

A PRELIMINARY ANALYSIS OF THE HERPETOFAUNA OF SONORA

CHARLES M. BOGERT AND
JAMES A. OLIVER

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INTRODUCTION

THIS INVESTIGATION is an outgrowth of an exploratory trip made by the senior author in 1939. With funds provided that year by a grant-in-aid from the Carnegie Corporation of New York through the American Association of Museums, he motored from Guadalajara in Jalisco along the west coast of Mexico, through the states of Nayarit, Sinaloa, and Sonora to Nogales, Arizona. While passing through northern Sinaloa and the southern portion of Sonora, a gradual change in vegetation from that of the arid tropics to that of the desert was noted, and the region surrounding the Río Fuerte was selected for future herpetological exploration. It was not possible, however, for him to undertake this work until the summer of 1942, when the town of Alamos was selected as a base for operations. Meanwhile in 1941 Mr. John W. Hilton of Thermal, California, generously offered to make collections for us at Guiricoba on the Río Fuerte drainage, and we were extremely pleased to avail ourselves of his services.

This report, therefore, is based primarily upon the Sonoran collections assembled by Mr. Hilton and by the senior author. The material thus obtained proved to be of such exceptional interest from a zoogeographic standpoint that we decided to attempt a preliminary analysis of the fauna of the entire state. We realize that our efforts may be premature, since a satisfactory understanding of the distributional problems in Sonora can be expected only after an extensive program of investigation has been carried out. At the present time there are insufficient locality records for the state to enable us to plot the ranges of even the commoner species of amphibians and reptiles with any precision. Our meager distributional data for Sonora and for the contiguous states suggest that some species occupy restricted habitats, with disjunct distributions perhaps, but it is uncertain whether this is actually the case or that we merely lack the necessary evidence. In many instances we know that genera are represented in the state by two or more distinguishable populations, but in several cases we do not know whether the ranges of two

closely related forms overlap in the intermediate territory, whether gradients are involved, or whether there are relatively narrow regions of intergradation. Moreover the nature of the intergradation is in doubt for even the better-known groups where interbreeding between recognizably different populations is inferred.

For these reasons any attempt at this time to analyze the herpetofauna of Sonora, from either systematic or ecological viewpoints, will arrive at conclusions that are tentative at best. Very often, however, even a preliminary survey of a region brings to light the problems that exist and thereby directs further effort toward their solution. We hope that the present survey will stimulate interest in the herpetofauna of Sonora and perhaps induce more collectors of herpetological material to undertake work within the state.

The need for more extensive herpetological exploration in northwestern Mexico has become increasingly apparent. Monographic treatment of individual species, or preferably genera, will be necessary before an understanding of amphibian and reptilian relationships in western North America can be gained. Most authors of generic monographs have found so little amphibian and reptilian material available from northwestern Mexico that it has been impossible for them to plot satisfactorily the ranges of the groups with which they were dealing. Commonly they found no Sonoran specimens at all representing the genus under consideration, or at best they found a few examples from one or two localities (for examples, see Klauber, 1940a, 1940b, 1941b; Stull, 1940; Smith, 1941a; Stickel, 1941, 1943; Gloyd and Conant, 1943).

Nevertheless the herpetofauna of Sonora is rich for a region so limited in area (roughly 77,000 square miles). At present 124 forms, including 111 species belonging to 64 genera, are reasonably well authenticated as members of the fauna, and perhaps half again as many will be included when the region has been thoroughly explored. The extent of the known fauna compares favorably with that of the larger state of California, and when more collecting has been done it can be an-

anticipated that the total number of forms will exceed that reported for Florida, a state rich in amphibians and reptiles; Carr (1940) lists 162 subspecies representing 136 species and 75 genera. The list of species known from Baja California has not been brought up to date, but Schmidt (1922, p. 611) over two decades ago included 149 species and subspecies in the fauna, of which 92 were known from the peninsula, and the remainder from the islands.

These peninsular faunas, in Florida and in Baja California, however, are rich in species by reason of successive waves of invasion from the north resulting in an accumulation of relicts (Schmidt, 1943). Sonora is rich in species for quite another reason. Within the state are found subtropical as well as desert, foothill, and mountain habitats. The fauna is composed of a complexity of elements, some represented by species belonging to groups with tropical centers of dispersal, and by others from Holarctic centers. As a result we find ranges of northern (temperate zone) animals interdigitating with those of tropical forms, especially in southern Sonora where the fauna is extremely complex and rich in species.

Sonora was selected as a region for herpetological exploration, therefore, not only to fill some of the gaps in the ranges of genera whose distributions extend from Mexico into southwestern United States, but to gain an estimate of the extent of this interdigitation. In this paper we have endeavored: (1) to list with suitable annotations the species taken at two localities, Alamos and Guirocoba, on the southernmost drainage system in the state; (2) to undertake such preliminary taxonomic revisions as became necessary in the identification of the material studied; (3) to list the species reasonably well authenticated as indigenous to the state (not including adjacent islands); and finally (4) to undertake an investigation of the faunal elements represented. Not so many years ago K. P. Schmidt (1922), in his classical analysis of the herpetofauna of Baja California, called attention to the fact that "An investigation of the herpetology of the state of Sonora on the east side of the Gulf of California could not fail to add greatly to our understanding of the origin and relations of the Lower Californian reptile fauna." Because the num-

ber of species known from Sonora has been more than doubled since the publication of Schmidt's work, we have included discussions of the fauna of Sonora in its relationship to that of Baja California, and this in turn throws some light on distributional patterns in both Arizona and Sonora.

ACKNOWLEDGMENTS

We are indebted to a number of persons who have assisted us during the preparation of this report. To Mr. John W. Hilton of Thermal, California, we owe our thanks for his efforts in assembling a collection at Guirocoba for us, and to Mr. Steve A. Glassell of Beverly Hills, California, who advised Mr. Hilton of our interest.

The senior author is particularly grateful to Mr. and Mrs. Melville H. Haskell of the Rincon Ranch and Stock Farm near Tucson, Arizona, for their cordial hospitality in 1939, as well as in 1942, when their ranch provided a base for our field activities in Arizona and Sonora. Also the senior author acknowledges the invaluable assistance provided in the field by Mr. William H. Woodin, 3rd, Mr. Charles Lowe, and Mr. William Riemer, all of whom collected material utilized in the preparation of this report.

For the loan of comparative material or for lists of Sonoran specimens in various museums we are greatly indebted to the following individuals and institutions: Dr. L. M. Klauber, San Diego Society of Natural History; Dr. Alden Miller and Mr. Thomas Rodgers, Museum of Vertebrate Zoology, University of California; Mr. Karl P. Schmidt and Mr. Clifford H. Pope, Chicago Natural History Museum; Dr. Doris M. Cochran, United States National Museum; Mr. Arthur Loveridge, Museum of Comparative Zoology, Harvard College; Mr. Joseph R. Slevin, California Academy of Sciences; Miss Margaret Storey, Stanford University Natural History Museum; Mrs. Helen T. Gaige and Dr. Norman Hartweg, Museum of Zoology, University of Michigan; and Señor Rafael Martín del Campo, Instituto de Biología in Mexico City.

Dr. Norman Hartweg, Dr. Edward H. Taylor, Dr. Hobart M. Smith, Dr. Howard K. Gloyd, Señor Rafael Martín del Campo, and particularly Dr. L. M. Klauber gener-

ously examined various specimens for us and supplied other valuable information. Mr. Robert T. Moore, Research Associate in Vertebrate Zoology, California Institute of Technology, kindly lent us his privately owned collection from northwestern Mexico, thus enabling us to report upon it in a separate section of the present paper. Data derived therefrom have contributed substantially to our understanding of the herpetofauna of Sonora.

Drawings accompanying the text were prepared by Mr. Dimitri Alexandroff, Mr. Sydney Aberman, Mrs. Alma W. Froderstrom, Mrs. Jeanet Dreskin, Miss Margaret Sorenson, and Mr. Plato Taleporos, while the figures and photograph of a new species of *Pseudocimexia* described herein were generously supplied by Dr. Edward H. Taylor. Other photographs were contributed by Dr. Howard K. Gloyd of the Chicago Academy of Sciences, and by Mr. Thane Bierwert of the American Museum of Natural History. The distributional table was prepared by the American Museum Artists Corps under the direction of Mr. Thomas Voter. Miss Levett Bradley prepared the map showing the topography of Sonora on the basis of the 1:5,000,000 map published by the American Geographical Society; Mr. Charles B. Hitchcock, head of the society's Special Projects Department, kindly granted us permission to reproduce this portion to fit our needs.

Both Dr. Edwin H. Colbert and Mr. Roger Conant read extensive portions of the manuscript, and their criticisms have been of immense value. Dr. L. M. Klauber has furnished detailed notes concerning the rattlesnakes reported herein which he has courteously permitted us to quote; similarly he has supplied extensive lists and offered numerous extremely helpful suggestions.

To all these individuals and institutions we are deeply grateful. Finally we acknowledge our thanks to the courteous officials of the Mexican Government, and to the Works Projects Administration, Official Project No. OP 265-1-97-16 W.P. 10.

PREVIOUS HERPETOLOGICAL WORK IN SONORA

Despite the fact that collections of reptiles were made in Sonora as early as 1851, our

knowledge of the herpetofauna of the state is still relatively inadequate. Until the last two decades most herpetological collections were assembled incidental to other surveys, and no special effort was made to collect amphibians and reptiles. Many of the earlier collections were made by mammalogists or by other explorers, whose activities have been outlined by W. H. Burt (1938). In many cases herpetological material, such as that secured by Carl Lumholtz (much of which was actually collected by F. Robinette in the early part of the present century), has never been made the subject of any report. Small collections from Sonora are present in various museums within the United States, but most of these have not been subjected to critical study. Owing to the incidental nature of the collecting, many of the older specimens are accompanied by inadequate or even inaccurate data; not a few of the types have locality data no more exact than "Sonora," whereas many, if not most, of those taken prior to the Gadsden Purchase of 1853 and labeled "Sonora" almost certainly were taken in what is now part of the state of Arizona (see also Taylor, 1938a, p. 475, and Bogert, 1939, pp. 198-199).

In recent years, however, a number of specimens with precise locality data have been secured and reported upon, principally by Allen (1933) and by Taylor (1938a). Prior to the publication of Taylor's paper the only attempt to list all the reptiles known from Sonora was that of Van Denburgh (1922), and Slevin (1928) provides a list of the amphibia. Taylor in his useful paper not only describes the material secured by him, chiefly between Hermosillo and Guáymas in the west central portion of Sonora, but he also summarizes the previous work done in the state and provides a list which includes most of the important references in an annotated bibliography. Accordingly, the history of herpetological exploration in the state of Sonora need not be repeated here in any detail. We may add, however, that information concerning a few Sonoran specimens has been included in various monographs and generic revisions that have appeared subsequent to the publication of Van Denburgh's work in 1922. As a result of these additions to the fauna of the state, along with forms

reported herein, we are able to list a total of 124 species and subspecies (table 1).¹

Indubitably many names will be added to this tabulation, as a result either of additional collecting in the state or of more intensive study of the various groups found within the region. Some notion of the increment in knowledge during the last two decades may be gained by citing figures. Whereas Van Denburgh in 1922 assembled a list of 52² reptiles, including (except for the deletions noted) 3 turtles, 28 lizards, and 18 snakes, we find it possible to report (with 3 forms reported by Van Denburgh deleted) a total of 108 reptiles, consisting of 9 turtles, 44 lizards, and 55 snakes. Slevin (1928) lists but 6 amphibians from Sonora, in contrast to 16 which may now be recorded. Thus, within a period of 21 years the total number of amphibian and reptilian species and subspecies has doubled. Diminishing returns in the number of forms likely to be added in the near future can scarcely be anticipated, and it seems to be a fair assumption that no more than two-thirds of the herpetofauna of the state is known.

SOURCES OF MATERIAL

The material comprising the basis of this report (to which we have appended notes on the R. T. Moore collection from northwestern Mexico) was obtained as the result of two trips into the southeastern portion of the state of Sonora. The first of these was undertaken by Mr. John W. Hilton, who spent the period between June 15 and October 15, 1941, at Guirocoba, where he secured a total of 183 specimens. The second

¹ The specimen representing *Eleutherodactylus angusti* was received too late to be included in the table, and an additional species and genus, *Leptodeira ephippiata* (Smith and Tanner, 1944), must be added to the list of Sonoran reptiles, making the total 125. Also, the Sonoran *Pituophis* apparently should be called *Pituophis catenifer affinis* rather than *P. s. affinis*, and the name *Crotalus cerastes laterorepens* has been given by Klauber, 1944, to the sidewinders of the Colorado Desert, including portions of Sonora and Baja California. This information was received too late to be incorporated in table 1.

² On the basis of recent monographs the following species have been deleted from Van Denburgh's list, although there is reasonable expectancy that most of them will eventually be discovered in the northern part of the state: *Sceloporus poinsettii*, *Sonora semiannulata*, *Sistrurus catenatus tergeminus*.

excursion into the region was made by the senior author, accompanied by Mr. William Riemer and Mr. Charles Lowe, students at the University of California at Los Angeles, who spent eight days, August 26 to September 3, 1942, in the state and collected 203 specimens at the old mining town of Alamos (one toad was taken at Navojoa). Both Alamos and Guirocoba are located on the Río Fuerte drainage system which empties into the Gulf of California in northern Sinaloa. Alamos was formerly accessible by rail, but the railroad has now been abandoned, along with the silver mines, and Alamos can be reached only by road. Guirocoba is some 28 to 30 miles via road (or about 20 miles in a direct line) southeast of Alamos. It can be reached by way of Alamos from the west only by traversing a route that is all but impassable during the rainy season which usually begins in July or August. Because the southern portion of Sonora is faunistically and floristically quite different from the northern half of the state, it will be of interest to describe in some detail the surroundings of the two localities where collections were made. Mr. Hilton has provided notes concerning the village where he assembled his collection, as follows:

"GUIROCOBA is a small village on a ranch by the same name located in the foothills of the Sierra Madre Occidental. The ranch is owned by the McCartys, an American family who have lived on it for a good many years. The village has been set aside from the main ranch since the advent of the Agrarian movement in Mexico; there are thirty-three families who have agrarian lands, and about the same number of semi-transient residents.

"The altitude of the ranch house is about 1,485 feet above sea-level, and the nearby hills rise to elevations of 3,500 to 4,000 feet. The main body of the ranch lies in a long valley between two spur ranges of the hills, comprising about 50,000 acres with the hill tops as borders and the peaks as corners. The valley is drained by one long arroyo and watered by several springs. All of the drainage eventually reaches the Río Fuerte in Sinaloa.

"The arroyo is marked by a dense growth of giant cypress trees while the banks on either side have sandy and bare stretches

where I took some of the more deserticolous reptiles. The gentle slopes on either side of the arroyo and its branches are covered with the typical thorn forest vegetation, dry and leafless during the winter, and green and tropical in appearance when it rains. These slopes are studded by thousands of giant *Pachycereus* and *Lemaireocereus* cacti, along with great white trunked trees of the *Ipomea* family. Mesquite and cats claw are also present.

"The north end of the ranch is a higher basin where the thorn forest gives way to open glades of grass land studded with oaks, palms, and giant cacti growing close together. The deep canyons are densely tropical in appearance, supporting many types of the so-called air plants, including tillandsias and orchids. Succulent trees of the families which include *Bursera*, *Plumeria* and *Ficus*, as well as 'wild bananas' add to the tropical appearance of the basin. Deep shaded areas support rank growths of ferns and tuberous begonias.

"The springs all contain small fish as do the arroyos when they have water in them. Frogs and toads seem to come from nowhere when the first rains put water in all the low spots. I collected a species of fresh water crab in several spots where these crabs abound throughout the year. Many specimens of amphibians and reptiles were brought to me by native boys and men for small rewards. In the case of the 'pichicuate' [*Agkistrodon bilineatus*] I had to raise the reward to five pesos before anyone would tackle one."

The village of Guirocoba (the name is a Cájitan Indian word meaning buzzard head and refers to a volcanic berg north of the valley, according to Gentry, 1942, p. 23) is not shown on many maps, and the topography of the region apparently has never been mapped with precision. Various drainage patterns are depicted, and a variety of names are applied by cartographers to the branches of the Río Fuerte. On the 1937 edition of the map of Sonora, prepared under the direction of the Secretary of the Departamento de Agricultura y Fomento of Mexico, the tributary of the Río Fuerte into which flows the stream from Alamos is labeled the Arroyo Alamos. On the map of North America, 1:1,000,000, prepared by the American Geographical Society, this same western tribu-

tary is called the Río Chuchujagui. Gentry (*supra cit.*, map 4) calls this the Arroyo Cuchujaqui, and his map indicates the tributary from Alamos as a small, nameless branch of the Arroyo Cuchujaqui.

ALAMOS: The town of Alamos lies just to the northwest of the intersection of latitude 27° N. and longitude 109° W. Immediately to the southwest of the town a small range, the Sierra de Alamos (see pl. 30), rises to an elevation of approximately 1783 meters (5850 feet) above sea level. The town itself is situated in a small valley at an elevation of 300 to 400 meters (1300 feet) through which runs a rivulet or arroyo which is dry except after rains. To the northwest the valley is flanked by low hills. Except for outcrops of the bedrock and for limited sandy areas along the edge of the arroyo (pl. 30, fig. 2), the region is covered by dense xerophytic scrub vegetation or "chaparral." Along streams or in places where more moisture is available there are plants of sufficient size to be classified as trees.

Alamos was once a thriving mining town which, according to residents, had a population of nearly 20,000 in its heyday. By 1910 it had but 6000 inhabitants, and this number is now reduced to approximately 3000. It is located scarcely 25 miles from the boundary of the state of Chihuahua, and 30 miles from the northern border of the state of Sinaloa, on the periphery of the Barranca region. Gentry (1942, p. 9) defines this as "the precipitous belt along the coast [of Mexico] in which the rivers have eaten back into the central plateau," adding that, "To the south in Nayarit and Jalisco, it is coastal; to the north in Sonora it lies inland, separated from the sea by a distance of 75 to 225 miles and several ranges of low mountains. It is in effect a long, narrow, intermittent strip of land across which the rivers and tributaries cut, forming an infinite number of salient corners jutting into the eastern highland. Because of these conditions it must remain a roughly designated area, without clear-cut and distinct borders."

The Sierra de Alamos, which is of volcanic origin, lies immediately to the west of the town of Alamos (see map 1). It is an isolated peak of relatively small area with steep slopes (40° to 60°) on its eastern side, and

with vertical cliffs, known as "los promontorios," on its western escarpment. It is the westernmost remnant of the dissected edge of the plateau in southern Sonora. It is flanked on the north by the Río Mayo drainage basin and on the south by the Río Fuerte drainage. Between Sierra de Alamos and the edge of the Mexican plateau in Chihuahua lies the Río Chinipas, the principal northern tributary of the Río Fuerte. Its canyon leaves a considerable gap between the hills east of Sierra de Alamos and the Sierra Madre Occidental, which extends along the western edge of the Mexican plateau. The entire region is described and mapped in Gentry's excellent work dealing with Río Mayo plants (1942).

The general region around Alamos and Guirocoba has a climate defined by Arias (1942) as semi-arid with dry summers. He provides temperature and rainfall records for Minas Nuevas, a locality a few miles north of Alamos at an elevation of 508 meters. Here the maximum rainfall occurs during the months of July and August, tapering off rather sharply in September. March, April, and May are the driest months, with scarcely any precipitation during April. The mean annual rainfall is 708 mm. (approximately 28 inches). Prior to our arrival at Alamos in late August, 1942, there had been heavy rains throughout the region, a factor which probably contributed to the success of our collecting endeavors.

The mean annual temperature recorded for Minas Nuevas is 22.5° C., with minimum temperatures of 0.5° during December, and maximums during July and August of 42°. During August and September there are extremes of temperature ranging from 12° to 41° with a mean of 26°. During our stay in Alamos we recorded temperatures between 24° and 30°, with relatively little fluctuation between day and night.

The vegetation of the Río Mayo drainage basin immediately to the north of Alamos has been rather thoroughly studied and described by Gentry in his splendid paper cited above. Gentry classifies the vegetation into four major divisions: (1) the Thorn forest of the

coastal plain from sea level to 2000 feet; (2) the Short-tree Forest, "a heterogeneous deciduous forest with a strong infusion of tropical elements," lies principally in the canyons of the Barranca region, and ranges from about 1000 to 3500 feet above sea level; (3) the Oak Forest is "a relatively narrow strip on the western slope of the Sierra Madre dominated by deciduous oaks and harsh bunch grasses, occupying elevations between 3000 and 5000 feet"; and (4) the Pine Forest is an area in the sierran region dominated by pines, between elevations of 5000 and 9000 feet above sea level.

Gentry (p. 27) describes these areas in considerable detail, and suggests that they may be interpreted in terms of the Merriam system of life zones as follows:

"Thorn Forest	Lower Sonoran life zone
Short-tree Forest	Subtropical life zone
Oak Forest	Upper Sonoran zone
Lower Pine Forest	Transition zone
High Pine Forest	Canadian and Hudsonian life zones"

It will be noted that he found it necessary to insert an additional zone between the Upper Sonoran and the Lower Sonoran zones, and it is precisely in this Short-tree Forest (see pl. 31, fig. 2) that all our material was secured at Alamos. Despite the fact that Sierra de Alamos is some distance removed from the Sierra Madre, it has pines on its summit and thus includes all but the uppermost of the zones which Gentry lists. Exploration of the summit of Sierra de Alamos might produce some interesting endemic amphibians or reptiles, although it is less favored with soil and rainfall than the mountains farther east. Gentry found the Sierra Saguaribo, a continuation of the divide between the Río Mayo and Río Fuerte drainages to the northeast of Alamos, to be the most interesting floristically of the mountains in this immediate region. He finds it to contain a vast number of plant species, many of which are related to those of tropical and subtropical environments. If it proves to be as interesting faunistically as it is floristically, it should be well worth further exploration.

FAUNAL RELATIONSHIPS

PAST DISTRIBUTIONS

ABUNDANT EVIDENCE has now been assembled which tends to prove that southern Mexico, as well as Central and South America, although now placed in the Neotropical region, contains numerous elements which are historically Nearctic. The principles laid down by Matthew (1915), who assembled the basic fossil evidence indicating a northern origin and southward dispersal for many vertebrate groups, have been most recently reviewed and implemented by Dunn (1931), by Simpson (1943), and by Schmidt (1943), all of whom stress the fact that dispersal routes for the existing reptilian groups having no fossil record can readily be interpreted in such a manner that they conform to the routes of those groups whose palaeontological history is known.

Simpson discusses the past and present distributions of the turtles, whose fossil history is better known than that of most other living reptilian groups, and demonstrates the numerous parallels indicated by these data and the more abundant mammalian evidence. Simpson, agreeing with the general conclusions presented by Dunn, follows him in pointing out that the herpetological fauna in the Americas can be divided into the following elements:

1. Holarctic. This is a modern circumpolar element which includes relatively few amphibians and fewer reptiles.
2. Old Northern. In this category are the main components of the herpetological faunas of the United States, Mexico, and Central America.
3. South American. This element includes the descendants of an older fauna which evolved *in situ* after South America was isolated at the beginning of the Tertiary.

The reestablishment of a land bridge connecting North and South America sometime in the late Pliocene provided the necessary dispersal route which permitted migrations of portions of the latter two elements in both directions. In general, however, whether as a result of climatological factors or from population pressures and the relative aggressive-

ness of the northern elements, this dispersal has been rather one-sided. Holarctic elements, such as the Ranidae (as well as a number of other vertebrate groups), and Old Northern elements, such as the Crotalidae, have reached South America. On the other hand, comparatively few South American elements have reached temperate North America, although a number of South American elements have penetrated the tropical portions of the continent, and several of these reach southern Sonora.

Simpson indicates the further convenience of dividing the continental Americas into five regions or zones on the basis of present evidence. The zones he advocates are: (1) Boreal North America; (2) Middle North America; (3) Southern North America; (4) Equatorial South America; and (5) Austral South America. He is careful to note that these zones cannot be bounded by lines on a map, that they interdigitate and intergrade broadly, though somewhat differently for different groups of animals. Likewise these zones have not been stationary; they have expanded or contracted, have moved north and south, or even in other directions locally, but at the same time have retained a vague sort of identity.

Simpson also points out that the Middle North American zone, comprising most of what is now the United States, has been a major evolutionary center in itself. Stocks have come into it and subsequently have undergone considerable differentiation there. Simpson mentions stocks from Boreal North America in particular, but as far as the reptiles and amphibians are concerned it appears probable that some faunal elements entered Middle North America from the south. In fact, Dunn (*ibid.*, p. 117) would place such generic groups as *Heterodon* and *Diadophis* as being South American in origin, with their present northward distributions paralleling those of the existing porcupines and the extinct sloths, South American elements that indubitably had their early Tertiary evolution in the Southern Hemisphere. Evidence supplied by present-day distributions of amphibians and reptiles in

North America indicates that many groups now represented in the American tropics were formerly portions of Old Northern elements which were driven southward by the increasingly colder climatic conditions in the late Tertiary. Following the last glacial period, with the resumption of warmer temperatures in the north, many of these groups pushed northward again. It is relatively certain that many genera and species became differentiated in Middle North America, before the glacial periods.

It seems clear, therefore, that the present amphibian and reptile faunas of the state of Sonora are composite, with an admixture of faunal elements. Furthermore, it is apparent that the state lies roughly on the zone of interdigitation between Simpson's Middle North American zone and his Southern North American zone. To test the validity of these postulations it is instructive to list the 20 families known to be represented on land or in fresh water in Sonora, with their probable origins indicated as tentatively proposed by Dunn. For brief consideration in connection with their distributions in the Americas it is convenient to list here the world distributions of the families represented in Sonora. (Families including only marine forms are excluded from the table which follows.)

The evidence discussed by Dunn suggests that certain of these families were split between North and South America. This has been indicated below by the word "part" after these families. As faunal elements the families represented in Sonora may be tabulated as shown on page 311.

The families Hydrophiidae and Dermochelidae need not concern us here, and they will be omitted from discussions which follow. The single sea snake that reaches the coast has a wide range in tropical portions of the Indian and Pacific oceans, and it is problematical just how or when it reached the coast. Presumably it arrived in comparatively recent times because it has undergone no differentiation in the Western Hemisphere. *Dermochelys* is sufficiently well adapted to its pelagic existence that it, and in all probability representatives of the family Cheloniidae which must reach the coast of Sonora, have been rather generally distributed in Pacific waters since the Mesozoic. Here too might be mentioned the Trionychidae, representatives of which presumably reach Sonora in the delta region of the Colorado River, there being records for Baja California.

In the absence of a fossil record the uncertainties concerning the pre-Tertiary distributions of some of these families are ad-

WORLD DISTRIBUTIONS OF FAMILIES REPRESENTED IN THE STATE OF SONORA
(The letter I indicates insular rather than continental representation)

	Europe	Asia	N. America	S. America	Africa	Australia
Pelobatidae	X	X	X	—	I	—
Leptodactylidae	—	—	X	X	X	X
Ranidae	X	X	X	X	X	X
Microhylidae	—	X	X	X	X	I
Bufo	X	X	X	X	X	—
Hylidae	X	X	X	X	X	X
Gekkonidae	X	X	X	X	X	X
Iguanidae	—	—	X	X	I	I
Teiidae	—	—	X	X	—	—
Anguidae	X	X	X	X	X	—
Helodermatidae	—	I	X	—	—	—
Scincidae	X	X	X	X	X	X
Leptotyphlopidae	—	X	X	X	X	—
Boidae	X	X	X	X	X	X
Colubridae	X	X	X	X	X	X
Elapidae	—	X	X	X	X	X
Crotalidae	X	X	X	X	—	—
Kinosternidae	—	—	X	X	—	—
Emydidae	X	X	X	X	X	—
Testudinidae	X	X	X	X	X	—

FAUNAL ELEMENTS IN SONORA

South American	Old Northern	Holarctic
1. Leptodactylidae	1. Pelobatidae	1. Ranidae
2. Hylidae	2. Bufonidae	
3. Microhylidae	3. Gekkonidae (part)	
4. Gekkonidae (part)	4. Iguanidae (part)	
5. Iguanidae (part)	5. Helodermatidae	
6. Teiidae	6. Anguidae	
7. Leptotyphlopidae	7. Scincidae	
8. Boidae (part)	8. Boidae (part)	
9. Colubridae (part)	9. Colubridae (part)	
10. Elapidae	10. Crotalidae	
	11. Kinosternidae	
	12. Emydidae	
	13. Testudinidae	

mitted. In many cases the evidence for the belief that family groups were confined to South America in the Western Hemisphere during most of the Tertiary is premised on the present-day distributions of members of these same families in Australia or in South Africa (indicating pre-Tertiary origins in the north followed by widespread distributions, southward dispersals, and, in some cases, extermination in the Northern Hemisphere during the early Tertiary) or upon the apparent failure of certain of them which are diversified in South America to extend their distributions beyond North America (as in the case of the Teiidae). Nevertheless, even though we grant the possibility of errors in the tabulation above, the mixture of faunal elements is obvious. Considering the climates, topography, and location of the state, the data are in accord with predictions that might be made on the basis of hypotheses advanced by Dunn and by Simpson.

Moreover, those families that Dunn looked upon as having had an early Tertiary representation in both continents appear to be represented by two elements in Sonora. Thus the Gekkonidae are represented by two genera, *Coleonyx* and *Phyllodactylus*. The former is certainly an Old Northerner, whereas *Phyllodactylus* in all probability is South American. Among the numerous iguanid genera represented in the state, the majority have undergone their major differentiation in southwestern North America, either in the Colorado Desert itself or around its periphery. Presumably these genera represent Old Northern elements, whereas *Anolis*

is South American. Two genera of boas are known from the state, and one of these, *Constrictor*, is definitely South American, while *Lichanura* again is an Old Northerner. The Colubridae are more difficult to treat, owing to the unsatisfactory state of our knowledge concerning subfamily groups. Of 24 colubrid genera in Sonora, only three (*Heterodon*, *Diadophis*, and possibly *Phyllorhynchus*) seem likely to be of South American origin, and nearly all the remaining genera seem to be Old Northerners. The "family" Boigidae (more commonly recognized as a subfamily, with as little justification) unquestionably is a thoroughly unnatural group despite the current use of the name. *Trimorphodon* and *Imantodes* may have affinities with the genus *Boiga* which occurs in Asia, Australia, and in Africa, where it has undergone differentiation into three related genera (Bogert, 1940, pp. 60-66). This distribution indicates the dubious possibility that these true opisthoglyphs may be South American elements which reached that continent at the same time that presumptive Old World relatives moved southward from old Holarctic dispersal centers.

Among the emydid turtles both Dunn and Simpson distinguish two groups: *Geoemyda* and *Pseudemys*, which occur in Sonora, are placed as Old Northerners, in contrast to *Emys* and *Clemmys* which they regard as Holarctic elements (as defined by Simpson). *Clemmys* ranges southward on the Pacific coast as far as northern Baja California but does not overlap in range with either *Pseud-*

emys or *Geoemyda*. In the eastern United States, however, there is some overlap in the distributions of *Clemmys* and *Pseudemys*, but in the American Southwest the Colorado and Vizcaino deserts seemingly have been the barriers that keep the stocks separate. The evidence concerning the family groups in the state of Sonora, therefore, seems to substantiate the views of both Dunn and Simpson.

PRESENT DISTRIBUTIONS

Turning now to a consideration of the genera represented in Sonora, it is a reasonable assumption that extensive differentiation after migration accounts in part for the numerous distinctive genera inhabiting the Colorado Desert and the extensive arid regions around its periphery. The diversity of the fauna, and more especially the number of endemic genera and species, indicate that this region has been a secondary center of evolution for a number of groups. The geological and palaeontological evidence, along with the distributional patterns of living groups, indicates that there were climatic cycles, with an alternation of wet and dry periods. But on the whole, the broad basin of the lower Colorado River drainage system must have been essentially an arid region since at least as long ago as the Miocene period. In part the diversity of the species may be accounted for by the specializations required of animals for existence in the rigorous conditions that have prevailed there. Occasional moist periods, on the other hand, seem to have permitted the influx of amphibians and perhaps some reptiles which now survive only around springs or on isolated moisture-catching mountain tops. However complex the surrounding circumstances were, it is a fair assumption that the temporal element played a conspicuous part. The beginnings of the secondary evolutionary center may date from the Miocene, but there have been influxes from the south at intervals perhaps up to the present time. South American elements could not have reached the region until late Pliocene or early Pleistocene, and some may have arrived even more recently. In line with this hypothesis is the relatively meager differentiation of the South American family elements. As listed above,

the South American elements present in Sonora comprise 10 families, in contrast to 13 Old Northern elements. Had these elements reached the state in their dispersals at the same time, it might be postulated that each group of families (or portions of families), that is, the South American and the Old Northern, would have become differentiated into numbers of genera in the proportion of 10 to 13. Genetic factors are possibly involved, but when we are dealing with as many as 10 families, differences in relative plasticity of those in each category should be compensated for. We find the genera listed on page 313 to be represented.

Thus, of 10 South American family elements that have invaded Sonora, only 16 genera have evolved, quite in contrast to 13 Old Northern families with 45 genera. The ratio is almost three to one, although these figures, to be sure, provide only a rough index to the relative arrival times of the two groups under consideration. Unquestionably many complex factors not mentioned in this brief analysis have been involved. Despite these considerations the figures offer convincing evidence in support of the hypothesis that the Colorado Desert, as a secondary center of dispersal, antedates the influx of South American elements following the late Pliocene isthmian land connection between the two western continents.

The peculiarities of desert faunas are mainly the result of environmental factors. This may be inferred from comparisons of species inhabiting deserts in various parts of the world. The iguanid genus *Uma*, for example, has its counterpart in the lacertid genus *Aporosaura* of the Kalahari Desert, and the American sidewinder, or horned rattlesnake (*Crotalus cerastes*), is paralleled in structure by *Bitis caudalis* of the Kalahari, as well as by *Aspis* in the Sahara, and by *Pseudocerastes* in the Arabian Desert. Many of the structural attributes of desert animals seemingly represent adaptive responses to sand or dune habitats, but in many instances the adaptations are those associated with fossorial habits, not necessarily in dunes. Burrowing forms, particularly among the snakes, are characteristic of the Colorado Desert region, and in some cases it seems altogether probable that these evolved more

SOUTH AMERICAN ELEMENTS

1. *Leptodactylus*
2. *Eleutherodactylus*
3. *Pternohyla*
4. *Agalychnis*
5. *Hyla*
6. *Microhyla*
7. *Phyllodactylus*
8. *Anolis*
9. *Cnemidophorus*
10. *Leptotyphlops*
11. *Constrictor*
12. *Heterodon*
13. *Diadophis*
14. *Phyllorhynchus*
15. *Micruroides*
16. *Micrurus*

OLD NORTHERN ELEMENTS

- | | |
|------------------------|--------------------------|
| 1. <i>Scaphiopus</i> | 24. <i>Lampropeltis</i> |
| 2. <i>Bufo</i> | 25. <i>Rhinocheilus</i> |
| 3. <i>Coleonyx</i> | 26. <i>Coluber</i> |
| 4. <i>Ctenosaura</i> | 27. <i>Salvadora</i> |
| 5. <i>Dipsosaurus</i> | 28. <i>Leptophis</i> |
| 6. <i>Sauromalus</i> | 29. <i>Gyalopion</i> |
| 7. <i>Crotaphytus</i> | 30. <i>Pseudoficimia</i> |
| 8. <i>Uma</i> | 31. <i>Tantilla</i> |
| 9. <i>Callisaurus</i> | 32. <i>Sonora</i> |
| 10. <i>Holbrookia</i> | 33. <i>Chionactis</i> |
| 11. <i>Uta</i> | 34. <i>Chilomeniscus</i> |
| 12. <i>Sceloporus</i> | 35. <i>Hypsiglena</i> |
| 13. <i>Phrynosoma</i> | 36. <i>Oxybelis</i> |
| 14. <i>Heloderma</i> | 37. <i>Trimorphodon</i> |
| 15. <i>Gerrhonotus</i> | 38. <i>Imantodes</i> |
| 16. <i>Eumeces</i> | 39. <i>Agkistrodon</i> |
| 17. <i>Lichanura</i> | 40. <i>Crotalus</i> |
| 18. <i>Thamnophis</i> | 41. <i>Kinosternon</i> |
| 19. <i>Drymobius</i> | 42. <i>Geoemyda</i> |
| 20. <i>Drymarchon</i> | 43. <i>Pseudemys</i> |
| 21. <i>Elaphe</i> | 44. <i>Terrapene</i> |
| 22. <i>Pituophis</i> | 45. <i>Gopherus</i> |
| 23. <i>Arizona</i> | |

or less recently from non-burrowing stocks. The genus *Sonora*, for example, must closely resemble and must have descended from the ancestral stock that gave rise to both *Chilomeniscus* and *Chionactis*.

The composition of a fauna is the result of a long sequence of events, therefore, of arrivals, modifications and subsequent dispersals of the modified stocks, of arrivals and subsequent fragmentations in distributions, of local exterminations, or even of extinctions of entire populations. Also, with climatic shifts there are expansions or contractions of ranges, so that a consideration of existing distributions can be expected to tell but a part of the history of a given fauna. But even a part is better than none at all, and something of the history of individual groups may be inferred from a tabulation of faunal elements and their known ranges. Distributional data for Sonoran amphibians and reptiles, some of which are included in the present paper, while others are taken from the literature, are summarized in table 1.

Before taking up a more detailed analysis based on this table, however, it is desirable to review briefly some of the main physiological features of the state of Sonora and the surrounding region. The eastern bound-

ary of the state coincides roughly with the dissected edge of the north-central plateau of Mexico, represented by the barrancas along the edge of the Sierra Madre Occidental. The main axis of this range, which is now sufficiently eroded that it is composed of a series of small ranges, extends diagonally to the northwest across the northeastern corner of the state (see map 1). The mountain ranges north of the international boundary in Arizona, that is, the Tumacacori Mountains, the Santa Rita Mountains, the Huachuca, and the Chiricahua Mountains, are essentially continuations of the Sierra Madre Occidental. The continental divide lies to the east, continuing southward from the southwestern corner of New Mexico into Chihuahua. In this region the continental divide is relatively low, in many places scarcely more than 4000 feet above sea level. Thus, the divide in northern Mexico has been no serious obstacle in the dispersal routes of several species that have extended their ranges to the west or northwest across Chihuahua.

