Alice Hanks, of the Santa Barbara Museum, informed me that she watched a *catenifer* at Berkeley digging by this method. Other snakes sometimes use the same scheme.

While normally terrestrial, gopher snakes occasionally climb trees in search of nestlings. A large *annectens* was found stretched along a branch of a manzanita bush about a foot above the ground. C. B. Perkins reports having seen *sayi* ascending cottonwoods in the wide cracks in the bark which characterize these trees. The same observation was made by A. M. Jackley, who watched a bull snake climb a cottonwood, evidently to reach a mourning dove's nest. Unfortunately time was not available to watch the outcome.

Temperament.—Although gopher snakes are generally peaceable, they may be quite pugnacious if startled or alarmed. At such times they hiss violently and strike with some accuracy, usually upward. Occasionally they will bite suddenly and unexpectedly while being handled, but usually they give warning by hissing, assuming a striking (S-shaped) posture, flattening the head, and vibrating the tail in the manner characteristic of so many snakes. A large gopher snake among dry leaves can buzz his tail and make a sound sufficiently like that of a rattler to cause one to jump, if the snake has not been discovered in advance. Young specimens bite much more readily than adults. All become quite tame in captivity.

No doubt it is these violent defensive actions upon the part of *Pituophis* that has led to the rather widespread belief—particularly prevalent in the intermountain states—that the rattlesnakes and bull snakes have crossed, producing a dangerously venomous hybrid, one greatly feared since it is without the tell-tale rattle. There is not the slightest foundation for this rumor.

I have noticed no differences in the actions and attitudes of the several subspecies of *P. catenifer*. All are able to hiss loudly by means of the vibration of the flap-like epiglottis, first noted by Dr. C. A. White (1884, p. 19). While other snakes hiss, I know of none which can approach an angry or frightened gopher snake in the volume of sound produced. No doubt this is the source of the names "bull" or "blow" snakes, as they are commonly called in the Mississippi Valley and intermountain regions.

A large *annectens* from Point Loma, while being held in the hand, was quite peaceable until a dog approached, whereupon it hissed and vibrated its tail.

Pituophis normally uses the sinuous method of locomotion, although the caterpillar method may be employed by large specimens when moving slowly. They can often be discovered along the roadside when a fresh track is found crossing a soft dirt or sandy road. The track is rather wide, like that of the rattler. The direction in which they have gone is not difficult to determine by noting the little piles of earth which are pushed backwards along the outer curves of the track. Like all snakes, gophers have trouble securing enough traction on paved highways to get speedily across, which increases their chances of destruction.

Pituophis is a constrictor, as has often been observed in watching them catch and eat their prey. It was noted that a large *annectens*, which was being held behind the head to keep it from biting, was able to squeeze the wrist and arm sufficiently so as almost to shut off the flow of blood, and to cause some pain. A pulsating pressure by the snake's muscles indicated this endeavor to cause damage was deliberate.

Food.—That *Pituophis* feeds primarily on small mammals is so well known as hardly to warrant additional confirmation. The very name of "gopher" snakes, as they are generally called along the Pacific Coast,

has been earned by their consumption of gophers. They have been variously reported as eating rats, mice, gophers, ground squirrels, rabbits, and similar creatures. Several authors have commented on the large number of mice they have been known to consume at a single feeding.

I have myself noted the following stomach contents: Rats and mice in *catenifer*; a half-grown kangaroo rat and ground squirrels (2 occasions) in *deserticola*; and mice in *affinis*. My experiences with *annectens* are somewhat more extensive: I have definite records of rats, mice, gophers, ground squirrels, and rabbits. Some specific instances have been as follows: A large snake was found to have eaten three rabbits out of five in a nest, two being still unharmed; a medium-sized snake, when caught, disgorged a small rabbit; a snake coming out of a gopher hole at 9:50 A.M. was found to contain a gopher; one was found eating a mouse; another, DOR, was noted with 2 rabbits squeezed out; a young of the year was found on October 15th to contain a full-grown mouse; another, somewhat larger snake, had eaten 2 mice. Frank F. Gander reported that he saw a small brush rabbit run into a bush, where it was heard almost immediately to squeal. He went over and found that the rabbit had been caught by a gopher snake, which was already constricting it.

While gopher and bull snakes usually kill their prey by constriction they may sometimes use pressure, particularly in the narrow confines of a hole.

A. T. Mercier observed a *catenifer* enter a hole to secure a gopher. As soon as the head reached the mammal, the posterior part of the body was wadded into a ball at the entrance to the hole so that the gopher's struggles could not drag the snake in.

That gopher snakes will eat birds when they can be caught is also well authenticated, several instances having been reported both of snakes in the wild and in captivity. In my own experience I found a large DOR *affinis* at Seeley, Imperial County, which had eaten two birds. An *annectens* was observed by my friend Alfred May trying to secure young birds from a phoebe's nest on a tank house by climbing a nearby eucalyptus tree. It was finally driven off by kingbirds. One from Manzanita, San Diego County, contained the remains of a bird. Another of the same subspecies was observed by Tom Weddle eating a quail old enough to fly. A *deserticola* at Betatakin, Arizona, had eaten four young crested jays. Allen L. Chickering reported having once seen a *catenifer* driven to seek refuge in a hole by the attacks of black birds, which may have been protecting a nest. Some of the island forms are probably large consumers of the young of the sea birds which nest there.

Eggs are also taken. I have several definite records, including a *verticalis* which disgorged 3 quail eggs, and an *affinis* which had eaten 8. C. B. Perkins observed an *annectens* eat a guinea hen's egg, which was so large, relative to the size of the snake's head, that in advance the feat seemed impossible. John Bedwell of San Marcos, San Diego County,

reported having found an *annectens* swallowing a hen's egg. That *Pituophis* is sometimes an extensive egg-eater has been shown by the observations of Imler (1945, p. 268) on the depredations of *sayi* on the ducks of a wild-life refuge in Nebraska. Here in one year (1938) bull snakes destroyed 114 duck nests out of 274, besides taking some eggs from others. On 16 occasions they were caught in the act of swallowing duck eggs. Imler also made the interesting observation that the eggs are usually broken in the throat before passing into the stomach by forcing each egg against a row of bony vertebral processes forming an internal ridge, in somewhat the same manner as the African egg-eating snake. Smaller, thinner-shelled eggs are probably not broken in this manner; Huey (1942, p. 375) found an *affinis* containing 8 unbroken quail eggs of which the stomach juices had already bleached out most of the mottling on the shells.

Lizards are occasionally eaten, probably more often by the young, as is the case with rattlesnakes. A small *affinis* was found at Somerton, Arizona, which had swallowed a full-grown *Chemidophorus t. tessellatus* head first; another from Brawley, California, had also eaten a whiptail. A young *annectens* at Zacatosa, Baja California, had eaten a *Sceloporus*. That gopher snakes may occasionally be cannibalistic is evident from an observation by James Deuel, who found a large DOR *annectens* that had swallowed another of the same subspecies almost as large; however, they probably seldom eat snakes of any kind. It is reported that amphibians are occasionally eaten, but of this I have no personal record.