The rivers of the state drain toward the southwest, with such exceptions as the upper portions of the Río Yaqui, and the Río Sonora which drain southward. Thus, their valleys provide dispersal routes for invaders

TABLE 1. AMPHIBIANS AND REPTILES KNOWN FROM SONORA WITH DISTRIBUTIONS OF THE SPECIES IN ADJACENT AREAS INDICATED

	Baja California	Arizona	Sonora	Sinaloa	South of Sinaloa
AMPHIBIA					
<i>Scaphiopus hammondi</i>					
<i>Scaphiopus couchii</i>					
<i>Bufo punctatus</i>					
<i>Bufo alvarius</i>					
<i>Bufo marinus</i>					
<i>Bufo mazatlanensis</i>					
<i>Bufo woodhousii</i>					
<i>Leptodactylus melanonotus</i>					
<i>Pterohyla fodiens</i>					
<i>Agalychnis dacnicolor</i>					
<i>Hyla arenicolor</i>					
<i>Hyla baudinii</i>					
<i>Microhyla olivacea</i>				?	?
<i>Rana pipiens</i>					
<i>Rana pustulosa</i>				?	
TURTLES					
<i>Kinosternon sonoriense</i>					
<i>Kinosternon flavescens stejnegeri</i>					
<i>Kinosternon integrum</i>					
<i>Geomyda p. pulcherrima</i>					
<i>Gopherus agassizii</i>					
<i>Pseudemys scripta hiltoni</i>				?	
<i>Terrapene ornata</i>					
<i>Terrapene klauberi</i>					
<i>Dermochelys schlegelii</i>					
LIZARDS					
<i>Coleonyx variegatus</i>					
<i>Phyllodactylus tuberculosus homolepidurus</i>				?	
<i>Anolis nebuloides</i>					
<i>Dipsosaurus d. dorsalis</i>					
<i>Dipsosaurus d. sonoriensis</i>					
<i>Sauromalus townsendi</i>					
<i>Crotaphytus collaris baileyi</i>					
<i>Crotaphytus wislizenii</i>					
<i>Uma notata cowlesi</i>					
<i>Callisaurus draconoides brevipes</i>					

LIZARDS (Continued)	Baja California	Arizona	Sonora	Sinaloa	South of Sinaloa
<i>Callisaurus draconoides inusitatus</i>					
<i>Ctenosaura hemilopha</i>					
<i>Holbrookia maculata approximans</i>					
<i>Holbrookia elegans thermophila</i>				?	
<i>Holbrookia texana</i>					
<i>Uta stansburiana stejnegeri</i>					
<i>Uta taylori</i>					
<i>Uta bicarinata tuberculata</i>					
<i>Uta ornata linearis</i>					
<i>Uta ornata lateralis</i>					
<i>Sceloporus clarki clarki</i>					
<i>Sceloporus c. boulengeri</i>					
<i>Sceloporus j. jarrovi</i>				?	
<i>Sceloporus m. magister</i>				?	
<i>Sceloporus scalaris slevini</i>					
<i>Sceloporus nelsoni</i>					
<i>Sceloporus undulatus virgatus</i>					
<i>Phrynosoma orbiculare hernandesii</i>				?	?
<i>Phrynosoma ditmarsii</i>					
<i>Phrynosoma platyrhinos platyrhinos</i>					
<i>Phrynosoma platyrhinos goodei</i>					
<i>Phrynosoma modestum</i>					
<i>Phrynosoma cornutum</i>					
<i>Phrynosoma solare</i>					
<i>Phrynosoma m'callii</i>					
<i>Heloderma suspectum</i>					
<i>Heloderma horridum</i>					
<i>Gerrhonotus kingii</i>					
<i>Cnemidophorus sackii perplexus</i>					
<i>Cnemidophorus sackii sackii</i>					
<i>Cnemidophorus burti</i>					
<i>Cnemidophorus melanostethus</i>					
<i>Eumeces callicephalus</i>				?	
<i>Eumeces parviauriculatus</i>					
SNAKES					
<i>Leptotyphlops humilis humilis</i>					
<i>Leptotyphlops humilis dugesii</i>					
<i>Lichanura roseofusca gracia</i>					
<i>Constrictor constrictor imperator</i>					
<i>Heterodon nasicus kennerlyi</i>					
<i>Phyllorhynchus decurtatus nubilis</i>					
<i>Phyllorhynchus browni fortitus</i>					
<i>Thamnophis eques eques</i>					
<i>Thamnophis eques cyrtopsis</i>					
<i>Thamnophis marciatus</i>	?				

SNAKES (Continued)	Baja California	Arizona	Sonora	Sinaloa	South of Sinaloa
<i>Thamnophis angustirostris</i>				?	
<i>Thamnophis macrostemma megalops</i>				?	
<i>Drymarchon corais rubidus</i>					
<i>Pituophis sayi affinis</i>					
<i>Arizona elegans occidentalis</i>					
<i>Elaphe chlorosoma</i>					
<i>Diadophis regalis laetus</i>					
<i>Lampropeltis getulus yumensis</i>					
<i>Lampropeltis getulus splendida</i>					
<i>Lampropeltis triangulum nelsoni</i>					
<i>Rhinocheilus lecontei antonii</i>					
<i>Drymobius margaritiferus fistulosus</i>					
<i>Coluber flagellum piceus</i>					
<i>Coluber flagellum testaceus</i>					
<i>Coluber bilineatus</i>					
<i>Coluber striolatus striolatus</i>					
<i>Salvadora hexalepis hexalepis</i>					
<i>Salvadora hexalepis deserticola</i>					
<i>Leptophis diplotropis</i>					
<i>Gyalopion desertorum</i>					
<i>Pseudocimexia hiltoni</i>					
<i>Tantilla hobartsmithi</i>					
<i>Chionactis occipitalis palarostris</i>					
<i>Sonora aemula</i>					
<i>Chilomeniscus cinctus</i>					
<i>Hypsiglena torquata torquata</i>					
<i>Hypsiglena torquata ochrorhyncha</i>					
<i>Oxybelis aeneus auratus</i>					
<i>Trimorphodon lambda</i>					
<i>Imantodes gracillima</i>					
<i>Micrurus diastema distans</i>					
<i>Micruroides euryxanthus</i>					
<i>Pelamis platurus</i>					
<i>Agkistrodon bilineatus</i>					
<i>Crotalus atrox</i>					
<i>Crotalus basiliscus</i>					
<i>Crotalus mitchellii pyrrhus</i>					
<i>Crotalus molossus molossus</i>				?	
<i>Crotalus tigris</i>					
<i>Crotalus scutulatus scutulatus</i>					
<i>Crotalus viridis viridis</i>					
<i>Crotalus viridis oreganus</i>					
<i>Crotalus willardi</i>					
<i>Crotalus triseriatus pricei</i>					
<i>Crotalus cerastes</i>					

moving either north or south. Of equal importance, however, is the coastal plain. This is relatively wide at the northern part of the state, where it includes part of the delta region of the Colorado River, but narrow, scarcely 25 miles in width, south of Navojoa in southern Sonora. In the state of Sinaloa on the south, the coastal plain and foothills continue without major interruptions to the state of Colima.

The desert regions of the northwestern portion of the state are essentially a continuation of the Colorado Desert, which flanks the river of the same name in the states of Arizona and California. West of the river this desert skirts the southern end of Salton Sea (which at one time was of greater dimensions) and extends as far into southern California as eastern San Diego County. Below the international boundary in Baja California an arm of this desert extends as far south as latitude 31°. West of this desert area mountains rise rather abruptly both in California and in Baja California, where some of them represent fault scarps.

The peninsula of Baja California is separated from Sonora only by the Colorado River in the northwestern corner of the state, but south of the delta the Gulf of California extends approximately 700 miles. The gulf is nearly 100 miles wide at its southern end, so that the peninsula of Baja California is isolated rather effectively from the state of Sonora. The extent of this isolation will become apparent from discussions which follow.

It is unnecessary to assume that all amphibian and reptilian stocks now represented in the Colorado Desert or around its periphery invaded the region from the south, but it seems probable that many groups that retreated southward have entered or reentered Sonora during the Pleistocene, or in recent times. The following tabulations may provide some clues to the sources of the generic elements represented, despite the fact that the state of our knowledge concerning distributions in northwestern Mexico is far from satisfactory.

GENERA KNOWN FROM SONORA BUT NOT
PRESENT IN ARIZONA

- | | |
|-------------------------|----------------------|
| 1. <i>Leptodactylus</i> | 2. <i>Pternohyla</i> |
|-------------------------|----------------------|

- | | |
|--------------------------|--------------------------|
| 3. <i>Agalychnis</i> | 10. <i>Leptophris</i> |
| 4. <i>Phyllodactylus</i> | 11. <i>Pseudoficimia</i> |
| 5. <i>Anolis</i> | 12. <i>Imantodes</i> |
| 6. <i>Ctenosaura</i> | 13. <i>Micrurus</i> |
| 7. <i>Constrictor</i> | 14. <i>Agkistrodon</i> |
| 8. <i>Drymarchon</i> | 15. <i>Geomyda</i> |
| 9. <i>Drymobius</i> | 16. <i>Pseudemys</i> |

Some of these genera may be discovered eventually in Arizona. Almost all are widely differentiated to the south. Five of them are represented by species that reach the United States on the Atlantic side of the continent where there is more abundant rainfall, but, significantly, none of them inhabits the higher elevations. *Agkistrodon* and *Pseudemys* include species with ranges extending to New England, and both of these genera have undergone their major continental diversifications in southeastern United States. (*Agkistrodon*, of course, has even more numerous representatives in Asia.) Insufficient moisture may be the most important factor that has prevented some of these genera from reaching Arizona, although thermal factors are undoubtedly involved. This is suggested by the fact that a few species seem able to survive and to extend or maintain their ranges by ascending the mountains where the rainfall is sufficient, but where temperatures are lower. It is noteworthy that only three of the 16, *Phyllodactylus*, *Ctenosaura*, and *Pseudemys*, are present in Baja California, the latter two confined to the cape region. The turtle *Pseudemys* may have reached the peninsula by crossing the gulf; it is poorly differentiated and closely related to the mainland form. But *Phyllodactylus tuberculatus* in all probability gained entrance to Baja California from the north. This gecko has now been found in California as far north as Palm Springs in Riverside County, and it is a reasonable supposition that it will be found in Arizona. *Phyllodactylus unctus* may be a relict species, but *P. tuberculatus* is, in our opinion, not completely differentiated from geckos of the genus taken in Sonora. *Ctenosaura* may have reached the peninsula across the chain of islands via Tiburón, San Esteban, and San Lorenzo, possibly through human agency inasmuch as the Indians of the region use it as food. Perhaps equally probable was its entry from the north at a time when its range extended into Arizona.

At present it does not inhabit regions quite so arid as the middle of the Colorado Desert.

It may be speculated that temporal and environmental factors, coupled with the lack of adaptability on the part of these 16 genera, have prevented their dispersal northward to reach Arizona. The fact that only three of them have reached Baja California suggests that few, if any, of the others had extensive ranges to the north prior to a cold period during the Pleistocene, else more of them would have been able to retreat southward to the cape as well as on the mainland. Had any of the genera now unknown north or west of Sonora succeeded in reaching California, some of them would have been expected to survive there. Nevertheless, none of them is known from California, despite the fact that some portions of the state are climatologically not far removed from the portion of Sonora where these genera occur. Most of these genera are represented in Sonora chiefly in the less arid Subtropical life zone, which Gentry (1942, p. 27) found necessary to insert between the Lower Sonoran and Upper Sonoran zones of the Merriam system. Our conclusion must, therefore, be tentative and speculative that many of these genera failed to reach Arizona because of their late arrival in Sonora. In their northward dispersal following the last glacial period they encountered an insurmountable barrier when they reached the borders of the Colorado Desert.

More light can be thrown on the problem, however, by a consideration of the genera that are common to Sonora and Arizona but have failed to cross the Colorado Desert to reach California or Baja California.

GENERA KNOWN FROM SONORA AND ARIZONA BUT
NOT PRESENT IN CALIFORNIA OR
BAJA CALIFORNIA

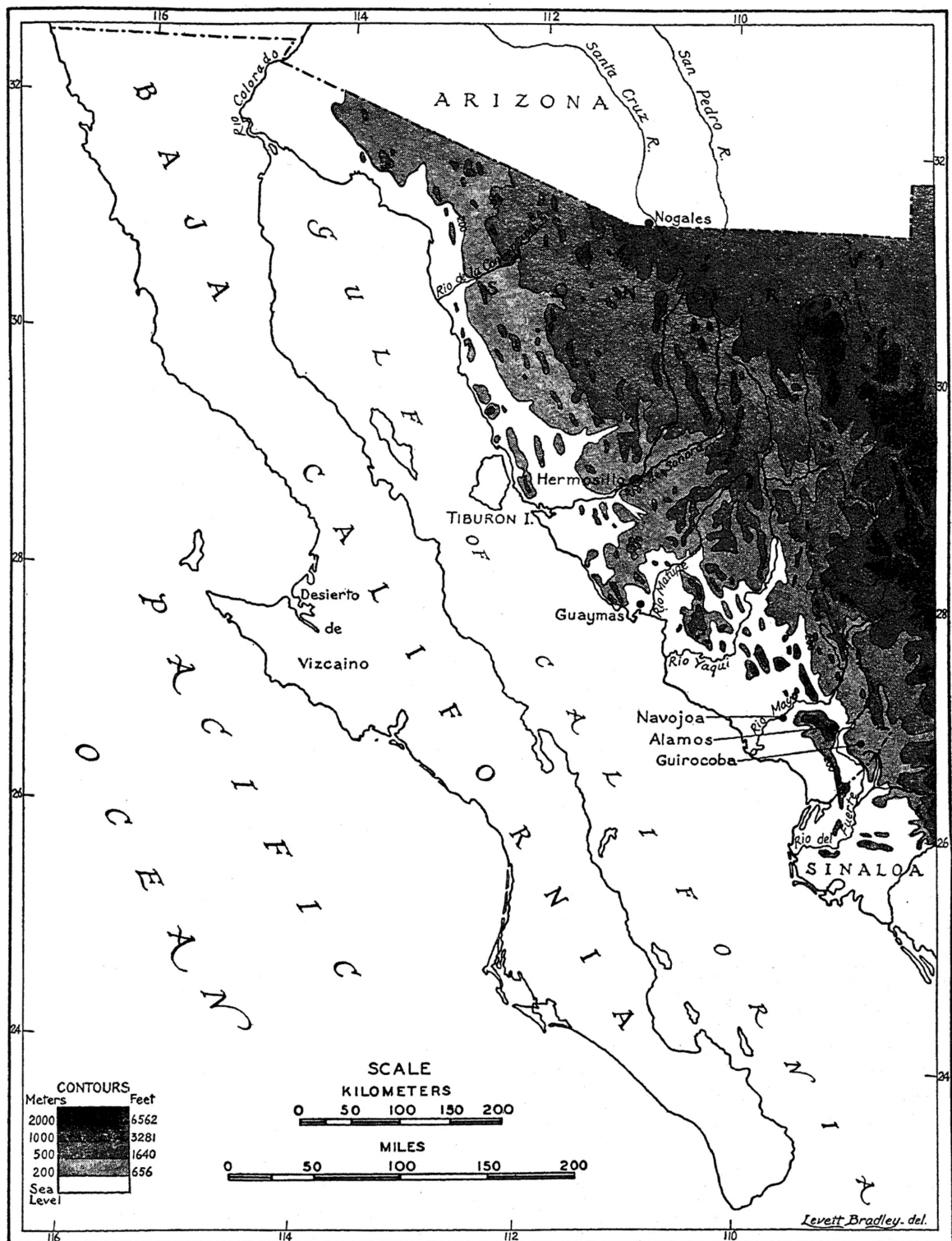
- | | |
|-----------------------------------|-----------------------|
| 1. <i>Eleutherodactylus</i> | 5. <i>Heterodon</i> |
| 2. <i>Microhyla</i> | 6. <i>Oxybelis</i> |
| 3. <i>Holbrookia</i> ¹ | 7. <i>Micruroides</i> |
| 4. <i>Heloderma</i> | 8. <i>Terrapene</i> |

¹ An old record for this genus in Baja California remains unsubstantiated, and a more recent record for California can most likely be attributed to human introduction, because no additional specimens have been found. Furthermore, the region where this specimen was taken is not ecologically similar to the habitat of *Holbrookia* where it occurs to the east.

This list, as it may be noted, is not quite half so large as the list of genera that reach Sonora but fail to reach Arizona. Furthermore, it is apparent that all these elements are not tropical so far as their recent centers of dispersal are concerned. Only *Eleutherodactylus*, *Microhyla*, *Heloderma*, *Oxybelis*, and *Terrapene* include tropical representatives at present. *Eleutherodactylus*, *Microhyla*, and *Oxybelis* have ranges that extend only a short distance into Arizona. These three probably represent comparatively recent entrants (or post-glacial reentrants) from the south. *Holbrookia* has its center of distribution on the northern end of the central plateau, but its greatest diversification occurs along the edges, in Texas and Arizona. The same stock is represented in the deserts proper by *Uma* and *Callisaurus*, but *Holbrookia* is essentially a plateau and plains element that was pushed southward during a Pleistocene cold period, and while it is found around the periphery of the deserts it has never succeeded in penetrating the truly arid regions.

Terrapene has its greatest differentiation in the southeastern portion of the United States. No fossils seem to be known west of the continental divide, although two species, *T. nelsoni* and *T. klauberi*, at present are known only from the Pacific slope, both of them from localities in the coastal foothills of Mexico. They may have entered from the plateau to the south, whereas *T. ornata* in Arizona and northern Sonora, with a much wider distribution in the plains along the eastern edge of the plateau and the Rocky Mountains, seemingly has entered from the east in comparatively recent times, crossing the continental divide where it is relatively low in elevation.

Heloderma is essentially a relict genus, nearly confined to the west coast of Mexico, but with a range extending northward through Arizona to southwestern Utah. Its distribution is a curious one, suggesting that the group reentered the fringes of the desert in relatively recent times. It has never succeeded in crossing the desert or has failed to survive there, although it does seem to have followed the Colorado River to the north to reach Utah. Both species occur chiefly in the vicinity of streams, and it is well known that captive specimens of each prefer moist situa-



MAP 1. Sonora and adjacent regions, with the topography of the state indicated. (From the 1:5,000,000 Map of the Americas published by the American Geographical Society in 1942 and redrawn to suit present requirements by permission of the society.)

tions in cages, and often select pools of water. The aridity of the deserts to the west seemingly has prevented the genus from extending its range in this direction.

Micruroides has a distribution that parallels that of *Heloderma suspectum*, and it seems to have entered the range it now occupies as a peripheral element of the family Elapidae, the stock of which presumably was confined to South America during most of the early Tertiary. It is possible that it represents a fragment of an Old Northern element that remained in North America when other New World elapids were cut off in South America in early Tertiary times; its supposedly more primitive characters do not necessarily belie this hypothesis.

Thus, four of these genera seem to be recent arrivals from the south, and three of them have entered from the east, all, with the possible exception of *Holbrookia*, in comparatively recent times. In the case of *Holbrookia*, however, its late arrival is not by any means a certainty. Other evidence implies that older stocks, upon arrival at climatological barriers, may be checked in their dispersals, whereas others, while delayed perhaps, seem able to undergo the necessary changes that fit them for survival under conditions prevailing in the adjacent territory. Thereupon dispersal can proceed. Very often these changes are reflected in the external morphology of the animals themselves, but it may be postulated in most cases that more fundamental physiological changes have taken place which permit these "new" forms to spread throughout the new environment which they have penetrated. Temperature presumably is often a factor involved in dispersal barriers. In fact Moore (1942) has assembled physiological evidence for frogs in the eastern United States from which he draws the conclusion that, "The role of temperature in evolution of northern and southern subspecies would be as a selector of mutations, appearing at random, that are necessary to fit the species to the new climatic zone."

Presumably the "new" form "selected" to penetrate a new climatic zone usually would be regarded by taxonomists as being sub-specifically related to its immediate ancestor were it possible to examine specimens shortly

after they had evolved, and this is conceivably what we are doing in some instances. The initial selection, however, can scarcely culminate in complete genetic isolation, unless the actual contact between the "old" and the "new" populations is interrupted. Nevertheless we have *Holbrookia* on the eastern periphery of the Colorado Desert, the genus *Callisaurus* in the desert but now spread to the periphery so that it overlaps *Holbrookia* in range, and finally we have the genus *Uma* in even more restricted habitats (sand dunes) in the middle of the desert but locally overlapping the range of *Callisaurus*. The similarities of these three genera are so obvious that any taxonomist would agree that they descended from a common ancestor.

We can account for these three genera only by assuming previous isolation by one means or another of three elements of a single ancestral stock. It is possible to explain the existence of *Callisaurus* and *Holbrookia* if we postulate a southward retreat of two populations during the last period of glaciation, the western one retreating on the peninsula of Baja California and evolving *Callisaurus*, and the eastern one retreating on the Mexican plateau and evolving *Holbrookia*. With the resumption of warmer climatic conditions representatives of the two groups migrated northward and intermingled, but failed to interbreed owing to the existence of isolating mechanisms of one sort or another that arose during the prolonged separation of the populations. The origin of the genus *Uma* is not readily accounted for. However, there are numerous parallels in sand habitats in other parts of the world where specialized reptiles have evolved from stock still present in the adjacent regions. Thus, we are forced to assume the probable existence of some isolating phenomenon peculiar to dune habitats. The genus *Uma* is closely paralleled in the Vizcaino Desert of Baja California by *Callisaurus crinitus*, as well as by *Aporosaurus* of the Kalahari, mentioned above. The presence of such parallels points to similar selective forces under similar environmental conditions, but it scarcely explains the genetic isolation of the species evolved therein.

For further consideration of problems concerned with isolation and dispersals it is instructive to list those species whose ranges

extend into Sonora from the surrounding regions. There are a sufficient number of locality records to enable us to obtain some notion of the principal distributional patterns represented, although there is especial need for additional herpetological collecting in both the northwestern and northeastern portions of the state. The listing of species, therefore, requires that certain species be assigned tentatively to one category or another, and revisions will undoubtedly prove necessary when more information is available.

First we may dispose of a relatively small number of species with extremely wide ranges. These species are all of common occurrence in southwestern United States and northern Mexico, but only the distributions of those that have been studied sufficiently to determine the differential characters of races throw some light on post-glacial dispersals.

SPECIES FOUND ON ALL SIDES OF SONORA

1. *Scaphiopus hammondi*
2. *Scaphiopus couchii*
3. *Bufo punctatus*
4. *Hyla arenicolor*
5. *Rana pipiens*
6. *Leptotyphlops humilis*
7. *Hypsiglena torquata*
8. *Rhinocheilus lecontei*

The first four species on this list may have evolved from stocks preserved on the plateau region of Mexico during the Pleistocene. All four seem to be particularly well adapted to cope with arid conditions, and while each requires water in which to breed, all four are apparently able to survive long periods of drought. Both species of *Scaphiopus* depend upon rains to provide the necessary temporary pools in which to breed, and perhaps for this reason neither species has penetrated, or at least has not survived in, the deserts of California despite the fact that both inhabit Baja California, *hammondi* in the north and *couchii* on the peninsula. *Bufo punctatus* occurs at scattered localities throughout the deserts, chiefly around springs or seepages, whereas *Hyla arenicolor* is more commonly found along intermittent streams in canyons around the edge of the desert. Both species ascend to considerable elevations, *Hyla arenicolor* having been taken on the summit

of the Santa Rita Mountains at an elevation of 9432 feet. At the present time none of these species has been studied sufficiently to determine whether subspecies have evolved or not, but obviously there are minor differences between populations on the east and west sides of the desert.

The relationships of leopard frogs, *Rana pipiens*, have been the subject of considerable debate, but no one has offered convincing evidence that more than one species is involved. In the American Southwest and northwestern Mexico *R. pipiens* is more or less confined to permanent or semi-permanent streams with pools of sufficient size to permit it to breed. If we assume it to be a Holarctic element (as suggested by the presence of a single *Rana* in South America), its entry into the desert has been from the north, by way of the Colorado River. While it reaches northwestern Baja California along the mouth of this river, it has never succeeded in reaching southern California until recently, when it was introduced by man.

We may add parenthetically that the successful introduction of frogs by man shows quite clearly that some species of Amphibia are capable of existing in regions which they normally could not have reached of their own accord. Thus, in the case of *Rana pipiens*, the desert has been penetrated only in Nevada and Utah along tributaries of the Colorado River, whereas the Salton Sea west of the Colorado in southern California has served as a barrier to the species in that direction. The leopard frog is known from northern California and might have penetrated southern California but for the aridity of the Tehachapi Mountains which lie between the Sierras and the less arid coastal regions of southern California. Under more favorable conditions for its dispersal along the edges of the plateau in Arizona, *R. pipiens* has seemingly pushed southward to Central America. Nevertheless its failure to reach southern California (until introduced) and the fact that no well-defined races have evolved (recognition of the "species" *Rana onca* and *Rana fischeri* to the contrary) indicate that its influx into the region west of the continental divide has been a recent one.

The bullfrog, *Rana catesbeiana*, has also been successfully introduced in many desert

streams and may, in fact, be present in northern Sonora. In August, 1942, numerous individuals of this species were seen and collected on the highway north of Nogales along the Santa Cruz River which drains a portion of northern Sonora. It remains to be seen whether this hardy frog, which requires permanent pools in which to breed but which strays some distance from streams during rains, will succeed in extending its range southward along the foothills. All individuals seen in the vicinity of the Santa Cruz River were abroad during a thunderstorm at night. Most of them were juveniles, and several were some distance away from the river.

So we may conclude that, despite the ability of certain Amphibia to maintain themselves and even to extend their ranges after introduction, there are, nevertheless, barriers that they are unable to cross. Just how *Hyla arenicolor* and *Bufo punctatus* achieved their wide distributions we can do little more than conjecture. Their distributions suggest invasion of the desert from the south at a time when a moist climate created suitable conditions for dispersal.

Of the three snakes on this list two are burrowers and the third is a secretive nocturnal form. All three species have representatives in Mexico and all range across the southwest from Texas to Mexico. The distributions of the races of *Rhinocheilus* and of *Leptotyphlops* (see papers by Klauber, 1940a and 1941b) suggest that each evolved races on the east and west coasts of northern Mexico, respectively, and that in each instance the eastern race has pushed westward across the continental divide to reach south-eastern Arizona. In neither species is it certain that the eastern form interbreeds with western populations in Arizona, although the morphological differences are so slight that interbreeding is inferred. The possibility remains that isolating mechanisms, not now understood, actually prevent interbreeding, despite any obvious differences in habitat preferences. This is obviously not true of the three western races of *Rhinocheilus lecontei*, namely, *antoni*, *clarus*, and *lecontei*, among which numerous intermediates exist. These intermediates have been interpreted as hybrids (Smith, 1942a), but it is obvious that no isolating mechanism exists in this case, and

therefore we are dealing with a single species.

The races of *Hypsiglena torquata* are less easily interpreted, and again it is not certain that interbreeding actually occurs. However, the presence of minor pattern differences scarcely can be taken as proof of specific distinctness, and we prefer to consider *Hypsiglena* as monotypic pending better evidence to the contrary. *Hypsiglena* is less confined in habitat preferences than either of the other two snakes mentioned in this discussion, neither of which ranges so far to the north as *Hypsiglena*, nor do they ascend mountains to the elevations where *Hypsiglena* occurs (as high as 7000 feet above sea level in California).

All three of these ophidian species are rather adaptable, however, and their present distributions suggest that each was forced southward during a late Pleistocene cold period. Three populations of each (except possibly *Hypsiglena*) appear to have been separated, one in Baja California, and two in Mexico, one on either side of the continental divide. Subsequent dispersals to the north in every case have resulted in overlaps of populations, some of which interbreed as noted above. In the case of *Hypsiglena*, a genus not yet subjected to critical review, the data are less readily interpreted. The race *torquata* appears to be the Mexican west coast population, and *ochrorhyncha* the Baja Californian population. Whether a recognizable race occurs in eastern Mexico is uncertain, but it may be represented by *H. t. dunklei*. The stock derived from a hypothetical Baja Californian population (*ochrorhyncha*) is obviously the more adaptable one and seems to have pushed northward to the state of Washington, eastward to Kansas, Oklahoma, and Texas, and southward on the Mexican plateau. In southern Sonora we have herein reported specimens with the patterns of *torquata* and of *ochrorhyncha* side by side. Hitherto this seeming overlap has not been known to occur, and because only the pattern serves to distinguish the specimens found at the same locality, and because no habitat differences are indicated by the data at hand, we have drawn the tentative conclusion that interbreeding is probable. Therefore, we consider the populations in existence to be subspecies.

We may add that the populations forced southward on the Mexican plateau were not necessarily split at the time of their southern withdrawal. In their northward dispersals, however, with migrations by way of the lowlands on either side of the plateau, a single southern population may have been split, with migrants following two routes. The range of the Mexican moccasin, *Agkistrodon bilineatus*, similarly is V-shaped, with populations flanking the coasts at the north, in Nuevo Leon and in Sonora, but with a confluence in their ranges south of the Mexican plateau.

As far as dispersal routes are concerned, therefore, it is probable that the three species of snakes, now so widely distributed, have entered Sonora from two sides, from the northwest and from the south. None of the three is yet known from northeastern Sonora, but it is quite likely that *R. l. tessellatus* and *L. h. segregus* will be found there (as well as *Leptotyphlops dulcis dissectus*). If these subspecies occur in Sonora, supposedly they would have entered from the east, as they seem also to have entered Arizona.

We can now turn to a list of those species belonging to groups whose ranges are sufficiently limited that some notion of their recent centers of dispersal can be attained. It seems probable that not one but four or five different dispersal routes were available, and that species already more or less adapted for one sort of environment or another penetrated the state of Sonora by the route most favorable ecologically. In general, lowland or desert species have seemingly sprung from stocks that came into the region along the coastal plain or through the valleys dissecting the arid plateau to the east. Mountain stocks, on the other hand, seem to have been derived from ancestors that were already adapted for an alpine or subalpine habitat to the extent that they could survive at lower temperatures, provided adequate moisture was present.

Because Sonora is bounded on the west by the Gulf of California, few amphibians or reptiles are likely to have entered the state by crossing the gulf from that side (this is indicated by data presented below), although two marine species, *Pelamis platurus* and *Dermochelys schlegelii*, reach its shores. We

might begin, therefore, by listing the species whose ranges extend into the state from the northwest, not forgetting the possibility that some of these actually may have entered Sonora from the south in post-glacial times, despite their current absence or poor representation in Sinaloa.

SPECIES RANGING INTO SONORA FROM THE NORTHWEST OR NORTH BUT NOT KNOWN FROM SINALOA

1. *Bufo alvarius*
2. *Coleonyx variegatus*
3. *Crotaphytus collaris*
4. *Crotaphytus wislizenii*
5. *Uma notata*
6. *Uta stansburiana*
7. *Sceloporus magister*
8. *Phrynosoma platyrhinos*
9. *Phrynosoma m'callii*
10. *Cnemidophorus melanostethus*
11. *Heloderma suspectum*
12. *Lichanura roseofusca*
13. *Diadophis regalis*
14. *Phyllorhynchus decurtatus*
15. *Phyllorhynchus browni*
16. *Arizona elegans*
17. *Chionactis occipitalis*
18. *Chilomeniscus cinctus*
19. *Trimorphodon lambda*
20. *Micruroides euryxanthus*
21. *Crotalus viridis (oreganus)*
22. *Crotalus mitchellii pyrrhus*
23. *Crotalus tigris*
24. *Crotalus cerastes*
25. *Gopherus agassizii*
26. *Kinosternon sonoriense*

With the single exceptions of *Diadophis regalis* and *Crotalus v. oreganus*, principally mountain forms in Arizona, all these species inhabit lowlands or foothills. Many are likely to be found in Sinaloa, but there is no reasonable expectancy that others will ever be found far beyond the southern limits of the Colorado Desert (here understood to include essentially the region defined by Dice, 1943, as his Sonoran Biotic Province). Of the species included in the list only two have close relatives known at present in Sinaloa. Of these two, *Heloderma suspectum* is replaced to the south by *H. horridum*, and *Trimorphodon lambda* is replaced by *T. paucimaculatus*. There is little, if any, likelihood that the two forms of *Heloderma* will intergrade, but it is altogether probable that the two

populations of *Trimorphodon* are subspecifically related; they differ chiefly in ventral counts, and gradients in this character occur in nearly every snake whose range extends through the region between southern Sinaloa and central Sonora. No *Trimorphodon* has yet been secured in this intermediate territory, although it is virtually a certainty that representatives of the genus occur. With the exception of *Crotalus viridis oreganus*, all these species seem to have evolved in the desert or along its periphery, and perhaps most of them descended from stocks that entered the desert lowlands from the plateau, or in a few instances from progenitors that invaded the deserts from the coastal plain to the south. The present distribution of *Lichanura*, with one species in the cape region of Baja California, a second one in the coastal region of southern California, and a subspecies of the latter inhabiting the Colorado and Mojave deserts, suggests that this genus may represent a peninsular relict of the sort discussed by Schmidt (1943, p. 249). If so, *L. roseofusca gracia* in Sonora may represent a post-glacial dispersal of a genus which for a time was restricted to the peninsula of Baja California.

For the most part (with the notable exceptions of *Diadophis regalis* and *Crotalus v. oreganus*) the species included in the list above may be considered desert species. A few of them are confined to its eastern edge, and some, such as the two species of *Crotaphytus*, have extensive ranges to the north and east, and a few of them have penetrated the cape region of Baja California.

Turning now to those species with more extensive ranges to the east or northeast, we find that scarcely more than half as many seem to have ranges extending into Sonora from this direction, and the list includes species of diverse origins:

SPECIES RANGING INTO OR ACROSS SONORA
FROM THE EAST OR NORTHEAST

1. *Bufo woodhousii*
2. *Holbrookia maculata*
3. *Sceloporus undulatus*
4. *Phrynosoma modestum*
5. *Phrynosoma cornutum*
6. *Thamnophis marcianus*
7. *Thamnophis macrostemma*
8. *Heterodon nasicus*

9. *Pituophis sayi*
10. *Lampropeltis getulus*
11. *Coluber flagellum*
12. *Crotalus atrox*
13. *Crotalus scutulatus*
14. *Crotalus viridis (viridis)*
15. *Kinosternon flavescens*
16. *Terrapene ornata*

The single amphibian in this list, *Bufo woodhousii*, belongs to a group of toads that inhabits most of Middle North America. Whether any Mexican toads belong in this group or not is problematical, but the closest relatives of *B. woodhousii* have extended their ranges but a short distance south of the international boundary. They may, therefore, represent a Holarctic element perhaps more closely related to Asiatic groups. The species is included in this list because it seems to have entered Sonora along the foothills in the northeastern portion of the state. It must occur along the Colorado River in Sonora as well, inasmuch as it has been taken in northeastern Baja California. Like *Rana pipiens* it has followed the streams, but unlike the latter it has failed to push southward.

Holbrookia maculata, *Phrynosoma modestum*, *Heterodon nasicus*, and *Kinosternon flavescens* are assuredly plateau forms, while *Sceloporus undulatus* occurs on both sides of the Rocky Mountains but has a more widespread distribution to the east; it enters Sonora only as a mountain race on the periphery of the range of the species.

Pituophis sayi affinis, the Sonoran race of the bull snake, is regarded by Stull (1940) as the most generalized form in the genus, and she believes it to be ancestral to the adjacent forms. If so, the center of dispersal for the genus would lie at the northwestern edge of the Mexican plateau. However, Klauber (1941c, p. 60) has questioned Stull's conclusions and suggests that either *P. deppii* or *P. lineaticollis* (considered to be races of a single species by Smith, 1943) of central and southern Mexico, respectively, are closer to a generalized ancestral colubrid and may, therefore, be more primitive representatives of the genus. This does not preclude the possibility that the central plateau was the center of dispersal in post-glacial times; rather it implies that the primitive forms may have been pushed southward to their present loca-

tions in the periphery of the range of the genus. Thus, *P. sayi* may represent the nearest relative of both eastern and western species, but it scarcely can have been ancestral to *P. deppii*.

The distributional pattern of *Pituophis* is rather closely paralleled by the racers of the *Coluber flagellum* group, although Smith's (1941b) suggested phylogeny of the group cannot be accepted, as we note under a discussion of these snakes in the annotated list later in the present paper. The species *mentovarius* may represent the primitive, but not necessarily the ancestral, form in this case. Whatever the ancestor was, the race *testaceus* (or possibly *lineatulus* if this race proves to be valid) would represent the plateau stock most closely related to *piceus* in Sonora.

The kingsnakes of the species *getulus* represent another Middle North American group which seems to have had its center of dispersal in northern Mexico. Blanchard (1921) regarded *L. g. splendida* as the form inhabiting a region most favorable for the "center of preservation and dispersal of a plains form of land snake," and the one form which possessed a pattern from which those of all other races could be most simply and naturally derived.

The distributions of rattlesnakes are far more complex and less readily interpreted. A single form, *Crotalus viridis viridis*, entering Sonora in the northeast is primarily a plains subspecies, although its range does extend into the plateau regions of Arizona and New Mexico. In the mountains it is replaced by *C. v. oreganus*, but the latter race has entered Sonora from the north rather than as a descendant of the *C. v. viridis* population which extends into northeastern Sonora. Klauber (1935, p. 86) was able to obtain evidence of intergradation between *oreganus* and *viridis* only via a circuitous route to the north through a series of three related subspecies. Thus, *viridis* and *oreganus* appear to have entered Sonora by separate routes, the former from the east, and the latter from the north.

The western diamond rattlesnake, *C. atrox*, is found throughout northern Mexico, from coast to coast, while its presence on the Isthmus of Tehuantepec indicates that at one time it may have had an even more in-

clusive range. Its present distribution suggests a post-glacial dispersal from the plateau, however, and presumably it is close to the ancestral stock (Gloyd, 1940, p. 211) that gave rise to *adamanteus* in Florida, and to *ruber* stock, including its insular and peninsular derivatives on the west coast. Each of the two main peripheral forms apparently survived as populations isolated during the Pleistocene on the peninsulas of Baja California and of Florida, whereas the immediate ancestors of *atrox* retreated southward on the Mexican plateau which is essentially a central peninsula (or "paleopeninsula," Schmidt, 1933, p. 250) of North America.

The range of *Crotalus scutulatus* is to some extent an anomalous one, chiefly because of its failure to penetrate the Colorado Desert west of the Colorado River, whereas it occurs on the Mojave Desert as far west as Los Angeles County in California. The greater part of its range, however, lies east of the continental divide where it is known as far south as the state of Puebla in Mexico. The species seems to be primarily adapted at present for existence in higher, arid habitats. Like *atrox* it seems to have been driven southward during late Pleistocene, and its dispersal to the north seems to have been relatively recent. It has failed to enter moist lowland habitats, except possibly in northwestern Sonora and the adjacent portion of Arizona. Its inability to penetrate the arid plains east of the Rocky Mountains is not readily understandable unless it be assumed that it could not meet the competition of the more perfectly plains-adapted *C. v. viridis*, hypothetically an earlier entrant that may have preëmpted the habitat. It seems, therefore, to have moved westward in its dispersal to occupy the territory which had been uninhabited or possibly vacated by races of *viridis*. Despite the "insular" occurrence of *oreganus* on mountains within the range of *scutulatus*, the ranges and habitats of *scutulatus* and *oreganus* are mutually exclusive for the most part. Gloyd (1940) regards *scutulatus* as an annectant species, intermediate between the *viridis* and *atrox* groups.

The range of *Thamnophis marciianus* bears certain resemblances to the distribution of *C. scutulatus*. The recent discovery of a close relative (*T. ruthveni*) in Tehuantepec suggests

that *T. marcianus* was once widely distributed. Likewise the distribution of *C. scutulatus* indicates the possibility that some other species, such as *Phyllorhynchus browni* and *Heloderma suspectum* now present in southwestern Arizona but absent in the Colorado Desert west of the Colorado River, may at one time have occupied the Mexican plateau east of the continental divide. Like *C. scutulatus* they pushed westward into the deserts, but failed to survive on the eastern drainage, although there is a possibility that *Phyllorhynchus* may yet be found there. There are some records for *Heloderma* east of the divide, although these usually have been questioned. This hypothesis would account for the presence of two species of *Phyllorhynchus* now occupying the same habitat without evidence of hybridization in Pima County, Arizona. An alternative hypothesis may be preferable, namely, that *Phyllorhynchus decurtatus*, like *C. ruber* stock, survived the glacial period by retreating to the cape in Baja California, while *P. browni* retreated southward on the Mexican palaeopeninsula. This theory assumes that the two stocks were evolved from a single progenitor, that differences arose during peninsular isolation, and that the present overlap in range has resulted from post-glacial dispersals to the north.