While many farmers fully appreciate the value of gopher snakes in the control of harmful rodents, and therefore do not disturb them, or even go further and bring them home when they are found along the road, it is undoubtedly true that they can become a nuisance around a hen house or rabbit hutch. The purity of their motives, in having originally come for the rats and mice that are likely to infest such places, does not always protect them. Frank F. Gardner tells me that he has repeatedly had to remove gopher snakes from his chicken yard or rabbit boxes at Lakeside, San Diego County, and the same individuals seemed to return. Mrs. S. Meling reported an *annectens* in a hen house trying to eat an egg. Another ate a young chicken. Another tried to eat goose eggs but was fought off by the goose. The state game farm at Chino, California, has had considerable trouble with both gopher and king snakes, and this is believed to be a rather general condition at game farms.

Desert gopher snakes must secure what moisture they require from their food. All subspecies drink readily in captivity. While those that live in well-watered areas do not hesitate to cross streams when necessary, they do not prefer riverbanks as do the garter snakes. I found an *annectens* on a riverbank at the edge of the water; either it had just swum across or had come down to drink.

Enemies.—I have little original data on the enemies of gopher snakes. From our knowledge of other snakes it is to be presumed that badgers and

coyotes are their principal mammal enemies. Jackson (1945, p. 78) found that even bushy-tailed ground squirrels would gang up on their hereditary enemy, *affinis*.

Among the birds, owls, hawks, and roadrunners probably destroy numbers of them. I have observed hawks carrying snakes several times, but never could be sure that the victim was a gopher snake. C. B. Perkins saw a Swainson's Hawk carrying a *P. c. sayi*. L. M. Huey observed a Red-tailed Hawk carrying an *annectens* at Doane Valley on Palomar Mountain, San Diego County, June 12, 1945. The bird was holding the snake about 6 inches behind the head. The long body of the snake was swinging pendulumwise in such a way as to interfere with the hawk's flight. A week before, another observer had seen a hawk carrying a gopher snake at the same place. In accumulating data on rattlesnake enemies, I have learned from a number of observers that *Pituophis* remains are found about hawks' nests much more frequently than *Crotalus*. The Red-tail seems to feed on snakes more generally than any other hawk.

On three occasions I have seen ravens eating young gopher snakes at the roadside, and in one instance the snake was still squirming; but I presume it had been run over by a car before the raven found it.

King snakes (*Lampropeltis getulus californiae*) are known to eat gopher snakes readily. We have watched them do so in captivity, and have found DOR specimens which contained *annectens*, *catenifer*, and *affinis*. R. M. Williams, of Arbuckle, California, saw a king snake try to master a *catenifer* that was too large for him to handle, so he finally had to give up the attempt to subdue it.

Automobile traffic is the greatest destroyer of snake life, with the possible exception of brush fires. With the poor traction which a snake gets on a smooth-surfaced highway, which thus prolongs his time of crossing, he is almost sure to be run over on any of our heavily traveled roads. The juvenile mortality is particularly high, as anyone will note who travels in good snake country in September and October. For example, William Derbonne counted no less than 19 juvenile *affinis* in the 6.6 miles of highway between Westmorland and Brawley, Imperial County, October 1, 1933. I have previously given some statistics on snake casualties caused by auto traffic (1931, p. 53; 1939, pp. 25, 59-63).

Gopher snakes are occasionally infested with the red mites that are more frequently found on lizards in this territory.

Reproduction—*Pituophis* is a genus of egg-laying snakes. The eggs are deposited in mid-summer and are hatched between mid-September and early October.

Among captive *annectens* bred in the wild, out of ten sets of eggs the earliest clutch was deposited July 7 and the latest Aug. 16. The mean date was July 24. The earliest to hatch was Sept. 15, the latest Oct. 21, the mean date Sept. 29. The period of incubation has been quite constant; minimum elapsed days 64, maximum 71, mean 66½. A captive *affinis*

laid her eggs June 29 and they began to hatch on Sept. 12, with a 77-day period of incubation. The above statistics refer to snakes bred in the wild. Five captive-bred *annectens* had incubation periods of 65, 67, 73, 75, and 76 days. One clutch was laid as early as May 27. The hatching dates listed are those when the first snake of the brood appeared; from 2 to 4 days always intervened between the earliest and last. Both the hatching dates given and the periods of incubation are believed to be fairly representative of conditions in the wild. Freshly hatched snakes are most prevalent along the roadside between Sept. 20 and Oct. 10.

The number of eggs in 13 *annectens* clutches deposited in captivity varied from 3 to 12, with an average of 6.8. A very large specimen from Corona, Riverside County, contained 18 eggs, and another 9. One *affinis* laid 12 eggs; two others contained 8 and 9 eggs. Specimens of *deserticola* have been noted with 4, 10, and 11 eggs, and a *catenifer* with 10. The eggs are, proportionate to those of other snakes, quite large, measuring up to 30 x 90 mm. As has been found to be the case with the rattlesnakes, it is believed that the larger mothers have larger broods. The data given here on captive broods have been collected by Mr. C. B. Perkins at the San Diego Zoo.

Since the maximum size reached by these gopher snakes varies territorially within each subspecies, only generalized figures may be presented as to size at birth. *Catenifer* and *deserticola* are about 370 mm. over-all at birth, *annectens* 380, and *affinis* 390.

An examination of extruded and inflated hemipenes of the four western mainland subspecies of *Pituophis* has failed to disclose any differences between them. The organ is single-lobed, although slightly branched or expanded at the outer end. The proximal half is almost smooth, although a few tiny points are to be observed along the edge of the sulcus. This section is also longitudinally ridged. The distal half is sheathed with closely set, short spines. Although somewhat irregularly spaced they number about 17 in the lowest row. The spines become shorter outwardly and then change quite suddenly into a reticulation composed of delicate vertical flounces, edged at intervals with tiny points. At the top, where the organ is slightly branched, there is a smooth area within a shallow V. The single sulcus reaches this by a slightly diagonal course up the shaft.

The mating pattern, as observed by C. B. Perkins at the San Diego Zoo, is somewhat as follows: The male crawls along and over the body of the female until he rests almost or entirely on top. During this time he is quite active, continually flicking out his tongue and advancing with a jerky motion. He also rubs the anterior part of his body over that of the female. The female is usually passive except for some tail waving. If copulation ensues the male sometimes seizes the female with his teeth either at the head or neck. In copulation only one hemipenis is used. There is considerable tail waving and some pulsation upon the part of both. From time to time the tails may be held vertical. In one instance copulation lasted at least an hour, but the beginning was not seen.

Aberrant Specimens.—Two-headed snakes seem to occur rarely in almost every genus and have been reported in *Pituophis* (Wright, 1878, p. 105 or 97; Stull, 1940, p. 149). I have not secured one in my collection.

Albinos are of much more frequent occurrence; out of the 3027 *annectens* recorded in the 21-year census of San Diego County snakes, 3 have been albinos, and I have seen others from elsewhere in the state. One of the San Diego County specimens was figured in an earlier paper (1924, p. 21), and another from Los Angeles County was reported (1931, p. 70).

For several years, we have had at the San Diego Zoo, an albino female *annectens* from Deerhorn Flat, San Diego County. She was twice bred to a normal male in 1943 and 1944. The first mating produced 3 eggs, of which two hatched normal-patterned young, the other failing to develop. The second mating resulted in 5 eggs, all of which hatched into young with normal, dark patterns.

Of the first brood one was a male, and to this the albino female was bred in the spring of 1945, the other, fully normal male, having been removed from the cage 9 months previously. At this time when the back-cross mating occurred, the F1 male was about 1½ years old. Four eggs were laid, of which two hatched, both albinos. One egg that failed to hatch contained a dead embryo with a normal pattern; the other was probably infertile.