Elsewhere we have listed *Gopherus agassizii* as a species ranging into Sonora from the northeast and north. On the basis of its present range the species is, indeed, to be regarded as a desert element. But when the current ranges of the three forms of the genus are considered in light of the evidence supplied by the distributions of diamond rattlesnakes, it is plain that certain parallels exist. The species *G. polyphemus* inhabits peninsular Florida and is found as far to the northwest as southern Arkansas (*vide* Stejneger and Barbour, 1943). A second species, *G. berlandieri*, inhabits western Texas and the adjacent portion of northeastern Mexico, while a third species, *G. agassizii*, inhabits the Mojave and Colorado deserts but is unknown in Baja California. Despite its present absence from Baja California it may have survived there during glacial times but became exterminated on this peninsula subsequent to its northern dispersal. In fact, the recent report of *Gopherus agassizii* in Pleistocene as-

phalt deposits in southern San Joaquin Valley (Miller, 1942) in California indicates that the desert tortoise had a more extensive range than it has today. If it became exterminated in San Joaquin Valley, why not also in Baja California? Pleistocene fossils from Florida, Texas, and California conceivably represent a single species.

It is possible to explain the existence of three closely related species of *Gopherus*, therefore, by assuming that a single ancestral form became separated into three peninsular populations following a southward retreat when they were completely isolated by the cold prevailing at the northern extremities of the peninsulas. In their post-glacial northward dispersals the three populations thus isolated never succeeded in regaining contact and, therefore, remain differentiated as three species. It is quite problematical whether or not they would interbreed had the gaps in their distributions been closed. It is not impossible that a similar explanation might be advanced to account for the distributions of species or even of genera in many other groups. The subject will be examined at greater length in a separate paper, where species other than those found in Sonora can be included in the discussion.

It must be emphasized here that present-day distributions of reptiles and amphibians are post-glacial, and that the majority of the genera with which we are dealing in this paper, the Old Northerners in particular, actually evolved in Tertiary centers north of the Mexican plateau and prior to the last glacial period. This is true as well of the species in the following list which supposedly have reentered the southern portion of Sonora in post-glacial times.

SPECIES WHOSE RANGES EXTEND INTO SONORA
FROM THE SOUTH BUT WHICH FAIL TO
REACH ARIZONA

1. *Bufo marinus*
2. *Bufo mazatlanensis*
3. *Leptodactylus melanonotus*
4. *Agalychnis dacnicolor*
5. *Pternohyla fodiens*
6. *Hyla baudinii*
7. *Rana pustulosa*
8. *Phyllodactylus tuberculosus*
9. *Anolis nebuloides*
10. *Ctenosaura hemilopha*

11. *Uta bicarinata*
12. *Sceloporus nelsoni*
13. *Heloderma horridum*
14. *Constrictor constrictor*
15. *Drymarchon corais*
16. *Drymobius margaritiferus*
17. *Coluber striolatus*
18. *Leptophis diplotropis*
19. *Gyalopion desertorum*
20. *Imantodes gracillima*
21. *Micrurus diastema*
22. *Agkistrodon bilineatus*
23. *Crotalus basiliscus*
24. *Kinosternon integrum*
25. *Geomyda pulcherrima*
26. *Pseudemys scripta*

Of the 26 species included in this list, all are known to be represented by the same subspecies or by a closely related subspecies in the narrow coastal plain, or along the foothills to the south, with the exception of *Rana pustulosa*. This frog is currently known from Durango, Morelos, and Colima, and its occurrence in Sinaloa can be anticipated. However, it may be primarily a plateau species with representatives in the foothills only at scattered localities where conditions are suitable. The species of *Pseudoficimia* described herein may also belong on this list if the specimens recorded from near Mazatlán prove to belong to the same species.

At the present time most of these species are known in Sonora only from the Río Fuerte or from the Río Mayo drainage systems. In fact, only *Pteronohyla fodiens*, *Phyllodactylus tuberculosus*, *Ctenosaura hemilopha*, *Constrictor constrictor*, and *Gyalopion desertorum* are known north of the Río Mayo, but the ranges of most of these five species extend only to the middle of the state. It is a reasonable assumption that a good many more of the 26 will be found in the lower portion of Río Yaqui drainage, particularly in the foothills, where no herpetological collections seem to have been made. It is doubtful, however, whether many of these species will be found in Arizona, despite the presence of *Oxybelis*, *Microhyla*, *Elaphe chlorosoma*, and *Rana tarahumaræ* in the southeastern portion of that state. More extensive collecting will presumably show that these species drop out one by one as their ranges approach the border.

We know too little at present concerning the environmental requirements of these forms, and we may, therefore, do little more than speculate as to the factors that inhibit their northward dispersal. Many of them are associated with the Short-tree Forest of the Subtropical life zone (as defined by Gentry, 1942) in their distributions to the south, but this may be a secondary association. Even those species that reach the middle of the state do not range beyond the semi-arid regions of Sonora where there are summer rains but dry winters. North of this central strip, as mapped by Thornthwaite (1931), there lies a region with deficiency in rainfall throughout most of the year. The chief environmental factor limiting the northern distributions of these amphibians and reptiles, therefore, is most likely to be moisture, although in the case of arboreal species the nature of the vegetation may be more directly involved.

It is probable that dispersals are intermittent, and that cycles in rainfall have permitted certain species to extend their ranges from one drainage system, or from one moist valley or canyon, to another during relatively brief moist periods. The data supplied by the field of dendrochronology provide evidence for such cycles in relatively recent times. However, once a species whose prime requirement is moisture succeeds in reaching an outpost such as the Santa Rita Mountains, where the summit is sufficiently high to capture a fair amount of moisture, it would be able to establish itself there, other conditions being suitable. Even though the territory between it and a moist region to the south subsequently returned to its original arid conditions when a shift to a dry cycle in rainfall occurred, the species would have succeeded in extending its range, perhaps with permanency. In fact, this seems to be the simplest explanation for the presence of various species at present known from several isolated mountains in Arizona. In a few instances there is evidence that this "insular" isolation on mountains has resulted in speciation or incipient speciation, for example, in some of the kingsnakes.

Unfortunately, there are no kingsnakes of the *triangulum* group known between the Santa Rita Mountains, where *Lampropeltis*

triangulum gentilis occurs, and Guirocoba in southern Sonora from which we can now report *Lampropeltis t. nelsoni*. It is uncertain whether these two populations were ever connected, or whether *nelsoni* evolved through a separate chain from the south, while *gentilis* entered southern Arizona from the northeast as has been assumed. In this and in other cases, the isolation of species or subspecies on mountains can be ascribed to factors that are primarily associated with moisture requirements. The failure of those in the Santa Rita, Chiricahua, and Huachuca Mountains to become differentiated from their Mexican relatives suggests, therefore, that most of them are relatively recent arrivals. The inability of other Sonoran species to reach Arizona may be ascribed to climatic conditions of the past and present, and this in turn introduces temporal factors. In other words, certain species failed to extend their ranges to the United States simply because they had not penetrated far enough to the north at a time or times in the past when the present intervening arid strip was moist enough to permit them to do so. The fact that certain mountain dwellers have reached Arizona indicates that this arid gap was not always present, as may be seen in the list that follows:

SPECIES WHOSE RANGES EXTEND FROM ARIZONA
SOUTHWARD THROUGH SONORA AS A
SINGLE FORM

1. *Eleutherodactylus angustis*
2. *Microhyla olivacea*
3. *Phrynosoma orbiculare hernandesi*
4. *Phrynosoma solare*
5. *Sceloporus scalaris slevini*
6. *Sceloporus jarrovi jarrovi*
7. *Gerrhonotus kingii*
8. *Eumeces callicephalus*
9. *Oxybelis aeneus auratus*
10. *Thamnophis angustirostris*
11. *Pituophis sayi affinis*
12. *Elaphe chlorosoma*
13. *Coluber flagellum piceus*
14. *Coluber bilineatus*
15. *Salvadora hexalepis deserticola*
16. *Crotalus molossus molossus*
17. *Crotalus willardi*
18. *Crotalus triseriatus pricei*

It is apparent that all these species, with the exceptions of *Pituophis sayi affinis*,

Coluber flagellum piceus, and *Salvadora h. deserticola*, are primarily mountain, plateau, or foothill forms. Seven of them are known in Arizona only from the partly isolated mountains that represent the northern extremity of the Sierra Madre Occidental. To the south their ranges are confined more or less to this mountain mass, and they supposedly entered via this mountain route. In this same category are *Crotalus lepidus klauberi* and *Rana tarahumarae* which occur in Arizona and on the plateau to the south, although there are as yet no authenticated records for Sonora. *Phrynosoma solare* is not strictly a foothill form, inasmuch as it ranges a short distance westward into the desert. A single record for Baja California suggests, however, that its range was once continuous, but that increasing aridity, to which it could not become adapted, resulted in its extermination in the intervening area. It seems to be more abundant in the foothills and supposedly evolved in, or on the edge of, the Colorado Desert. *Salvadora h. deserticola* has a peculiar range which extends from the Big Bend region of Texas westward across northern Chihuahua and southern New Mexico into southeastern Arizona and from there southward into Sinaloa. In the northwestern portion of the state, however, it is replaced by *Salvadora h. hexalepis*, which was probably derived from it. The range of *Coluber flagellum piceus* extends throughout most of the arid and semi-arid region west of the plateau regions of Sonora, Arizona, and Utah, but the form seems to intergrade with *Coluber f. testaceus* along the dissected edge of the plateau from southeastern Arizona southward to and probably including northeastern Sinaloa. The supposed relationships and derivations of this form, as well as of *Pituophis sayi affinis*, have been commented upon above in the list of forms whose ranges extend into Sonora from the east. Both species occupy most of, if not all, the territory within the state, but they seem to have entered from the plateau. Each of them is sufficiently adaptable to have penetrated the Imperial Valley in California.

The races of the horned lizard, *Phrynosoma orbiculare*, are so inadequately studied that we use the specific name with considerable diffidence, although we are inclined to agree

with Klauber (1939, p. 92) who placed American short-horned forms as races of *orbiculare*. Smith's (1942c, pp. 361-363) evidence to the contrary seems to us to be inconclusive, since the relative tail lengths of an insufficient number of populations were studied. At any rate, the Sonoran representative of *orbiculare* seems to belong to a species that has dispersed northward in post-glacial times, passing through the northeastern corner of the state.

Of the species on this list, but three, *Microhyla olivacea*, *Oxybelis aeneus*, and *Coluber bilineatus*, seem likely to have entered Sonora along the coastal plain from the south. We may sum up this list, therefore, by noting that it includes: (1) 10 species that are essentially mountain forms, nearly confined thereto, which have followed the dispersal route of the Sierra Madre Mountains in their penetration of Arizona; the rattlesnake, *Crotalus molossus*, is included here, although it is not strictly limited to the mountains, and it may intergrade in southern Sonora with a coastal form as noted in the annotated list of species herein reported; (2) two forms that have entered the states of Sonora and Arizona as derivatives of plateau stock; (3) two species from the Colorado Desert; and (4) three that represent influxes along the coastal plain from the south.

SPECIES ENDEMIC TO SONORA

1. *Uta taylori*
2. *Phrynosoma ditmarsii*
3. *Cnemidophorus burti*
4. *Tantilla hobartsmithi*
5. *Pseudoficimia hilltoni*
6. *Terrapene klauberi*

In addition to these species, *Sauromalus townsendi* inhabits only Tiburón Island and northwestern Sonora. Both *Eumeces parvauriculatus* and *Sonora aemula* are known only from Sonora and the adjacent region in Chihuahua. It can be anticipated, of course, that some of the forms seemingly restricted to Sonora will eventually prove to be present in adjacent states, or that names will prove to be invalid. About half of these species are at present known only from the desert, and half of them are known from the mountains or foothills; at present there is no precise local-

ity for *Phrynosoma ditmarsii*, but the species is obviously closest to *orbiculare* and presumably occurs at higher elevations.

It is possible to assign each of these species to elements entering from one or another of the directions specified above. Thus, *Uta taylori* is most closely related to *Uta stansburiana* and assuredly entered from the north where lizards of this group have undergone their recent diversification and dispersal. The *Tantilla* is said to be most closely related to *T. atriceps*, suggesting derivation from stocks to the north or east. The species is based upon a single specimen in bad condition and may prove to be a synonym of *atriceps* (Smith, 1942d, p. 36). *Sonora aemula* is most nearly allied to species in the plateau to the south. *Phrynosoma ditmarsii* is certainly derived from *P. orbiculare* of the plateau and thus entered from the northeast. The skink, *Eumeces parvauriculatus*, is supposed to be "distantly related" to *E. parvulus* of Colima, Sinaloa, and Nayarit (Taylor, 1936a, p. 371), but it is placed by Taylor in the group which includes this species. If this assumption is valid, it may be postulated, therefore, that it entered from the south along with the *Pseudoficimia* which certainly has close relatives (possibly of the same species) in Sinaloa. The *Terrapene* is morphologically similar and possibly subspecifically related to *T. nelsoni* of Nayarit.

The teiid, *Cnemidophorus burti*, is said to be close to *perplexus* which makes its occurrence within the range of *perplexus* anomalous, unless it is actually closer to, and possibly derived from, *labialis* or even from *hyperythrus* of Baja California. It is conceivable that it evolved in isolation on one of the islands in the gulf and subsequently reached the mainland where it failed to interbreed with *perplexus*. It is also conceivable that it can be interpreted as a mutant pattern phase of the latter. Tentatively it can be assigned to the group which ranges into Sonora from the northwest.

Thus, of the species supposedly endemic to Sonora or to the immediate region, it is probable that of their various ancestral stocks, three entered from the north, two from the plateau, and four came into the region from the south.

SPECIES REPRESENTED BY TWO SUBSPECIES
WHICH INTERGRADE IN SONORA

1. *Dipsosaurus dorsalis*
2. *Callisaurus draconoides*
3. *Uta ornata*
4. *Holbrookia elegans*
5. *Sceloporus clarkii*
6. *Phrynosoma platyrhinos*
7. *Cnemidophorus sackii*
8. *Leptotyphlops humilis*
9. *Thamnophis eques*
10. *Coluber flagellum*
11. *Salvadora hexalepis*
12. *Hypsiglena torquata*
13. *Lampropeltis getulus*
14. *Rhinocheilus lecontei*

This list, it is significant to note, is composed principally of foothill, valley, or lowland species. In addition, the following species, most of which are lowland forms, are as yet known from but one subspecies in Sonora, although intergrades may occur within the borders of the state:

1. *Phyllodactylus tuberculosus*
2. *Uma notata*
3. *Phyllorhynchus decurtatus*
4. *Phyllorhynchus browni*
5. *Chionactis occipitalis*
6. *Kinosternon flavescens*

For some other species the presence of intergrades in Sonora is less certain, but it may be suspected that intergrades are likely to occur between:

1. *Coleonyx variegatus* and *C. fasciatus*
2. *Uta taylori* and *U. stansburiana*
3. *Sauromalus townsendi* and *S. obesus*
4. *Cnemidophorus melanostethus* and *C. tessellatus*
5. *Lampropeltis triangulum gentilis* and *L. t. nelsoni*
6. *Tantilla hobartsmithi* and *T. atriceps*
7. *Trimorphodon lambda* and *T. paucimaculatus*
8. *Crotalus basiliscus* and *C. molossus*

These tabulations do not exhaust the possibilities. Beyond much doubt further exploration of the state will bring to light subspecies whose existences are unknown or unrecognized.

The arbitrary lists utilized above to provide a framework for our discussions have omitted mention of several Sonoran species. Those omitted fall roughly into two groups: (1) desert-adapted species whose ranges ex-

tend into Sonora from the northwest, and (2) foothill species with ranges which extend chiefly along the base of the mountains, some of them into the coastal plain. Species in each category include populations in both the northern and southern portions of the state, many of them with ranges extending into Sinaloa. Those not discussed before, which appear to have entered from the west or northwest, include *Coleonyx variegatus*, *Dipsosaurus dorsalis*, *Callisaurus draconoides*, *Uta ornata*, and *Sauromalus townsendi*. Each of these species has close relatives (whether they now chance to be called species or subspecies is of little concern to us here) on one or more of the islands off the coast of Baja California. We regard them as stocks that survived the last glacial period isolated in Baja California. Their present ranges are attributed to post-glacial dispersals. Some of them have migrated southward as far as central Sinaloa (*Uta*, *Coleonyx*, and *Callisaurus*), others have reached only northern Sinaloa (*Dipsosaurus*), and *Sauromalus* seems to be unknown on the mainland south of Guáymas. The overlap in range of *Uta ornata* and *Uta bicarinata* is thus attributed to isolation of two stocks during the Pleistocene or perhaps earlier.

Of the foothill species, the range of *Sceloporus clarkii* fits a situation comparable to that for *Uta ornata* and *Uta bicarinata*. The population of *S. clarkii* represents the mainland population, and *S. magister* represents the Baja Californian population isolated during part of the Pleistocene. Smith (1939, p. 29) places these two species in the same group but does not seek to account for the extensive overlap in range as well as in habitat. He does, however (*ibid.*, p. 124), comment on the discrepancies in statements concerning habitats and suggests that there is some avoidance of competition in localities where both species occur. Our observations are not completely in accord with Smith's conclusions. We consider *magister* much less restricted than *clarkii*, which does, however, show some preference for trees. Nevertheless, *magister* is often taken in trees in many parts of its range, and contrariwise *clarkii* resorts to boulders when nothing more suitable is available. In the foothills of the Agua Caliente Mountains east of Tucson, Arizona, we found both species in almost equal numbers inhabit-

ing the boulders of a dry wash. We conclude, therefore, that temporary territorial isolation in the past accounts for the present genetic isolation. This cannot be ascribed to habitat differences, although the nature of the actual isolating mechanism which now prevents interbreeding is unknown. The far more extensive overlap in the ranges of these two species than that occurring between the two lizards of the genus *Uta* may be attributed to the more rapid dispersals of the larger lizards.

With reference to *Cnemidophorus sackii* (as the species is tentatively placed in this paper) we are not yet certain that intergrades between *perplexus* and *sackii* occur, although their occurrence is a possibility. The existence of *C. labialis* in Baja California indicates that the ancestral stock was split as a result either of the cold glacial period or of increasingly arid conditions in post-glacial times. The populations of the group inhabiting central Mexico are all referred to *sackii* by Burt, and we can discover no very obvious differences between specimens of *sackii* from Texas and specimens taken in southern Sonora. Tentatively, we are assuming that *perplexus* is derived from *sackii* and, therefore, entered the region it now occupies as an influx from the south.

When there are a sufficient number of locality records to plot the ranges of all these forms in detail and to determine the actual relationships and the regions of intergradation (as well as the nature of the intergradation), a more reliable understanding of the phenomena involved can be attained. Meanwhile the data available suggest that three principal distributional patterns may be recognizable, including those of: (1) coastal plain and desert species which intergrade in the vicinity of Guáymas; (2) foothill species which intergrade near the southern border, probably in the Río Fuerte or Río Mayo drainages; and (3) mountain species whose ranges extend in varying degree from the Santa Rita, Huachuca, and Chiricahua Mountains, southward as far as Durango, Guanajuato, or Michoacán without becoming strongly differentiated. All species, to be sure, do not fit one or another of these patterns, and this is to be expected since all species are not of similar adaptability, nor have their histories been the same. Some species exceed the limits suggested above for mountain

forms, with a few, like *Crotalus molossus* and *Gerrhonotus kingii*, having extended their ranges into the plateau region of Arizona. Thus, species inhabiting the mountains of Mexico to some extent overlap the ranges of Arizonan mountain species in the southeastern portion of the latter state. Similarly, on the coast the ranges of foothill and desert forms overlap the ranges of tropical species along the southern boundary of the state, or in Sinaloa.

In general, the mountain forms and to a lesser extent the foothill forms are those that range through the state without exhibiting much evidence of differentiation. In contrast to these are the lowland forms, few of which range through Sonora without becoming differentiated into recognizable populations.

DISPERSAL ROUTES

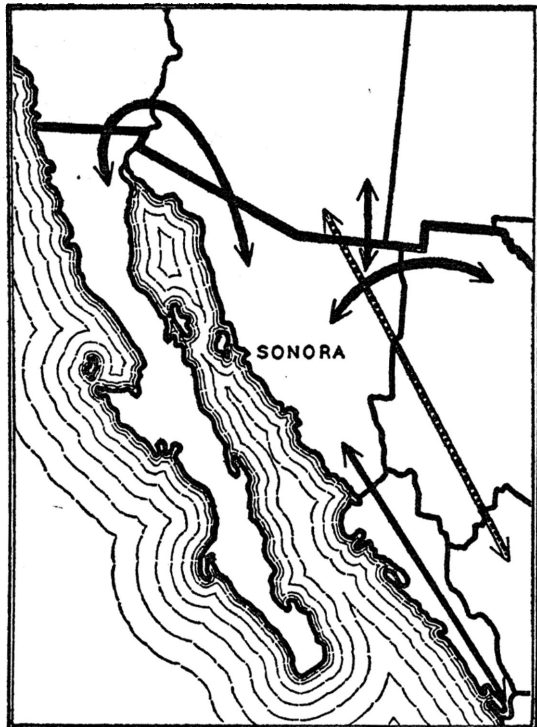
The lists utilized in the preceding discussions are arbitrary and artificial owing to the fact that the ranges and habitats of two species are never identical. However, if due allowance is made for some arbitrary assignments of species to one category or another and for gaps in the record, it is possible to gain some understanding of dispersal routes and some notion of the more probable post-glacial centers of dispersal. The conclusions derived therefrom are to be considered estimates rather than well-authenticated facts.

From our analysis above it is possible to recognize the following main dispersal routes (see map 2): (1) from the south, along the narrow coastal plain; (2) from the south, along the Sierra Madre Occidental; (3) from the east, of plateau or plains elements, via valleys through the dissected north end of the Sierra Madre; (4) from the north, that is, from the mountains in Arizona; and (5) from the northwest, the Colorado Desert. Many of the elements now in this desert are believed to have survived the Pleistocene cold in Baja California.

The 109 terrestrial species of amphibians and reptiles known from Sonora are tentatively regarded as descendants of stocks which entered the state along the routes specified above. (1) Thirty-six species represent derivatives from stocks to the south that have entered along the coastal plain. Most of these

species belong to groups that are essentially tropical or subtropical, or that now have their greatest diversifications to the south. Relatively few have reached Arizona. (2) Eleven species, as far as known, are more or less confined to mountains or foothills in their

by way of the mountains to the north, and a second, *Rana pipiens*, may have followed the edge of the Mexican plateau southward in its dispersal. (5) Thirty-four species are derivatives of Old Northern stocks that have probably evolved in Baja California, in the Colorado Desert or along its periphery, some of them perhaps within the borders of Sonora.



MAP 2. Sonora and adjacent regions, with arrows indicating hypothetical dispersal routes of faunal elements now represented in the state. Arrows are intended to indicate the general directions of dispersals rather than narrow pathways. The dotted arrow indicates the Sierra Madre Occidental, now interrupted by intervening arid areas in northeastern Sonora. Compare with map 1. For additional information see text.

distributions within the state, and appear to have pushed northward following the Sierra Madre Occidental, many of them reaching Arizona by this route. (3) Twenty-four species are derived from stocks that entered from the plains or plateau by way of valleys dissecting the Sierra Madre along the northeastern boundary of Sonora. (4) A single species, represented by *Crotalus viridis oreganus*, seems to have gained entrance to the state

SUMMARY OF DISTRIBUTIONAL DATA

Of the 109 terrestrial species now known from Sonora, only 74 have reached Arizona, and but 44 Sonoran species are known to be present in California or Baja California. Furthermore, only 32 are common to Sonora, Arizona, California, and Baja California. The species included in the latter category are almost exclusively Old Northerners, with one, or possibly two, Holarctic representatives. The list, with the exception of *Crotalus viridis* which has intergrading populations to the north of the arid deserts, is composed of: (1) species highly adapted for dune habitats common to all four political divisions; (2) species that are relatively well adapted for existence in arid regions; and (3) species that have crossed the desert, entering from either the east or the west at a time which antedates the present aridity of the lower basin of the Colorado River. Species in this latter group are now found within the arid regions only around springs or around the periphery of the desert on moist mountain tops. Some species are found both around lowland springs or on the higher, moist summits.

The species having more restricted distributions in Sonora and the surrounding region have, in their post-glacial dispersals, encountered barriers represented by the Colorado Desert and the Gulf of California. It is inferred that two populations of many individual ancestral stocks were isolated respectively on the mainland and in Baja California during cold periods of the Pleistocene, and that subsequent northern dispersals account for numerous cases of overlaps and "regions of intergradation" currently recognized. Furthermore, the existence of populations belonging to the same species or subspecies that now are represented on mountain tops

along the periphery of the deserts (but not in intervening territory) is interpreted as evidence for the belief that a moist period followed the last period of glacial cold. Species that require moisture for their existence succeeded in crossing at a time when a wetter climate prevailed. Other species that were less advanced in their northward migrations following the glacial period have failed to cross the desert barrier or have failed to survive on one side or the other of the existing desert.

Thus, we conclude that origins of the present fauna of the state of Sonora involve: (1) Pleistocene climatic changes; (2) southward withdrawals of populations on the peninsula of Baja California and on the mainland as a result of the most recent glacial period; (3) partial or complete differentiation during isolation; and (4) subsequent migrations or secondary dispersals by way of five main dispersal routes.

DESERTS AS BARRIERS TO AMPHIBIAN AND REPTILE DISPERSALS

FROM THE PRECEDING LISTS and discussions it is apparent that many species represented in Sonora have entered the state by means of different routes at different times. Furthermore, it can be observed that there are numerous overlaps in the ranges of species derived from diverse sources. Despite this interpenetration it is possible to divide the entire fauna of the state into two lists: (1) those that have succeeded in crossing the deserts, either from the east to reach California or Baja California, or from the west to reach Sonora, and (2) those that have failed to cross the deserts from the east to reach either California or Baja California. The two lists which follow are based solely upon the existing distributions known for the species included. As we have pointed out above, some of these species were quite possibly represented on both sides of the desert at one time but became exterminated over parts of their range.

SPECIES REPRESENTED IN SONORA BUT ABSENT FROM CALIFORNIA AND BAJA CALIFORNIA

1. *Bufo marinus*
2. *Bufo mazatlanensis*
3. *Leptodactylus melanonotus*
4. *Eleutherodactylus augusti*
5. *Agalychnis dacnicolor*
6. *Pternohyla fodiens*
7. *Hyla baudinii*
8. *Microhyla olivacea*
9. *Rana pustulosa*
10. *Anolis nebuloides*
11. *Sauromalus townsendi*
12. *Holbrookia maculata*
13. *Holbrookia elegans*
14. *Holbrookia texana*
15. *Uta taylori*
16. *Uta bicarinata*
17. *Sceloporus clarkii*
18. *Sceloporus jarrovi*
19. *Sceloporus scalaris*
20. *Sceloporus nelsoni*
21. *Sceloporus undulatus*
22. *Phrynosoma ditmarsii*
23. *Phrynosoma modestum*
24. *Phrynosoma cornutum*
25. *Heloderma suspectum*
26. *Heloderma horridum*
27. *Gerrhonotus kingii*
28. *Cnemidophorus melanosthetus*
29. *Cnemidophorus burti*
30. *Cnemidophorus sackii*
31. *Eumeces callicephalus*
32. *Eumeces parvauriculatus*
33. *Constrictor constrictor*
34. *Heterodon nasicus*
35. *Diadophis regalis*
36. *Phyllorhynchus browni*
37. *Thamnophis eques*
38. *Thamnophis angustirostris*
39. *Thamnophis macrostemma*
40. *Drymobius margaritiferus*
41. *Drymarchon corais*
42. *Elaphe chlorosoma*
43. *Lampropeltis triangulum*
44. *Coluber bilineatus*
45. *Coluber striolatus*
46. *Leptophis diplotropis*
47. *Gyalopion desertorum*
48. *Pseudoficimia hiltoni*
49. *Tantilla hobartsmithi*
50. *Sonora aemula*
51. *Oxybelis aeneus*
52. *Imantodes gracillima*
53. *Micruroides euryxanthus*
54. *Micrurus diastema*
55. *Agkistrodon bilineatus*
56. *Crotalus basiliscus*
57. *Crotalus molossus*
58. *Crotalus tigris*
59. *Crotalus willardi*
60. *Crotalus triseriatus*
61. *Kinosternon flavescens*
62. *Kinosternon integrum*
63. *Geoemyda pulcherrima*
64. *Terrapene ornata*
65. *Terrapene klauberi*

To this list might be added those species with ranges on both sides of the Gulf of California but which are absent from California or Arizona. As suggested above, the following species perhaps were once present in California but failed to survive there: *Scaphiopus couchii*, *Ctenosaura hemilopha*, *Phrynosoma solare*, and *Pseudemys scripta*. The gap in the range of each may be attributed to increasing aridity in the north which forced contraction of ranges following their dispersals. Similarly, *Phrynosoma orbiculare* is absent from the deserts but has reached northern California, perhaps by way of a less arid route north of the Mojave Desert. The

absence of *Phyllodactylus tuberculosus* in Arizona is difficult to explain. Probably it will eventually be taken in Arizona since it ranges north of the border in California.

Some of the forms on this list are capable of existing in rather arid habitats, but none of them seems to have penetrated the hotter and drier portions of the desert. None appears to be especially adaptable; possibly all are relatively stenohygric or stenothermic. Many of them prefer moist places of concealment or riparian habitats, yet a few species with superficially similar habitat preferences have penetrated the desert to reach Baja California.

Particular significance may be attached to the fact that only two species, *Ctenosaura hemilopha* and *Pseudemys scripta*, are known from both Baja California and Sonora without evidence of their occurrence north of the international boundary. In the same category would fall *Natrix valida* which occurs in the cape region and in Sinaloa but so far has not been authenticated in Sonora. Except for these three species, all others common to the peninsula and the mainland could easily have migrated via land routes, as indicated by their known distributions. It is noteworthy that two of the three species, the *Natrix* and the *Pseudemys*, are aquatic. Aside from these three there is not the slightest evidence of any migration across salt water in the gulf, either on rafts (which would be scarcely expected in such arid regions with small rivers) or as wind-blown waifs. Obviously the gulf itself, narrow as it is, has been a formidable barrier to dispersals of the terrestrial poikilotherms under consideration.

SPECIES COMMON TO SONORA, ARIZONA,
CALIFORNIA, AND BAJA CALIFORNIA

1. *Scaphiopus hammondi*
2. *Bufo punctatus*
3. *Bufo woodhousii*
4. *Hyla arenicolor*
5. *Rana pipiens*
6. *Coleonyx variegatus*
7. *Dipsosaurus dorsalis*
8. *Crotaphytus collaris*
9. *Crotaphytus wislizenii*
10. *Uma notata*
11. *Callisaurus draconoides*
12. *Uta stansburiana*

13. *Uta ornata*
14. *Sceloporus magister*
15. *Phrynosoma platyrhinos*
16. *Phrynosoma m'callii*
17. *Leptotyphlops humilis*
18. *Lichanura roseofusca*
19. *Phyllorhynchus decurtatus*
20. *Pituophis sayi*
21. *Arizona elegans*
22. *Lampropeltis getulus*
23. *Rhinocheilus lecontei*
24. *Coluber flagellum*
25. *Salvadora hexalepis*
26. *Chionactis occipitalis*
27. *Chilomeniscus cinctus*
28. *Hypsiglena torquata*
29. *Crotalus atrox*
30. *Crotalus mitchellii*
31. *Crotalus viridis*
32. *Crotalus cerastes*

The occurrences in the desert of the Amphibia on this list are restricted to springs or to intermittent or permanent streams. Similarly several of the reptiles either seek the moisture or the insulation provided by crevices or subterranean habitats. Only *Crotalus viridis* among the reptiles is unable to live in the desert, although the range of the species skirts its borders except on the south. All the other species are sufficiently adaptable or sufficiently specialized that they may be regarded as desert inhabitants in parts of or throughout their ranges. Despite the fact that the following species fail to reach (or to survive in?) Baja California, all have penetrated the desert to some extent: *Bufo alvarius*, *Thamnophis marcianus*, *Trimorphodon lambda*, *Crotalus scutulatus*, *Kinosternon sonoriense*, and *Gopherus agassizii*.

Of the reptiles and amphibians known from Sonora, therefore, only 38 have penetrated the desert in contrast to 65 which have not. An additional five species now have disjunct distributions with representatives in Sonora and Baja California, but with records absent for either California or Arizona, and a sixth species has reached northern California by way of a circuitous route to the north of the more arid deserts. As explained above, any one of several factors may have inhibited or restricted the dispersals of those species found only east of the Colorado River. Nevertheless these data provide a rough index of the effectiveness of the desert as a barrier.

BIOTIC REGIONS IN SONORA

SEVERAL ATTEMPTS have been made in recent years to define boundaries of "biotic provinces" in Sonora. However, no two authors are in agreement in mapping the southern boundary of the "Sonoran Province," even though this desert region is somewhat better characterized than many other provinces. In connection with ornithological studies, Van Rossem (1931) delimited what he called the "Colorado Desert district" and placed the southern boundary slightly south of Tiburón Island. Some years later W. H. Burt (1938) criticized Van Rossem's conclusions and on the basis of mammalian distributions indicated the southern limit of the "Sonoran Province" (as he called it) somewhat farther south, extending the line to the coast at Guáymas. More recently H. M. Smith (1940) has undertaken an analysis of the biotic provinces of Mexico based on the known ranges of the lizards of a single genus (*Sceloporus*), and, using a third name for the region, he places the southern extremity of the "Arizonan Province" still farther south. Dice (1939 and 1943) follows Burt and retains use of the term "Sonoran." This is perhaps an unfortunate choice of terms because the word is already in use as the adjectival form for the state, as well as for the lower zones in the Merriam system.

The complexities of the situation in southern Sonora are best illustrated in Gentry's (1942, map 2) excellent map of the Río Mayo basin in which he has delimited the four principal vegetational areas. As noted above, Gentry is able to fit these into the Merriam system only by inserting a Subtropical life zone between the Upper and Lower Sonoran zones. Both Alamos and Guirocoba fall within this Subtropical zone. Yet, of over 50 species of amphibians and reptiles secured at the two localities, approximately one-third are inhabitants of the desert to the north. Burt would include Alamos and Guirocoba in the Durangan Province, but Smith would exclude this province from the state of Sonora and place all the southern extremity of the state in the Sinaloan Province as mapped by him. Actually there are at present entirely too few locality records for vertebrate animals from

southern Sonora to permit accurate plotting. It can be anticipated, however, that many species with ranges extending northward from Sinaloa will be found not only in the basins of the Río Fuerte (as we demonstrate in this paper) but in the Río Mayo and Río Yaqui as well. Numerous species now found in Sinaloa will supposedly be found throughout the barranca region along the southern half of the western boundary of Chihuahua. However, we can scarcely bound biotic provinces on the basis of such suppositions; until additional field work has been done, it would be fruitless to attempt additional revisions of the several maps already published.

Burt's inclusion of the lower portion of the Río Yaqui in the Sinaloan Province will, without much doubt, prove to be correct for amphibians and reptiles, as well as for mammals. On the other hand, data presented herein indicate that much of the Río Fuerte drainage, including Alamos, should be included in the Sinaloan, rather than in the Durangan as Burt preferred. In this respect Smith's interpretation of southern Sonora seems more nearly sound.

Burt seemingly extended the boundary of the Durangan Province westward in southern Sonora, in order to include Sierra de Alamos. Doubtless many mammals found on this mountain are also characteristic of the Durangan. Among amphibians and reptiles it is probable that *Rana pustulosa*, *Terrapene klauberi*, and *Eumeces callicephalus* belong in the Durangan Province too, but the majority of the southern derivatives that we are able to list from Alamos and Guirocoba are characteristic of the Sinaloan Province.

The existence of such isolated mountains as Sierra de Alamos makes it extremely difficult to delimit biotic provinces satisfactorily. Dice (1943, p. 4) insists that a biotic province "is never discontinuous (except on marine islands)." By definition, therefore, little cognizance can be taken of the existence of isolated mountains with pine forests on the summit which are surrounded by subtropical short-tree forests. Conversely such provinces as the Durangan erected for the Sierra Madre fail to include any serious consideration of the

penetration of lowland animals and plants in the barrancas. Dice would recognize these separately as life belts or vertical subdivisions of provinces but suggests that it is best to think of each belt as limited to a single province. As far as reptile distributions are concerned such a concept is of limited value.

We have called attention above to the fact that nearly all the species which occur in the mountains of Sonora likewise are known from the Sierra Madre Occidental of the Durango Province as well as from the small, isolated mountain ranges of southeastern Arizona. Along the northeastern boundary of Sonora and the adjacent parts of Chihuahua, New Mexico, and Arizona, a number of species from the plains or plateau have penetrated the valleys dissecting the mountain ranges. If locality records are plotted on a map without due cognizance of elevations, we have what superficially appears to be a dilution of the mountain fauna by a plains fauna. Locally there may be actual overlaps of the two faunas, but the two nevertheless remain essentially distinct. A map of the life zones in this region would clarify the situation, but the segregation of this region as the Apachian Province serves only to obscure the distributional picture.

The concept of biotic provinces is perhaps not without value, but as far as the distributions of amphibians and reptiles are concerned, it appears to us that more can be gained by plotting life zones and dispersal routes than by attempts to bound biotic provinces. We freely admit that life zones are nearly as difficult to map as biotic provinces, but considerably more detail is possible, as Gentry's excellent map of the vegetation of the Río Mayo basin indicates. Vertebrates, particularly the birds and mammals, are not likely to be so restricted or so easily assigned to one association or another as plants are. But until detailed maps, such as Gentry's, can be made for vertebrates, boundaries, as such, are nearly meaningless because they involve such arbitrary delimitations.

Dice's definition (1943, p. 3) of a biotic province as covering "a considerable and continuous geographic area . . . characterized by the occurrence of one or more important ecological associations that differ, at least in proportional area covered, from the associations

of adjacent provinces" is purposely loose perhaps. He adds that, "In general biotic provinces are characterized also by peculiarities of vegetation type, ecological climax, flora, fauna, climate, physiography, and soil," but even though all these criteria were used we would still fail in any attempt to delimit provinces in Sonora.

On the basis of this definition, it would seem to be dubious procedure to attempt to bound such ill-defined areas as biotic provinces on a very meaningful basis. Dice's rejection of the term "biotic region" proposed by Vestal can scarcely be considered valid for the reason given by Dice, namely, that the term region "is often applied to a loosely defined geographic area." Because we consider a biotic area to be no more and no less than a loosely defined area, we prefer to retain the term "biotic region."

Just as the boundaries of the less inclusive "biotic provinces" or biotic regions are nearly impossible of delimitation on anything but an arbitrary basis, so also are the boundaries of the major divisions. These were designated "realms" by Heilprin and by Lydekker in the latter part of the last century, but more often they are termed "regions" by recent workers. As mapped by Bartholomew, Clarke, and Grimshaw (1911), according to the ideas set forth by A. Russel Wallace, the Mexican sub-region of the Neotropical region was extended northward along the coastal plain and barranca regions of the west coast of Mexico approximately as far as the northern boundary of Sinaloa. H. M. Smith (1939, p. 15, and 1940), on the basis of the distributions of the lizards of the genus *Sceloporus*, maps the most northern limit of the Neotropical region in northern Nayarit on the west coast of Mexico. Those who desire to map such regions should note that nearly two-thirds of the species herein reported from Alamos and Guirocoba in southern Sonora are species with major portions of their range to the south, or they are forms with their closest affinities with species in more tropical portions of Mexico to the south. Thus, the evidence favors the inclusion of the Río Fuerte drainage basin (and probably some of the barrancas to the north) in the Neotropical region.

Simpson (1943a), whom we quote in our

discussion of past distributions, prefers to use the term "zones" instead of regions and prefers not to attempt to bound them by lines on the map because they not only interdigitate (and not in precisely the same manner for all groups of animals), but because the zones may expand or contract or shift to the

north or south. The neontologist is perhaps not so deeply concerned with these shifts in zones as the palaeontologist, but it is well to bear the notion in mind that none of these provinces or regions so simply and arbitrarily mapped has any real permanence.

ANNOTATED LIST OF THE AMPHIBIANS AND REPTILES SECURED IN SOUTHERN SONORA

IN THE FOLLOWING ACCOUNT we have attempted to list, with suitable annotations, the species and subspecies in collections assembled by John W. Hilton at Guirocoba in 1941, and those made at Alamos (one specimen was taken at Navojoa) by C. M. Bogert, assisted by Charles Lowe and William Riemer, in 1942.

In general, synonymies have been abbreviated to include only the citation for the original description, followed by the type locality, unless other papers dealing with the same species or subspecies are referred to in the text. References to papers not included in synonymies are cited by year, or by year and page when necessary. Complete citations of such works will be found in the bibliography.

The following abbreviations have been used to refer to catalogued collections:

A.M.N.H., American Museum of Natural History
C.A.S., California Academy of Science

L.M.K., L. M. Klauber

M.V.Z., Museum of Vertebrate Zoology, University of California

R.T.M., Robert T. Moore

U.M.M.Z., University of Michigan, Museum of Zoology

AMPHIBIA

PELOBATIDAE

Scaphiopus couchii Baird

Scaphiopus couchii BAIRD, 1854, Proc. Acad. Nat. Sci. Philadelphia, vol. 7, p. 62; Coahuila and Tamaulipas, Mexico.

Alamos, 7 (A.M.N.H. Nos. 51349-51355).

Three adult males, snout-vent lengths 59-63 mm., and four females, snout-vent lengths 50-56 mm., were collected during the breeding season. Two of the females contain mature eggs in the oviducts, while the other two apparently had deposited their eggs prior to capture. The males have dark horny pads on the first, second, and part of the third fingers. The males have more extensive webs on the feet than do the females.

Several of the specimens were infested with larval mites embedded in the skin on the venter. Some of these were sent to Dr. H. E.

Ewing, of the United States National Museum, who kindly identified them as the larva of *Hannemania hylae* Ewing.

BUFONIDAE

Bufo alvarius Girard

Bufo alvarius GIRARD, in Baird, 1859, U. S. and Mexico boundary survey, vol. 2, pt. 2, p. 26, pl. 41, figs. 1-6; valley of the Gila and Colorado rivers.

Alamos, 9 (A.M.N.H. Nos. 51386-51394).

Guirocoba, 8 (A.M.N.H. Nos. 51204, 51206, 51218-51223).

The 17 specimens, of which 16 are females, range in size from 39-178 mm. in snout-vent length. In the Guirocoba series the two smallest specimens, 39 and 52 mm. in snout-vent length, respectively, differ from the six larger individuals in coloration and in the absence of the prominent leg glands characteristic of the adults. The dorsal coloration of these two specimens is dark gray with numerous small white spots; the white spots usually are bordered by black. The ventral color is white to grayish white with irregular black markings on the chest.

The adults are uniformly olive drab in dorsal coloration, lacking the white spots observed in the two juveniles. The glands on the hind legs are prominent in all adult specimens; the foreleg glands are prominent in the Alamos specimens, but they are lacking or only scarcely discernible in the Guirocoba series. This may be a result of the manner of preservation.

Two of the females collected at Alamos between August 27 and September 2 contain mature eggs in the oviducts.

One of the juvenile specimens from Guirocoba was collected at an elevation of 4000 feet.

These specimens extend the known range of this species a considerable distance to the south and indicate that the range of *alvarius* overlaps the range of *Bufo marinus*. Both species were secured at Alamos in similar habitats.

The stomach contents of the six adults from Guirocoba were examined, and the in-

sects contained in the material were kindly identified for us by Dr. Mont A. Cazier of the American Museum. The specimens contained the following items:

over to Dr. Raymond B. Cowles of the University of California at Los Angeles. Dr. Cowles utilized these and specimens of *B. alvarius* from the same locality to perform some

A.M.N.H. No. 51218

<i>Calosoma</i> sp.	Family Carabidae	Order Coleoptera
<i>Ligyris gibbosus</i>	" Scarabaeidae	" "
<i>Pinotus amplipollis</i>	" "	" "
<i>Pinotus colonicus</i>	" "	" "
<i>Acanthocephala femorata</i>	" Coreidae	" Hemiptera
One small centipede		

A.M.N.H. No. 51219

<i>Pasimachus</i> sp.	" Carabidae	" Coleoptera
<i>Temnochila aerea</i>	" Ostomidae	" "
Larvae	" Noctuidae	" Lepidoptera

A.M.N.H. No. 51220

<i>Philerus illatus</i>	" Scarabaeidae	" Coleoptera
<i>Pinotus colonicus</i>	" "	" "
Larvae	" Noctuidae	" Lepidoptera

A.M.N.H. No. 51221

<i>Epicauta</i> sp.	" Meloidae	" Coleoptera
<i>Cyclocephala</i> sp.	" Scarabaeidae	" "
Adult ant	" Formicidae	" Hymenoptera

A.M.N.H. No. 51222

<i>Calosoma</i> sp.	" Carabidae	" Coleoptera
Larvae	" Chrysomelidae	" "
<i>Cyclocephala</i> sp.	" Scarabaeidae	" "
<i>Ligyris gibbosus</i>	" "	" "
<i>Trox suberosus</i>	" "	" "
Adult moths	" Noctuidae	" Lepidoptera

A.M.N.H. No. 51223

<i>Canthon chevrolati</i>	" Scarabaeidae	" Coleoptera
<i>Cyclocephala</i> sp.	" "	" "
<i>Ligyris gibbosus</i>	" "	" "
<i>Onthophagus landolti</i>	" "	" "
<i>Blapsstenus longulus</i>	" Tenebrionidae	" "
Adult ants	" Formicidae	" Hymenoptera

***Bufo marinus* (Linnaeus)**

Rana marina LINNAEUS, 1758, Systema naturae, ed. 10, vol. 1, p. 211; America. Alamos, 3 (A.M.N.H. Nos. 51383-51385).

The three specimens, two females and one male, are very badly emaciated. They measure 89-111 mm. in snout-vent length. This toad does not appear to be common in Sonora, and the Alamos specimens represent the second known record for this species in the state. Several additional specimens were brought back alive from Alamos and turned

preliminary experiments with the poisons secreted by the parotoid glands.

In the latter part of November, 1939, the senior author secured several specimens of *Bufo marinus* under boulders along the river at Culiacán in Sinaloa. This was during the dry season and apparently the toads were hibernating. While these specimens were being collected a native boy watched with interest as the toads were placed in the sack and finally commented, "echan leche" (they throw milk), in reference to the whitish venom secreted by the parotoid glands. This

secretion is readily ejected a distance of a foot or so if the glands are squeezed. However, the toad has not been observed to expel the poison such a distance voluntarily.

It has been noted on several occasions that *B. marinus*, when killed by being placed in formalin or alcohol, commonly secretes quantities of viscous, whitish liquid from the parotoid glands. A similar phenomenon has not been observed in other species so far as we can determine.

It seems probable that some races of *B. marinus* may be recognized, although it is reasonably certain that the same species inhabits a vast range from Sonora and Texas on the north, southward on either side of the Mexican plateau, through Central America to southern Peru and Argentina. Extremely large specimens are known from northern South America, far larger than any that have been reported from Mexico. Size, unfortunately, is not a dependable criterion upon which to base satisfactory conclusions. Individuals from Tehuantepec are notably paler in coloration than specimens from the humid eastern slope of the continental divide in southern Veracruz, but those taken as far north as Acaponeta, in Nayarit, are equally pale, while individuals secured north of Nayarit on the Pacific slope are moderately dark in coloration.

Bufo punctatus Baird and Girard

Bufo punctatus BAIRD AND GIRARD, 1852, Proc. Acad. Nat. Sci. Philadelphia, vol. 6, p. 173; Río San Pedro tributary of the Río Grande del Norte, Texas.

Alamos, 1 (A.M.N.H. No. 51366).

Guircoba, 3 (A.M.N.H. Nos. 51205, 51207a, 51207b).

The Alamos specimen is an adult female with snout-vent measurement of 52 mm. Of the three Guircoba specimens, two (A.M.N.H. No. 51207) are newly transformed young and are too small to allocate with confidence, but they agree more closely with this form than any other. The third specimen, although in poor condition, is readily referred to this species. The specimen measures approximately 30 mm. in snout-vent length.

Hilton collected A.M.N.H. No. 51205 along with a juvenile *Bufo alvarius* at an altitude of 4000 feet. He notes further that these

two specimens were found "high in the hills far from water. The natives didn't have a name for them and said that they were scarce." At Alamos this toad was known as "sapo pinto," although the name was applied by some natives to *B. mazatlanensis*, particularly when a reward was offered for collecting additional specimens of *punctatus*.

Bufo mazatlanensis Taylor

Bufo mazatlanensis TAYLOR, 1940, Univ. Kansas Sci. Bull., vol. 26, p. 492, pl. 53, fig. 1, pl. 54; Mazatlán, Sinaloa.

Alamos, 30 (A.M.N.H. Nos. 51368-51382, and 15 untagged).

Guircoba, 11 (A.M.N.H. Nos. 51208-51217, 51321).

Navojoa, 1 (A.M.N.H. No. 51367).

This species is the common toad of both Alamos and Guircoba. Five of the specimens are juveniles with snout-vent measurements of 21 to 43 mm. The remaining specimens are adults and are distributed in size as shown below. Four of the females collected at Alamos contain mature eggs in the oviducts.

SIZE DISTRIBUTION OF ADULTS

(Snout-vent length in mm.)

61-65 66-70 71-75 76-80 81-85 86-91

Males	1	3	14	2	0	0
Females	1	2	2	4	6	2

These specimens agree well with Taylor's description (*supra cit.*) which was based on specimens from Mazatlán, Sinaloa, the only locality hitherto recorded for the species. The juveniles differ from the adults in being profusely marked with irregular black spots on the belly, chest, and throat. When describing this species, Taylor had only female specimens at hand and consequently could not note the position of the vocal sac openings in the males. In the adult males from Sonora there are two openings, one on either side of the mouth, in four specimens; a single opening which is sinistral in position in eight specimens; and a single opening which is dextral in position in six specimens. The conditions observed here are similar to those reported (Taylor, *loc. cit.*) for *Bufo gemmifer* to which *mazatlanensis* is reportedly related.

One adult, A.M.N.H. No. 51321, was removed from the stomach of a *Drymarchon*

c. rubidus, and a juvenile specimen was found in the stomach of *Hypsiglena t. ochrorhyncha*.

LEPTODACTYLIDAE

Leptodactylus melanonotus (Hallowell)

Cystignathus melanonotus HALLOWELL, 1860, Proc. Acad. Nat. Sci. Philadelphia, vol. 12, p. 485; Nicaragua.

Leptodactylus occidentalis TAYLOR, 1936, Trans. Kansas Acad. Sci., vol. 39, p. 349, fig. 1, pl. 1; Tepic, Nayarit, Mexico.

Alamos, 15 (A.M.N.H. Nos. 51356-51365, and 5 untagged).

Guircoba, 13 (A.M.N.H. Nos. 51248-51260).

We have compared 16 adult males from Alamos and Guircoba with 10 randomly selected males of comparable size from Nicaragua. In addition to minor differences in coloration and the nature of the vomerine teeth, there are differences in proportional measurements as indicated below. It will also be noted that the Alamos and Guircoba males differ in certain proportional measurements. Sufficient specimens have not been measured to test the significance of these differences statistically.

cies melanonotus is composed of an assemblage of geographic races which as yet have not been analyzed and delimited. Until all the components are properly evaluated, their variation and relationships understood, it seems ill advised to recognize nomenclatorially populations from any restricted geographical area of the species range. Such procedure may contribute only to the synonymy of the species.

A number of names have been proposed for specimens obtained from Mexico. When the species has been thoroughly analyzed certain of these will be applicable to some of the subspecies occurring in Mexico. Among these names are: *fragilis* Brocchi (1877, p. 182; type locality, Tehuantepec); *microlis* Cope (1879, p. 265; type locality, Guanajuato); *perlaevis* Cope (1879, p. 269; type locality, Japan); and *occidentalis* Taylor (1936b, p. 349; type locality, Tepic).

Concerning *L. occidentalis*, Taylor (1936b, p. 352) states, "The narrow head, the small maximum size (38 mm. for females, 33 mm. for males), the character of the postaxillary and postfemoral glands [*italics ours*], the narrower

TABLE OF COMPARISON OF MALES

	(Means in parentheses)		
Ratios	Nicaragua—9	Alamos—6	Guircoba—10
Tympanum/head length	.20-.24 (.22)	.16-.18 (.16)	.15-.21 (.17)
Eye/head length	.29-.39 (.35)	.28-.34 (.30)	.29-.34 (.31)
Head width/snout-vent length	.31-.35 (.33)	.30-.33 (.31)	.29-.32 (.30)
Tibia/snout-vent length	.43-.47 (.45)	.45-.48 (.46)	.40-.44 (.42)
Foot/snout-vent length	.70-.78 (.72)	.72-.75 (.73)	.63-.73 (.68)

Besides the proportional differences seen in the Alamos and Guircoba males, there are marked differences in coloration emphasized by the presence in the Alamos population (both males and females) of dark horny (glandular?) areas on the lateral pectoral and postfemoral surfaces. All the 15 Alamos specimens can be separated from all the 13 Guircoba specimens by the presence in the former of these horny areas.

On the basis of the three samples considered above, it might appear that there are three forms which are worthy of nomenclatorial recognition. However, examination of additional material from other localities strongly indicates that the wide-ranging spe-

groups of vomerine teeth, clearly distinguish this western Mexican form from the more robust, larger *melanonotus* to the south." The variation in the character of the postaxillary and postfemoral horny (or glandular) areas is not clearly understood. Taylor (*loc. cit.*) suggests that they may appear only during the breeding season. As mentioned above, the Alamos and Guircoba specimens can be separated by the presence of these in the former and their absence in the latter. Yet in both series there are specimens with mature or ripe eggs. It might be suggested that their absence in the Guircoba specimens may be due to a difference in the method of preservation. Close examination of the specimens indi-

cates that this is not true. Also there are series, preserved under the same conditions, in the collections of the American Museum in which some specimens have the horny areas and others do not. That there is some connection between the presence of the horny areas and sexual maturity is suggested by the fact that these have not been observed in any specimen smaller than 25 mm. in snout-vent length. Yet many sexually mature individuals of both sexes, in and out of breeding season, have been examined and such areas have not been noted. The development of these areas is not so restricted geographically as the reported range (Nayarit and Sinaloa) of Taylor's *occidentalis*. Specimens with the horny areas developed to varying degrees have been seen by us from the Mexican states of Sonora, Sinaloa, Nayarit, Jalisco, Colima, and from Panama. Furthermore, on the basis of the specimens we have examined, there would seem to be no specific or subspecific restriction of the horny areas. Possibly the horny areas may be the result of a particular environmental factor which is present sporadically from northern Mexico to Panama.

Snout to vent dimensions of specimens from Alamos and Guirocoba are as follows (the numbers in brackets indicate the number of specimens in each category; means are in parentheses):

	MALES	FEMALES
Alamos	[6] 33.7-36.8 (35.46)	[9] 36.6-42.3 (39.18)
Guirocoba	[10] 34.5-37.8 (36.15)	[3] 38.1-39.0 (38.72)

HYLIDAE

Agalychnis dacnicolor (Cope)

Plate 31, figure 1

Phyllomedusa dacnicolor COPE, 1864, Proc. Acad. Nat. Sci. Philadelphia, vol. 16, p. 181; Colima, Colima, Mexico.

Alamos, 5 (A.M.N.H. Nos. 51395-51399).

Guirocoba, 5 (A.M.N.H. Nos. 51239-51243).

Four adult males measure 67, 73.7, 74.3, and 83 mm. in snout-vent length. Six females measure 81.9, 83.4, 92, 93.1, 99, and 100 mm. in snout-vent length. These females exceed in size the maximum, 83 mm., recorded by Kellogg (1932, p. 143) for this species, who reports specimens from Sinaloa. The species

has not previously been recorded from Sonora.

The stomach contents of the largest female were examined and found to consist of four large beans, one scorpion, one spider, and the hard parts of several undetermined insects. At Alamos these frogs were known as "rana verde."

Hyla baudinii Duméril and Bibron

Hyla baudinii DUMÉRIL AND BIBRON, 1841, *Erpétologie général*, vol. 8, pp. 564; Mexico.

Guirocoba, 25 (A.M.N.H. Nos. 51225-51237, 51238 [12 transforming young]).

The largest adult male has a snout-vent length of 66 mm.; the largest adult female, 76 mm. The transforming young are somewhat distorted in shape and difficult to measure. The range in snout-vent length of these specimens is approximately 16 to 18 mm.

This species has been known from Sinaloa for many years, but the present record represents the first for Sonora.

MICROHYLIDAE

Microhyla olivacea (Hallowell)

Engystoma olivaceum HALLOWELL, 1856, Proc. Acad. Nat. Sci. Philadelphia, vol. 8, p. 252; no type locality given, probably Kansas.

Microhyla texensis PARKER, 1934, A monograph of the frogs of the family Microhylidae, p. 148

(corrected to *Microhyla olivacea* in the corrigenda, p. 200).

Guirocoba, 4 (A.M.N.H. Nos. 51244-51247).

Three males and one mature female, with well-developed eggs in the oviducts, were collected by Hilton. The largest male measures 28.7 mm. in snout-vent length; the female measures 29.6 mm.

Both Allen (1933, p. 3) and Taylor (1938b, p. 516; 1940b, p. 531) have suggested the possibility that Sonoran and Sinaloan specimens represent an unrecognized form. Sufficient material is not at hand to verify this.

Hilton says in his field notes, "This is one of the noisiest amphibians in the arroyos but difficult to locate. They sit under dead leaves

and twigs along the bank and make a shrill call that sounds more like that of a bird. This frog is called 'rana pajarito' and is not easy to capture."

RANIDAE

Rana pustulosa Boulenger

Rana pustulosa BOULENGER, 1883, Ann. Mag. Nat. Hist., ser. 5, vol. 11, p. 343; Ventanas, Durango, Mexico.

Guircoba, 1 (A.M.N.H. No. 51224).

A single female distended with mature eggs was collected by Hilton. This specimen has a snout-vent length of 74 mm. It has been compared with a specimen from Colima in the Museum of Zoology, University of Michigan collection (U.M.M.Z. No. 79990). These specimens agree closely except in coloration and pustulosity. The Sonoran specimen is somewhat lighter on the sides and the anterior and posterior surface of the thighs, and has more numerous and more distinct pustules. In these two characters it is in closer agreement with the type of the species than is the Colima specimen.

The known range of this species includes Guircoba, Sonora; Ventanas, Durango (type locality); Queseria, Colima (Oliver, 1937, p. 7); and two localities in the state of Morelos (Taylor, 1942a, p. 44).

REPTILIA

GEKKONIDAE

Phyllodactylus tuberculosus homolepidurus Smith

Phyllodactylus homolepidurus SMITH, 1935, Univ. Kansas Sci. Bull., vol. 22, p. 121; 5 miles southwest of Hermosillo, Sonora.

Guircoba, 8 (A.M.N.H. Nos. 63643-63650).

The lizards of this genus exhibit considerable variation and are characterized by marked local differentiation. In recent years at least nine species have been described from western Mexico. Certain of these proposed species are allopatric, and their characters strongly suggest that a more accurate indication of the biological conditions that exist may be obtained by considering them as subspecies, or as races of a single species.

The earliest name applied to the section of the genus involved here is *tuberculosus* of Wiegmann. This name enjoyed wide and long

usage to designate specimens from a variety of localities in the Americas, including the west coast of Mexico, Baja California, and southern California. In 1935a, Smith (pp. 120-121) mustered certain data which served to satisfy him that this name was not applicable to any form from North or Central America. Part of Smith's argument is based on information supplied by Stejneger on the itinerary of the collector of the type of *tuberculosus*. Mosauer (1936, pp. 144-146) in a discussion accompanying his description of a new species from Mexico presents a rebuttal to Smith's argument against the use of *tuberculosus* for any North American form. Stejneger, though furnishing some of the information utilized by Smith, does not follow Smith's proposed restriction of the name *tuberculosus* (vide Stejneger and Barbour, 1943, p. 64).

Taylor (1942b) mentions the uncertainties surrounding the name *tuberculosus* as applied to North American specimens, citing the earlier remarks of Smith and of Mosauer. He concludes that "Mosauer's opinion should be given no more credence than those expressed by Smith, since he saw no unquestionably *P. tuberculosus*. Until the type of the Wiegmann species is rediscovered and studied by a competent person, there will be doubt as to which form must bear the name *tuberculosus*. Even then the matter may not be settled, since the type has a regenerated tail and the characters of the original tail are pertinent in defining the species of the genus."

Without having any evidence to contribute toward a settlement of this question, it seems to us that the wisest procedure is to restrict the use of the name to the form occurring in the region of the apparent type locality as given by the original describer of the species and to which the original description is applicable. In changing a name of such long standing it seems much wiser to place the burden of proof on those advocating such a change rather than on those questioning the validity of the proposed change. When the proof is established, then, and then only, is action justified. No progress toward a stable nomenclature can be obtained by substituting one uncertainty for another.

Our specimens range in size (snout-to-vent

length) from 37–69 mm. The characters considered to be of taxonomic significance (Smith, 1935a; Taylor, 1940b, 1942b) in this difficult genus indicate that these specimens present a condition somewhat intermediate between *homolepidurus* and *lanei* of Smith. The specimens agree with *lanei* as follows: they possess two, or rarely three, pairs of enlarged scales per tail segment, at least on basal segments; enlarged scales on the orbital border are present, and there are six or more prominent enlarged scales on the posterodorsal surface of the thigh. Affinity with *homolepidurus* is shown by the lighter coloration and by the large number of scales between the orbits (counted between the middle of the orbit rather than at the narrowest point). In this character, however, the Guirocoba specimens have an even higher number (30–40) than Taylor (1940b, p. 543) records for *homolepidurus* (19–24). There is a possibility that a difference in method of making the counts may be partially responsible for the magnitude of the differences in the results obtained. Our counts were made from, but did not include, the enlarged scales on the orbital border and not from the rim of the supra-orbital fold. Even counting only the scales between the supraorbital rims gives a higher count than that recorded by Taylor. The chin shields are in contact with a single labial on both sides in four specimens; with two labials on both sides in two specimens; and with one on one side and two on the opposite side in two specimens.

IGUANIDAE

Anolis nebuloides Bocourt

Anolis nebuloides BOCOURT, 1873, Études sur les reptiles. Mission scientifique au Mexique et dans l'Amérique Centrale, pt. 3, sect. 1, no. 2, pl. 13, fig. 10; Mexico.

Guirocoba, 1 (A.M.N.H. No. 63658).

A single male specimen is provisionally referred to *nebuloides*. This specimen has somewhat flat, pavement-like ventrals, and weakly keeled dorsal scales which might serve to distinguish this form as a representative of a northern race of this species. However, the specimen is in a poor state of preservation, and it is difficult to assign it with certainty. An additional specimen from Guirocoba (L.M.K. No. 28395) differs in some details

but probably represents the same form. Neither specimen is referable to *utowanae* Barbour which possesses a different arrangement of head scales.

REMARKS: Representatives of the genus *Anolis* previously have not been reported from Sonora. Cope (1879) recorded *Anolis nebulosus* from Batopilas in the adjacent portion of the state of Chihuahua, and it seems probable that the populations occurring in Batopilas and in Guirocoba belong to the same species. As nearly as we can judge, our specimens are closer to *nebuloides*. Because several Mexican forms of *Anolis* lack adequate descriptions and type localities in many instances are no more precise than "Mexico," it is doubtful whether some of the species are valid. So far no satisfactory study of the variation within any species has been attempted, and possibly much more material will have to be assembled before thorough studies can be undertaken. It is obvious that more than one species occurs at many localities, suggesting that two or more infrageneric groups may be recognized.

Ctenosaura hemilopha (Cope)

Cyclura (*Ctenosaura*) *hemilopha* COPE, 1863, Proc. Acad. Nat. Sci. Philadelphia, vol. 15, pp. 105–106; "Cape St. Lucas," Baja California.

Alamos, 11 (A.M.N.H. Nos. 64169–64179).

Guirocoba, 7 (A.M.N.H. Nos. 63651–63657).

The specimens at hand, including young and adult individuals, agree well with examples from more northern localities, and we cannot detect any differences when comparisons are made with specimens from Baja California. The young are uniform green on the body with dark bands on the tail. The adults are much darker with little or no green on the body, and with dark cross bands on the back.

At Alamos these large lizards were abundant. They inhabited sandstone outcrops along the arroyo inside the town but took to crevices in the rocks upon the approach of a person. Outside of Alamos they were more commonly seen in the ubiquitous rock walls, although they were seen as well on fence posts. Always they were within a few feet of some sort of refuge. Individuals seen on posts invariably had selected those with central cavities large enough to permit concealment of the entire body and tail.

***Uta ornata lateralis* Boulenger**

Uta (Phymatolepis) lateralis BOULENGER, 1883, Ann. Mag. Nat. Hist., ser. 5, vol. 11, p. 342; Presidio, near Mazatlán, Sinaloa.

Urosaurus ornatus schottii MITTLEMAN (*partim*), 1942, Bull. Mus. Comp. Zool., vol. 91, p. 149.

Alamos, 2 (A.M.N.H. Nos. 64207-64208).

Guircoba, 1 (A.M.N.H. No. 64031).

These specimens and the status of this race already have been commented on by Oliver (1943). Lizards of this species were relatively common at Alamos, but they proved to be extremely difficult to capture. They were most often seen on fence posts, from which they commonly jumped to the ground and sought concealment in the dense vegetation when attempts were made to capture them.

***Uta bicarinata tuberculata* Schmidt**

Uta tuberculata SCHMIDT, 1921, Amer. Mus. Novitates, no. 22, p. 4; Colima, Colima, Mexico.

Urosaurus bicarinatus tuberculatus MITTLEMAN, 1942, Bull. Mus. Comp. Zool., vol. 91, p. 169, pl. 12 (bottom).

Guircoba, 3 (A.M.N.H. Nos. 63662-63664).

Mittleman (1941, p. 73) has recently reported this form from near "Guircoba" (=Guircoba), Sonora, extending the range northward into this state. Our specimens confirm the presence of this species in Sonora and demonstrate an actual overlap in the ranges of *ornata* and *bicarinata*. It is not known whether or not the two species have different habitat preferences at Guircoba.

***Holbrookia elegans thermophila* Barbour**

Holbrookia thermophila BARBOUR, 1921, Proc. New England Zool. Club, vol. 7, p. 79; Guáymas, Sonora.

Holbrookia elegans thermophila SMITH, 1935, Univ. Kansas Sci. Bull., vol. 22, p. 194, pl. 27, fig. 1, pl. 28, fig. 4.

Alamos, 1 (A.M.N.H. No. 64199).

Guircoba, 24 (A.M.N.H. Nos. 63674 [15 specimens], 63675-63683).

The specimens collected include 10 adults and 15 newly hatched young. These specimens are from a region geographically intermediate between the known range of *thermophila* and *elegans*, but in the characters listed by Smith (*supra cit.*) as being of taxonomic importance (differences in relative tail length, femoral pore size, and in coloration) in separating the two races, the adults are referable

to *thermophila*. All adults with complete tails have the tail longer than the body. In the newly hatched young, six have tails that are shorter than the body, one has a tail that is longer than the body, and two have the tail equal to the body length. The variation seen in the young in this character may be attributed to an ontogenetic difference in proportional growth rate between the body and the tail, to the presence of intergrading populations in southern Sonora, or simply to a greater variability in the young than exists among adults. In the femoral pore character, all adults exhibit the condition reported by Smith for *thermophila*.

The newly hatched young vary from 17 to 25 mm. in snout-vent length. There is no indication in Hilton's field notes that these represent a single batch of eggs. Eight of the young are males and seven are females. There seems to be no sexual difference in size.

The single female from Alamos differs from the Guircoba specimen in having a much shorter head. This can best be expressed by a comparison of the head width to head length ratios of the adults. The five Guircoba males have ratios of 0.88-0.98, mean 0.92; the four Guircoba females have ratios of 0.80-0.95, mean 0.87. For the Alamos female this ratio is 1.02. This specimen also has fewer femoral pores than any of the other adults: 9 to 8 as compared with extremes of 10 to 16 in the Guircoba series.

Callisaurus draconoides brevipes

Bogert and Dorson

Callisaurus draconoides brevipes BOGERT AND DORSON, 1942, Copeia, p. 173; Guircoba, Sonora, Mexico.

Alamos, 7 (A.M.N.H. Nos. 64200-64206).

Guircoba, 9 (A.M.N.H. Nos. 63665-63673).

The Guircoba series (type and paratypes) has been previously reported by Bogert and Dorson (*supra cit.*). The Alamos specimens agree closely with the type series in all pertinent details (averages in parentheses):

Femoral pores	11-15 (12.35)
Lamellae, fourth toe	30-33 (31.64)
Ratio, ¹ hind leg length to snout-vent length82-.88 (.84)
Ventral scales, gular fold to anus	77-86 (80.28)

¹ These ratios for toe and hind leg were inadvertently transposed in the original description.

Color notes recorded in the field from a large male from Alamos are: "Dorsum with reticulated dark pattern on yellowish ground color; on the sides the ground color is pink. Underside of throat dark ochraceous on throat fan. Mid-ventral region yellowish-white with an ochre-colored triangular blotch posterior to each axilla, followed by an emerald green blotch with faint traces of diagonal black bands."

The females when freshly preserved had three bright, reddish orange ventral spots, one in the central gular region and one on each side in the lateral pectoral region just posterior to the axillae. Otherwise the coloration is as described by Bogert and Dorson.

Since the description of this species was prepared, del Campo (1941, p. 761) has reported lizards of this genus from Mazatlán (Isla de los Chivos), Sinaloa, provisionally referring them to *inusitatus*.¹ This locality extends the distribution of the genus considerably to the south of the previously known southern limit. Señor del Campo kindly forwarded two specimens for comparison with the type series of *brevipes*. The Mazatlán specimens differ sufficiently from *brevipes* in coloration and in at least one morphological character to warrant nomenclatorial recognition. There are fewer lamellae on the fourth toe in this insular population, and the Mazatlán specimens fit into a geographical gradient which involves a decrease in number from north to south.

At Alamos *brevipes* was observed only in the arroyo where it shared the habitat with *Holbrookia*. Neither lizard was uncommon, and they were often seen in the open sandy areas adjacent to the stream. When disturbed they invariably sought shelter in the dense shrubbery bordering the arroyo.

Phrynosoma solare Gray

Phrynosoma solaris GRAY, 1845, Catalogue of . . . lizards in the . . . British Museum, p. 229; "California."

Alamos, 8 (A.M.N.H. Nos. 64180-64187).

Guiracoba, 2 (A.M.N.H. Nos. 63684-63685).

Of two males and eight females of this very distinct horned lizard, the largest male has a

¹ A name has now been applied to this insular population by del Campo (1943, An. Inst. Biol., Mexico, vol. 14, p. 619).

snout-vent length of 73 mm., the largest female has a snout-vent length of 97 mm. There is a marked sexual difference in the length of the tail in these specimens. The tail to snout-vent ratio in the females is 0.34-0.39, mean 0.36, while in the single male with a complete tail it is 0.56. The other male has an incomplete tail with a tail to snout-vent ratio of 0.45+.

Three of the females with snout-vent dimensions of 80.5 to 97 mm. contain eggs varying in number from seven to 21.

Sceloporus nelsoni Cochran

Sceloporus nelsoni COCHRAN, 1923, Jour. Washington Acad. Sci., vol. 13, p. 185; "Plumosas" (= Plumosas), Sinaloa.

Alamos, 1 (A.M.N.H. No. 64198).

Guiracoba, 3 (A.M.N.H. Nos. 63659-63661).

One adult male, two adult females, and one immature individual represent this species. The females both measure 52 mm. in snout-vent length, and have 16-16 and 17-17 femoral pores. The adult male measures 58 mm. in snout-vent length and has 15-16 femoral pores.

This species of *Sceloporus* was not observed in the same habitat as *S. clarkii* at Alamos. The single specimen secured at this locality was taken a few hundred yards above the village on the side of Sierra de Alamos in a rocky habitat.

Sceloporus clarkii Boulengeri

Stejneger

Sceloporus boulengeri STEJNEGER, 1893, North Amer. Fauna, vol. 7, p. 180, fig. 5a-c, 1 pl.; Presidio, about 50 miles from Mazatlán, Sinaloa.

Sceloporus clarkii *boulengeri* SMITH, 1939, Publ. Field Mus. Nat. Hist., zool. ser., vol. 26, p. 128, pl. 15.

Alamos, 29 (A.M.N.H. Nos. 64188-64197, and 19 untagged).

Smith (*ibid.*, p. 132) presents in tabular form the respective frequencies of three "scale characters" in the two races of *clarkii*. Examination of this table reveals that only one of these characters, the number of the femoral pores, is worthy of mention as an aid in differentiating these two subspecies. Another character utilized by Smith, namely, the relative size of the outer femoral pores, is of value in segregating the females of the two forms. On the basis of the characters of taxo-

nomic value the Alamos specimens appear to represent intergrades between *clarkii clarkii* and *clarkii boulengeri*, although perhaps closer to the latter. Of the 29 specimens, 58 per cent have 10 or fewer femoral pores, while 42 per cent have more than 10 pores. In some females the distal femoral pores are markedly smaller in size (characteristic of *boulengeri*), while in others there is little or no decrease in size, as in *clarkii*. Our assignment of the Alamos specimens to *boulengeri* is, therefore, somewhat arbitrary.

The specimens of this species in the R. T. Moore collection (see below, p. 402) from Ahome, Sinaloa, represent a population which agrees more closely with *boulengeri*, though some of the characters of *S. c. clarkii* are still present.

These lizards were abundant at Alamos where they inhabited the trees, particularly those bordering the arroyo.

TEIIDAE

Cnemidophorus sackii sackii Wiegmann

Cnemidophorus sackii WIEGMANN, 1834, Herpetologia Mexicana, p. 28; "Mexico."

Cnemidophorus sexlineatus gularis BURT, 1931, Bull. U. S. Natl. Mus., no. 154, p. 97.

Cnemidophorus sexlineatus sackii BURT, 1931, Proc. Biol. Soc. Washington, vol. 44, p. 73.

Alamos, 17 (A.M.N.H. Nos. 64209-64218, and 7 specimens without tags).

Guircocoba, 12 (A.M.N.H. Nos. 63686-63697).

These specimens have been compared with related forms from Arizona, Texas, and Mexico. In pattern characters they differ from Arizona specimens but they are similar to specimens secured in Texas, as well as to those from Sinaloa, Nayarit, and other Mexican localities. In *perplexus* from Arizona the light, paravertebral stripes are close together and nearly parallel from the occiput to the base of the tail. Our specimens from Alamos and Guircocoba, as well as those from Texas and localities in Mexico, possess relatively narrow paravertebral stripes that diverge from the mid-dorsal line on the posterior portion of the body. The distance between these stripes on the neck is roughly two-fifths of the distance that separates them above the insertion of the hind legs.

Burt (1931a) originally referred popula-

tions from most of Mexico to *C. sexlineatus gularis*, but after the publication of his monograph he published a short note in which he concluded that the name *sackii* of Wiegmann was applicable. Owing to the indefinite type locality, it remains to be determined whether or not the type is actually representative of all the populations that Burt includes within the range of the form. The material at hand provides no evidence from which we might draw conclusions contrary to Burt's, although we do not concur in his proposal to place *sackii* as a race of *sexlineatus*. Burt indicates a wide overlap in the ranges of the two forms in eastern Texas, but there is no evidence whatever that the two forms interbreed. *C. s. sexlineatus* is a much smaller species when sexually mature. Accordingly we are considering *sackii* as distinct from the form that inhabits eastern United States. Although Burt (1931a, fig. 25, map) indicates juxtaposition of the ranges of *perplexus* and *gularis* (= *sackii*) in southern Sonora, no specimens were actually available from the region. Therefore, the present specimens represent the first record of *sackii* from the state, and actual intergrades remain to be discovered if they actually occur. It is possible that two distinct species overlap, but pending further studies which are impossible without additional material we have placed *perplexus* as a race of *sackii*.

These lizards were extremely abundant at Alamos, especially in the vicinity of rock walls along the arroyo. One specimen was removed from the stomach of a patchnosed snake, *Salvadora hexalepis deserticola*.

SCINCIDAE

Eumeces callicephalus Bocourt

Eumeces callicephalus BOCOURT, 1879, Études sur les reptiles. Mission scientifique au Mexique et dans l'Amérique Centrale, pt. 3, sect. 1, no. 6, p. 431, pl. 22D, fig. 2a-c, pl. 22E, fig. 2; Guanajuato, Mexico; TAYLOR, 1936, Univ. Kansas Sci. Bull., vol. 23, p. 290, pl. 23, figs. 44, 45.

Alamos, 1 (A.M.N.H. No. 64219).

A single male specimen, with snout-to-vent length of 61 mm., agrees in all pertinent details with the description of this species given by Taylor (*supra cit.*) who predicted the presence of this species in Sonora. This specimen confirms Taylor's prediction.

HELODERMATIDAE

Heloderma horridum (Wiegmann)

Trachyderma horridum WIEGMANN, 1829, Isis, no. 4, p. 421; Mexico.

Heloderma horridum WIEGMANN, 1829, *ibid.*, no. 4, p. 627.

Alamos, 5 (A.M.N.H. Nos. 64220-64224).

Guiricoba, 6 (A.M.N.H. Nos. 63698-63703).

The specimens range in size from 396 mm. to 762 mm. in total length; the largest specimen is a male. The tail to snout-vent ratios in five males are 0.70 to 0.75; in two females 0.68 to 0.71. The ventral scales, from gular fold to the cloacal opening, vary from 61 to 68; the subcaudals, from 78 to 83. In all pertinent details of scutellation and coloration they agree with specimens from Sinaloa, Colima, Guerrero, and Oaxaca.

These 11 specimens constitute the first record of this species from Sonora and suggest the possibility that the ranges of the two species of the genus may overlap in Sonora. *Heloderma suspectum* is at present known from as far south in Sonora as Guáymas. In 1939 when one of us (Bogert) was waiting to cross the Río Fuerte on the "pango" at the town of Fuerte, he talked with natives who stated that both an "escorpión grande" and an "escorpión pequeño" occurred in the immediate region. Farther south all natives along the coast were acquainted only with the large "escorpión."

Hilton states that at Guiricoba "the natives fear the escorpión, not only for its poison, but as an omen of ill luck. They believe that the only way to break the evil spell caused by encountering one of these lizards is to kill it and hang it up by the tail in front of the house for three days. These reptiles apparently live mostly on the eggs of birds; one specimen collected containing eggs, probably those of the Douglas quail." The stomachs of specimens taken at Alamos were filled with liquid presumed to be a mixture of yolk and albumen. The liquid contained numerous fragments of white shells, probably from the eggs of the local dove.