The albino was again bred to her eldest son in the spring of 1946. Four eggs were laid on May 13. These hatched July 29, resulting in 3 normal young and one albino.

The following is a color analysis of the female albino, using Ridgway's Standards, 1912. It should be understood that, with a mottled pattern such as that of a gopher snake, in which no considerable area is of a uniform color, the designations can only be approximate. For comparative purposes the colors of a live normal *annectens* from the type locality are also given:

	Albino	Normal <i>annectens</i>
Head		
Top, light areas	Cream Color	Light Brownish Olive
Top, dark areas	Carrot Red (between scales only)	Sepia to Black
Sides	Marguerite Yellow	Ecrú-Olive to Deep Colonial Buff (toward commissure)
Underside	White	Marguerite Yellow
Neck		
Blotches	Drab-Gray	Black
Interspaces	Marguerite Yellow (scale centers)	Ivory Yellow
	Vinaceous-Cinnamon (between scales)	
Underside	Mustard Yellow	Mustard Yellow

	Albino	Normal <i>annectens</i>
Mid-body		
Blotches	Smoke Gray	Black
Interspaces	Ivory Yellow (scale centers)	Honey Yellow to Isabella Color
Sides	Rufous (between scales) Ivory Yellow and Naples Yellow scales, with Carrot Red between	Isabella Color
Below	Ivory Yellow	Naples Yellow
Posterior body		
Blotches	Pale Smoke Gray	Black
Interspaces	Ivory Yellow (scale centers)	Clay Color
Below	Dragons-blood Red (between scales) Carrot Red blotches on Cream-Buff ground	Marguerite Yellow
Tail (at center)		
Blotches	Pale Smoke Gray	Black
Interspaces	Ivory Yellow (scale centers)	Clay Color speckled with darker
Below	Dragons-blood Red (between scales) Mottled Salmon Color and White	Smoke Gray suffusion in center with Colonial Buff edges

An analysis of this color comparison and a study of the albino lead to the conclusion that the principal pigment element that is absent is black. The only areas which seem to lack pigment, judging not only by color but by texture, are the dorsal and lateral blotches which are solid black in a normal specimen. Although these areas are variously recorded as being Drab-Gray, Smoke Gray, or Pale Smoke Gray in the albino, they have the appearance of being at least partially translucent, such color as there is coming from beneath. One does not sense this in the scales containing various shades of yellow or pink. This snake had not recently shed at the time of this examination, and these barren spots had become somewhat opaque; it is thought that a more pinkish cast would have been evident from the tissue showing through, were the skin fresh. It is further evident that the brown and gray of which much of the pattern of the normal snake is composed, are compounded of yellow, red, and black, the latter being often in the form of tiny punctations, although not in the dorsal blotches which are normally solid black. With the black missing, the yellow and red become more conspicuous, particularly

the latter, in a manner not evident in a normal snake. The red in the albino, which gives it a generally pink appearance, is produced by true pigment and does not result from blood being seen through colorless scales, as might be presumed, although this may be possible to a minor extent in the dorsal-blotch areas. Red pigment is especially prominent laterally and posteriorly, and most often between scales. Anteriorly the sides are more yellow, the lower scale rows being Amber Yellow on the neck. Speaking technically, it is evident that true albinism is complete only in the dorsal blotches (and some of the laterals) where black pigment alone is normally present.

The tongue and eye of the albino are pink or red; in a normal specimen the iris is brown and the tongue black.

I have made some similar color notes on live specimens of *deserticola* and *affinis* from as near their respective type localities as were available to me, these being, for *deserticola*, 1/2 mi. east of Ash Creek Bridge, north of Pintura, Washington Co., Utah; and, for *affinis*, Headquarters of Petrified Forest National Monument, Apache Co., Arizona.

	<i>Deserticola</i>	<i>Affinis</i>
Head		
Top, light areas	Sayal Brown	Wood Brown
Top, dark areas	Verona Brown to Sepia	Clove Brown
Sides	Light Pinkish Cinnamon	Pale Drab-Gray
Below	Cartridge Buff	White
Neck		
Blotches	Black (with scale centers of Snuff Brown)	Natal Brown with Black edges
Interspaces	Cream-Buffer streaked with Black and Isabella Color	Olive-Buffer
Below	Ivory Yellow	Ivory Yellow
Mid-body		
Blotches	Warm Sepia	Snuff Brown
Interspaces	Cream-Buffer streaked with Black	Cream-Buffer
Below	Marguerite Yellow	Ivory Yellow
Posterior body		
Blotches	Black	Sepia to Black
Interspaces	Mikado Brown	Sayal Brown
Below	Chamois	Colonial Buff with Bistre blotches
Tail (at center)		
Blotches	Black	Black (rings)
Interspaces	Mikado Brown	Sayal Brown
Below	Chamois	Cream-Buffer

It is to be remembered that *affinis* in the neighborhood of its type locality is considerably darker than the more common snakes of southern Arizona.

Returning to aberrants, Fitch (1935, p. 144) and Fisher (1935, p. 151) have described longitudinally striped specimens of *catenifer* from Vacaville and Carmel Valley, California. I have seen two snakes of this pattern from Napa. No doubt the relationship of these aberrants to the normally blotched population is somewhat similar to that between the striped and ringed king snakes of San Diego County. However, the striped gopher snakes seem nowhere to comprise any but a small fraction of the population of blotched snakes, whereas in the vicinity of San Diego the striped king snakes make up 41 per cent of the population. Nor is the contrast between the patterns nearly as striking in the gopher snakes, owing to the less vivid color contrast between light and dark areas.

SCALE-COUNT SYNOPSIS

In order that intrasubspecific differences and trends may be more readily apparent, I present in Table 4 the mean scale and blotch counts of the series which have been studied. I again remind the user of the table that, where there are territorial variations, as in the five mainland subspecies discussed in this paper, the means are affected by the localities most heavily represented in my samples. Also, with respect to the island subspecies, some series are too small for authoritative conclusions. Data on the Baja California and island forms are taken from my two previous papers on *Pituophis* (1946a, 1946b); those on *sayi* are derived largely from Miss Stull's published counts.

In Table 5 I present, for the more variable counts only, the probable normal ranges, that is, the ranges which should include about 95 per cent of the specimens encountered, but not aberrants. In the case of some of the Baja California and island forms, the presently available series of which are quite inadequate for final conclusions, I have estimated the normal ranges based on the dispersions shown in the larger series, the usual extent of sexual dimorphism, and relationships with some of the other subspecies. This table, while in part theoretical, should be of some aid in classification.

Tables 6, 7, and 8 show the proportional spreads in scale rows, labials, and oculars, the figures giving the distributions to the nearest unit per cent. In the case of the scale rows, the specimens having an even number of rows have been divided between the odd-numbered counts next above and below. An asterisk (*) indicates that a count is represented, but to an extent of less than one-half of one per cent.

TABLE 4
Mean Scale and Blotch Counts in the Subspecies of *Pituophis catenifer*

Subspecies	Scale rows	Ventrals, males	Ventrals, females	Subcaudals, males	Subcaudals, females	Supralabials	Infralabials	Preoculars	Postoculars	Body blotches	Tail spots
<i>Sayi</i>	32.0	222.8	227.7	59.0	53.0	8.47	12.32	1.32	3.41	50.7	13.0
<i>Affinis</i>	32.0	233.6	238.6	64.5	57.6	8.23	12.74	1.58	3.53	48.0	13.6
<i>Deserticola</i>	31.1	234.5	239.7	66.7	59.9	8.31	12.52	1.77	3.54	56.4	16.2
<i>Bimaris</i>	32.6	243.5	255.5	67.0	58.8	8.82	12.81	2.00	3.32	40.8	11.3
<i>Vertebralis</i>	33.5	243.5	250.4	65.0	59.2	8.99	12.90	2.03	3.21	44.0	11.3
<i>Insulanus</i>	32.7	240.0	247.7	62.3	58.0	8.64	12.57	1.93	3.57	55.3	13.6
<i>Catenifer</i>	31.9	219.1	224.6	69.2	62.4	8.32	12.69	1.87	3.43	64.8	20.5
<i>Annectens</i>	32.6	227.4	232.8	77.8	70.7	8.29	12.83	1.71	3.56	76.4	23.7
<i>Fuliginatus</i>	32.7	229.7	242.2	76.5	70.3	8.60	12.83	1.25	3.82	62.6	19.1
<i>Coronalis</i>	34.3	220.0	231.0	82.0	70.0	8.38	12.88	2.12	4.25	67.3	21.5
<i>Pumilus</i>	28.4	215.0	216.5	70.9	58.0	8.24	11.89	1.17	3.33	75.6	22.2

TABLE 5
Probable Normal Ranges of Scale and Blotch Counts
in the Subspecies of *Pituophis catenifer*

Subspecies	Ventrals, males	Ventrals, females	Subcaudals, males	Subcaudals, females	Body blotches	Tail spots
<i>Sayi</i>	213-233	218-238	51-67	46-60	36-66	9-19
<i>Affinis</i>	220-245	226-251	56-71	50-64	34-63	9-21
<i>Deserticola</i>	220-249	224-254	60-75	53-68	43-71	12-22
<i>Bimaris</i>	239-252	246-259	63-72	55-63	35-47	8-14
<i>Vertebralis</i>	238-251	245-258	61-70	54-62	38-51	8-15
<i>Insulanus</i>	235-245	243-253	58-65	55-62	52-64	10-18
<i>Catenifer</i>	207-236	212-241	59-79	54-69	47-90	14-31
<i>Annectens</i>	216-239	219-247	69-89	62-79	56-102	16-33
<i>Fuliginatus</i>	226-236	233-245	72-81	66-74	55-70	15-23
<i>Coronalis</i>	218-228	225-235	77-84	69-75	60-77	18-26
<i>Pumilus</i>	210-220	216-226	68-75	60-66	69-83	19-27

TABLE 6
Distribution of Scale-Row Counts
at Mid-body in Per Cent

Subspecies	Scale Rows						
	27	29	31	33	35	37	39
<i>Sayi</i>		8	45	35	11	1	
<i>Affinis</i>		8	43	41	8		
<i>Deserticola</i>	1	24	48	23	4		
<i>Bimaris</i>			31	53	16		
<i>Vertebralis</i>			9	60	31		
<i>Insulanus</i>			14	86			
<i>Catenifer</i>		6	50	38	6	*	
<i>Annectens</i>		3	31	51	14	1	
<i>Fuliginatus</i>			29	57	14		
<i>Coronalis</i>				38	62		
<i>Pumilus</i>	28	72					

Note: Even-numbered specimens have been divided between odd-numbered counts next above and below.

* Signifies present but to an extent of less than 1/2 of 1 per cent.

TABLE 7
Distribution of Labial Counts
in Per Cent

Subspecies	Supralabials						Infralabials							
	6	7	8	9	10	11	10	11	12	13	14	15	16	
<i>Sayi</i>		1	53	44	2		2	15	39	38	6	*		
<i>Affinis</i>	*	*	77	21	2			6	32	46	14	2	*	
<i>Deserticola</i>		1	68	29	2	*	*	12	33	44	10	1		
<i>Bimaris</i>			21	76	3			3	24	63	10			
<i>Vertebralis</i>			14	73	13			1	26	56	16	1		
<i>Insulanus</i>			43	50	7				50	43	7			
<i>Catenifer</i>		*	70	28	2		*	8	26	53	12	1		
<i>Annectens</i>		2	69	28	1		*	4	24	57	14	1		
<i>Fuliginatus</i>			41	59					28	61	11			
<i>Coronalis</i>		25	37	13	25			12	13	50	25			
<i>Pumilus</i>			78	17	5		6	17	61	16				

* Less than 1/2 per cent.

TABLE 8
Distribution of Ocular Counts
in Per Cent

	Preoculars			Postoculars				
Subspecies	1	2	3	2	3	4	5	6
<i>Sayi</i>	68	31	1	*	58	37	5	
<i>Affinis</i>	43	57	*	1	50	44	5	*
<i>Deserticola</i>	25	74	1	2	51	40	7	*
<i>Bimaris</i>		100			71	26	3	
<i>Vertebralis</i>	1	96	3		80	18	2	
<i>Insulanus</i>	14	79	7		50	43	7	
<i>Catenifer</i>	13	87		1	59	35	5	
<i>Annectens</i>	31	67	2	1	51	39	8	1
<i>Fuliginatus</i>	75	25			32	54	14	
<i>Coronalis</i>		87	13		13	50	37	
<i>Pumilus</i>	50	50			67	33		

* Less than 1/2 per cent.

TABLE 9
Average Ratios of Tail Length
to Length Over-all in Adults

Subspecies	Males	Females
<i>Sayi</i>	.125	.117
<i>Affinis</i>	.136	.125
<i>Deserticola</i>	.148	.136
<i>Bimaris</i>	.140	.127
<i>Vertebralis</i>	.135	.123
<i>Insulanus</i>	.143	.129
<i>Catenifer</i>	.157	.143
<i>Annectens</i>	.170	.155
<i>Fuliginatus</i>	.175	.157
<i>Coronalis</i>	.172	.156
<i>Pumilus</i>	.173	.156

Note: Some island forms estimated from insufficient data

PHYLOGENY

The most primitive forms of *Pituophis* are the subspecies of *deppei*—*d. deppei*, *jani*, and *lineaticollis*. They are primitive in the sense of resembling, more nearly than any other members of the genus, a generalized or standardized colubrid. This is particularly true of head scales, for they lack the multiplied and often irregular prefrontals that characterize the northerly species.

The first of these northerly forms to acquire the *Pituophis* type of prefrontals was probably an early form resembling *affinis*, from which the descent of the others may be traced. Toward the east there developed *sayi*, and the other sharp-nosed forms which are not discussed in this paper—*ruthveni*, *lodingi*, *mugitus*, and *melanoleucus*. Another major off-shoot of *affinis* was *deserticola*. From this developed a series of slimmer, longer-tailed, and darkening subspecies—first *catenifer*, reaching its final differentiation along a narrow strip of coast in central California; and then turning southward it evolved into the subspecies *annectens*, not very sharply differentiated from the coastal *catenifer*, but more so from those of interior California. Each of these was ancestor to island forms that eventually became sufficiently differentiated to warrant recognition—*pumilus* from *catenifer*, and *coronalis* and *fuliginatus* from *annectens*.