LEPTOTYPHLOPIDAE

Leptotyphlops humilis dugesii

(Bocourt)

Catodon dugesii BOCOURT, 1881, Bull. Soc. Philom., ser. 7, vol. 6, p. 81; Colima, Mexico.

Leptotyphlops humilis dugesii KLAUBER, 1940, Trans. San Diego Soc. Nat. Hist., vol. 9, p. 129.

Leptotyphlops dugesii TAYLOR, 1940, Univ. Kansas Sci. Bull., vol. 26, p. 538, fig. 5.

Alamos, 1 (A.M.N.H. No. 64225).

This specimen has a mid-dorsal scale count from rostral to tail spine of 257, and 15 subcaudals. There are 14 scale rows on the body, 12 on the tail. The dorsum, including nine scale rows, is dark, and a tinge of pigment is present on the lower row of each side; the remaining rows of scales on the venter lack pigment. The head is likewise dark above and light on the underside, with dark pigmentation following the sutures to the lips.

REMARKS: This specimen is referred to *dugesii* (with the provision noted by Klauber, *supra cit.*, p. 131) on the basis of the pigmentation and the dorsal scale count. Klauber gives 257 as the minimum count for *L. h. humilis* and the maximum for *dugesii*, however, and it is possible that the Alamos specimen represents a population which may prove to be intermediate. The predominance of tropical forms at Alamos, however, leads us to suspect that intergradation with *L. h. humilis* occurs somewhat farther north. An old record exists for *L. humilis* at San Miguel de Horcasitas (or simply Horcasitas on recent maps) near the middle of the state, but this specimen presumably would be referable to *L. h. humilis* were it available and in suitable condition for examination. Klauber (*supra cit.*, p. 94) mentions a specimen from Chihuahua that Cope recorded from Batopilas, and he implies that this is referable to *L. h. dugesii*. The presence of *dugesii* at Alamos tends to confirm this assumption, although *L. h. dugesii* is reported by Klauber from no farther north than southern Sinaloa because he had no Sonoran or Chihuahuan specimens of either race available for examination.

Dr. L. M. Klauber has examined the specimen from Alamos, and he (*in litt.*) comments as follows: "This is the first specimen I have ever seen of which one could be sure of the color, all others having suffered from poor preservation. . . . Assuming that the other mainland snakes are like this, it will serve to segregate this subspecies from *slevini* of the Cape Region of Lower California which has five dorsal rows lightly pigmented, whereas

your specimen has nine which are very dark brown—even darker than most coastal *humilis humilis* [The dorsal count of 257] equals the previous high record for *dugei*, that of the specimen from Mazatlán. As this high count comes within the range of *slevini*, the difference in coloration becomes more important."

Taylor (*supra cit.*), whose paper was apparently in press at the time Klauber's revision appeared, was "not prepared to admit that the relationship [between *humilis* and *dugei*] is subspecific." It is apparent, however, that all characters of pigmentation and scalation overlap, and while Taylor notes that "the head is more truncate than in *humilis* and the median scales following the rostral have straight transverse edges," we are unable to observe these differences in the material at hand. Furthermore, his statement that "the prefrontal is much larger in *dugei*" does not seem to be borne out by our material, if his figure is accurately drawn. Some specimens of *humilis* from Arizona agree in all important details with Taylor's figure, although the size of the prefrontal obviously varies somewhat in *humilis*.

Alamos, it may be noted, is about midway between the localities known for *L. h. dugei* from southern Sinaloa, and the southernmost Arizonan localities for *L. h. humilis* which Klauber indicates on his map. Hence, our specimen offers confirmation for the supposition of Klauber that intergradation between *dugei* and *humilis* occurs in northwestern Mexico, despite a hiatus in the range as far as locality records indicate at present.

The specimen was found in a moist situation under a rock at the edge of the arroyo that flows through the town of Alamos.

BOIDAE

Constrictor constrictor imperator (Daudin)

Boa imperator DAUDIN, 1803, Histoire naturelle des reptiles, vol. 5, p. 150; no type locality.

Constrictor constrictor imperator, STULL, 1935, Proc. Boston Soc. Nat. Hist., vol. 40, p. 404.

Guero-coba, 1 (A.M.N.H. No. 63704).

A female with the dorsal scale formula 61-76-39, ventrals, 231, anal divided, caudals 52. Precise measurements are impossible owing to the poor preservation of the specimen,

but the approximate dimensions are 1515 mm. over all, tail 142 mm.

REMARKS: The Mexican boa constrictor hitherto has been reported from La Posa (Taylor, 1938a), and from Hermosillo (Allen, 1933). A specimen in the American Museum (A.M.N.H. No. 7257) was among the material collected by F. Robinette in "North Sonora." From time to time there have been unverified oral reports of this boa in southern Arizona, but since none was found far from habitations it is not certain whether they were accidental importations that crossed the international border with Mexican produce.

Hilton notes that only one specimen was taken at Guero-coba, although the species was reputedly common "Natives state that a length of nine feet is sometimes attained, such specimens being known to devour whole litters of young pigs. Natives fear and hate this snake. The specimen obtained contained three young rabbits."

COLUBRIDAE

Phyllorhynchus browni fortitus, new subspecies

The relationships of the snakes within the genus *Phyllorhynchus* were inadequately known until the last decade owing to the rarity of these serpents in collections. During recent years, however, Klauber, the foremost student of the group (1935, 1940), has been able to assemble sufficient material to recognize two species, *browni* with two races, and *decurtatus* with three races. Improved collecting techniques in the American deserts have brought abundant material, especially from California, into collections. Nevertheless, only a few specimens are known from Mexico, and Klauber (1940b, p. 195) was able to plot only four localities from Baja California and three from Sonora. All Sonoran specimens he allocated to *P. decurtatus nubilis*, although he notes that these are intermediate between *P. d. nubilis* and *P. d. decurtatus* in numbers of body blotches, while they have fewer ventrals than either form. The other species, *browni*, while probably not rare, is difficult to collect in Arizona and has remained undiscovered south of the international border.

It was with considerable interest, therefore, that the senior author obtained a specimen belonging to the genus *Phyllorhynchus* at

Alamos. Although the species *decurtatus* has been taken as far south as Guáymas, the Alamos specimen is obviously more closely related to *P. b. browni*, and, therefore, we are assigning it to *browni* as a new subspecies. Thus, not only is the range of the genus on the mainland extended to the south, but an extension of some 400 miles in the range of *browni* is indicated.

We are indebted to Dr. L. M. Klauber for his courtesy in examining the Alamos specimen, particularly because he has already seen most of the material in collections. Information supplied by him, together with data obtained from four specimens of *browni* in the American Museum, enables us to recognize several characters, especially those of pattern and coloration, which serve to diagnose the form. Despite the long hiatus created in the range of *browni* by assigning the Alamos specimen to this species, it seems relatively certain that specimens intermediate in character eventually will be discovered in the intervening territory. Much of the region between Alamos and southern Arizona must provide suitable habitats for *P. browni*, and interbreeding populations must be present in the valley of the Río Mayo or of the Río Fuerte. Because the type locality is on the Río Fuerte drainage we are designating the new form as

Phyllorhynchus browni fortitus,
new subspecies

Plate 32, figure 1; text figure 1

DIAGNOSIS: A subspecies of *Phyllorhynchus browni* closely related to the typical form, *P. b. browni*. It differs from *browni* in possessing slate gray (instead of brown) blotches which extend to the first or second scale row, instead of to the third or fourth row. Furthermore, the blotches are relatively longer, closer together, and more regularly indented on the sides than in *browni*, whereas the light central circles in the blotches are more strongly developed. The rostral is exceptionally large, more strongly raised above the surrounding scales on the snout, and blunter at the upper end where it reaches the prefrontals than it is in any other member of the genus.

TYPE: A.M.N.H. No. 64239, a male, probably sub-adult, secured at Alamos, Sonora, Mexico, by C. M. Bogert, August 31, 1942.

It was dead when brought in by a native who had killed it in his yard. The body is injured at the fifth blotch, but otherwise the specimen is in good condition.

LEPIDOSIS: Dorsal scales with single apical pits, smooth anteriorly but with mid-dorsal rows feebly keeled over the anal region and on the tail. Scale row formula 21-19-17. The first reduction occurs on the neck where it involves suppression of the fourth row above the tenth ventral on the right and above the eleventh ventral on the left. The second reduction results from union of the fourth and fifth rows 10 scales anterior to the anal scute on the left, but on the right side reduction is irregular, two rows uniting and then separating in the region opposite the normal reduction of the left side. Ventrals 157; anal plate entire; caudals 33, the tail terminating in a blunt scale.

Rostral strongly enlarged, imbricate, with projecting lateral edges grooved behind the borders of the hardened anterior surface. Above, the rostral extends backward onto the snout, forming a strongly raised, blunt termination which completely separates the internasals and projects somewhat between the paired prefrontals; below, it is concave, with a rough margin bordering the smooth anterior surface where it meets the mouth. (See fig. 1.) Internasals small and triangular, with raised posterior edges. Prefrontals larger than supraoculars, each with a lateral portion extending onto the side of the head to the posterior nasal, thus separating the internasal from the preocular. Frontal pentagonal, longer than broad, its width about equal to the common suture of the parietals which are individually somewhat smaller than the frontal. Supraoculars small, not projecting over the eye.

Nasal divided by the nostril (which is closed by a flap or nasal valve) and a suture below it extending to the first supralabial; anterior portion of the nasal much smaller than posterior portion. Loreal single on the right side, vertically elongate, extending from the third labial to the prefrontal; on the left it is divided, the upper portion cuneate and incompletely separating the posterior nasal from the lower preocular; the lower portion is small and horizontally elongate, separating the upper loreal from the third labial. Pre-

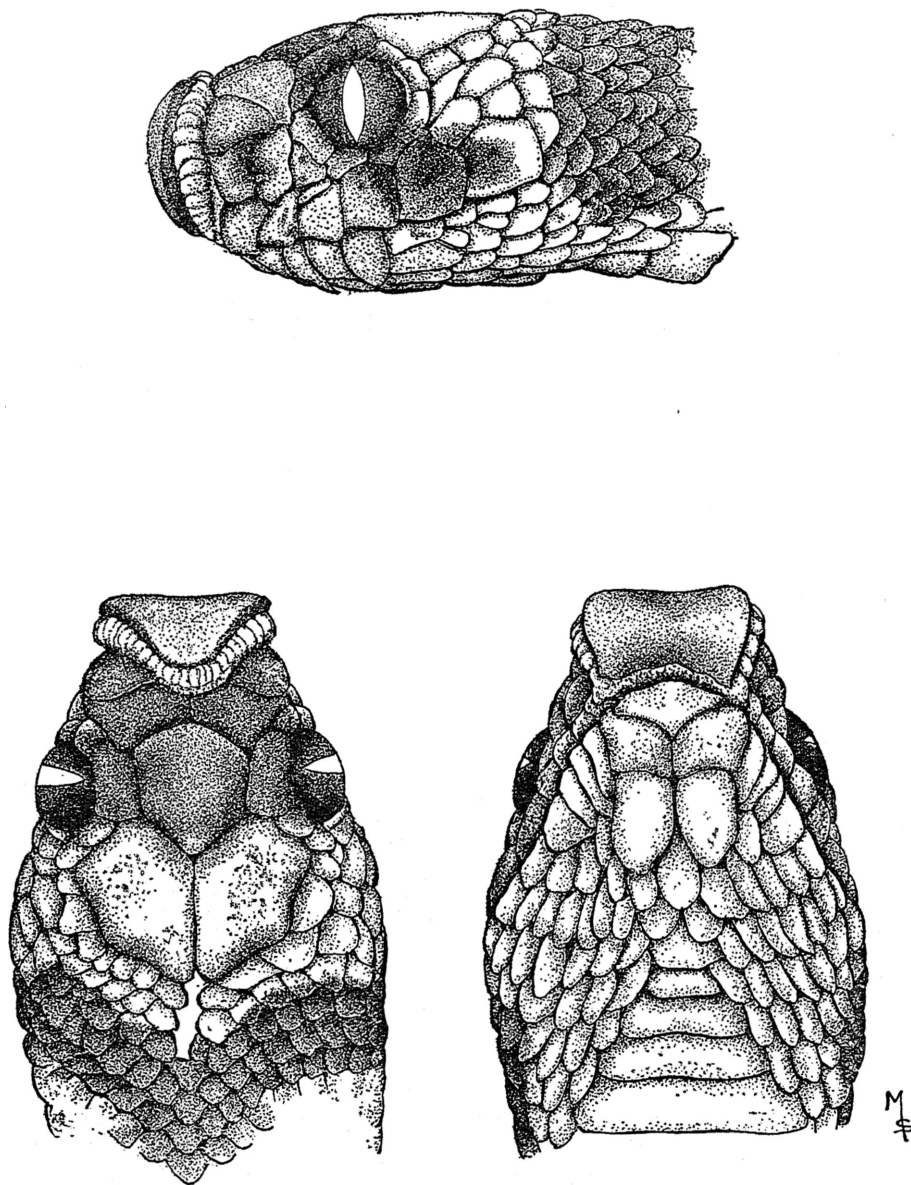


FIG. 1. Lateral, dorsal, and ventral views of the head ($\times 6$) of the type specimen of *Phyllorhynchus browni fortitus*, new subspecies. Sub-adult male, A.M.N.H. No. 64329, from Alamos, Sonora.

oculars two on each side, the upper smallest; suboculars three on the right, two on the left; postoculars three on each side. Thus, including the supraocular, nine scales surround the eye on the right, eight on the left, while the supralabials are completely separated from the orbit. Temporals 3+3, somewhat irregular on the left. Eye large, protruding, with vertically elliptical pupil; diameter of the eye greater than its distance from the mouth, slightly less than the distance between it and the posterior border of the rostral at the level of the nostril.

Supralabials six, the anterior three smallest and subequal in size, the fourth slightly larger, while the fifth and sixth are largest, and of similar size. Anterior supralabial in contact with the rostral and both portions of the nasal; third, fourth, and fifth labials reaching the suboculars. Mental broader than long, partly separating the first pair of infralabials which meet on a median suture behind it. Infralabials nine, the first pair largest, and in broad contact with the anterior chin shields, the second and third reaching the lateral borders of the anterior chin shields. Anterior chin shields largest of the scales on the chin, their common suture extending a distance slightly greater than their width. Posterior chin shields indistinguishable from gular scales in size and shape and smaller than a median scale which separates them; posteriorly they are separated from the first ventral by a pair of scales followed by two single scales.

DIMENSIONS: Length over all 223 mm., the tail 25 mm., comprising 11.2 per cent of the total length. Greatest width of head 7 mm., approximately equal to the distance between the edge of the rostral and the angle of the mouth.

DENTITION: Eight subequal maxillary teeth followed after a diastema by three enlarged teeth. Palatine teeth three; a single pterygoid tooth; nine subequal teeth in the dentary. Only the teeth on the right side were examined.

HEMIPENIS: The organ on this snake cannot be described in detail owing to the small size of the specimen, but it seems to differ in no important details from those of larger specimens of other *Phyllorhynchus* examined. As dissected in position in the tail, it extends

to the fourteenth caudal, with a feeble distal bifurcation. (Vestigial bifurcation of the sulcus on the extreme distal end is apparent in larger specimens of all described subspecies of *P. decurtatus*, and likewise in adult *P. b. browni*. Probably it is present in *P. b. fortitus*, but it could not be observed in the dissection.) Spines are arranged in longitudinal series, most strongly developed in the middle of the organ.

PATTERN AND COLORATION: The pattern consists of slate gray markings on a white ground color approximately like the underside of the chin and venter. On the head an ill-defined dark band extends across the frontal, includes small corners of the parietals and portions of the prefrontals, and passes through the eyes to the angles of the mouth. Between this band and the rostral there are scattered punctations involving all the scales in the region except the third supralabial on each side. Posterior to the dark band, a light area, which includes most of the parietals and adjacent scales, separates the dark frontal band from the first body blotch which extends well onto the neck. (See pl. 32, fig. 1.)

The dark blotch on the neck involves 19 transverse rows of scales, the second body blotch 15 scales, and subsequent blotches are from 12 to 14 scales long. All dark body blotches, of which there are 11, are strongly and regularly indented on the sides; the lateral portions of the blotches extend to the first or, more commonly, to the second row of scales. The edges of the blotches tend to be darker than other portions and, beginning with the fourth blotch, a circular whitish area lies in the center of each, being present on all blotches posterior to this, and strongly developed in the fifth to eighth blotches. The dark blotches are separated by light interspaces, two to three scales in width on the sixth to eighth scale rows where the inner spaces are narrowest. Laterally the scales of the whitish areas are suffused with darker punctations. On the tail there are two blotches 12 to 13 scales long, the posterior one being interrupted on the right side by a white indentation extending to the median line. These are separated by whitish interspaces about as wide as those separating the body blotches. The end of the tail, principally the terminal scute, is gray and separated from

the previous blotch by two or three whitish scales.

REMARKS: Recognition of three subspecies of *browni* suggests that a south-to-north gradient in pattern characters may be demonstrated within the species as a whole, when sufficient material from Sonora can be assembled. In *fortitus* the body blotches are four or five times as long as the interspaces; in *browni* the blotches are usually slightly longer than the interspaces, and in *lucidus*, at the northern extremity of the range, the blotches are "little, if any, longer than the interspaces" (Klauber, 1940, p. 209), while in the paratype of *lucidus* (figured by Klauber, 1935, fig. 3) the interspaces are longer than the blotches.

This condition may be discussed more satisfactorily in mathematical terms by counting the light and dark scales involved in a single row and expressing the result in a ratio of dark to light. Utilizing the four specimens of *P. b. browni* on hand, the type of *fortitus*, and data for the type *lucidus* kindly supplied by Dr. Klauber, this ratio has been calculated for the three races. For convenience all counts were made on the seventh longitudinal scale row (this becomes the eighth on the neck, or may become the sixth near the posterior portion of the body), which avoids the white circular areas in the blotches of *fortitus*. Individual scales on the margins of the dark blotches are partly light and partly dark; arbitrarily these are included in counts for both dark and light scales. The ratio of dark scales to light scales in each of the three forms follows:

<i>fortitus</i>	<i>browni</i>	<i>lucidus</i>
5.48	1.56 (mean)	1.23

Ventral counts serve to separate *browni* from *lucidus* (known from but two specimens at present), and average differences may exist between *browni* and *fortitus* when sufficiently large hypodigms¹ are available for comparisons. Klauber (1940, p. 202) provides data for 15 males of *P. browni browni* and for one male of *lucidus*. Thus, comparing males only, we have *fortitus* with 157 ventrals, *browni* with 158.8 (mean), and *lucidus* with 172, suggesting a possible gradient paralleling

¹ This useful term was coined by Simpson (1940, p. 417).

pattern characters. Both ventral count and blotch data, however, are based upon too few specimens to provide satisfactory figures at present.

The systematic position and relationships of the genus *Phyllorhynchus* have remained obscure since it was described by Stejneger in 1890. In his diagnosis of the genus, Stejneger contrasts it with *Salvadora* (which Cope had placed in the subfamily Natricinae) and notes that *Phyllorhynchus* "appears to be one of the Coronellinae." Since there is no group of characters that provides any sound basis for recognition of the latter subfamily, Stejneger's statement is nearly meaningless. Boulenger (1893, p. 417), apparently without having seen a specimen, assigned *Phyllorhynchus* to the synonymy of *Lytiorhynchus*, the type species of which is a North African snake and bears little resemblance to these American snakes. *Phyllorhynchus* has, therefore, been recognized by most authors, and in check lists it has commonly been placed close to *Salvadora* which it resembles only in external snout characters. The shapes of the premaxillae in the two genera are totally different.

Dunn (1928, p. 23) included *Phyllorhynchus* in his arrangement of American colubrid genera along with those lacking apical pits and a diastema, although both are present in *Phyllorhynchus*. Likewise, Dunn indicates that the genus is referable to the subfamily Colubrinae as defined by him, whereas Klauber (1935, p. 14) notes that the hemipenis of *P. d. perkinsi* has the "sulcus divided distally," which theoretically would place it in the Xenodontinae.

All subspecies of both species of the genus, except *P. b. lucidus*, are represented in the American Museum collections. The majority of these specimens are males, and dissections reveal no important penial differences between species. The distal bifurcation of the sulcus described by Klauber is readily seen in larger specimens, although it is not easily found in juveniles. On the everted organ the bifurcation is not apparent without additional dissection, and it is problematical whether the extreme distal branch is any longer of functional significance. Presumably it represents a vestigial condition, indicating a xenodontine origin for the genus, but such a

statement implies more than seems to be warranted; evidence now assembled for snakes of other continents suggests that many, and very likely all, colubrine genera have evolved from groups having the sulcus spermaticus forked. Furthermore, it seems probable that the simple sulcus has been evolved not once, but several times, in various zoogeographic regions. The bifurcated sulcus appears to be more common in occurrence and more widely distributed in the Southern Hemisphere, while the simple sulcus is represented in the majority of colubrids in the Northern Hemisphere. The true significance of the penial characters remains to be interpreted when more genera can be examined.

Strangely enough no complete description

of the dentition of *Phyllorhynchus* has ever appeared. Stejneger (1890) states merely "palatine teeth present; dentition diacranterian." Because all the snakes in the genus are small it is difficult to obtain accurate tooth counts, but in larger specimens there is no doubt concerning the accuracy. We have had available a specimen of *P. d. perkinsi* cleared and stained with alizarin, and in addition several maxillae have been removed for examination or cleaned and examined *in situ* after a jet of compressed air was directed on the bones. The results of this investigation may be presented in tabular form, as follows (a plus sign indicates a diastema and a dash separates counts from the right and left sides, respectively):

DENTITION IN <i>Phyllorhynchus</i> (Dentary counts omitted)				
Subspecies	A.M.N.H. No.	Maxilla	Palatine	Pterygoid
<i>P. d. decurtatus</i>	14226	8+3-8+3	1-1	?-3
" " "	14227	7+3-8+3	1-1	3-?
<i>P. d. nubilis</i>	20590	8+3-?	2-2	1-1
" " "	60112	8+3-?	2-2	1-1
<i>P. d. perkinsi</i>	60507	8+4-8+4	4-4	3-3
" " "	63890	7+4-7+4	3-2	1-1
" " "	64499	8+4-7+4	4-4	3-3
" " "	60665	7+4-7+4	2-3	3-3
" " "	62916	8+4-?	?	?
" " "	60750	6+3-6+3	4-4	3-3
" " "	61754	6+4-6+4	4-4	3-3
" " "	58905	8+3-8+3	3-?	3-?
" " " (intergrade)	58904	7+3-7+4	5-4	3-3
" " "	60567	7+3-8+3	3-3	4-3
<i>P. b. browni</i>	38362	9+3-7+3	1-0	0-0(?)
" " "	60500	7+3-?	3-3	2-2
" " "	63500	8+3-?	2-2	1-1
" " "	63501	7+3-?	2-?	?-?
<i>P. b. fortitus</i>	64239	8+3-?	3-?	1-?

Many of the specimens tabulated above have been studied by Klauber, and locality data have already been published. Both specimens of *P. d. decurtatus* are from La Paz, Baja California, the two *P. d. nubilis* are paratypes from the region immediately south of Tucson in Pima County, Arizona. Those listed under *P. d. perkinsi* include two

(A.M.N.H. Nos. 60507 and 63890) from Coachella Valley, Riverside County, California, and five specimens (A.M.N.H. Nos. 20665, 62916, 60750, 61754, and 64499) from San Felipe Wash, San Diego County, California. Of the remaining specimens listed under *perkinsi*, one (A.M.N.H. No. 58905) is from 4 miles east of Gila Bend, while

A.M.N.H. Nos. 60567 and 58904 are, respectively, from 29 and 33 miles east of Gila Bend in Maricopa and Pinal counties, Arizona. The latter two specimens have been designated as intergrades between *perkinsi* and *nubilis* by Klauber (1940, p. 201). The four specimens of *P. b. browni* are all from the vicinity of Tucson, Arizona, with one possible exception (A.M.N.H. No. 38362) which has no more precise data than "Arizona."

Until many more specimens are examined, the taxonomic significance of a few differences that seem to exist on the basis of these small samples remains uncertain. It is of interest, however, to note that an edentulous area at the front of the maxilla is characteristic of all forms, and that the number of enlarged teeth behind the maxillary diastema seems to be constantly three in all representatives of the genus except *P. d. perkinsi* (fig. 2) in which four enlarged posterior teeth appear to be the rule. Furthermore, it is probably of significance that of 14 specimens of *decurtatus* that we examined two out of three specimens having only three posterior teeth were from the region of intergradation between *nubilis* and *perkinsi* determined by Klauber on the basis of pattern characters, ventral, and subcaudal counts. Thus, dentitional characters seem to confirm Klauber's conclusions concerning the relationships of the subspecies of *decurtatus*, but they offer no additional proof concerning



FIG. 2. Right maxilla ($\times 10$) of *Phyllorhynchus decurtatus perkinsi*, A.M.N.H. No. 61574, from San Felipe Wash, San Diego County, California.

the validity of two genetically distinct but morphologically similar species, *decurtatus* and *browni*, which inhabit the same region in Arizona.

The skull of *Phyllorhynchus* is not radically different from that of most colubrids, although the maxilla and mandible are relatively short and stout, and the dentary teeth, not included in the tabulation above, vary in

five specimens of the genus from seven to 11. The palatine is long and slender, with the few teeth in it located anterior to an elongate internal process. The pterygoid is broadened posteriorly but relatively narrow anteriorly where from one to four teeth are commonly present, although one specimen of *P. b. browni* apparently lacks pterygoid teeth. The skull is exceptionally wide in the parietal region, and the fused parietals are smooth, lacking the ridges so prominent in most colubrids. The postorbital is greatly reduced in size. Anteriorly, despite the remarkable external development of the snout, the skull is quite normal in most respects, and the premaxilla is scarcely modified from a fairly normal colubrid condition.

The rather extensive variation in teeth and the great reduction in tooth number, particularly on the pterygoid, suggest that snakes of the genus *Phyllorhynchus* are in the process of losing their teeth, possibly as a result of egg-eating habits. The African colubrids, *Dasypeltis* and *Oophilosotum*, with similar propensities, appear to have lost many of their teeth. Klauber (1935, p. 25) presumes that snakes of the genus *Phyllorhynchus* eat insects and lizards, and he reports *Coleonyx* to be eaten by captive specimens, although the majority of specimens he examined contained lizard eggs. Insectivorous snakes in general do not appear to lose teeth in the course of their evolution, although many burrowing snakes with specialized rostral developments tend to undergo reduction in maxillary teeth, and edentulous spaces in the anterior of the bone are not uncommonly met with in burrowers.

Examination of the skull and hemipenis throws little light on the origin of the genus. Whatever the relationships of the group may be, it cannot at present be placed in any phylogenetic scheme of genera; certainly its affinities are not with *Salvadora*. Presumably the leaf-nosed snakes evolved in the desert regions they now inhabit, and either they have acquired numerous modifications in response to their habitat or their progenitor and its closest relatives have failed to survive. Possibly both phenomena are involved.

Thamnophis eques eques (Reuss)

Coluber eques REUSS, 1834, Mus. Senckenbergianum, vol. 1, p. 152, fig. 2, pl. 8; Mexico.

Thamnophis eques RUTHVEN, 1908, Bull. U. S. Natl. Mus., vol. 61, p. 158.

Thamnophis eques eques SMITH, 1942, Zoologica, vol. 27, p. 106.

Thamnophis vicinus SMITH, 1942, *ibid.*, vol. 27, p. 104; "near Temaxcal, Michoacán."

Alamos, 3 (A.M.N.H. Nos. 64226-64228).

Guircocoba, 2 (A.M.N.H. Nos. 63705-63706).

Dorsal scale rows uniformly 19-19-17. A single male from Guircocoba has 164 ventrals; the remainder of the specimens are females with 157, 159, 159, and 161 ventrals, respectively. Two Alamos females with complete tails have 90 and 94 ventrals; tails are incomplete on other specimens. Supralabials 8-8 except in an Alamos female with 8-7; infralabials 9 to 10. Loreal single, preocular single, postoculars 3, temporals 1+3 in all specimens. Maxillary teeth 24 in each of three maxillae examined.

The specimens vary in total lengths from 465 mm. to 790 mm., the two larger females with complete tails having tail/total length ratios of 0.28 and 0.26, respectively. Vertebral stripe confined to a single scale row.

REMARKS: Smith (1942b) has recently advanced reasons for separating a northern race, *cyrtopsis*, of the species currently known as *eques*. He points out that in *T. eques eques* the vertebral stripe occupies no more than a single scale row, whereas *T. e. cyrtopsis* "over most of its range... is characterized by having the middorsal light stripe involving parts of adjacent scale rows." In addition he notes differences in ventral counts, providing raw data which may be summarized (with the mean for each sex preceding the extremes in parentheses) as follows:

	No.	<i>eques</i>
Males	32	160.6 (146-171)
Females	38	153.7 (145-164)

These data when analyzed statistically and supported by the differences in the width of the vertebral stripe apparently provide a satisfactory basis for recognition of at least two populations. Alamos and Guircocoba females described above, with from 157 to 161 ventrals (mean 159), obviously are closer to *eques* than to *cyrtopsis*, whereas the Guircocoba male with 164 ventrals likewise falls nearer to the mean for *eques*. The narrow

vertebral stripe confirms this conclusion, and we feel justified in assigning these specimens to *T. e. eques* despite the fact that Smith gives the northwestern limit of the range as "central Durango and southern Sinaloa." He lists the range of *cyrtopsis* as "the eastern half of Sonora southward to northern Durango and along the Sierra Madre Occidental to northern Nayarit; eastward through Chihuahua to eastern Coahuila, and southward on the central plateau to southern San Luis Potosí and probably northern Zacatecas." Thus, on the basis of the data he is able to assemble, he recognizes an overlap of range in Durango and Nayarit, and while he includes eastern Sonora in the range of *cyrtopsis*, the specimens he lists are from near Guáymas on the west coast, and from "Guadalupe Canon" (which we assume to be Cañon de Guadalupe) in extreme northeastern Sonora. Because our specimens are obviously referable to *eques*, it seems more probable that this southern form ranges northward along the Pacific coast west of the Sierra Madre Occidental through coastal Nayarit and Sinaloa, and that intergrades eventually may be taken north of Alamos and presumably in Durango and Nayarit. However, it may be no simple task to decide which specimens are intergrades on the basis of pattern characters owing to the dichotomous nature of the vertebral stripe character. The stripe is either confined to the middorsal scale row or it may include all or part of the contiguous rows. Ventral counts may be of greater value in deciding which individuals are intermediate. In fact the specimens which Smith reports from La Posa, 10

No.	<i>cyrtopsis</i>
21	171.2 (163-177)
13	169.9 (163-176)

miles north of Guáymas, may represent intergrades. In his series of three females and six males from this region the minimum ventral count for each sex is represented.

The range of the species *eques*, as understood by Ruthven (1908, p. 161, fig. 70), extended from Arizona, New Mexico, and Texas southward to Guatemala. He confused the name *sumichrasti*, however, with the form having 17 mid-body scale rows as Smith

(*supra cit.*) has shown. The name *sumichrasti* is now applied by Smith to snakes with 19 mid-body scale rows (the same populations that Ruthven referred to *eques*), and Smith considers *sumichrasti* to be a distinct species with four subspecies. He states, with reference to *T. s. sumichrasti*, that "In form, scutellation and type of pattern it is undoubtedly a close relative of *eques*, which differs by having a distinct dorsal stripe and higher average ventral and caudal counts. The two are considered as distinct species because there is no evidence whatever of an intergradation between the curious pattern of *sumichrasti*—a median and two lateral rows of spots—with that of *eques*, which has a median light stripe and four lateral series of spots. *T. sumichrasti* does intergrade with races which do have patterns similar to that of *eques* (viz. *s. fulvius*, *s. praeocularis*), but from that fact it cannot be inferred that *sumichrasti* must also intergrade with *eques*."

This concluding statement is quite true; it cannot be inferred that *sumichrasti* necessarily intergrades with *eques*, but, on the other hand, it is a reasonable assumption that it does. When samples from two populations bear such close resemblance that only minor differences serve to separate them it may properly be inferred that intergrading specimens eventually will be found. Smith, in the same paper from which the quotation above was extracted, describes *postremus* as a race of *eques*, noting that it differs from the latter in having fewer ventrals (138 to 141) than *eques* (with 145 to 171 ventrals, Smith's data). Thus, with only four specimens of *postremus*, there is no conclusive evidence that ventral counts overlap. Specimens intergrading in this particular character are lacking at present, yet Smith infers that such specimens will eventually be found, or he certainly would have described the form as a full species. As a matter of fact, the lower means for ventral counts in *sumichrasti* appear to represent the southern segment of a gradient or cline. The mean for four males listed by Smith is 151, and for three females 142.7. The few data assembled for Mexican and Central American specimens are not adequate to plot such a gradient with precision, but means of the samples of each population for which Smith provides raw data may be

calculated. When arranged from north to south, these indicate a trend as follows:

	<i>cyrtopsis</i>	<i>eques</i>	<i>sumichrasti</i>
Males	171.2	160.6	151.0
Females	169.9	153.7	142.7

Despite the supposed lack of critical material actually to demonstrate the genetic continuity of *eques* and *sumichrasti*, Smith's data indicate that a single, rather plastic species, *eques*, occupies a range extending from the United States to Nicaragua. The species in all probability will include several recognizable subspecies, although the ranges of the populations described or recognized by Smith are somewhat anomalous. *Thamnophis eques sumichrasti*, as we prefer to call the form, includes individuals from Tabasco, Chiapas, Guatemala, Nicaragua, and possibly also Veracruz, according to Smith's interpretation of his samples. He also recognizes two other Guatemalan populations, *cerebrosus* on the Pacific coast and *fulvus* in the Guatemalan highlands. In addition he recognizes a fourth race, *praeocularis*, inhabiting the Yucatán peninsula, including British Honduras, Quintana Roo, and Yucatán. This arrangement, of course, is not impossible, particularly if it can be demonstrated that different habitats are populated by each race. On the basis of relatively small samples, however, it is not certain by any means that each of these nominal forms warrants recognition. Tentatively they may be recognized as subspecies of *eques*, although Reuss' plate (*loc. cit.*) leaves not a little doubt concerning the application of the name.

As a further argument in favor of recognizing *sumichrasti* as a distinct species, Smith points to the discovery of *Thamnophis vicinus* which "has made it evident that intergradation between forms with patterns as different as those of *sumichrasti* and *eques* is not to be taken for granted. *T. vicinus*, with a pattern like *sumichrasti* but with a ventral count like *eques*, occurs in the same localities as the latter species, yet remains quite distinct." Again Smith's data appear to be open to an alternate interpretation. The taxonomist does not merely attach names to samples or to series of specimens. In modern practice he is concerned with the inferences he can draw concerning the characters and the extent of

the variation within the populations which his samples represent (see Simpson, 1940). Quite obviously many taxonomic problems cannot be settled with finality until breeding experiments can be conducted, but since it is manifestly impossible to undertake such experiments for every taxonomic question that arises, the systematist must interpret his data in the light of the experimental evidence which exists for related groups where similar problems have occurred.

Blanchard and Blanchard (1941) have demonstrated that melanism in *Thamnophis s. sirtalis* is inherited in simple Mendelian fashion, black being recessive to normal striped patterns. They have shown this to be true of at least two local populations, and apparently the same factor is involved in each, as well as in a third population not yet thoroughly investigated. Where melanistic individuals occur they usually represent a minority of the population, and Logier is quoted as judging that about one-third of a population of *T. s. sirtalis* in Ontario is composed of melanistic individuals. No one assumes that two species are represented here, and there is little, if any, evidence that the factor for melanism originated in an isolated population that subsequently gained genetic contact with populations of striped individuals.

Smith diagnoses *vicinus* as "differing from *eques* in the complete absence of a middorsal light stripe which is replaced by a series of dark spots, and perhaps in having a smaller size." Following his description of the types and paratypes, which consist of four females and six males, he comments that "since *vicinus* is so like *eques* from the same area in scutellation, the two might be considered subspecies; this arrangement is not supported, however, by the existence of perfectly typical *e. eques* at exactly the same localities as those in which *vicinus* has been collected. For the present they must be considered distinct species."

The parallel between this case and that reported by Blanchard and Blanchard is obvious. Whereas the snakes described as *vicinus* are not melanistic, they differ only in a minor pattern character which may very well be determined by a single genetic factor. Some additional evidence may be brought to

bear. Ventral counts for *vicinus* may be compared with those of *eques* from the same region. Utilizing Smith's data for five males and 16 females from Michoacán only, means are herewith listed, with extremes in parentheses:

	<i>eques</i>	<i>vicinus</i>
Males	159.6 (146-171)	159.0 (155-162)
Females	154.0 (149-157)	152.0 (149-156)

Using Simpson and Roe's formula for the comparison of small samples, the value of P for ventral counts of *eques* and *vicinus* may be calculated for each sex. Comparing males, the value of P is 0.8, and for females P is 0.4. Hence, on the basis of ventral counts we may safely assume that these two samples could represent the identical population. Furthermore, it may be noted that when males and females of the two pattern phases are compared, the amount of sexual dimorphism is nearly identical in each and with larger samples probably would be even more so.

Are we to believe, then, that two species of snakes in the same genus, each with similar numbers of ventrals and with similar sexual dimorphism occur side by side in the same region and do not interbreed? There is no evidence that an isolating mechanism exists, nor can we expect intermediates or intergrades to occur within the population if the minor difference in the pattern is determined by a single genetic factor. We know that even greater differences exist between individuals within local populations of *T. s. sirtalis* and that melanism is inherited in a simple Mendelian fashion. Therefore, we consider it a valid inference that *vicinus* is not a species, but only a pattern phase, possibly a simple mutant of *T. e. eques*. Accordingly we propose to assign it to the synonymy of that form. Without rather extensive series it would be difficult to demonstrate taxonomic validity of the criterion of size which Smith mentions as a possible diagnostic character.

Some years ago Ruthven (1908, pp. 163-164) mentioned the fact that of six specimens from Zacaultipan, Hidalgo, "three were typical *eques* and the others, while agreeing with them in scutellation, differ in the apparent total absence of lateral and dorsal stripes." He concluded that those without stripes represented variations of *eques*. It appears,

therefore, that throughout a wide area in middle Mexico *eques* has given rise to snakes lacking stripes, although such snakes have not been reported to the north where, in general, there is a definite trend toward a widening of the mid-dorsal stripe. Southward a race (*sumichrasti*) lacks dorsal stripes, but its lateral offshoots, if the small samples represent recognizable populations, have retained the stripes, or the supposed populations may have evolved them independently. The former assumption seems far more reasonable.

Examination of the series of *Thamnophis eques* in the American Museum discloses the existence of a fair amount of variation in pattern characters in the northern subspecies. Three Texan specimens are all similar and in all probability represent the subspecies *cyrtopsis*. They differ from specimens from other regions in possessing exceptionally large square blotches behind the head, nearly twice as large as the neck blotches on other specimens from the United States; also the black lines bordering the supralabial sutures are much broader. Furthermore, black borders are present on the infralabial sutures, while these are nearly or completely absent in other specimens in the American Museum. If present at all, the borders are very faint or apparent on but one or two sutures. The type locality of *cyrtopsis* is in Coahuila. Therefore we suspect that such Texan specimens are referable to this subspecies. The race inhabiting portions of New Mexico, Arizona, and Sonora remains to be assigned a name when its range and differential characters can be studied.

Ruthven's map (1908, fig. 70) indicates a peninsular extension of the range of *T. eques* into central Texas. Such a distribution would parallel that of *Coluber taeniatus ornatus*. Whether or not partial or complete isolation of this form can be demonstrated when more material from the state is assembled for study remains to be seen. The American Museum specimens referred to above are A.M.N.H. No. 62525, Government Spring, Chisos Mountains, Brewster County; A.M.N.H. No. 62984, Big Bend region west of Chisos Mountains, 150 miles south of Marathon, Brewster County; A.M.N.H. No. 20861, San Antonio, Bexar County. Satisfactory re-

vision of the subspecies of *eques* must await acquisition of material from critical regions, but undoubtedly study of the material already assembled in museums would yield fruitful results.

Drymarchon corais rubidus Smith

Drymarchon corais rubidus SMITH, 1941, Jour. Washington Acad. Sci., vol. 31, p. 474; Rosario, Sinaloa.

Alamos, 4 (A.M.N.H. Nos. 64229-64232).

Guero-coba, 4 (A.M.N.H. Nos. 63707-63710).

Dorsal scale rows uniformly 19-17-15. Ventral counts: Alamos male 193, three Guero-coba males 195, 196, 196; three Alamos females 193, 194, 195; Guero-coba female 197. Caudals in the same order 68, 67, 69, 68, and 64, 71, 67, 69. Anal entire, supralabials 8, the fourth and fifth reaching the orbit, infralabials 9, loreal 1, preocular 1, postoculars 2 without deviation. Temporals more commonly 2+2, rarely 2+3.

The largest specimen in the series is a Guero-coba male measuring 1467 mm. over all, the tail (276 mm.) comprising 19 per cent of the total length. The smallest juvenile, a female from Alamos, measures 521 mm., and the tail (91 mm.) comprises 17 per cent of the total length. Two juveniles are essentially like the adults in coloration except for the fact that dorsal scales possess lighter margins which produce a mottled instead of a uniformly black coloration.

REMARKS: These specimens agree very well with Smith's (*loc. cit.*) description of the race, but they extend the range from southern Sinaloa to southern Sonora. Since the publication of Smith's work, Brock (1942) has described an additional race, *cleofae*, from the Tres Marias Islands. With only four specimens available from the insular population he was able to demonstrate a statistically significant difference in ventral counts. It seems probable that he might have been able to demonstrate significant differences in caudal counts as well since he describes the type as having 78 subcaudals, and the Maria Madre Island specimen reported by Smith had 82 subcaudals. The maximum that Smith reports for *rubidus* is but 78, and the mean for the mainland race may be calculated (for 12 specimens with the tails complete listed by Smith) as 74.3.

Nevertheless, in the present state of our knowledge it seems to be of questionable value to base new subspecies solely upon statistical differences in ventral and caudal counts. Whereas it has long been recognized that the number of vertebrae in many species of snakes varies from population to population, it is still not known for certain whether these differences between populations are genetic or merely phenotypic expressions of environmental differences. It is conceivable that thermal factors affecting the embryo during its ontogeny may increase or decrease the number of somites. Klauber (1941a, pp. 73-79) has shown that among snakes of the same species occurring on both the coastal and desert sides of the mountains in southern California "there is an almost universal tendency toward a higher number of ventrals in the desert specimens, as compared with those collected in the more humid cismontane region." Furthermore he notes that, while there are any number of secondary environmental differences between the two regions, humidity and temperature differences are outstanding. Klauber shows that statistically significant differences between the means in ventral counts of several species common to the two regions can be demonstrated. Where subspecies have been recognized there have always been other differences in pattern or scalation correlated with the differences between the means in ventral counts.

Mertens (1934) has called attention to the fact that insular races of snakes are commonly larger and often possess more vertebrae than populations on the adjacent mainland. In taxonomic practice, however, it has not been the custom to recognize these insular populations by name on the sole basis of differences in the mean number of vertebrae. It may, of course, be possible to demonstrate experimentally that the number of vertebrae is determined by genetic factors, and that the numbers of ventrals in individual local populations result from selectional factors that have operated through countless generations. But the existence of gradients in ventral counts in nearly every species that has been thoroughly investigated tends to dispel any likelihood that this is the case.

Brock, of course, is not without precedent¹

¹ Since these notes were prepared, H. M. Smith (1943)

in describing a new subspecies based solely on ventral count differences, but continuation of the practice will almost certainly result in the tentative and needless recognition of races that will have to be placed in synonymy. When a geographical gradient in ventral counts indicates a directional trend, any individual population will, of necessity, be based on arbitrary definition of its range, a practice to be avoided rather than to be encouraged.

Pituophis sayi affinis (Hallowell)

Pityophis affinis HALLOWELL, 1852, Proc. Acad. Nat. Sci. Philadelphia, p. 181; New Mexico.

Pituophis sayi affinis STULL, 1940, Bull. U. S. Natl. Mus., no. 24, p. 123.

Alamos, 2 (A.M.N.H. Nos. 64237-64238).

Guero-coba, 2 (A.M.N.H. Nos. 63711-63712).

A male and a female from each locality. Dorsal scales 29-33-23, a single female with 29-33-25. Ventrals, males 231, 227, females 238, 232, the higher count for each sex being represented by the Alamos specimen. Anal plate single, caudals, males 62 and 52+, females 57 and 54. Supralabials 8-8 in three, 8-7 on one; infralabials 12 to 13. Loreal single; preocular single on three specimens, 2-2 on the fourth; postoculars 3-3 on two, 3-4 on one, 4-4 on another; subocular present on three specimens. Body blotches 46 and 47 on males, 42 and 40 on females; tail bars 11 on both males, 12 on both females. Maxillary teeth vary as follows: males 17-17, 16-16; females 17-16 and 14-14. All specimens are adults with over-all dimensions from 1070 mm. to 1451 mm. Ratios of tail to total length 0.12 and 0.13 in males, 0.12 in females.

The female from Alamos contained eight eggs in each oviduct. Hilton states that at Guero-coba "These snakes are called 'burillo' and are believed by the natives to be as poisonous as rattlers. The one with all the tooth marks was found in a death grip with one of the big blue snakes (*Drymarchon*)."

REMARKS: Although Stull (1940) maps the range of *P. s. affinis* as extending into Sinaloa,

has followed Brock's unfortunate example and described several additional races of snakes from the Tres Marias Islands, all characterized by higher ventral counts. We feel inclined to doubt the validity of this procedure until it is known whether we are dealing with genetic or phenotypic characters.

she lists no locality records to substantiate the occurrence of the form in that state. We have been unable to locate "Rush Lake" which Stull credits to Cope as a Sonoran locality, but the only other definite record is that of Taylor for Noria in the northern portion of the state slightly farther west than Stull's map indicates. The specimens from Guirocoba appear to possess no conspicuous pattern differences when compared with Arizona specimens. Stull (1940, p. 126) records the variation in maxillary teeth as 16-17; the specimen with 14, mentioned above, thus indicates a more extensive range. Stull does not mention the number of maxillae examined.

***Coluber striolatus striolatus* Mertens**

Bascanion lineatus BOCOURT, 1890, Études sur les reptiles. Mission scientifique au Mexique et dans l'Amérique Centrale, pt. 3, sect. 1, no. 12, p. 700, pl. 48, fig. 1a-c; "Mexique."

Masticophis lineatus ORTENBURGER, 1928, Mem. Univ. Michigan Mus., vol. 1, p. 134, pl. 25, figs. 3-5.

Coluber striolatus MERTENS, 1934, Zoologica, vol. 32, p. 190; new name for *Coluber lineatus* Duméril and Bocourt, preoccupied by *Coluber lineatus* Linnaeus.

Masticophis flagellum striolatus SMITH, 1941, Jour. Washington Acad. Sci., vol. 31, p. 393.

Guirocoba 1 (A.M.N.H. No. 63721).

A juvenile female with the dorsal scale formula 19-17-13, ventrals 183, anal divided, caudals 118. Supralabials 8, infralabials 9, loreal 1, preoculars 2, postoculars 2, temporals 2+2+3+3. Maxillary teeth 17, the two penultimate of which are enlarged, the posterior tooth slightly smaller. Over-all dimensions 493 mm., tail 140 mm., ratio of tail to total length 0.28. Top of head brown, upper preocular and postoculars with lighter areas, anterior portion of loreal lighter but with no horizontal light line. Scales on dorsum gray, with basal and apical black margins. On the neck there are 15 to 16 narrow, white, black-edged cross bars. Under-side immaculate except for a few small black flecks on the edges of the chin shields and the gular region.

STOMACH CONTENTS: This small snake contained an adult *Perognathus* sp.

REMARKS: It is now apparent that this racer should not be considered a subspecies

of *flagellum*, as Smith (*supra cit.*) was inclined to believe. With inadequate material from the critical area, Smith concluded that the similarities of *lineatus* and *striolatus*, together with their known distribution, warranted subspecific status for the latter. The occurrence of both *C. f. piceus* and *C. striolatus* in the same territory offers rather positive evidence that this view is not tenable.

Insignificant as the character would appear, all workers who have studied the group have found the white line on the loreal to be diagnostic of juvenile *piceus* (*frenatum* auct.). Ortenburger (1928, p. 116) states that the "cream line through the loreal is even more pronounced in the young than in the adult." The juvenile described above not only lacks the loreal stripe but bears little resemblance to juvenile *piceus* in pattern characters, the belly being immaculate and the narrow dorsal bars on the neck being quite unlike those on juvenile *piceus*.

Aside from pattern characters, the ventral and caudal counts (respectively 198 and 103 for the male of *piceus*, and 183 and 118 for the female *striolatus*) would be anomalous on two specimens of the same species from a single locality, particularly when the female has fewer caudals and more ventrals. Additional material from the state of Sinaloa in the collection of R. T. Moore bears out the conclusions drawn from these two specimens. We have no hesitancy in concluding that *C. striolatus* is not conspecific with *C. flagellum*, and the specimen of the former from Guirocoba constitutes an addition to the fauna of the state of Sonora. Hitherto, it has been reported only as far north as central Sinaloa. Data presented below in this paper indicate that *flagellum* and *striolatus* inhabit the same territory but remain quite distinct in northern Sinaloa as well as in southern Sonora. Ventral counts alone readily distinguish the two forms, aside from pattern differences.

The snake described by Smith (1943, p. 448) as *Masticophis flagellum variolosus*, if it proves to be valid, should be placed as a subspecies of *Coluber striolatus*.

***Coluber bilineatus* (Jan)**

M[asticophis] bilineatus JAN, 1863, Elenco sistematico ofidi, p. 65; Mexico.

Masticophis bilineatus SMITH, 1941, Jour. Washington Acad. Sci., vol. 31, p. 389.

Alamos, 1 (A.M.N.H. No. 64234).

Guirocoba, 2 (A.M.N.H. Nos. 63722-63723).

Three males, with dorsal scale formula 17-17-13, ventrals 201, 202, and 204, anal divided, caudals 135, 133, and 132+. Supralabials 8, infralabials 10-11, loreal 1, preoculars 2, postoculars 2, temporals 2+2. All three specimens possess the pattern that is characteristic of the species.

REMARKS: Smith (*supra cit.*) has shown that Jan's name *bilineatus* is with little doubt applicable to the snake known as *Masticophis semilineatus*. Until better diagnostic characters for the genus *Masticophis* can be determined, we prefer to use the name *Coluber* (see below). Hilton's notes state that these snakes are known at Guirocoba both as "culebra de pollo" and "culebra chocolate." The former name has reference to the belief that the snake eats small chickens, and it is quite possible that chicks are sometimes taken by this racer.

Coluber flagellum piceus (Cope)

Bascanium piceum COPE, 1892, Proc. U. S. Natl. Mus., vol. 14, p. 625; Camp Grant, Arizona.

Masticophis flagellum frenatum TAYLOR, 1938, Univ. Kansas Sci. Bull., vol. 24, p. 490.

Masticophis flagellum piceum SMITH, 1941, Jour. Washington Acad. Sci., vol. 31, p. 397.

Coluber flagellum piceus KLAUBER, 1942, Copeia, p. 96.

Alamos, 2 (A.M.N.H. Nos. 64235-64236).

Guirocoba, 1 (A.M.N.H. No. 63720).

One of the specimens consists of the anterior portion of the body and head of a juvenile secured from a peddler in Alamos who had attempted to preserve it in native rum. The other specimens are both males with tails probably complete. Dorsal scale formulas for the two are 19-17-12 and 19-17-13, respectively. Ventrals 198 and 200, anal divided, caudals 103 and 105. All three specimens are alike in possessing 8 supralabials, 1 loreal, 2 preoculars, and 2 postoculars.

Of six maxillae examined four contained 18 teeth, and two contained 19 teeth. Total lengths of the two complete specimens are 1595 mm. (Alamos) and 1107 mm. (Guirocoba), the tails comprising, respectively, 0.22 and 0.25 of the total lengths.

The light horizontal dash through the loreal is present on the specimen from Guirocoba and on the juvenile from Alamos but it is absent from the large adult from Alamos. The latter specimen is uniformly brownish olive above and essentially devoid of markings, although each of the lateral scales has a lighter area in the anterior median part. This specimen compares favorably in coloration with specimens of *Coluber flagellum testaceus* from Texas, although its coloration is somewhat darker than any specimens at hand. The sides of the head, including the lips, are almost uniformly brownish and bear no trace of the pattern found commonly on *piceus*. However, these markings of *piceus* are present on the juvenile from the same locality and on the individual from Guirocoba. The underside of this large specimen was creamy yellow in life, with the brownish olive of the dorsum extending onto the edges of the ventrals and onto the gular region. The chin is pigmented irregularly with the same color, quite in contrast to the juvenile from the same locality and the specimen from Alamos, each of which possesses definite dark, more or less symmetrically arranged markings on the chin. On these two latter specimens there also are two series of spots on the anterior ventrals, with less regular rows of spots on the edges of the ventrals toward the neck.

Conceivably specimens of *Coluber* from southeastern Sonora might be referable to any one of three races, *testaceus* (which we use instead of *flavicularis* in accordance with the views expressed by Klauber, 1942, p. 93), *piceus* which ranges southward into Sinaloa along the coast, or to the form described by Smith (1941b, p. 394) as *lineatulus* (type locality: San Buenaventura, Chihuahua). The large adult from Alamos in many respects is closer to *testaceus* than it is to *piceus*, while none of the specimens possesses the salmon-red color of the subcaudal surface which Smith utilizes to characterize *lineatulus*. Scale-count data summarized by Klauber (*supra cit.*) and the data listed by Smith (*supra cit.*) indicate that no scale character is of value in assigning specimens to named subspecies. We are, therefore, forced to place more emphasis on pattern characters, and since two of the three specimens possess the

light loreal stripe, we have assigned them to *piceus*, not without realizing the arbitrary nature of our decision.

Taylor (*supra cit.*) lists six specimens from Sonora (referring four of them to *frenatum* and two individuals to *piceus*, following Ortenburger's arrangement) and notes a wide amount of variation in pattern characters in the populations currently assigned to *piceus* in the southwestern portion of the range. While we continue to recognize a western subspecies, it becomes increasingly difficult to allot specimens from critical areas, and for the most part identifications are not based on characters but on geographical data.

The complexity of this situation becomes even more apparent with the recognition of *lineatulus*. According to Smith's (*supra cit.*) interpretation, this form ranges from Guajuato in central Mexico northward to Valencia County, New Mexico, while a few specimens from southeastern Arizona and northeastern Sonora are assigned to *flavicularis* (= *testaceus*). It may be observed that if such a population of *testaceus* exists to the west of the range of *lineatulus*, it would be completely isolated from *testaceus* in Colorado, Oklahoma, and Texas, southward to San Luis Potosí. Such mosaic distributions certainly require more adequate explanation than any that has been offered.

Additional material from Mexico that has come into collections in recent years, or material that was on hand but heretofore had not been studied, has served to obscure the relationships of the whip snakes and racers rather than to clarify them. As understood by Ortenburger (1928), these snakes were assigned to two genera, *Coluber* with one species in the United States and one in Oaxaca, and *Masticophis* with three groups, each of which was composed of allopatric species except *flagellum*, which included one sympatric form, *piceus*, occurring within the range of *C. f. frenatum*.

The suppression of *frenatum* by Smith (1941b) and the thorough study of the variations within the subspecies *piceus* by Klauber (1942) have materially improved the taxonomic situation in the western portion of the range. Unfortunately Smith's decision to place *striolatus* as a subspecies of *flagellum* proves to be based upon insufficient evidence.

Material reported herein demonstrates an overlap of nearly 200 miles in ranges of *piceus* and *striolatus*, thus precluding the inclusion of the two populations in the same species without some explanation of their failure to interbreed. Smith states that *striolatus* is obviously a close relative of *lineatulus*. He infers that the line of descent has been from *striolatus* to *lineatulus*, and from the latter via *flavicularis* (= *testaceus*) to *piceus*. If this were proved, it would be an extremely interesting case, analogous to some of those summarized by Mayr (1942, pp. 176-185). When two terminal links in a chain of subspecies overlap, however, the proof of intergradation should be definite, and even some of the cases mentioned by Mayr are far from being well authenticated. The weakest link in the chain, as far as the races of *Coluber flagellum* are concerned, lies in Smith's failure to demonstrate intergradation between *striolatus* and *lineatulus*. His inference concerning the relationships of *striolatus* should not, however, be too severely criticized. At the time he wrote he was unaware of the overlap that can now be demonstrated. His assumption perhaps was a valid one on the basis of the information and maps provided by Ortenburger. It serves to emphasize the need for material from critical areas. Before correct inferences can be drawn concerning the relationships of the populations in the group, much more material from regions where ranges adjoin will have to be assembled.

Since the publication of Ortenburger's (*supra cit.*) monograph, *C. ortenburgeri* has been described by Stuart (1934), and additional races of *Coluber constrictor* have been recognized. Also Dunn (1933) has commented on an additional specimen of *Coluber oaxaca* that allegedly came from Colima. The information contained in these papers makes it increasingly difficult to provide any sound basis for recognizing *Masticophis*.

It has recently been stated that the snakes assigned to the genera *Coluber* and *Masticophis* "form natural, sufficiently easily recognizable and convenient assemblages" to provide sufficient reason for retention of both categories. Unfortunately the statement is hardly borne out by the data supplied by Stuart (*supra cit.*) who admittedly was com-

pelled to resort to geographic criteria in assigning *ortenburgeri* to the genus *Coluber*. It cannot be stated with any assurance that the species *constrictor*, *oaxaca*, and *ortenburgeri* comprise a natural group. Indeed the widely separated ranges of *oaxaca* and *constrictor* suggest that each of these species may have evolved from different stocks. Juvenile pattern characters in *constrictor* differ somewhat from those of juveniles belonging to species assigned by Ortenburger to *Masticophis*, but at the present time nothing is known of the juvenile patterns of *oaxaca* and *ortenburgeri*. When these data become available they may throw some light on the putatively close relationships of the three species.

If three New World species are to comprise the genus *Coluber*, it would seem equally logical, if not more so, to assign to separate genera each of the groups placed by Ortenburger in *Masticophis*. The group comprised of striped forms is sufficiently easily recognizable, and it would be a "convenient assemblage," at least quite as convenient and perhaps more readily separated than *Masticophis*, as the larger assemblage was understood by Ortenburger. In fact, each of the groups composed of allopatric species could be assigned generic rank, and each group in turn would occupy a definite range overlapping that of one or more other groups. But only a single group should not be separated on doubtful anatomical evidence unless all of them are recognized.

Because we do not believe it desirable to recognize four genera, some of which would be monotypic, we continue to assign *flagellum* to the genus *Coluber*. It may be added that Old World snakes currently placed in the same group almost certainly are not congeneric. African and European species have been commented upon previously by one of us (Bogert, 1940, p. 48), and recently we have examined the Chinese species *spinalis*. Like the African and European species it proves to possess a diastema followed by two enlarged teeth in the maxilla, in contrast to New World species which either lack a diastema or have three enlarged posterior maxillary teeth separated from the others. Ortenburger also pointed out differences in the hemipenes which appear to be valid. In case the dentitional differences prove to be

sufficiently constant and can be correlated with other characters, re-recognition of the genus *Zamenis* Wagler (type *gemonensis*), would be necessary and Old World snakes currently placed in *Coluber* should be removed from this American genus.

The conclusions here expressed were drawn up prior to the appearance of a paper by Inger and Clark (1943). These authors attempt to partition the genus *Coluber* (in its broadest sense) on the sole basis of scale reduction patterns. Whereas these authors have provided some extremely useful data as a result of their studies of reduction patterns, we are inclined to consider any generic separations based solely upon a single character to be ill advised. There is no logical basis for the assumption that any individual difference or similarity is of greater taxonomic importance than another. In any generic separation it is desirable that several characters as well as distributions be considered. Thus, we might utilize pattern characters as the basis for separating *Coluber* into several genera and come to wholly different, but perhaps equally valid or invalid, conclusions.

We have noted above that *Coluber spinalis* of eastern Asia possesses two posterior maxillary teeth that are enlarged and separated by a diastema from others in the series. In dentition, therefore, it is similar to European members of the assemblage. On the other hand, the pattern of *C. spinalis* consists of a light mid-dorsal stripe flanked by a darker ground color, quite unlike the pattern of *Coluber constrictor*. Furthermore, the Asiatic species possesses a premaxilla that bears little resemblance to that bone in either European or American racers. Superficially it resembles the premaxilla of snakes of the genus *Arizona* or of *Pituophis sayi*. Merely because of similarities in the scale reduction pattern, Inger and Clark include *spinalis* with *constrictor* in the genus *Coluber*. Perhaps *spinalis* has closer relatives in Asia, or it may be desirable to place it in a monotypic genus. The problem cannot be settled without further study.

Inger and Clark fail to make any mention whatever of *Coluber oaxaca* although they place *ortenburgeri* in *Masticophis*, contrary to the conclusions drawn by Stuart who was utilizing geographical criteria when he placed it in *Coluber*. Similarly *striolatus* is seemingly

considered to be a subspecies of *Masticophis taeniatus* by Inger and Clark. This conclusion may be more nearly correct than that offered by Smith who referred *striolatus* to *flagellum* as a subspecies of it. Owing to the absence of any data or discussion of the problem by Inger and Clark, we can scarcely consider the matter settled. Despite the laudable efforts of these authors, the fact remains that no satisfactory basis for partitioning *Coluber* has yet been offered. Solutions to the problems involved can be expected only when several characters have been studied and evaluated.

***Salvadora hexalepis deserticola* Schmidt**

Salvadora hexalepis deserticola SCHMIDT, 1940, Publ. Field Mus. Nat. Hist., zool. ser., vol. 24, p. 146, fig. 14; Government Spring, near Chisos Mountains, Brewster County, Texas.

Salvadora hexalepis celeris SMITH, 1941, Smithsonian Misc. Coll., vol. 99, p. 9, fig. 6; San Blás, Sinaloa.

Alamos, 2 (A.M.N.H. Nos. 64151-64152).

Guircoba, 2 (A.M.N.H. Nos. 63724-63725).

One specimen from Alamos consists of a head and neck only. The other three specimens, a male and two females, possess the dorsal scale formula 17-17-13. Ventrals 189 (male), and 194 and 198 (females); anal divided; caudals 83 (male), and 77 and 80 (females). Supralabials 9-9, the fifth and sixth entering the orbit on both sides of the Guircoba male, the Alamos female, and on one side of the Guircoba female; on the remaining side the fourth, fifth, and sixth labials enter the orbit. Infralabials 10. Loreal single, in contact with the fourth and fifth labials, preoculars 2, postoculars 2, temporals 2+2. Paravertebral stripes on sixth and seventh scale rows, lateral stripes on edges of third and fourth rows.

REMARKS: This race heretofore has not been recorded from Sonora, although the typical form (*S. h. hexalepis*) is represented by a few specimens from the state. Additional Sonoran material referable to *deserticola* has been available, but the senior author reserves comment upon it pending conclusion of more extensive studies of the genus *Salvadora*. The race *celeris* described by Smith (*supra cit.*) differs from *deserticola* only in possessing more ventrals. No other character listed in Smith's diagnosis serves to separate it. The

specimen described above with 198 ventrals indicates that there is no satisfactory difference between *celeris* with 200 to 205 ventrals (two specimens only) and *deserticola* with from 179 to 198. A difference of two ventrals, with so few specimens from the southern portion of the range now available, hardly suffices for recognition of *celeris*. The complexity of gradients or clines in the genus *Salvadora* will be discussed in some detail in a future paper by the senior author, but for the sake of clarifying the use of the name *deserticola* for the Guircoba specimens it seems best to refer *celeris* to the synonymy of the former at this time.

***Leptophis diplotropis diplotropis*
(Günther)**

Text figure 3

Ahaetulla diplotropis GÜNTHER, 1872, Ann. Mag. Nat. Hist., ser. 4, vol. 9, p. 25; Tehuantepec, Mexico.

Leptophis diplotropis OLIVER, 1942, Occas. Papers Mus. Zool. Univ. Michigan, no. 462, p. 9. Alamos, 1 (A.M.N.H. No. 64233).

Guircoba, 5 (A.M.N.H. Nos. 63726-63731).

Five males and two females, with the dorsal scale formula uniformly 15-15-11. The ventral counts on the five males vary only from 178-179, and the two females have 181 and 183 ventrals, respectively. Anal divided; caudals 151 and 157 on the only complete specimens, both males. Supralabials 8, infralabials 10 on five specimens, and 9 on one. Loreal single, preocular single, postoculars 2, temporals 1+2, with the posterior temporals partly fused on one male and completely fused on one female. Maxillary teeth 18 on four maxillae, 17 on three, with the last two teeth enlarged in all cases.

REMARKS: These specimens represent the first record of the genus *Leptophis* for Sonora, although Oliver (*supra cit.*) has reported the occurrence of the present species in Chihuahua on the basis of specimens taken from the Río Mayo drainage. Without doubt the form will be taken in the valley of the Río Mayo in Sonora. To the south it has long been known from Sinaloa and the Tres Marias Islands. Those from the latter islands are given the name *L. d. forreri* by Smith (1943, p. 443) solely upon the basis of Boulenger's ventral and caudal counts.

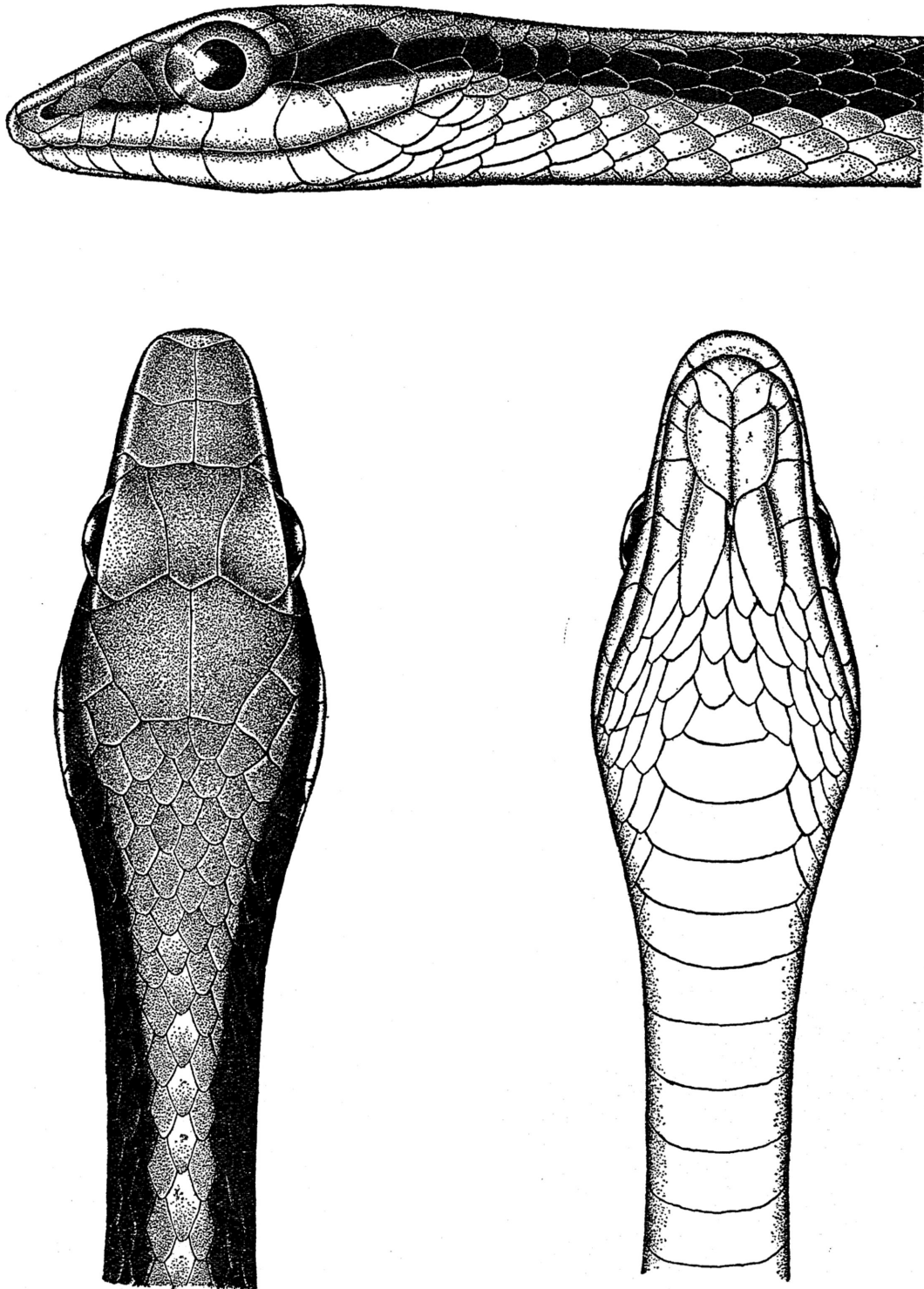


FIG. 3. Lateral, dorsal, and ventral views of *Leptophis d. diplotropis* (approximately $\times 3.5$), A.M.N.H. No. 63731, adult male from Guirocoba, Sonora.

In Alamos, as well as at Guirocoba, this snake is known simply as the "culebra verde." It did not appear to be common in the region around Alamos, although its coloration may render it difficult to see during the rainy season when the vegetation provides an exceedingly dense cover.

Lampropeltis triangulum nelsoni
Blanchard

Plate 32, figure 2; text figure 4

Lampropeltis triangulum nelsoni BLANCHARD, 1920, Occas. Papers Mus. Zool. Univ. Michigan, no. 81, p. 6, fig. 1; Acambaro, Guanajuato; BLANCHARD, 1921, Bull. U. S. Natl. Mus., no. 114, p. 155, fig. 65.

Guirocoba, 2 (A.M.N.H. Nos. 63713-63714).

Two females with dorsal scale rows 23-21-19 and 21-21-19, ventrals 215 and 212, anal single, caudals 48 and 48, each with one or two missing from the tip of the tail. Supralabials 7-7, infralabials 9-9, preocular 1, postoculars 2, temporals 2+3. The pattern on these two specimens conforms with that shown in Blanchard's (1921) figure, there being 12 triads on the body of one and 13 on the other, including the band on the nuchal region. Each has four white rings on the tail, interspersed with black; red bands like those separating the triads on the body are completely absent on the tail of one and present only immediately behind the anal region on the other. Maxillary teeth 12, 13, and 14 on three maxillae examined.

STOMACH CONTENTS: One specimen contained two unidentifiable reptile eggs approximately 17 mm. in length, and the other contained remains of two juvenile mammals too far digested for identification.

REMARKS: These specimens have been compared with those from Excuinapa, Sinaloa (A.M.N.H. Nos. 3525-3528), mentioned by Blanchard and confirm his prediction that this subspecies "should be expected in Sonora west of the Sierra Madre." Taylor's inclusion of "*Lampropeltis annulatus*" in his list of Sinaloan reptiles (1938b) doubtless has reference to *L. t. nelsoni*. Blanchard's records of *L. t. annulata* were all east of the Sierra Madre. Hilton's notes state that this form and *Rhinocheilus l. antonii*, *Sonora aemula*, and the Sonoran coral snake, *Micruroides*,

were all known locally as "coralillo" and equally feared.

Rhinocheilus lecontei antonii Dugés

Text figure 5

Rhinocheilus Antonii DUGÉS, 1886, Proc. Amer. Phil. Soc., vol. 23, p. 290; "environs de Mazatlán," but now believed to be San Blás, either in Sinaloa or Nayarit.

Rhinocheilus antonii BOULENGER, 1894, Catalogue of the snakes in the British Museum, vol. 2, p. 213.

Rhinocheilus lecontei antonii KLAUBER, 1941, Trans. San Diego Soc. Nat. Hist., vol. 9, p. 314.

Rhinocheilus antonii antonii SMITH, 1942, Amer. Midland Nat., vol. 28, p. 203.

Alamos, 4 (A.M.N.H. Nos. 64241-64244).

Guirocoba 2 (A.M.N.H. Nos. 63715-63716).

Three specimens of each sex are represented in this series, but one Alamos male had been cut in two with a machete before it was received, and one Guirocoba female is poorly preserved. Scale rows on the neck and at mid-body are uniformly 23, with a reduction to 19 anterior to the anal plate on all specimens except an Alamos male which has 17 rows posteriorly. Two Alamos males possess 197 and 199 ventrals, while three females have 197, 201, and 206 ventrals, respectively. Anal plate undivided in all. Caudals 49, 49, and 50 on three males, 45 on the only female with the tail complete. Loreal 1, preocular 1, postoculars 2, and temporals 2+3.

The body patterns of snakes in this series consist of black rings or saddle-shaped blotches (see fig. 5), portions of which extend onto the ventrals in varying degrees. The interspaces are red in freshly killed specimens, with portions of scales adjacent to the black blotches white. The red interspaces of the Guirocoba specimens were somewhat bleached when received, and the specimens taken at Alamos faded rapidly in preservative with the exception of the largest male which still retains much of the color. The red of the interspaces extends to the second or third scale row, and the venter is yellowish or cream colored, with irregular blotches of black, or with somewhat regularly arranged quadrangular black blotches on the venter alternating in position with the black saddles of the dorsum. Laterally the dark blotches have scales with yellowish centers, but there

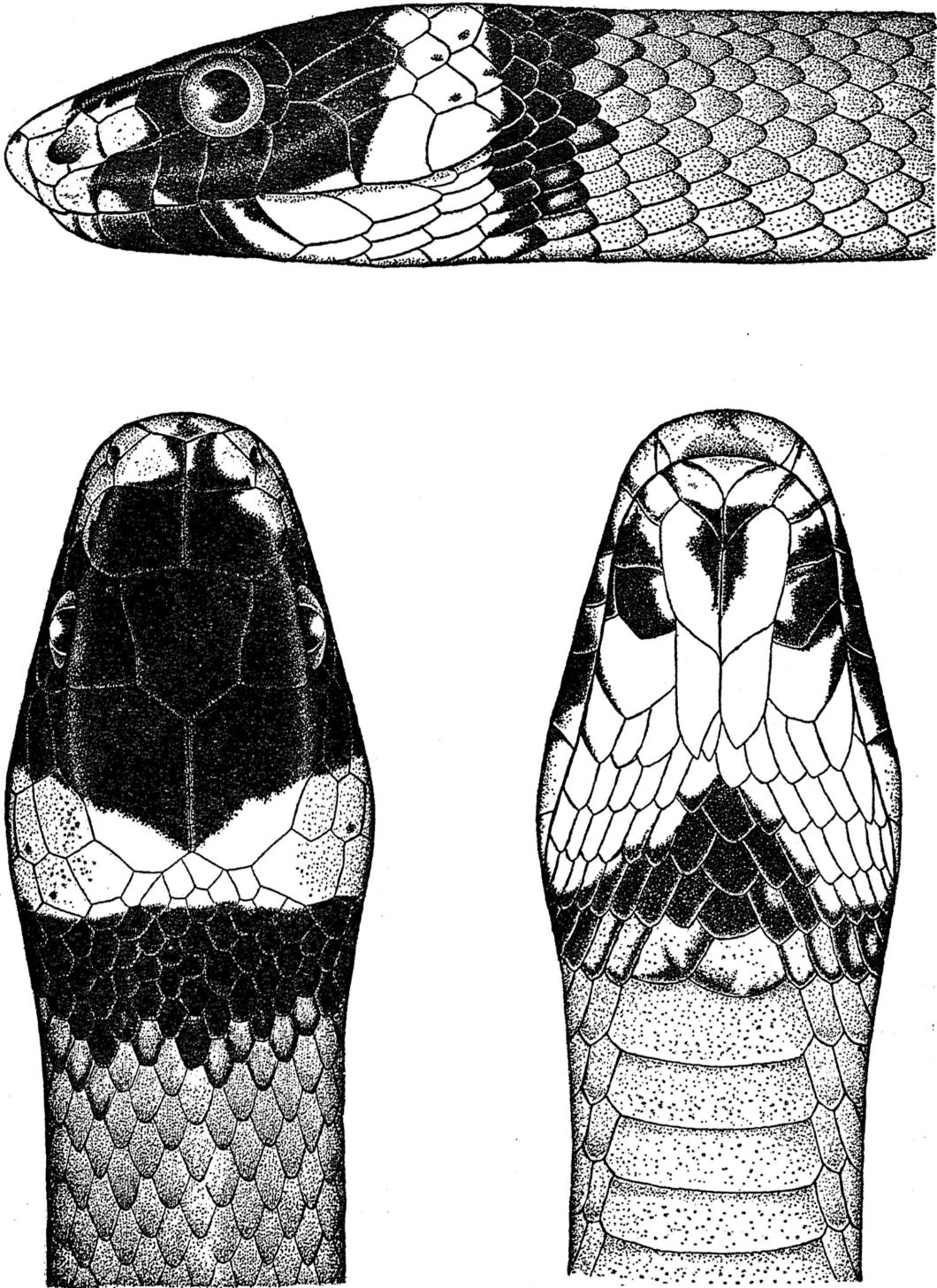


FIG. 4. Lateral, dorsal, and ventral views of head (approximately $\times 3.5$) of *Lampropeltis triangulum nelsoni*, A.M.N.H. No. 63714, from Guirocoba, Sonora.

is only a faint trace of such markings in the largest specimen. Viewed from above, prior to preservation, these snakes were essentially black and red. The width of the blotches is from two to four times the width of the

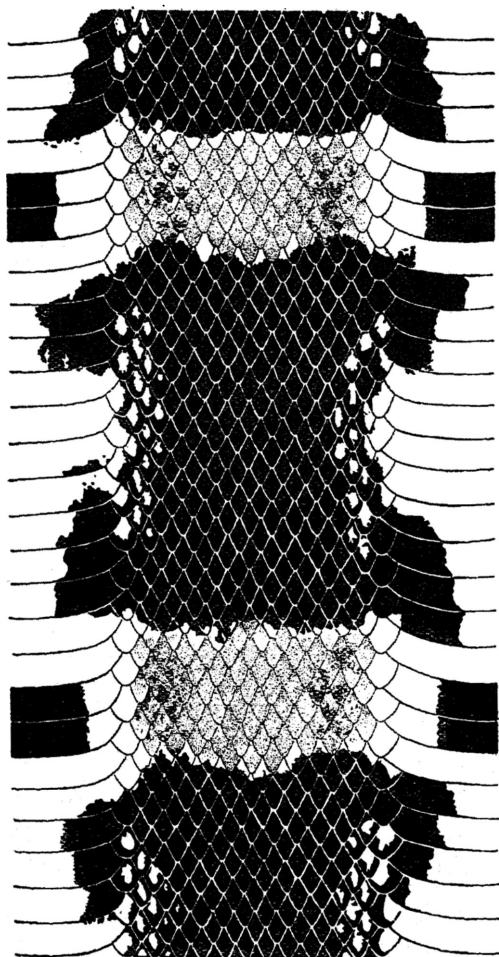


FIG. 5. Pattern at mid-body of *Rhinocheilus lecontei antonii*, A.M.N.H. No. 63716, from Guirocoba, Sonora. Whereas the drawing indicates the dark scales edged with white and vice versa, this was done only to outline the scales. Black on the drawing indicates black on the specimen, the shaded areas are red, and portions left white are yellowish in live specimens.

interspaces, averaging closer to three times the width. Body blotches on females are 12, 14, and 15; on two complete males 15 and 15. The same pattern continues onto the tail,

except that the black blotches tend to meet underneath to form complete rings, there being four such rings on most specimens, and five on one specimen in which the blotch in the anal region is preponderantly on the tail. On other specimens such blotches have been allocated to the body count.