To me the most difficult phylogenetic problem involves the derivation of *bimaris* and *vertebralis*. *Bimaris* has several evident resemblances to *deserticola*, while *vertebralis* is closer to the earlier *affinis*. It is well known that the Cape fauna shows both Sonoran and San Diegan influences; it is difficult to account for all the forms found there without presupposing

Fig. 2. The Phylogeny of the Subspecies of *Pituophis catenifer*.

influxes both from the north and east. So these two forms may have originated (1) from an *affinis*-like ancestor somehow crossing the area now occupied by the Gulf of California, in which case *vertebralis* later gave rise to *bimaris*, with a curious parallelism to *deserticola*; or (2) *deserticola* was the ancestor, finding its way southward, across what is now the Cahuilla Basin and along the easterly desert coast of Baja California, and thence spreading on to the Cape and from coast to coast around the southerly end of the San Pedro Mártir and San Miguel mountains. If this were the course taken we have a reversion in *vertebralis* back toward *affinis* for which we must account, just as, on the other theory, we have to account for the *deserticola-bimaris* parallelism. Also, if the second theory be supported, we must assume that the *deserticola-bimaris* connection was eventually broken by the expansion of Lake Cahuilla or a northerly extension of the Gulf, followed, when these barriers disappeared, not by a remerging of *deserticola* and *bimaris*, but by a new intrusion of modern *affinis* from the east. It is possible to visualize a combination of both theories—*bimaris* derived from the north and *vertebralis* from the east, with their subsequent merger in the vicinity of the present area of intergradation.

It will be observed that either theory might be true whether or not intergradation be demonstrated between *affinis* and *bimaris* at San Felipe. While I have shown in fig. 2 the *affinis-vertebralis* theory of the derivation of the Lower California forms, I admit a considerable uncertainty on this point.

Insulanus is an obvious derivative from *bimaris*.

With regard to the phylogenetic tree shown in fig. 2, I should like to clarify one point: Forms that are interposed in a direct line of descent are necessarily older than the later forms issuing from them. While given the names of presently existing subspecies, these ancestral forms are not to be deemed as necessarily the exact counterparts of the existing subspecies having the same name. Changing conditions may have modified the stay-at-homes while the emigrants were being changed by the new conditions found in newly occupied areas.

KEYS

I present, first, an abbreviated key to the five subspecies of *Pituophis catenifer* found in the western United States. By omitting the Baja California and island forms it is possible to simplify the key considerably, yet it will be found territorially adequate for much practical work.

- 1a Rostral narrow, considerably higher than wide, raised conspicuously above the adjacent scales, and (when viewed from above) with a sharp curve of small radius at the front *P. c. sayi*
- 1b Rostral wide, but little higher than wide, or often wider than high, flush with, or raised only slightly above the adjacent scales, and with a flat or but slightly curved anterior edge when viewed from above 2
- 2a Ground color of lateral areas between blotches not suffused with gray, being cream or buff, although there are often black or brown streaks on the keels of the scales in these interspaces; ratio of tail length to length over-all usually less than .15 in adult males and .14 in adult females 3
- 2b Ground color of the lateral areas between blotches suffused with gray, especially posteriorly, this color covering entire scales and not being restricted to their keels; ratio of tail length to length over-all usually exceeding .15 in adult males and .14 in adult females 4
- 3a Anterior dorsal blotches usually brown, separated from each other and from the adjacent lateral series *P. c. affinis*
- 3b Anterior dorsal blotches usually black (gray, but black-edged, in juveniles), confluent with each other and the adjacent lateral series to form a black longitudinal band on the neck, in which the light interspaces appear as isolated blotches. (The light scales of these interspaces usually have black streaks on their keels.) *P. c. deserticola*
- 4a Anterior dorsal blotches usually brown, or, if black, then separated from each other and from the adjacent lateral series *P. c. catenifer*
- 4b Anterior dorsal blotches black, irregularly confluent with each other and with the adjacent lateral series *P. c. annectens*

In a key of the dichotomous form it is impossible to bring each subspecies in juxtaposition with the others with which it intergrades, or which it may approach territorially, yet it is for the segregation of these contiguous pairs that keys are most frequently used. This involves a certain amount of generalizing in the primary stages of a key, and the non-use of characters which might be of assistance in particular cases. For this reason I offer the following additional points of difference between these contiguous pairs, with the reminder, however, that even these will

often fail in the very localities where they are most needed, namely, in areas of intergradation. I have included, in the combinations below, every pair which intergrades or approaches a territorial contact.

Sayi—affinis: *Sayi* usually has black anterior blotches, *affinis* brown, although this is often not true of the former in the southern part of its range. *Sayi* is more heavily and darkly mottled below, and the streaks which mark the labial sutures are more prominent, this being especially true of the infralabials. In *sayi* the interspaces between the anterior dorsal blotches are narrower than in *affinis*, and the scales comprising them are usually dark forward and light behind. This gives a peculiarly characteristic speckled effect, different from that in *affinis*, wherein the interspace scales are often longitudinally streaked along their keels.

Sayi—deserticola: Besides the sharp snout and protruding rostral of *sayi*, as compared to *deserticola*, there is the transverse marking of the anterior interspace scales, as described above, whereas in *deserticola* there are longitudinal dark streaks on the keels of the interblotch scales. In *sayi* the anterior dark blotches are separated, the light lines which divide them forming a chain-like pattern; in *deserticola* the dark blotches themselves are usually confluent, the interspaces becoming a series of light (but streaked) islands in a black, longitudinal stripe.

Affinis—deserticola: In addition to the differences pointed out under 3 in the key, it may be noted that the tail blotches are usually brown in *affinis* and black in *deserticola*.

Affinis—annectens: *Affinis* usually has brown and fairly regular dorsal blotches anteriorly, while in *annectens* they are generally black, highly irregular, and confluent. *Affinis* seldom has as many as 60 body blotches, *annectens* seldom so few.

Deserticola—annectens: I think it best to distinguish these two by the presence of a grayish (sometimes brownish) suffusion on the posterior sides and ventrum of *annectens* that is absent in *deserticola*. *Annectens* has more body blotches but the overlap is considerable (table 5). Although both are characterized by black anterior blotches, the interspaces being represented by irregular light lines in *annectens* and isolated lights spots in *deserticola*, many specimens in the area of intergradation (desert edges of the San Gabriel and San Bernardino ranges) have brown and well-separated anterior blotches, somewhat resembling those of *catenifer*.

Deserticola—catenifer: One should look for the same grayish or brownish suffusion that characterizes the separation of *annectens* from *deserticola*. The anterior blotches in *catenifer* are usually brown and separated; in *deserticola* they are black and confluent. On the average, *deserticola* has about 15 more ventral scales than *catenifer* (table 4), but there is considerable overlapping (table 5).

Catenifer—annectens: In addition to the blotch differences pointed out under 4 in the key, it may be noted that *annectens* has more ventrals and

subcaudals, on the average, than *catenifer*, although much overlapping is to be expected (tables 4 and 5).

In offering the following more complete key to all the subspecies of *Pituophis catenifer*, I wish, again, to warn the user not to expect universal accuracy in its application, for the gopher snakes are too variable and there is too much overlapping between subspecies to secure such a result. Therefore, a certain amount of dependence must be placed on geographical localities, which are to be considered an essential part of the key. The synoptical tables of scale and blotch counts should also be consulted.

- 1a Snout sharper; rostral narrow, considerably higher than wide, raised conspicuously above the adjacent scales, and (when viewed from above) with a sharp curve of small radius at the front *P. c. sayi*

The Great Plains area, from southeastern Alberta and southwestern Saskatchewan, southward to northern Coahuila and Nuevo León. The east-and-west range is from the eastern slope of the Rocky Mountains to southern Minnesota and Wisconsin, northwestern Indiana, western Arkansas, and eastern Texas.