Maxillary teeth subequal, uniformly 13 on four jaws examined. The posterior two teeth are somewhat lance shaped or flattened. The largest specimen in this series, a male from Alamos, measures 830 mm. The tail comprises 14.0 and 14.6 per cent of the total length in two males, and 12.3 and 14.7 of the total length in two females.

Dr. Horace W. Stunkard has kindly identified some parasites found in the tissues of the body cavity of one specimen from Guirocoba. Because of poor preservation these could not be named specifically, but Stunkard calls them "second stage, that is, acanthella larvae of some acanthocephalan worm."

REMARKS: Klauber (*supra cit.*) in his recent survey of the genus *Rhinocheilus* was able to assemble but 14 specimens of *antonii*. It is not surprising, therefore, that the present series extends the known range of variation within the subspecies. Represented in the series described above are (1) a specimen with fewer dark body rings, (2) a specimen with two more ventrals, and (3) a larger specimen than any that were available to Klauber. Furthermore, this fresh material indicates that the pattern of the subspecies in life is predominantly red and black above rather than brown and white as some of the older specimens from Escuinapa in the American Museum collection would lead one to believe. Aside from these minor additions to the data concerning extremes of variation presented by Klauber, the specimens agree very well with his description.

Boulenger (*supra cit.*) reports that the number of maxillary teeth in the genus varies from 16 to 19. All four maxillae mentioned above contained 13 teeth as noted, 14 are present in a Texan specimen of *R. c. tessellatus*, 14 to 15 were present in Arizonan *R. l. lecontei*, while three paratypes of *R. l. clarus* include all three counts. Boulenger's minimum, therefore, was not substantiated in the material examined, and the maximum he reports is certainly open to doubt.

Smith (*supra cit.*) seeks to re-interpret the data presented by Klauber and draws the conclusion that the genus is composed of two species, *lecontei* and *antonii*, each with a single race. The intergrades occurring in Arizona and California are interpreted by Smith as hybrids. Despite the fact that specimens with pattern characters of *clarus* occasionally appear within the range of *R. c. lecontei*, it cannot safely be inferred that two species are represented. The presence of specimens intermediate in all characters so far tabulated shows rather conclusively that no isolating mechanism exists, that the two populations are poorly differentiated, and that interbreeding occurs. Intermediates, or "hybrids" as Smith prefers to call them, are not rare around the periphery of the range of *clarus* and occur elsewhere as well. The fact that intergradation in this case is not confined to narrow geographic limits hardly warrants the conclusion that two species overlap and hybridize on occasion only.

Species, as most modern workers recognize, consist of populations that are "closed systems" under natural conditions. Obviously there is not a little interbreeding between *clarus* and *lecontei* and possibly between *lecontei* and *antonii* as well. The latter assumption remains to be substantiated when material from northern Sonora becomes available. In our interpretation, the genus, not

Guircoba, 1 (A.M.N.H. No. 63738).

The complete male from Guircoba has dorsal scale rows 17-15-15, dorsal scales with single apical pits, ventrals 147, anal divided, caudals 42. Supralabials 7, infralabials 7-8, nasal semi-divided, loreal single, preoculars 1, postoculars 2, temporals 1+2. Dorsal scales smooth anteriorly, but faint keeling is apparent at the twentieth ventral anterior to the vent, the keeled condition becoming more pronounced until from the vent to the end of the tail each dorsal scale carries a raised spine as depicted in figure 6. A black area covers the supraoculars, frontal, and parietals, extending slightly beyond their borders as depicted in figure 7. Anteriorly the ground color is reddish, with a black spot in the center of each scale and with a black band on the neck. On the posterior half of the body there are three triads consisting of white bands bordered by two black bands of the tail. Maxillary teeth 16, the two penultimate teeth slightly enlarged (see fig. 8), and most of the posterior teeth feebly grooved, the two enlarged teeth being but slightly more strongly grooved than the adjacent teeth. The approximate extent of the grooving is shown in figure 8. Length over all 240 mm., tail 40 mm.; ratio of tail to total length 0.17. Hemipenis single, with the sulcus single and extending to the tenth caudal. There are two large basal spines adjacent to the sulcus at

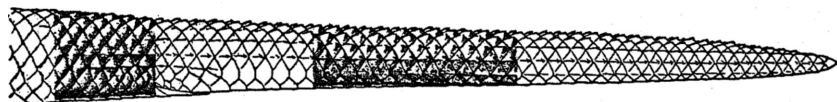


FIG. 6. Posterior extremity of *Sonora aemula*, A.M.N.H. No. 63738, male (approximately $\times 2$), to show the keeled and submucronate scales on the tail and pre-anal region. The pattern is not shown; areas of pre-anal region and middle portion of tail are shaded only to indicate the character of the scales in greater detail than they are shown in unshaded portions of the drawing.

unlike some other burrowing groups, remains monotypic but polymorphic.

Sonora aemula (Cope)

Text figures 6-8

Procinura aemula COPE, 1879, Proc. Amer. Phil. Soc., vol. 18, p. 262; Batopilas, Chihuahua.

Scolecophis aemulus DO AMARAL, 1929, Mem. Mus. Inst. Butantan, vol. 4, p. 218.

Alamos, 1 (A.M.N.H. No. 64255, shed skin only).

the fourth caudal, followed by small spines and merging with calyces on the area between the seventh and tenth caudals.

The shed skin from Alamos was found by William Riemer under a rock at the foot of the eastern slope of the Sierra de Alamos, a few kilometers northwest of the town. Because of the strongly keeled or mucronate scales on the tail the skin was readily identified and therefore saved. Needless to mention,

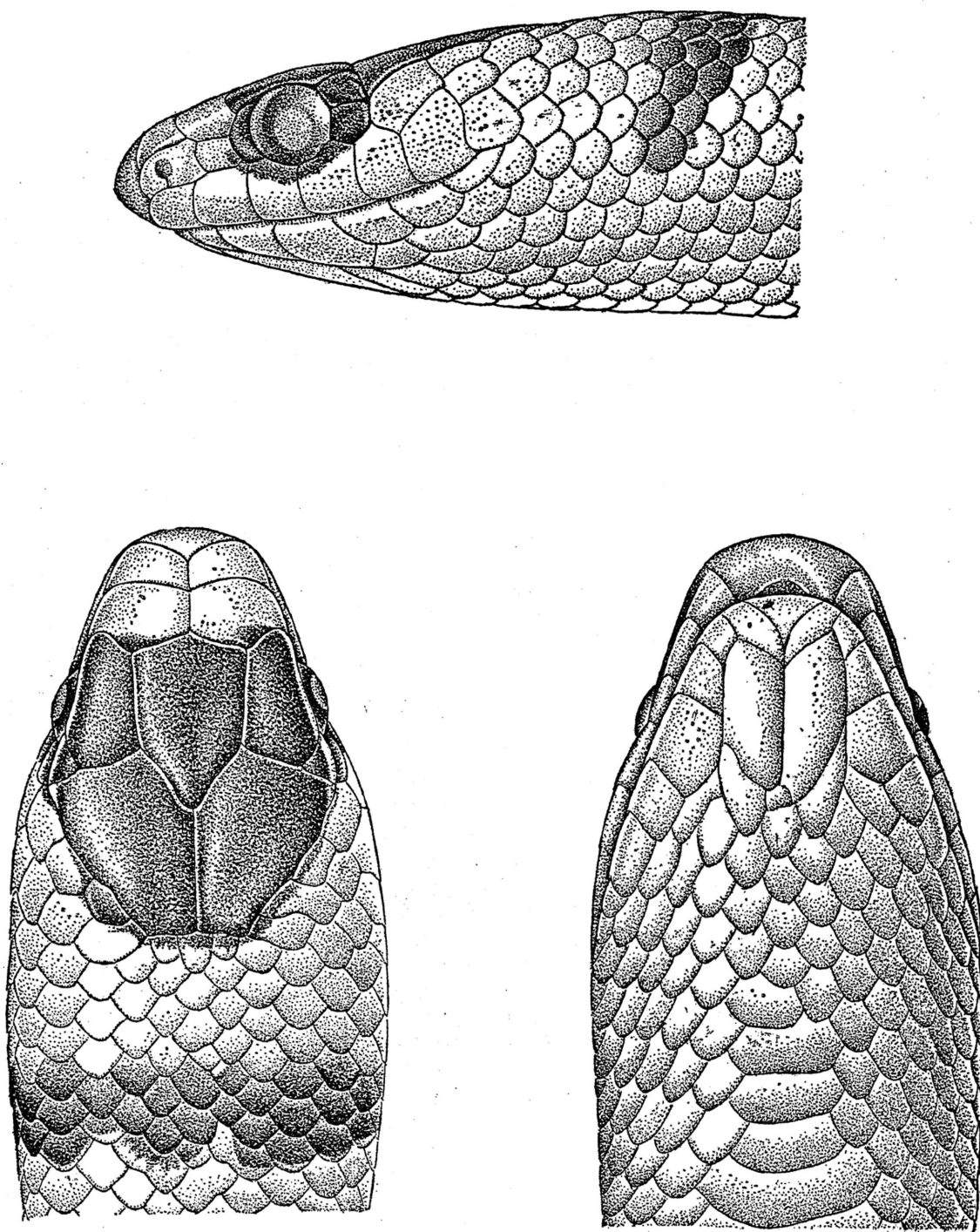


FIG. 7. Lateral, dorsal, and ventral views of the head ($\times 8$) of *Sonora aemula*, A.M.N.H. No. 63738, from Guirocoba, Sonora.

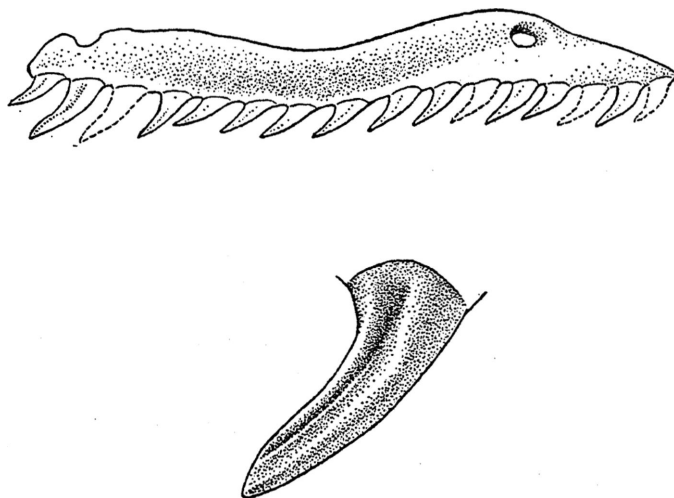


FIG. 8. Right maxilla ($\times 20$) of *Sonora aemula*, A.M.N.H. No. 63738, from Guirocoba, Sonora. Teeth indicated in dotted lines were missing from the removed jaw. Lower figure represents the penultimate tooth, greatly enlarged (approximately $\times 60$) to show the feeble grooving on the outer side.

only scale characters can be described from such a specimen, but the skin is sufficiently complete to note some of these with accuracy. The scale rows are 15-15-15, ventrals 156, anal divided, caudals 36, supralabials 8 on the left side and probably 8 on the right, infralabials 7-7, postoculars 2-2, temporals 1+2. The other characters cannot be determined with accuracy. The type and the specimen from Guirocoba are both males with similar ventral and caudal counts, whereas this shed skin is from an individual with more ventrals and fewer caudals, suggesting that in all probability it was from a female. The dimensions of the skin indicate that it came from a specimen slightly smaller than the Guirocoba individual.

STOMACH CONTENTS: The snake from Guirocoba contained two lycosid spiders and a phalaenid moth larva.

REMARKS: This snake has hitherto been known only from the type secured at Batopilas, Chihuahua, by Edward Wilkinson, Jr. This locality is likewise on the drainage system of the Río Fuerte, some 60 miles east of Guirocoba. Through the courtesy of Dr. Hobart M. Smith and Mr. William Stickel we have seen photographs of the type, now No. 11614 in the collection of the Academy of Natural Sciences of Philadelphia. It differs

from the present specimen in having rings on the anterior portion of the body, with a total of nine triads, not counting the collar, the first being apparently white bordered by black, and the second black bordered by white. Cope described the pattern as being "almost an exact repetition of *Elaps* [= *Micrurus*] *fulvius*." In scale characters, however, our specimen is almost an exact duplicate of the type, having but one less ventral and one more caudal.

The relationships of this form are almost certainly with the genus *Sonora*, although do Amaral, following Boulenger, referred it to *Scolecophis*. The specimen has been forwarded to Mr. William Stickel who has long been interested in *Sonora* and related genera, and we await his conclusions which are based on more extensive data than are now available to other workers. The remarkable spines on the tail may have some functional significance. Cope suggests that "the tail is used as a fulcrum in pushing against rough and resistant bodies." He notes that the species inhabits a rocky, mountainous region, and he has "little doubt that this peculiar character enables the animal to force itself into the earth or beneath stones." Since two specimens are males, and the shed skin is but presumptively female, there would seem to

remain a faint possibility that the keels are confined to males.

Unique as the spines are, there is little to be gained by segregating the species in a monotypic genus (*Procinura*) when cranial characters point to such close relationships with *Sonora*. It is more useful to indicate by name that the species is a specialized *Sonora* than to imply that its evolution has proceeded along such divergent lines that it can no longer be fitted into the genus. Monotypic genera would seem to be excusable only when it is impossible with reasonable certainty to allocate a given species to a known generic group.

***Chilomeniscus cinctus* Cope**

Chilomeniscus cinctus COPE, 1861, Proc. Acad. Nat. Sci. Philadelphia, p. 303; "near Guáymas, east coast of Gulf of California," Sonora, Mexico; VAN DENBURGH, 1922, Occas. Papers California Acad. Sci., vol. 10, p. 869; LINSDALE, 1932, Univ. California Publ. Zool., vol. 38, p. 381; MOSAUER, 1936, Occas. Papers Mus. Zool. Univ. Michigan, no. 329, p. 12.

Alamos, 1 (A.M.N.H. No. 64245).

A juvenile female with the dorsal scale formula 13-13-13. Ventrals 111; anal divided; caudals 24. Supralabials 7-7; preoculars 1-1; postoculars 2-2; temporals 1+1. On the body there are 16 black bands, narrower on the venter, which completely encircle the body. The interspaces were reddish orange on the dorsum when the specimen was collected but they quickly faded to white in alcohol.

Length over all 97 mm., tail 13 mm.; ratio of tail to total length 0.13. Eleven subequal maxillary teeth, those at the posterior extremity of the jaw feebly but distinctly grooved and not unlike those of *Sonora aemula*. Palatine with five teeth in the anterior portion and an edentulous space posteriorly. Pterygoid teeth 13.

REMARKS: Apparently no snake of this species has been recorded from Sonora since the type was described from near Guáymas. The Alamos specimen agrees with the description of the type in having but 16 dark rings on the body. It has been compared with specimens from Tucson, Arizona (A.M.N.H. No. 2550), and from Socorro (A.M.N.H. No. 64512) and La Paz (A.M.N.H. No. 14225)

in Baja California. There appear to be no noteworthy differences in scalation, but it is of interest to point out that the type, which had "sixteen black rings," and the Alamos specimen apparently possess fewer black bands on the body than any at present reported from Baja California, California, or Arizona. Van Denburgh (*supra cit.*) reports variation in bands from 18 to 28, Linsdale reports 21 to 40 for seven specimens from the cape region of Baja California, and Mosauer (*supra cit.*) reports seven specimens from the Vizcaino Desert region with 19 to 26. Two Baja Californian specimens in the American Museum collection, mentioned above, have 23 and 28 bands, respectively, while the Arizonan specimen has 19. Mr. William Woodin, 3rd, has supplied us with a photograph of an additional specimen from Tucson with 24 black bands.

Thus, none of the specimens for which data are available possesses the minimum number of bands present on the two Sonoran specimens. The extreme variation in the number of bands in the population from the cape region of the peninsula, however, indicates that until larger series are available, no satisfactory conclusion can be reached. It would be premature at this time to re-recognize Cope's *fasciatus*, the type of which came from La Paz, Baja California.

Mosauer (*supra cit.*) describes the habits of *Chilomeniscus* and points out some of the adaptive modifications of the external morphology. He makes no mention of the characters of the skull which differ from those of the more usual terrestrial colubrid and presumably represent additional specializations that have evolved in response to the burrowing habits of *C. cinctus*. The premaxilla is greatly flattened and recurved above so that the upper portion is in the same plane as the nasal bones. The nasal bones are unusually broad and are essentially in contact with the lateral edges of the premaxilla. At their posterior ends the nasals form broad sutures with the frontal bones so that much additional support must be provided for the snout. The shape of the premaxilla is quite distinctive, with the lateral processes sharply recurved instead of projecting laterally as they do in most colubrids.

The grooves on the posterior teeth of

Chilomeniscus, *Sonora*, and several related genera bear little resemblance to those of *Boiga*, *Leptodeira*, *Trimorphodon*, or to other true opisthoglyphs. They are extremely shallow, whereas in *Boiga* or *Trimorphodon*, for example, the grooves on the teeth are more like tubes with a slit on one side. Whether or not the teeth of *Chilomeniscus* actually serve for the conduction of venom is problematical, and snakes of the genera *Sonora* (at least some species), *Tantilla*, *Chilomeniscus*, *Gyalopion*, *Ficimia*, and *Pseudoficimia* and perhaps others, might be more properly designated as pseudo-opisthoglyphs.¹ Most of them, as far as known, feed upon arthropods, and the nature of the teeth may in some manner be associated with such feeding habits.

***Gyalopion desertorum* (Taylor)**

Ficimia desertorum TAYLOR, 1936, Proc. Biol. Soc. Washington, vol. 49, p. 51; 1938, Univ. Kansas Sci. Bull., vol. 24, pl. 43, fig. 1; 12 kilometers northwest of Guáymas, Sonora.

Gyalopion desertorum SMITH AND TAYLOR, 1941, Jour. Washington Acad. Sci., vol. 31, p. 359, figs. 2, 7, 15.

Alamos, 1 (A.M.N.H. No. 64240).

Guircoba, 2 (A.M.N.H. Nos. 63718-63719).

Two males from Guircoba have dorsal scales 17-17-17, ventrals 127 and 129, anal entire, caudals 32 and 27. A juvenile female from Alamos has 126 ventrals, anal single, and 30 caudals. Supralabials 7, the first labial fused with anterior nasal, infralabials 7, loreal 1, oculars 1-2, temporals 1+2. Body blotches 29 and 31 (males), and 28 (female); tail blotches 9 and 8 on males, 8 on the female. Over-all dimensions 262 mm., 263 mm., and 118 mm., tails 39 mm., 35 mm., and 17 mm. Maxillary teeth 12, feebly grooved on both males. The juvenile female has maxillary teeth 13-13, palatine teeth 7-7, pterygoid teeth 12-11, dentary teeth 16-16.

REMARKS: This species has hitherto been known only from the type which was secured 12 kilometers northwest of Guáymas, Sonora. The ground coloration on our specimens is considerably darker than it is on the type. On the Guircoba specimens it is brownish, rather than cream colored on the

mid-dorsum as described by Smith and Taylor (1941). The presence of an undivided anal, which Smith and Taylor thought might be abnormal, seems to be typical of the species. They state that "With some reason the species could be separated in a monotypic genus, especially if the single anal proves constant." The erection of monotypic genera on such slim grounds would certainly contribute nothing to an understanding of the relationships of these snakes, particularly when the anal plate character is unstable in many genera, *Trimorphodon*, for example. Furthermore, examination of the only specimen of *Gyalopion canum* in the American Museum collection (A.M.N.H. No. 3806 from Lake Walters, New Mexico) discloses the fact that this individual has the anal only partly divided, the suture reaching only halfway across the plate. The snout on *canum* is more distinctly upward projecting, but it lacks the sharp, knife-like edge found on these specimens of *desertorum*. The specimens with 126 and 127 ventrals have fewer than Smith and Taylor (*supra cit.*) report for the genus.

STOMACH CONTENTS: All three specimens contained spiders of the genus *Pachylomerides*. The specimen of *Gyalopion canum* mentioned above also contained a spider of the family Lycosidae (and it is of interest to note that Mulaik and Mulaik, 1943, report the diet of *F. streckeri* to consist chiefly of spiders). Dr. W. J. Gertsch kindly supplied the identifications of arachnids in material examined by us.

***Pseudoficimia hiltoni*, new species**

Plate 33; text figure 9

DIAGNOSIS: Apparently most closely related to *P. pulcherrima* recently described by Taylor and Smith (1942a, p. 246) but differing from it in possessing light spots between blotches two or more scales wide, an additional infralabial and a double line across the frontal region. Furthermore, it possesses more caudals, a slightly longer tail, and it probably differs in size since the single individual exceeds all specimens previously reported by nearly 200 mm.

TYPE: A.M.N.H. No. 63717, an adult male, collected at Guircoba, Sonora, Mexico, by John W. Hilton, 1941.

¹ Since these notes were written, Stickel (1943) has proposed the term "pleuroglyph" to designate such snakes.

LEPIDOSIS: Dorsal scales smooth, with single apical pits, disposed in 17 rows throughout the length of the body, median row smallest, increasing in width laterally. Ventrals 153, anal divided, caudals 50, in two series (end of tail not quite complete, probably lacking three or four caudals).

Rostral projecting strongly, pointed and slightly upturned, the portion visible from above greater than its distance from frontal. Internasals meeting behind rostral, wider than long, their length approximately equal to the width of the supraoculars. Prefrontals extending on sides of head, reaching nasal, second labial, and preocular. Frontal more than one-third longer than wide, longer than parietals. Nasals with nostril pierced below center of internasals, a suture extending from the nostril to the apex of the first labial; posterior end of nasal extending ventrally between first nasal and prefrontals. Preocular single, postoculars 2-2, the upper larger and in contact with the parietal and anterior temporal, temporals 2+2. Supralabials 7-7, the sixth largest, the third and fourth reaching the eye. Infralabials 8-8, the first pair meeting on median suture behind a rather large mental, the first four touching the anterior pair of chin shields, the fifth largest. Anterior chin shields in contact throughout their length, followed by two small chin shields scarcely distinguishable from the gulars, and separated by two small scales. Five scales between angle of mouth and first ventral; four scales between anterior chin shields and first ventral.

DIMENSIONS: Length over all 700 mm., tail 132 mm. (small portion missing), comprising 18.8 per cent of the total length. Greatest width of head 16.7 mm. End of snout to angle of jaw 24 mm.

DENTITION: Maxillary teeth 17-17, slightly smaller anteriorly, many with feeble, irregular grooves. Palatine teeth 9-11, subequal, no grooves. Pterygoid teeth 14-14, somewhat larger posteriorly. Dentary teeth 18-18, a few with feeble grooves similar to those in the maxillary series.

HEMIPENIS: Extends to eleventh caudal, bifurcating at the tenth to create two short terminal lobes, the sulcus extending to the one on the outer side in the normal retracted position. Basal portion with enlarged spines

in symmetrical arrangement. Two largest spines flanking sulcus in region of third caudal, followed distally by four diagonal rows of spines which diminish in size and merge with deep, well-developed, reticulated calyces with crenulated edges near region contiguous to seventh caudal. Calyculate area extends from opposite seventh caudal to terminus.

COLORATION: Pattern of head more or less symmetrical, as depicted in figure 9, the lighter area of the snout brownish, the lighter cross bands cream color, the dark areas blackish. Two dark-edged blotches extend from the middle of the parietals onto the neck, being separated behind by a cream-colored area one and two half scales in width. Body pattern composed of about 45 dark blotches, some of them fused anteriorly, most of them extending to the first scale row on the sides. Along the mid-dorsal line the dark blotches average two to three scales in width, tending to have darker margins. These blotches are separated by whitish areas which are a trifle less than a scale in length and approximately three scales in width. On the sides the darker blotches are interspersed with a grayish ground color which extends well onto the ventrals except on the neck which is yellowish. Tail with approximately 20 blotches.

Tongue with light-colored tips, a darker cross bar near the bifurcation, and with a row of spots on the medial dorsal surface.

STOMACH CONTENTS: The digestive tract contained only the remains of arthropods, including a tarantula of the genus *Aphonopelma* and moth larvae. This suggests that the food of this relatively large burrowing snake consists of prey similar to that of *Gyalopion*. The tarantula remains were identified by Dr. W. J. Gertsch.

REMARKS: Boulenger (1894, p. 270) mentions specimens of *Contia frontalis* from near Mazatlán, and from Ventanas, Durango. Both of these have higher caudal and lower ventral counts than Cope recorded for the type, and quite possibly they should now be referred to *P. hiltoni*; a few other reptiles seem to be common to Ventanas, Mazatlán, and Guirocoba. Taylor and Smith (1942a), however, are inclined to refer them to *frontalis*. They report *frontalis* to have but 9 to

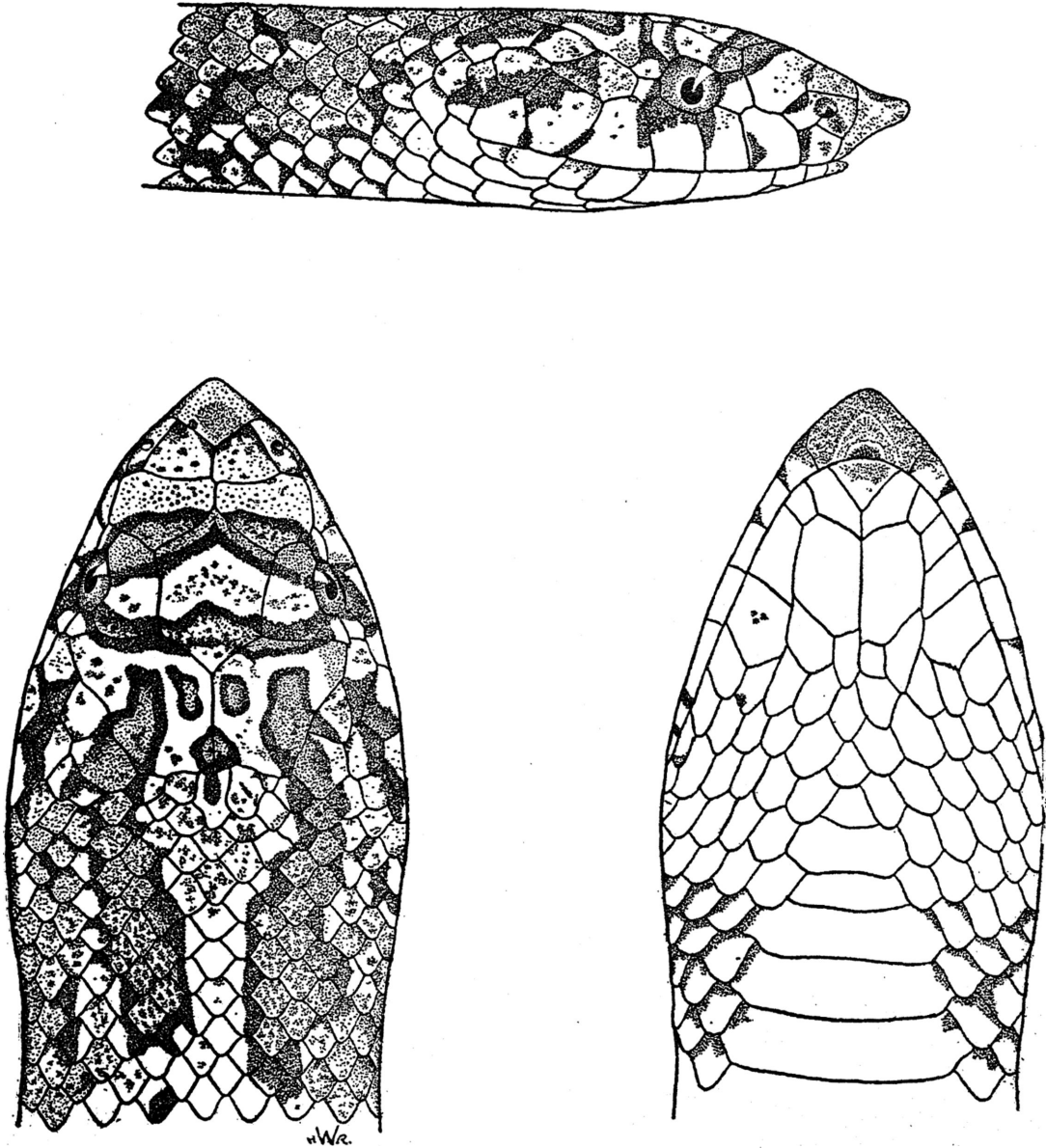


FIG. 9. Lateral, dorsal, and ventral views of the head (approximately $\times 3.2$) of the type of *Pseudocercamia hiltoni*, new species, A.M.N.H. No. 63717, adult male from Guirocoba, Sonora. (Courtesy of Dr. Edward H. Taylor.)

14 maxillary teeth, 7 infralabials, and 35-48 caudals. The present specimen with an incomplete tail still exceeds in caudal count any specimen of the genus yet reported. The type of *P. hilloni* has been examined by Drs. E. H. Taylor and Hobart M. Smith, who compared it with the specimens belonging to the genus which they have assembled. We are indebted to them for the figures of the type, as well as for the photograph used in plate 33. Their kindness in making the comparisons and for other information supplied is much appreciated.

We follow Taylor and Smith in assigning this form to the genus *Pseudoficimia* which can be separated from some related forms (*Conopsis* and *Toluca*) by some of the differences they point out (1942a, p. 243). Several of the characters they list, however, represent only mean differences, or average differences expressed in qualitative terms. There are dichotomous differences in the number of vertebrae and in the character of the nasal. On the other hand, the similarities of snakes now placed in three genera are numerous, and there is little doubt but that they form a collective genetic unit which might more conveniently be designated as a genus (*Conopsis*) composed of three groups (or infrageneric units) of more closely related species. Taylor and Smith (1942b) provide diagnoses of the "genera" *Conopsis* and *Toluca* which include no characters that might serve to separate them, although Dr. Smith (*in litt.*) informs us that the chief difference between the two assemblages lies in the presence of feeble grooves on the posterior teeth of *Conopsis*, whereas these are not present in *Toluca*. Even this character is not apparent in their plate (1942b, pl. 35), and it has already proved necessary to include snakes with and without grooved teeth in the same genus—the African "genus" *Elapops* with *Aparallactus*, for example. Accordingly, we prefer to consider *Toluca* a synonym of *Conopsis*, but tentatively we are willing to recognize *Pseudoficimia*.

It is perhaps unnecessary to point out, as has already been so ably done by Mayr (1943, p. 138) and implied by Simpson (1943a), that the function of the generic name is to indicate similarities, whereas differences in taxonomic characters are more

properly indicated by means of infrageneric groupings into subgenera, species, or subspecies. The inherent difficulties, of course, evolve from the fact that our nomenclatorial system, where combinations of names are used to imply gross relationships, denotes the existence of dichotomies, whereas in actual practice we are concerned with all degrees of similarity or difference. In setting up taxonomic groups we are concerned with the nature of the variations and commonly with a number of characters which vary independently. The nature of these variations cannot, of course, be indicated satisfactorily by a simple binominal or trinominal name, but the fundamental difference between the functions of the generic and specific units should be borne in mind when generic names are either erected or synonymized.

Hypsigena torquata-ochrorhyncha
(intergrades?) $\times 17$

Alamos, 1 (A.M.N.H. No. 64246, with pattern of *ochrorhyncha*).

Guiracoba, 6 (A.M.N.H. Nos. 63732-63733, with pattern of *torquata*; Nos. 63734-63737, with pattern of *ochrorhyncha*).

These seven specimens, four males and three females, cannot be referred definitely to either *torquata* Günther, 1860 (type locality, Laguna Island, Nicaragua), or to *ochrorhyncha* Cope (type locality, Cape San Lucas, Baja California) for reasons which will be explained below.

All specimens have the dorsal scale formula 21-21-15. Ventrals 172, 173, 176, 187 (males) and 178, 179 (females), caudals 62, 63, 65 on three males, other specimens with incomplete tails. Supralabials 8, infralabials 10, loreal 1, preoculars 2, postoculars 2, temporals 1+2 without variation. Two of the males have the light nuchal band hitherto considered characteristic of *torquata* whereas the other two males and two females have the dark "*ochrorhyncha*-type" of nuchal band. On all six Guiracoba specimens the patterns posterior to the dark or light nuchal bands are essentially similar, with 58, 52, 63, 52, 53, and 57 blotches, respectively; the Alamos specimen has 64. A male and a female from Guiracoba and the female from Alamos with "*ochrorhyncha*" markings have the dark nuchal band connected with the dark lines

behind the eyes, while on two other specimens the lines are not connected. Maxillary teeth, 9 on 8 maxillae and 10 on 3, followed by a diastema and two enlarged teeth in all cases. Over-all dimensions of largest male 436 mm., of largest female 477+ (tail incomplete). Ratios of tail to total length in three complete males vary from 0.19 to 0.20, for two females from 0.15 to 0.16.

STOMACH CONTENTS: One specimen contained two small *Bufo alvarius* while another contained a half-grown *Bufo mazatlanensis*. Hilton's notes state that these snakes are known at Guirocoba as the "vibora muda" and are commonly believed to be poisonous. The senior author found the same name applied at Alamos.

REMARKS: The snakes of the genus *Hypsiglena* have been reviewed by Dunn (1936, pp. 689-698), who assigned to the genus *Leptodeira* all species formerly referred to *Hypsiglena*. Also Dunn regarded *ochrorhyncha* as a race of *torquata*. More recently Taylor (1938c, pp. 367-376, pl. 37) has resumed use

of the name *Hypsiglena* for certain forms, and he considers *torquata* (with a race, *dunkeli*) to be distinct from *ochrorhyncha*.

On the basis of pattern characters alone, two of the Guirocoba snakes would be referred to *torquata* while the remaining four (and the Alamos specimen) would be referred to *ochrorhyncha*. Hitherto snakes with patterns characteristic of each of these forms have not been reported from a single locality. Fortunately several additional specimens from the west coast of Mexico and from the United States are available for comparison. With additional data tabulated from these it is possible to offer further evidence bearing on the relationships of the six individuals from Guirocoba.

In the American Museum collection there are seven snakes from the west coast of Mexico taken in the states of Colima, Nayarit, and Sinaloa, which should be referred to the subspecies *torquata* on pattern characters. All, except for minor variations, are similar in cephalic scalation. Taylor (1938c

VENTRAL AND CAUDAL COUNTS FOR *Hypsiglena*

A.M.N.H. No.	Locality	Sex	Pattern ¹	Ventrals	Caudals
12779	Colima, Colima	♂	T	161	17+
12778	" "	♀	T	168	38
19775	" "	♀	T	171	39
62258	Acaponeta, Nayarit	♂	T	164	50
4312	Escuinapa, Sinaloa	♂	T	161	34+
19787	Mazatlán, Sinaloa	♂	T	168	54
19785	" "	♀	T	170	41
R.T.M. 344	Ahome, "	♀	O	178	50
A.M.N.H. No.					
63732	Guirocoba, Sonora	♂	T	176	62
63733	" "	♂	T	172	63
63735	" "	♂	O	178	65
63736	" "	♂	O	173	55+
63734	" "	♀	O	178	46+
63737	" "	♀	O	179	50+
64246	Alamos, "	♀	O	177	53
2545	Tucson, Arizona	♂	O	170	51
3707	"Arizona"	♂	O	168	60
63506	30 mi. SW. Tucson, Ariz.	♂	O	178	53
2542	Tucson, Arizona	♀	O	179	44
5099	" "	♀	O	182	44
62938	" "	♀	O	186	48
63505	24 mi. SW. Tucson, Ariz.	♀	O	177	52
9184	Phoenix, Arizona	♀	O	183	51
15068	Huachuca Mts., Ariz.	♀	O	179	46
63507	" " "	♀	O	178	49

¹ The symbol T refers to the *torquata* pattern, with the whitish nuchal band; O refers to the *ochrorhyncha* pattern without the whitish nuchal band.

p. 373), perhaps through a typographical error, concluded that "The probability is that 7-7 is the normal formula for upper labials in western Mexican specimens." Six of the American Museum specimens possess the supralabial formula 8-8, only one being asymmetrical and having the formula 7-8; Taylor reports two specimens with 8-8, two with 7-8, and only one with 7-7. Klauber (1931, table 8) reports 8 labials as normal for *ochrorhyncha* from San Diego and Imperial counties in California, although 7 and 9 occur. Thus the number of labials offers no basis for separating *ochrorhyncha* from *torquata*.

Ventral and caudal counts tabulated (p. 379) for the few specimens available suggest that there are gradients for these characters.

The differences between populations may be analyzed most easily by summarizing the data, listing means for the sexes separately and grouping the specimens by regions.

REGIONS
Colima, Nayarit, and Sinaloa
Guero-coba and Alamos, Sonora
Arizona

region is composed of a population having both patterns. No penial, dentitional, or other morphological difference seems to be correlated with the difference in pattern. If the nuchal blotch proves to be the result of a single genetic factor it is a reasonable supposition that both patterns may occur on the young of a single litter in the region where the ranges of the two forms adjoin or merge. Conclusive evidence may have to await the results of breeding experiments. It is conceivable that ecological differences separate the two forms at Guero-coba, but this seems doubtful. The form, *ochrorhyncha*, is not a specialized snake as far as habitat is concerned and may occur in almost any type of country from sea level to 7000 feet elevation. The tropical form seems to be similarly versatile, and the specimen mentioned above from Acaponeta, Nayarit, was collected by the senior author under a stone, in precisely the same sort of situation where *ochrorhyncha* might occur.

SEX	VENTRALS (MEANS)	CAUDALS (MEANS)
♂	163.30	52.0
♀	171.75	42.0
♂	174.80	63.3
♀	178.00	53.0
♂	172.00	54.6
♀	180.60	47.7

This information indicates that, from south to north, there is an increase in the number of ventrals, with Guero-coba and Alamos specimens falling closer to Arizonan specimens. For caudals there seems to be a striking increase in number in Guero-coba specimens, the latter having more than either Arizonan *ochrorhyncha* or coastal Mexican *torquata*. It is of interest to note, however, that Klauber's table (*supra cit.*) indicates that all extremes occurring in Mexican and Arizonan specimens also occur in specimens from San Diego and Imperial counties of California.

From this summary of limited data the conclusion may be drawn that the two nuchal patterns occurring in the Guero-coba series do not represent two species. Rather, the existence of both patterns in a single locality in a region situated between the ranges of a northern form, *ochrorhyncha*, and a southern form, *torquata*, implies that the intermediate

Thus, these additional facts now available appear to confirm the conclusion drawn by Dunn (*supra cit.*), namely, that *ochrorhyncha* should be placed as a subspecies of *torquata*. Taylor (*supra cit.*) has supplied a diagnosis for *Hypsiglena*, which serves to separate the snakes of this group from *Leptodeira*, however, and the form occurring in the United States and northwestern Mexico accordingly should be known as *Hypsiglena torquata ochrorhyncha*, pending better evidence to the contrary.