- 1b Snout blunter; rostral but little higher than wide, or wider than high, flush with, or raised only slightly above the adjacent scales, and (when viewed from above) with a flat or but slightly curved anterior edge 2

- 2a Supralabials usually not in contact with the eye, and without black-streaked scales in the light anterior interspaces *P. c. coronalis*

South Coronado Island, Baja California.

- 2b At least one supralabial in contact with the eye, or with scales having conspicuous black streaks on their keels within the light interspaces between the dark dorsal blotches 3

- 3a Two parallel dark stripes, made up of contiguous scale blotches, on the underside of the tail, there being an even-edged light line between *P. c. fuliginatus*

San Martín Island, Baja California.

- 3b No paired continuous dark stripes on the underside of the tail, although there may be two rows of dark triangles 4

- 4a Scale rows at mid-body normally 29 or fewer, and without black-streaked scales in the light anterior interspaces *P. c. pumilus*

Santa Cruz Island, California.

- 4b Scale rows at mid-body normally exceeding 29, or with scales having conspicuous black streaks on their keels in the anterior light spaces between the dark dorsal blotches 5

- 5a Ground color of the lateral areas between secondary blotches suffused with gray, especially posteriorly, this color covering entire scales

and not being restricted to their keels; ratio of the tail length to length over-all usually exceeding .15 in adult males and .14 in adult females 6

- 5b Ground color of the lateral areas between blotches not suffused with gray, being cream or buff although there are often black or brown streaks on the keels of the scales in these interspaces; ratio of tail length to length over-all usually less than .15 in adult males and .14 in adult females 7

- 6a Anterior dorsal blotches usually brown, or, if black, then separated from each other and from the adjacent lateral series *P. c. catenifer*

Oregon, west of the Cascade Mountains, from Yamhill and Multnomah counties southward; California west of the Sierra Nevada from Oregon south to the northern boundary of Santa Barbara County and the desert slopes of the Tehachapi Mountains.

- 6b Anterior dorsal blotches black, irregularly confluent with each other and with the adjacent lateral series *P. c. annectens*

California from northern Santa Barbara County and the desert slopes of the San Gabriel and San Bernardino ranges, south to the Rosario River (Lat. 30° N.) in Baja California. The east-and-west range is from the Pacific coast to the lower desert slopes of the Peninsula ranges (San Bernardino, San Jacinto, Sierra Juárez, San Pedro Mártir, etc.)

- 7a Anterior dorsal blotches usually red, red-brown, or brown 8

- 7b Anterior dorsal blotches usually black, or, in juveniles, composed of gray scales with black edges 9

- 8a Anterior dorsal blotches red and confluent laterally; posterior dorsal blotches black (at base of tail); a dark subcaudal stripe usually present *P. c. vertebralis*

Cape Region of Baja California south of Lat. 24°20' N.

- 8b Anterior dorsal blotches brown and separated; posterior dorsal blotches brown or dark-brown (at base of tail); no dark subcaudal stripe usually present *P. c. affinis*

From the desert areas of southeastern California and northeastern Baja California eastward to east-central New Mexico; including the desert areas of Riverside, San Diego, and Imperial counties, California; northeastern Baja California; Arizona south of the Grand Canyon and Canyon de Chelly, western and central New Mexico, extreme western Texas, Sonora, extreme northern Sinaloa, Chihuahua, and western and southern Coahuila.

- 9a Anterior light dorsal interspaces containing many scales having black or dark-brown streaks on their keels *P. c. deserticola*

From the Kamloops-Okanagan area of British Columbia southward and eastward through the Great Basin, to the northern edge of the Colorado Desert and northern Arizona, including trans-Cascade Washington and Oregon; California east of the Sierra Nevada, together with the Mojave Desert south to the northern boundary of Riverside County; Nevada; central and southern

Idaho; the Green River drainage area of Wyoming; Utah; western and southwestern Colorado; the northwestern corner of New Mexico; and Arizona north of the Grand Canyon and Canyon de Chelly.

9b Anterior light dorsal interspaces clear or only faintly streaked 10

10a Body blotches 50 or more *P. c. insulanus*

Cedros Island, Baja California.

10b Body blotches less than 50 *P. c. bimaris*

Central area of the Baja California peninsula from the Pacific to the Gulf, and from Lat. $24^{\circ}20'$ N. to Lat. 30° N., with an occasional specimen as far north as Lat. $31^{\circ}30'$ N. Also Santa Margarita and Magdalena islands.

ACKNOWLEDGMENTS

I am very grateful to the following individuals and institutions for the gifts and loan of material, and for other assistance: Mr. Charles M. Bogert, American Museum of Natural History; Mr. Joseph R. Slevin, California Academy of Sciences; Messrs. Karl P. Schmidt and Clifford H. Pope, Chicago Natural History Museum; Dr. Howard K. Gloyd, Chicago Academy of Sciences; Mr. Louis Schellbach, Grand Canyon National Park; Dr. Ross Hardy, Weber College; Mr. Albert J. Kirn, Somerset, Texas; Mr. Murray R. Butler, Salmon National Forest; Dr. Howard R. Hill, Los Angeles County Museum of History, Science and Art; Messrs. William E. Branch and L. Floyd Keller, Petrified Forest National Monument; Mr. Wilbur Doudna; Mr. Edwin D. McKee, Museum of Northern Arizona; Mr. Arthur Loveridge, Museum of Comparative Zoology, Harvard University; Mr. Thomas L. Rodgers, Museum of Vertebrate Zoology, University of California; Miss Margaret Storey, Natural History Museum, Stanford University; Dr. Waldo L. Schmitt and Dr. Doris M. Cochran, United States National Museum; Dr. Raymond B. Cowles, University of California at Los Angeles; Mrs. Helen T. Gaige and Dr. Reeve M. Bailey, Museum of Zoology, University of Michigan; Prof. James R. Slater, College of Puget Sound; Dr. Emmett R. Dunn, Academy of Natural Sciences of Philadelphia; Mr. George F. Baxter, University of Wyoming.

I was assisted in making scale counts by Mr. Charles E. Shaw and Miss Mary Ramage.

I am indebted to Mr. C. B. Perkins for assistance in editing the manuscript. The photographs and map were executed by Mr. Leslie C. Kobler.

SUMMARY

The four western mainland subspecies of the gopher snake, *Pituophis catenifer*—*P. c. catenifer*, *P. c. annectens*, *P. c. deserticola*, and *P. c. affinis* are resurveyed. Nomenclatorial and systematic problems are considered; descriptive data, relationships, and field notes are set forth. Ranges, as newly defined, are given. Synopses and keys of all the subspecies of *Pituophis catenifer*, including Baja California and island forms, are presented.

BIBLIOGRAPHY

Abbott, W. G.

1940. A Snake is Born. Santa Barbara Mus. Nat. Hist., Mus. Leaflet, vol. 15, no. 2, pp. 15-17.

Anderson, O. I. and Slater, J. R.

1941. Life Zone Distribution of the Oregon Reptiles. Occ. Papers College Puget Sound, no. 15, pp. 109-119.

Baird, S. F.

1859. Reptiles: In "Explorations and Surveys for a Railroad Route from the Mississippi River to the Pacific Ocean". Vol. 10, Gen. Rept. pp. 13-16, plates 24-36.

Baird, S. F. and Girard, C.

1852. Reptiles: In "Expedition to the Valley of the Great Salt Lake of Utah", by Howard Stansbury. Appendix C, pp. 336-365.
1853. Catalogue of North American Reptiles and Amphibians in the Museum of the Smithsonian Institution. Part 1—Serpents, pp. 1-172.

Blainville, H. D. de

1835. Description de Quelques Espèces de Reptiles de la Californie. Nouv. Ann. Mus. d'Hist. Nat., vol. 4, pp. 233-296.

Bocourt, F. (with Duméril, A., and Mocquard, F.)

- 1870-1909. Mission Scientifique au Mexique. Les Reptiles, pp. 1-1012. Atlas.

Bogert, C. M.

1930. An Annotated List of the Amphibians and Reptiles of Los Angeles County, California. Bull. So. Calif. Acad. Sci., vol. 29, part 1, pp. 3-14.

Burt, C. E.

1935. Contributions to Texas Herpetology. III Bullsnares of the Genera *Arizona* and *Pituophis*. Journ. Wash. Acad. Sci., vol. 25, no. 8, pp. 380-383.

Clay, W. M.

1935. The Occurrence of Albinos in a Brood of the Common Water Snake, *Natrix sipedon sipedon* (L.). Copeia, no. 3, pp. 115-118.

Cope, E. D.

1860. Notes and Descriptions of New and Little Known Species of American Reptiles. Proc. Acad. Nat. Sci. Phila., vol. 12, pp. 339-345.
1861. Contribution to the Ophiology of Lower California, Mexico, and Central America. Proc. Acad. Nat. Sci. Phila., vol. 13, pp. 292-306.
1887. Catalogue of Batrachians and Reptiles of Central America and Mexico. Bull. U. S. Nat. Mus., no. 32, pp. 1-98.
1900. The Crocodilians, Lizards, and Snakes of North America. Report of U. S. Nat. Mus. for 1898, pp. 153-1294.

Cowan, I. M.

1937. A Review of the Reptiles and Amphibians of British Columbia. Rept. Provincial Mus. for 1936, pp. K16-25.

Cowles, R. B.

1935. Notes on the Life History of *Pituophis catenifer deserticola* (Stejneger). Copeia no. 1, p. 44.

Duméril, A. M. C. and Bibron, G.

1854. *Erpétologie Générale*, vol. 7, p. 1, pp. xvi + 780.

Fisher, Edna M.

1935. Color Variation in the Coast Gopher Snake. Copeia, no. 3, pp. 151-152.

Fitch, H. S.

1935. An Abnormal Pattern in a Gopher Snake. Copeia, no. 3, pp. 144-6.
1936. Amphibians and Reptiles of the Rogue River Basin, Oregon. Am. Midl. Nat., vol. 17, no. 3, pp. 634-652.

Garman, S.

1884. North American Reptiles and Batrachians. Bull. Essex Inst., vol. 16, pp. 1-46.

Girard, C.

1858. United States Exploring Expedition during the years 1838, 1839, 1840, 1841, 1842, under the Command of Charles Wilkes. Herpetology. Philadelphia, pp. xvii + 496 + Atlas of 32 plates.

Grinnell, J. and Camp, C. L.

1917. A Distributional List of the Amphibians and Reptiles of California. Univ. Calif. Pubs. in Zool., vol. 17, no. 10, pp. 127-208.

Hallowell, E.

1852. Descriptions of New Species of Reptiles Inhabiting North America. Proc. Acad. Nat. Sci. Phila., vol. 6, pp. 177-182.
1854. Reptiles: In Report of an Expedition down the Zuni and Colorado Rivers by Capt. L. Sitgreaves, pp. 106-147.

Hisaw, F. L. and Gloyd, H. K.

1926. The Bull Snake as a Natural Enemy of Rodents. Journ. Mammalogy, vol. 7, no. 3, pp. 200-205.

Hudson, G. E.

1942. The Amphibians and Reptiles of Nebraska. Neb. Cons. Bull., no. 24, pp. 1-146.

Huey, L. M.

1942. A Vertebrate Faunal Survey of the Organ Pipe Cactus National Monument, Arizona. Trans. San Diego Soc. Nat. Hist., vol. 9, no. 32, pp. 353-376.

Imler, R. H.

1945. Bullsnares and their Control on a Nebraska Wildlife Refuge. Journ. Wildlife Management, vol. 9, no. 4, pp. 265-273.

Jackson, E.

1945. About Bull Snakes. Animal Kingdom, vol. 48, no. 3, pp. 75-79.

Jan, G. (with Sordelli, F.)

- 1860-1881. Iconographie Générale des Ophidiens. Pp. 100 and 3 vol. Atlas. Milan and Paris.

Johnson, M. L.

1942. A Distributional Check-List of the Reptiles of Washington. Copeia, no. 1, pp. 15-18.

Klauber, L. M.

1924. Notes on the Distribution of Snakes in San Diego County, California. Bull. Zool. Soc. San Diego, no. 1, pp. 1-26.
1931. A Statistical Survey of the Snakes of the Southern Border of California. Bull. Zool. Soc. San Diego, no. 8, pp. 1-93.
1939. Studies of Reptile Life in the Arid Southwest. Part 1. Night Collecting on the Desert with Ecological Statistics. Bull. Zool. Soc. San Diego, no. 14, pp. 6-64.
- 1941a. Variations and Relationships in the Snakes of the Genus *Pituophis* [A Review of Miss Stull's paper of 1940]. Copeia no. 1, pp. 57-60.
- 1941b. The Frequency Distributions of Certain Herpetological Variables. Bull. Zool. Soc. San Diego, no. 17, pp. 5-31.
- 1941c. The Correlation between Scalation and Life Zones in San Diego County Snakes. Bull. Zool. Soc. San Diego, no. 17, pp. 73-79.
1943. Tail-length Differences in Snakes with Notes on Sexual Dimorphism and the Coefficient of Divergence. Bull. Zool. Soc. San Diego, no. 18, pp. 1-60.
- 1946a. The Gopher Snakes of Lower California, with Descriptions of New Subspecies of *Pituophis catenifer*. Trans. San Diego Soc. Nat. Hist., vol. 11, no. 1, pp. 1-40.
- 1946b. A New Subspecies of *Pituophis catenifer* from Santa Cruz Island, California. Trans. San Diego Soc. Nat. Hist. vol 11, no. 2, pp. 41-48.

La Rivers, I.

1942. Some New Amphibian and Reptile Records for Nevada. Jour. Ent. and Zool. Pomona Coll., vol. 34, no. 3, pp. 53-68.

Linsdale, J. M.

1938. Environmental Responses of Vertebrates in the Great Basin. Am. Midl. Nat., vol. 19, no. 1, pp. 1-206.
1940. Amphibians and Reptiles in Nevada. Proc. Am. Acad. Arts and Sci., vol. 73, no. 8, pp. 197-257.

Logier, E. B. S.

1932. Some Account of the Amphibians and Reptiles of British Columbia. Trans. Royal Canadian Inst., vol. 18, part 2, pp. 311-336.

McKee, E. D. and Bogert, C. M.

1934. The Amphibians and Reptiles of Grand Canyon National Park. Copeia, no. 4, pp. 178-180.

Mearns, E. A.

1907. Mammals of the Mexican Boundary of the United States. Part 1: Bull. U. S. Nat. Mus., no. 56, pp. xv + 530.

Meek, S. E.

1905. An Annotated List of a Collection of Reptiles from Southern California and Northern Lower California. Field Col. Mus., Zool. Ser., vol. 7, no. 1, pub. 104, pp. 1-19.

Minton, S.

1944. Introduction to the Study of the Reptiles of Indiana. Am. Midl. Nat., vol. 32, no. 2, pp. 438-477.

Mittleman, M. B.

1942. *Pituophis catenifer deserticola* Stejneger in Arizona. Proc. New Eng. Zool. Club, vol. 21, pp. 43-45.

Mocquard, F.

1899. Contribution a la Faune Herpétologique de la Basse-Californie. Nouv. Arch. Mus. Nat. Hist., ser. 4, vol. 1, pp. 297-344.

Owen, R. P.

1940. A List of the Reptiles of Washington. Copeia, no. 3, pp. 169-172.

Perkins, C. B.

- 1943a. Notes on Captive-bred Snakes. Copeia, no. 2, pp. 108-112.
1943b. The Most Valuable Snake. Zoonoos, vol. 16, no. 10, pp. 3-4.

Pope, C. H.

1944. Amphibians and Reptiles of the Chicago Area. Chicago Natural History Museum, pp. 1-275.

Rodgers, T. L. and Jellison, W. L.

1942. A Collection of Amphibians and Reptiles from Western Montana. Copeia, no. 1, pp. 10-13.

Ruthven, A. G.

1907. A Collection of Reptiles and Amphibians from Southern New Mexico and Arizona. Bull. Am. Mus. Nat. Hist., vol. 23, art. 23, pp. 483-604.

Schmidt, K. P.

1922. The Amphibians and Reptiles of Lower California and the Neighboring Islands. Bull. Am. Mus. Nat. His., vol. 46, art. 11, pp. 607-707.

Slater, J. R.

1941. The Distribution of Amphibians and Reptiles in Idaho. Occ. Papers College Puget Sound, no. 14, pp. 78-109.

Smith, H. M.

1943. Summary of the Collections of Snakes and Crocodilians Made in Mexico under the Walter Rathbone Bacon Traveling Scholarship. Proc. U. S. Nat. Mus., vol. 39, no. 3169, pp. 393-504.

Smith, H. M. and Mittleman, M. B.

1943. Notes on the Mansfield Museum's Mexican Reptiles Collected by Williamson. Trans. Kan. Acad. Sci., vol. 46, pp. 243-249.

Stejneger, L.

1893. Annotated List of the Reptiles and Batrachians Collected by the Death Valley Expedition in 1891, with Descriptions of New Species. North Am. Fauna no. 7, pp. 159-228, 394-398.

Stejneger, L. and Barbour, T.

- 1917 A Check List of North American Amphibians and Reptiles, pp. iv + 125. Cambridge.
1923. Same. Second Edition, pp. x + 171. Cambridge.
1933. Same. Third Edition, pp. xiv + 185. Cambridge.
1939. Same. Fourth Edition, pp. xvi + 207. Cambridge.
1943. Same. Fifth Edition, pp. xix + 260. Cambridge.
(Bull. M.C.Z., vol. 43, no. 1)

Storer, T. I.

1916. An Instance of Albinism in the Western Gopher Snake. Copeia, no. 35, pp. 74-6.

Streets, T. H.

1877. Contributions to the Natural History of the Hawaiian and Fanning Islands and Lower California. Bull. U. S. Nat. Mus., no. 7, pp. 1-172.

Stull, Olive G.

1932. An Annotated List of the Forms of the Genus *Pituophis*. Occ. Papers Mus. Zool., Univ. Mich., no. 250, pp. 1-5.
1940. Variations and Relationships in the Snakes of the Genus *Pituophis*. Bull. U. S. Nat. Mus., no. 175, pp. vi + 225.

Tanner, V. M.

1940. A Biotic Study of the Kaiparowits Region of Utah. Great Basin Nat., vol. 1, nos. 3 and 4, pp. 97-126.

Tanner, W. W.

- 1939. The Status of the Utah Gopher Snake. Proc. Utah Acad. Sci., vol. 16, p. 107.
- 1940. Notes on the Herpetological Specimens Added to the Brigham Young University Vertebrate Collection During 1939. Great Basin Nat., vol. 1, nos. 3 and 4, pp. 138-146.

Van Denburgh, J.

- 1895. A Review of the Herpetology of Lower California. Part 1 - Reptiles. Proc. Cal. Acad. Sci., ser. 2, vol. 5, pp. 77-162.
- 1897. The Reptiles of the Pacific Coast and Great Basin. Occas. Papers Calif. Acad. Sci., no. 5, pp. 1-236.
- 1905. The Reptiles and Amphibians of the Islands of the Pacific Coast of North America from the Farrallons to Cape San Lucas and the Revilla Gigedos. Proc. Cal. Acad. Sci., ser. 3, vol. 4, no. 1, pp. 1-27.
- 1920. A Further Study of Variation in the Gopher-Snakes of Western North America, Proc. Cal. Acad. Sci., ser. 4, vol. 10, no. 1, pp. 1-27.
- 1922. The Reptiles of Western North America. Occas. Papers Calif. Acad. Sci., no. 10, 2 vols., pp. 1-1028.
- 1924. Notes on the Herpetology of New Mexico, with a List of Species Known from that State. Proc. Cal. Acad. Sci., ser. 4, vol. 13, no. 12, pp. 189-230.

Van Denburgh, J. and Slevin, J. R.

- 1914. Reptiles and Amphibians of the Islands of the West Coast of North America. Proc. Cal. Acad. Sci., ser. 4, vol. 4 no. 5, pp. 129-151.
- 1919. The Gopher Snakes of Western North America. Proc. Cal. Acad. Sci., ser. 4, vol. 9, no. 6, pp. 197-220.
- 1921. A List of the Amphibians and Reptiles of the Peninsula of Lower California, with Notes on the Species in the Collection of the Academy. Proc. Cal. Acad. Sci., ser. 4, vol. 11, no. 4, pp. 49-72.

White, C. A.

- 1884. On the Character and Function of the Epiglottis in the Bull Snake (*Pityophis*). Am. Nat., vol. 18, pp. 19-21.

Woodbury, A. M.

- 1931. A Descriptive Catalog of the Reptiles of Utah. Bull. Univ. Utah, vol. 21, no. 5, pp. x + 129.

Wright, J. W. A.

- 1878. A Very Wonderful Freak of Nature. Pacific Rural Press, vol. 15, no. 7, p. 105. Also Mining and Scientific Press, vol. 36, no. 7, p. 97.

Yarrow, H. C.

1883. Check List of North American Reptilia and Batrachia, with Catalogue of Specimens in U. S. National Museum. Bull. U. S. Nat. Mus., no. 24, pp. 1-249.

Fig. 3. *Pituophis catenifer catenifer*. Pacific Gopher Snake. Adult male from Visalia, Calif. Collected by F. T. Scott.

Fig. 4. *Pituophis catenifer annectens*. San Diegan Gopher Snake. Adult female from Mesquite Point, Baja Calif. Collected by Dr. C. L. Hubbs.

Fig. 5. *Pituophis catenifer deserticola*. Great Basin Gopher Snake. Adult male from 14 miles north of Reno, Nev. Collected by Benjamin Banta.

Fig. 6. *Pituophis catenifer affinis*. Sonoran Gopher Snake. Adult male from 10 miles west of Benson, Ariz. Collected by Robert Hoard.