To the known range of *H. t. ochrorhyncha* may be added Clarion Island. Through the generosity of Dr. William Beebe, the American Museum has received a small collection taken on that island by the "Zaca" expedition, which includes a male with dorsal scales 21-21-17, ventrals 183, anal divided, caudals 59+, supralabials 8-9, infralabials 10, loreals 2, preoculars 2-3, postoculars 1, temporals 1+2. This specimen possesses some

unusual characters but none that is not known to occur in mainland specimens; the pattern is quite typical of *ochrorhyncha*. This specimen extends the known range of the subspecies some 400 miles from the closest known point of occurrence on the peninsula of Baja California.

After the above notes were prepared a somewhat amazing paper by Wilmer W. Tanner appeared. In this paper Tanner (1943, pp. 49-54) proposed two names, "*Hypsiglena nuchalatus*" and "*Hypsiglena slevini*." The former is based upon specimens from central California, the type locality being Lemons Cove, Tulare County. Whereas he calls this form a "species," he follows his description by a discussion of "relationships and intergradations [*sic*]" and proceeds to list intergrades from three localities and to discuss areas of intergradation. It seems obvious that his *nuchalatus*, if the pattern characters described by him serve to differentiate it, should be placed as a subspecies of *torquata*. No precise data are provided to substantiate the statement in the diagnosis that the form has "a more elongate snout and a narrower head" than *ochrorhyncha*. The width of the head is certainly subject to measurement, and it should have been stated what datum for comparison was used.

The second "species," *slevini*, is based on a single specimen (No. 53631 in the California Academy of Sciences) from Puerto Escondido, Baja California. Because the types of both *ochrorhyncha* and its apparent synonym, *venusta*, came from the same peninsula, it is not a trifle astonishing to find a third name being erected on the basis of a single specimen. The form is diagnosed as having "a high ventral and subcaudal count, and by the parietals contacting [*sic*] the lower postoculars. The snout is blunt and the eye is large. The color pattern is also distinct."

Of these statements the last two sentences are meaningless without further data to substantiate them. The fact that the parietals are in contact with the lower postocular indicates that the upper postocular has fused, probably as an abnormality, with the parietal; with a single specimen taken within the range of a population previously named this can hardly be construed as evidence of differentiation. A ventral count of 190 is within

the reported range (160 to 199, *fide* Klauber, 1931, and Woodbury, 1931), while a caudal count of 68 scarcely exceeds the maximum reported some years ago by Klauber (*supra cit.*) before so many specimens were available. We are forced to the assumption that Tanner was diagnosing a specimen rather than drawing inferences concerning the population comprising the species which a type is supposed to represent. Accordingly we assign *slevini* to the synonymy of *ochrorhyncha*.

We may add that the maxillary counts reported by Tanner are without doubt erroneous. We find from eight to 10 teeth, followed by two that are enlarged in the specimens we have examined, whereas Tanner reports but four in *nuchalatus* and but five in the type of *slevini*, in addition to the posterior pair of enlarged teeth. It seems probable that he was counting only the ankylosed teeth and not the sockets, which must, of course, be included.

Oxybelis aeneus auratus (Bell)

Text figures 10, 11

Dryinus auratus BELL, 1825, Zool. Jour., vol. 2, pp. 324-326, pl. 12; "Mexico."

Oxybelis acuminatus BOULENGER (*partim*), 1896, Catalogue of the snakes in the British Museum, vol. 3, p. 192.

Oxybelis microphthalmus BARBOUR AND DO AMARAL, 1926, Proc. New England Zool. Club, vol. 9, p. 80; Calabasas Cañon, Santa Cruz County, Arizona.

Oxybelis potosiensis TAYLOR, 1941, Univ. Kansas Sci. Bull., vol. 27, p. 128, pl. 6, figs. 4, 5, 6; 38 kilometers northwest of Ciudad Maiz, San Luis Potosí, Mexico.

Alamos, 2 (A.M.N.H. Nos. 64247-64248).

Guero-coba, 3 (A.M.N.H. Nos. 63739-63741).

This material consists of three males, a female, and one specimen (from Guero-coba) too poorly preserved to determine the sex or to make ventral and caudal counts. Dorsal scale row formula uniformly 17-17-13. Ventrals: female 198; males 195, 195, and 200. Anal plate divided. Caudals 178 and 184 in two Alamos males, with the tail definitely incomplete on other specimens and not certainly complete in these two. Supralabials 8-9 on three, 9-9 on two. Infralabials 10, one specimen with 9 on one side. Loreal absent. Preocular single; postoculars 2, one specimen from Alamos having the postoculars fused on

one side. Temporals uniformly 1+2. Over-all dimensions of the four complete or nearly complete specimens are 1415 mm. (female) and 1173, 1350, and 1411 mm. (males). The ratios of tail to total length vary from 0.40 to 0.41.

All these Sonoran specimens are essentially alike in coloration, being brownish gray above, with black dots occurring at irregular and widely spaced intervals on the body.

of the dorsum, and this darker coloration extends onto the sides of the head to the edges of the supralabials. The first labial and the lower portion of the nasal are white, but the remainder of the supralabials are margined with black above, thus producing, in effect, a dark streak that extends from the posterior part of the nasal onto the neck. Infralabials, gular region, and underside of the neck immaculate, gradually merging with the darker

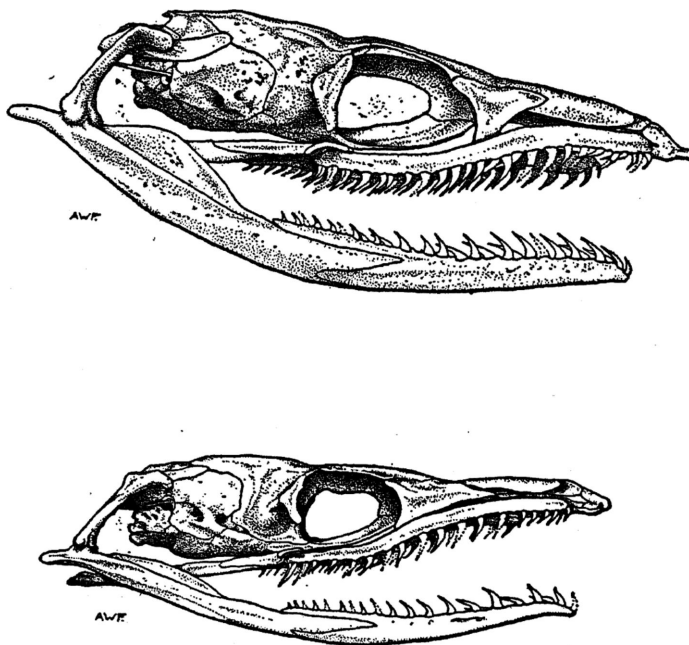


FIG. 10. Lateral views of the skulls of *Oxybelis aeneus aeneus* (upper, A.M.N.H. No. 13440, from Paramba, Ecuador) and of *Oxybelis aeneus auratus* (lower, A.M.N.H. No. 61050, from Tehuantepec, Oaxaca, Mexico). Note the relatively more attenuate structure of the Tehuantepec specimen, particularly the prefrontal, as compared with the specimen from Ecuador. Enlargements are approximately $\times 3$.

Anteriorly the lower basal portion of some individual scales is black, or the black area may occasionally fall on the upper portion. However, these dark areas are normally obscured by the overlapping of the scales so that unless the skin is distended they are not apparent. The underside is but slightly darker than the dorsum, with obscure blackish lines paralleling the edges of the venter, and with a faint lighter streak down the middle of the venter. Prior to preservation the Alamos specimens possessed a tinge of yellowish on the dorsal scales of the anterior portion of the body. The upper surface of the head is somewhat darker than the remainder

venter on the anterior fifth of the body.

STOMACH CONTENTS: One specimen from Alamos contains a *Uta ornata linearis*.

REMARKS: In order to classify these Sonoran specimens the availability of several names had to be considered. These included those listed in the synonymy above, as well as additional forms described on the basis of South American examples. The validity of the names proposed will be discussed following a summary of conclusions derived from study of a total of 96 specimens of the group.

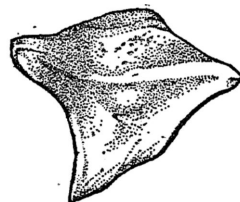
With the material at hand (which includes a single specimen from Arizona kindly lent by the Museum of Zoology, University of

Michigan) and with the data published, we have sought to determine (1) whether there are any morphological differences that might warrant recognition of more than one species, and (2) whether there are any recognizable subspecies. The material we have examined includes specimens from the following regions (with the numbers of specimens listed in parentheses): SOUTH AMERICA, Peru (10), Brazil (1, type of *acuminatus*), Ecuador (9), Colombia (5), Bolivia (2), British Guiana (31), Trinidad (4); CENTRAL AMERICA, Costa Rica (7), Nicaragua (4), Honduras (1), Guatemala (1); MEXICO, Yucatán (1), Veracruz (1), Oaxaca (6), Guerrero (2), Nayarit (1), Sinaloa (4), Sonora (5); UNITED STATES, Arizona (1).

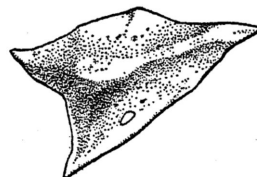
Whereas this material is representative, it is, of course, quite inadequate for any satisfactory study of a variable form ranging over large portions of two continents. The conclusions we are able to draw, therefore, must be considered tentative, more especially because all characters on many specimens could not be tabulated, owing to faulty preservation, loss of tails, or other defects. In fact, the exceedingly long, slender tails of snakes in the genus are so often incomplete and possibly subject to such a wide amount of variation that we have made no attempt to utilize caudal scale data in this study. The number and the arrangement of scales on the head do not appear to offer any suitable means of segregating populations, although there are obvious proportional differences in the sizes of certain scales which we have attempted to utilize. The pattern, scalation, and dentition, as well as penial and osteological characters, may be considered in order, followed by comments on the validity of the various names proposed.

PATTERN: With reference to pattern differences we have been unable to observe any constant differences that might serve to differentiate populations. Some of the variation observable may be attributed to different methods of preservation, to fading or to slight ontogenetic changes. The general appearance may vary from relatively pale gray, to brownish gray, or individual specimens may have tinges of green, or the skin may be a trifle golden. Among Mexican specimens the relative frequency and the size of the

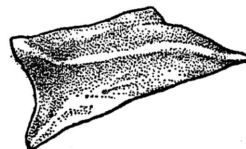
black dots on the skin vary but within rather narrow limits. South American specimens, on the other hand, include snakes with patterns that are hardly distinguishable from those of Mexican specimens, and in addition some with more distinctly mottled patterns. The whitish line down the center of the belly



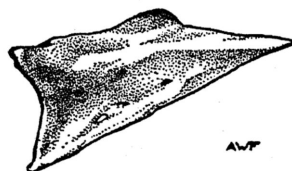
PARAMBA, ECUADOR
NO. 13440



CUKRA, NICARAGUA
NO. 12694



TEHUANTEPEC, OAXACA
NO. 61050



GUIROCOCHA, SONORA
NO. 63740

FIG. 11. Dorsolateral views of the prefrontal bone (approximately $\times 10$) from adult specimens of individuals representing four populations of *Oxybelis aeneus*. These bones provide pictographic evidence of a gradient in skull structures which extends from populations in central South America to southern Arizona in the United States.

varies in prominence and appears in several parts of the range. Parallel dark streaks, one on each side of venter, are equally variable and of sporadic occurrence in both North and South American portions of the range. One character, a mottled condition of the throat which is normally immaculate, perhaps may be of value in segregating a race from the upper Amazon, but there are faint indications of this condition in a few other South American specimens. For the time being we see nothing to be gained by recognizing a race on such a tenuous basis. The black or sometimes brownish streak that commonly extends along the upper edge of the supralabials may extend in varying degrees onto the neck, it may be narrow or wide, or it may be nearly absent. But no condition is especially characteristic of any population of any size.

SCALATION: The variation in scale characters has been summarized by Boulenger (*supra cit.*) and need not be repeated here, except for a few comments. An extra scale may be present or one may be missing (or fused with a contiguous scale) in what constitutes the normal complement in the supralabial, infralabial, preocular, postocular, and

temporal series. The loreal appears to be consistently absent, but it is quite probable that an extra scale may occasionally be wedged in between the labials and the prefrontal; small additional scales are sometimes present between the scales on the top of the head. The material on hand, however, demonstrates no tendency for any of these minor abnormalities to be confined to any particular population.

Ventral count data provide no basis for separating populations, although a north-south trend is suggested by the means. Data derived from our specimens have been combined with additional counts drawn from the literature, particularly Boulenger (*supra cit.*). The sexes have not been segregated because the dimorphism in ventrals is almost negligible in the samples tabulated; of 26 South American specimens tabulated, for instance, the mean for 14 males is 184.8, and for 12 females 185.4. Tabulation of the samples for three physiographic regions offers no sound basis for any segregation of forms, although there are slight differences between means. These may be analyzed roughly, as follows (the mean is followed by its standard error):

	No.	EXTREMES	MEAN	COEFFICIENT OF VARIATION
Mexico and United States	33	174-204	190.24 \pm 1.24	4.24
Central America	23	177-194	187.95 \pm 0.95	2.37
South America	33	174-197	184.87 \pm 1.02	3.10

It may be added that Hartweg and Oliver (1940, p. 27) indicate extremes of 189 to 204 for specimens from the vicinity of Tehuántepec, Oaxaca. Similarly Barbour and do Amaral (*supra cit.*) describe the type (a male) of *microphthalmus* as having 187 ventrals whereas U.M.M.Z. No. 75779 from Peña Blanca Springs, only a few miles distant from the type locality, is a female with 202 ventrals.

A few other scale characters, such as the relative length of the nasal scale, seem to be relatively constant in individual populations but to vary from locality to locality with no particular trend. There are, to summarize,

Number of maxillary teeth	18	19	20	21	22	23	24	25	26	27
Mexico and United States	4	2	10	1						
Central America	7	1	3	4	1	1				
South America	4	2	0	4	1	3	1	1	0	1

no scale characters which seem to provide any basis for segregating populations.

DENTITION: The results of a limited survey of dentitional characters point to some interesting possibilities for further studies of directional trends in mean maxillary counts. However, these data do not permit us to define populations at present, despite the occurrence of higher counts in certain portions of the range in South America. Counts for 17 maxillae have been tabulated for samples drawn from each of three main physiographic regions represented by the sample, and these may be summarized as follows:

Comparison of means, respectively 19.6, 19.6, and 21.2 for the three regions, provides no information of great value, because it is evident that material from individual localities tends to be fairly consistent, but the counts may be either high or low. Specimens from British Guiana, for example, tend to have lower counts than those from Colombia and Ecuador, although the maximum (27) is represented by a specimen from Paramba, Ecuador, and the minimum for South America by a specimen from Colombia with 18. Specimens from the west coast of Mexico (Oaxaca, Guerrero, Sonora), also Arizona, contain variable numbers of teeth, with extremes of 18 and 21, but 20 is the mode. In contrast two specimens available from the east coast (Veracruz and Yucatán, three maxillae examined) uniformly contain 18 teeth. With adequate material it might be demonstrated that the populations from the western portion of the range in each continent tend to have a higher mean number of maxillary teeth.

In general the snakes possessing more teeth in the maxilla tend also to have more slender teeth than those with few teeth. All specimens have the posterior two teeth deeply grooved, and commonly the two fangs are somewhat larger than the adjacent teeth; a

diastema preceding the fangs may or may not be present, and the tooth preceding the fangs may be nearly as large as the latter. Whereas the paired fangs are invariably grooved (one or both of them may be ankylosed) the teeth anterior to them may be grooved or not. On some specimens the tooth anterior to the normal fangs is nearly as strongly grooved as the two posterior teeth. Exceptional specimens have distinct grooves on half their maxillary teeth, but grooves have not been detected on the anterior teeth. Furthermore, the grooves on the teeth anterior to the fangs are more commonly found on large specimens; juveniles appear to have the grooving confined to the two or three teeth on the posterior extremity of the bone.

Teeth in other series have not been examined in any number of skulls, although these are commonly of less value in taxonomic work than the maxillary series in all other snakes with which we have dealt, and we do not anticipate that any characters of systematic importance will be found. The information pertaining to all teeth in one specimen from each of five representative portions of the range may be presented in tabular form (two figures indicate right and left sides, respectively):

LOCALITY	MAXILLA	PALATINE	PTERYGOID	DENTARY
Guircoba, Sonora	20-20	12-13	11-10	24-24
Tehuantepec, Oaxaca	19-18	13-11	11-11	21-19
Panteon Viejo, Veracruz	18-18	10-11	8-8	21-19
Cukra, Nicaragua	18-19	15-15	11-11	21-21
Paramba, Ecuador	25-22	13-13	13-13	29-28

It is of interest to note one fact in connection with this tabulation, namely, that specimens with a greater number of teeth in the maxillary series also tend to have more teeth than is usual in other series. This has been observed in other groups of colubrids, but it is by no means a rule. It may be added that distinct grooves very often are present on nearly all the dentary teeth in adult *Oxybelis* of *aeneus* stock from all regions from which samples were drawn. Grooves have not been observed on the palatine and pterygoid teeth, however.

To summarize the dentitional data, evidence for a separation of subspecies is negative.

HEMIPENES: The male copulatory organs of a few specimens from selected portions of the range in both continents have been examined, but no significant differences have been observed. The hemipenis is variable in length, extending in the tail from the seventh to the tenth caudals when examined *in situ*. No enlarged basal spines are present. The basal portion is provided with relatively small hooks or recurved, claw-like spines which are staggered in about 10 rows. These spines merge with calyces having denticulated edges after a distance of about two caudals. The calyces are progressively less strongly denticulated toward the distal end. Cope's figure (1900, pl. 28, fig. 16) is approximately

accurate except that he indicates small spines rather than hooks on the base. The sulcus is single as depicted by Cope.

HEAD PROPORTIONS: When South American specimens are compared with those from Mexico certain differences in the relative proportions of the heads of the snakes from the two regions become apparent. Those from Mexico appear to be relatively more slender, with a more attenuated snout than those from South America. In general, the snout of Mexican specimens extends farther beyond the lower jaw than it does on South American individuals; commonly the anterior extremity of the mental of Mexican individuals falls immediately below the anterior end of the first supralabial, whereas on South American snakes the mental may rest under the rostral. But there is not a little variation, with all intermediate conditions represented, and without doubt the position of the snake's jaw at the time of preservation introduces additional error. The nature of the variations makes this a difficult character to treat statistically.

Ratios of head width to head length provide information of some value, but because relative proportions of the head in vertebrates do not remain constant throughout the ontogeny of the individual, comparisons of small samples are inadequate.

Utilizing adult individuals only, we have calculated ratios of head width to head length for 10 Mexican and American specimens, for 11 from South America, and for seven from Central America. Only specimens in which the head had not been distorted in preservation were utilized. Measurements were made of the head width at the posterior ends of the parietals, while the length of the head was measured from the posterior extremity of the parietals to the end of the snout. The data may be summarized as follows (with extremes in parentheses):

	RATIO, HEAD WIDTH/HEAD LENGTH
Mexico and United States	.33 (.28-.38)
Central America	.35 (.31-.40)
South America	.38 (.33-.44)

Thus, while there is no evidence of any satisfactory taxonomic difference between the populations compared, these data sug-

gest that, were sufficient material available, regression coefficients might be calculated which would show that Mexican specimens, as they approach adult proportions, tend to acquire relatively slender heads when compared to South American individuals. But the Central American specimens again prove to be intermediate, and there is little likelihood that the ratio considered will provide any basis for segregating races.

We may turn now to a consideration of the relative size of the eye. One form, *microphthalmus*, is diagnosed as having "a much smaller eye," despite the fact that this statement is nearly meaningless unless the datum for comparison is mentioned. The diameter of the eye obviously is not proportionately large when compared with the depth of the head, and it may be inferred, in fact, that the eye is "smaller" because the skull itself has become relatively slender. Thus it is necessary to select some measurement that can be made with accuracy and one that represents some horizontal dimension if we are to make a satisfactory comparison of relative eye sizes in the populations we wish to compare. After testing various characters we selected the length of the internasal scutes as the datum for comparison with the horizontal diameter of the eye. When the internasals were not of equal length, the dimensions of the longer one of the pair were recorded. Measurements of eye diameter are not entirely satisfactory, particularly when the eyes are sunken in poorly preserved specimens, or when the scales surrounding the eye have been distorted at the time specimens were hardened in preservative. We have omitted poorly preserved or distorted specimens from this study, therefore, while the eye and the internasal length of the specimens utilized were measured with a vernier caliper under a dissecting microscope. The resulting data were recorded to the nearest tenth of a millimeter.

But again, in comparing relative dimensions of the eyes, we are confronted with the necessity of considering ontogenetical changes; the eyes of juvenile snakes of almost any colubrid appear, upon inspection, to be relatively larger than those of adults, and this is borne out by actual measurements. Because problems of relative growth are in-

volved, we present our data in the form of a scatter diagram (fig. 12). Unfortunately comparatively few juveniles are available, and with the few suitable specimens on hand only a crude estimate of the trends for populations can be established. An overlap in characters

These data may be considered in another fashion, perhaps more readily adapted to taxonomic procedure, by segregation of the specimens at an arbitrary level on the basis of the ratios calculated for individuals. Separating those having an eye diameter as large

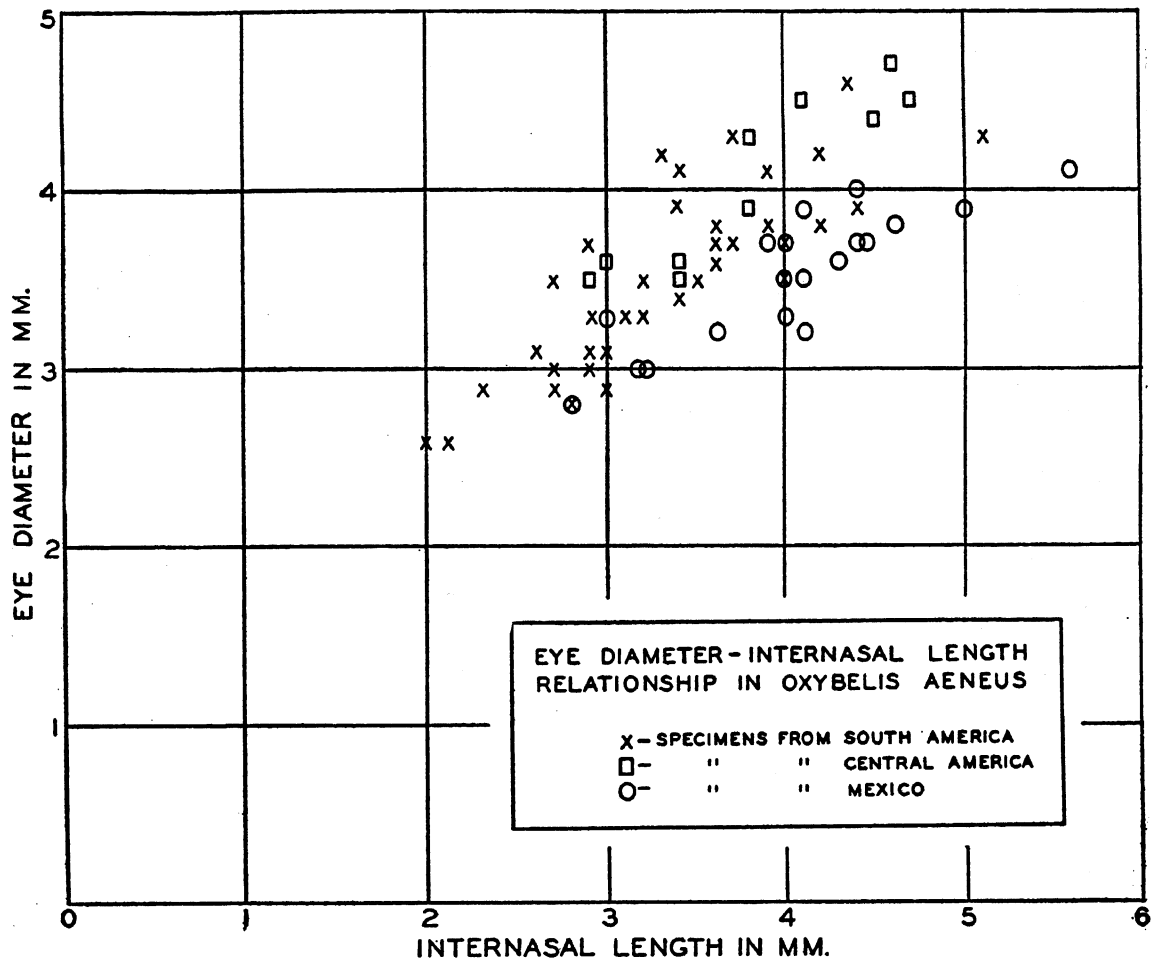


FIG. 12. Scatter diagram, illustrating relationships of the eye diameter and internasal length in *Oxybelis aeneus*. Mexican, Central American, and South American specimens are plotted with separate symbols in order to show the similarities of Central American and South American specimens, and the overlap between these populations and that of Mexico in the ratios represented.

becomes apparent, but there is, nevertheless, evidence of differentiation in the Mexican population. However, on the basis of the eye/internasal-length ratio the Central American specimens cannot be separated from South American specimens comprising the sample.

or larger than the length of the internasal, it becomes possible to segregate a high percentage of Mexican individuals from those from Central and South America. These data may be tabulated, using the symbols E for eye diameter and I for internasal length, as follows:

	No.	E/I = LESS THAN 1.0	E/I = 1.0 OR MORE
Mexico and			
United States	18	88.9%	11.1%
Central America	11	9.1%	90.9%
South America	42	21.9%	79.1%

This tabulation, of course, does not take into consideration all the facts available. The only specimens from Mexico that do not have eye diameters smaller than the internasal length are two juveniles, one from Oaxaca and one from Guerrero. Thus, had only adults been considered, 100 per cent of the Mexican specimens would have had eyes with a diameter as large, or larger than, the length of the internasal. Now if we combine the data for South American and Central American specimens, approximately 81 per cent of these specimens possess eyes of greater diameter than the internasal length, and some basis for recognition of races is provided.

Of the South American specimens tabulated, those having an eye diameter less than the internasal length include one specimen from Colombia, three from British Guiana, and two from Ecuador. The type of *acuminatus* has an eye/internasal ratio of 0.96, and both the maximum and minimum ratios calculated for the South American sample are represented by specimens from British Guiana; these ratios are, respectively, 1.3 and 0.88.

Of 11 specimens from Central America, the only specimen having an E/I ratio of less than 1.0 is from Chontales, Nicaragua. It is apparent that these Central American specimens agree with those from South America on the basis of this character. While the single adult specimen from Guatemala provides a meager basis upon which to draw conclusions, it would appear that the most abrupt change in proportional eye size occurs somewhere between Guatemala and southern Oaxaca, possibly in Chiapas. However, the change may be more or less gradual, and with ample samples from various Pacific coastal states in Mexico, regression coefficients could possibly be calculated to demonstrate this. The minimum ratios for specimens from western North America include specimens from Arizona, Sonora, and Oaxaca; on a single specimen from Veracruz the ratio is

relatively low, whereas another specimen, the only one available from Yucatán, is relatively high (0.95) for a Mexican individual. But if this peninsular specimen proves to be representative, the Yucatán population would be included in the Mexican assemblage.

To sum up the situation, these somewhat tenuous data point to the presence of different growth factors in (1) the Mexican and Arizonan, and in (2) the Central and South American populations. The size of the eye in proportion to the length of the snout becomes relatively small in adults of the northern population, but during the ontogeny of Central and South American representatives of the group the ratio of the eye to internasal length tends to remain more nearly constant. On the basis of the character in question there is no evidence of any further segregation of smaller populations, but the differential in ontogenetic trends in the two larger groups may be worthy of taxonomic recognition.

SKULL CHARACTERS: It is to be expected, of course, that external differences in head proportions will be reflected in cranial elements. To determine the validity of this assumption a few skulls from samples from various portions of the range have been removed and cleaned, and certain aspects of the cranial osteology have been determined in other specimens partly dissected. The maxilla, quadrate, and mandible of Mexican specimens prove to be relatively slender when compared with Central and South American specimens, and essentially the same statement applies to nearly all the individual cranial elements (see fig. 10). But if the few skulls examined provide a reliable index to mean differences between populations there is no evidence of dichotomy. Rather, four skulls respectively from Ecuador, Nicaragua, Oaxaca, and Sonora suggest that the differences observed represent progressive steps in a gradient extending from the United States to South America.

Adequate series of specimens would doubtless disclose a fair amount of variation, and from the small samples prepared for osteological examination it is apparent that all skull elements have not been affected in precisely the same degree. The prefrontal of Mexican specimens, for example, appears to

have become even more elongate in proportion to its width than most other elements. The changes in relative proportions seem to be exaggerated in this bone, and we have for that reason chosen to depict it (fig. 11) to demonstrate the various steps in the gradient of which it appears to be but one of several elements so affected.

It is possible, of course, that sexual dimorphism is present in relative skull proportions, but owing to the limited material at our disposal we have not sought to determine this. We have, however, examined juveniles of both South American and Mexican populations, finding that the shape of the prefrontal in Mexican juveniles closely approximates that of South American adults, whereas the prefrontals of juveniles from British Guiana are not unlike those of adults from the same region.

A few other differences between Mexican and South American specimens may be mentioned. The premaxilla of specimens from the southern continent is broader in proportion to the length of the head, with more distinct lateral projections, in contrast to Mexican specimens which usually have narrow premaxillae, with the lateral processes more or less vestigial or missing. The tabular is amazingly flattened and scarcely raised from the skull anterior to the articulation of the quadrate on both forms, but the reduction is even more marked in Mexican specimens. Similarly the postorbital bone is reduced in size in specimens from Mexico.

THE VALIDITY OF NAMES PROPOSED

Such evidence as we have been able to assemble on the basis of 96 specimens indicates that a single, widely distributed species is represented. Several characters studied vary in such a manner that their taxonomic use is difficult, but one character, the size of the eye in proportion to the length of the internasals, offers some basis for recognition of two races, (A) one inhabiting Mexico, and (B) one inhabiting Central America and northern and central South America. Because no fewer than six names have been proposed it must be determined which is applicable to each of these populations. Those available may be discussed in chronological order under the dates of their proposal:

1824 *Dryinus aeneus* WAGLER, in Spix, *Serpentum Brasiliensium*, p. 12, pl. 3; type locality, "sylvis adjacentibus flumini Solimões, prope Ega."

The locality "Ega" apparently is an older name for a former mission station and town now known as Teffé on the south bank of the Amazon River near the junction of the Río Teffé, almost in the center of the state of Amazonas. As depicted in Spix, the dorsum of the type is exceptionally brown or bronze-colored. A few specimens from the upper Amazon tend to be darker than others examined, but whether the type was discolored or depicted in colors somewhat darker than in life cannot be stated. Likewise the snout appears to be upturned, presumably as an accident of preservation, but aside from these characters it is identifiable as the form of *Oxybelis* in question. It was described as having 203 ventrals and 180 caudals, both counts being included within the known range of the form, although the ventral count is near the maximum. The name *aeneus* appears to antedate any name proposed for the species and, furthermore, was designated as the type species of the genus.

1825 [*Coluber*] *acuminatus* WIED, *Beiträge zur Naturgeschichte von Brasilien*, vol. 1, p. 322; type locality, Río Espírito Santo, Brazil; type specimen, A.M.N.H. No. 3886.

Commonly (but not always) the name *acuminatus* has been credited to Wied's "Abbildungen zur Naturgeschichte Brasiliens," the title page of which bears the date 1823, although it was issued in separate numbers or parts over a period of nine years. Heft 1 was mentioned in Oken's *Isis* in 1822, while Heft 15 apparently appeared in 1831. Heft 14, in which *Coluber acuminatus* was depicted, is listed in Oken's *Isis* for 1831, but according to the "Catalogue of the books . . . in the British Museum (Natural History)" it was published in 1830. Following his diagnosis of *C. acuminatus* in his "Beiträge" Wied mentions his "Abbildungen" but cites no particular plate, and apparently he was merely indicating his intention of depicting the snake in his work which was then in preparation. On the other hand, in the text accompanying the plates in his "Abbildungen" he often mentions his "Beiträge,"

citing volume and page, indicating that the latter appeared before many parts of the "Abbildungen" had been published. Furthermore, in the closing paragraph of his description of *acuminatus* he mentions *Dryinus aeneus*, crediting it to Spix. Therefore, all evidence indicates that *aeneus* of Wagler (in Spix) is the older name, and because there is no evidence that two species are involved, the name *aeneus* has priority.

The type of *acuminatus*, heretofore not recognized as such, is still extant and present in the American Museum collection. The collection of Prince Alexander Philip Maximilian of Wied, which included mammals, birds, fishes, and reptiles, was purchased between 1869 and 1870 by the Museum, but only within recent years has it become apparent that several types were included. The types included among the reptiles were not labeled as such, but those that we have examined agree in such detail with the specimens depicted by Wied that there can be no doubt concerning their authenticity.

A single specimen of *Oxybelis acuminatus* was included in Wied's collection. It bears an old American Museum paper tag (in addition to the tin tag bearing the number 3886, which was doubtless attached when the present catalogue was begun) with the name *Oxybelis aeneus* Wagler abbreviated on one side, and below it is penned "Brazil" and "Maximilian." On the other side of the label, in quotation marks, is the name "Coluber acuminatus Wied." Complete scale counts were made of the specimen, and they agree in nearly all particulars with the description supplied by Wied. The specimen is a female with the dorsal scale formula 17-17-15, 197 ventrals, anal plate divided, and 144 caudals (though the tail is not complete the terminus is healed and the count agrees with that of the original description). Supralabials 8-9, the fourth and fifth reaching the eye on the right side, whereas the fourth, fifth, and sixth do so on the left. Infralabials 8-8. Nasal entire, loreal absent, preoculars 1-1, postoculars 2-2, temporals 1+2. Length over all 1225 mm., the incomplete tail comprising 444 mm. of the total length. The head width is 9.4 mm., the length (from posterior extremity of parietals to end of snout) 23.8 mm. The eye diameter is 4.4 mm., and the length of the

internasals is 4.6 mm. The specimen, therefore, has relatively smaller eyes than the majority of South American specimens, although in relative head width it is closer to the mean. The specimen is in comparatively good condition, although it has about 10 ventral scutes decomposed near the posterior portion of the venter. An accurate ventral count can still be made, however, by counting the oblique dorsal rows in this section. The teeth, unfortunately, cannot be examined owing to a crystalline deposit of some sort in the mouth which cannot be removed without risking breakage of the bones.

1855 *Dryophis vittatus* GIRARD, in Gilliss, J. M., United States naval astronomical expedition, vol. 2, p. 211, pl. 36; type locality, Taboga Island, Bay of Panama.

The characters listed by Girard include nothing beyond the known range of variation in *aeneus*. The ventral count is reported as "193+2" or 194 including a divided scale preceding the divided anal scute. The caudals are 165 plus "verticils of scales surrounding the remaining portion of the tail." Pending the assemblage of considerably more material from South and Central America this form (as well as *acuminatus*) will have to be considered a synonym of *Oxybelis aeneus aeneus*.

We may now turn to the forms with type localities in Mexico.

1825 *Dryinus auratus* BELL (*supra cit.*).

With no more definite source than "Mexico" it is perhaps unfortunate that this name appears to be applicable to the Mexican population. The type as described and depicted, doubtless with minor inaccuracies, seems to be fairly representative of Mexican specimens. Bell diagnosed it as having 196 ventrals and 160 caudals and correctly noted that it had "considerable relation to *Dr. aeneus*" but that it differed in color, and was "of more slender proportions."

1926 *Oxybelis microphthalmus* BARBOUR AND DO AMARAL (*supra cit.*).

Whereas we have not seen the type (No. 22417 in the Museum of Comparative Zoölogy), we have seen a female from Peña Blanca Springs (No. 75779 in the Museum of Zoology, University of Michigan) which is

essentially topotypic. This specimen proves to be not unlike specimens from other regions in Mexico, as do Amaral (1929, p. 216) anticipated when he suggested that Mexican specimens had been confused with *acuminatus* (= *aeneus*). Do Amaral's assumption proves to be correct, although he seemingly neglected to consider the priority of *auratus* to which the poorly differentiated Mexican population must be referred until better evidence to the contrary can be assembled. The "reddish" coloration of the dorsum described by Barbour and do Amaral is not apparent on the specimen from Peña Blanca Springs and on the type may have resulted from the preservative or contamination from the container. The type (a male) is described as having 187 ventrals and 181 caudals, whereas the female from Peña Blanca Springs has 202 ventrals and 166 caudals with the tail incomplete. Because there is no evidence of such striking sexual dimorphism in the ventral counts in other samples available, it seems fair to assume that these differences may be attributed to the normal variation within the local population in Arizona. It may be added that the counts for the Arizona female are close to the counts tabulated for specimens from southern Sonora.

1941 *Oxybelis potosiensis* TAYLOR (*supra cit.*).

We have not seen the type (No. 23614 in the Taylor-Smith collection) of this form from the Atlantic drainage of the Mexican plateau, but the description leads us to believe that it closely resembles the single specimen we have had available from Panteon Viejo, Veracruz. On the basis of a single specimen the diagnostic characters provided do not warrant the inference that a distinct species is represented. The head may, indeed, be "less attenuated" than specimens from Guerrero (with which it was compared on the assumption that these represented *acuminatus*), but no precise data are provided to substantiate this conclusion. In any case relative head proportions are quite variable and subject to ontogenetical changes. The presence of a very small, inferior preocular, from the very nature of the scale, can best be interpreted as an anomaly, resulting from an abnormal suture on the fourth labial; we find

precisely the same sort of additional scale on the left side of A.M.N.H. No. 17349 from Greytown, Costa Rica. The first pair of labials are described as being "longer than the first pair of chin shields," although Taylor's figure (fig. 5) shows the anterior chin shields to be about one and one-half as long as the first pair of labials. This character may be assumed to be of doubtful importance. The "black transverse markings, conspicuous when the skin is stretched" occur, as noted above, with varying degrees of prominence in specimens from several parts of the range but provide no evidence indicating segregation of populations, nor can the absence of lineation on the venter be considered diagnostic in the assemblage which we refer to *Oxybelis aeneus*. Other characters mentioned but not included in the diagnosis are concerned with the dentition, but again the variations in the number of teeth summarized above include every character represented in the type of *potosiensis*, save only the maxillary count. Taylor reports the maxillary teeth to number 15, followed by two grooved fangs. If this count is correct (and an anterior socket is readily overlooked unless the bone is examined carefully when dry), it extends by one tooth the known range of variation. This is to be expected considering the small number of maxillae we examined.

We are forced to conclude that *potosiensis* is referable to the synonymy of *auratus* Bell.

SUMMARY: A somewhat limited study of several characters leads us to the tentative conclusion that but two populations of *Oxybelis aeneus* can be recognized, namely, *O. a. aeneus* with a range extending from Guatemala to southeastern Brazil, and *O. a. auratus* which ranges from southern Arizona, in the northwest, and from San Luis Potosí in the northeast, southward to the Isthmus of Tehuán-tepec and the Yucatán peninsula.

South of the Isthmus of Tehuán-tepec the form gradually merges with *O. a. aeneus*. Gradients or excessive variation in nearly every character studied were indicated, and four proposed names are relegated to the synonymies of the two forms retained.

Adults of the two forms can most conveniently be separated on the basis of the following characters:

1. Diameter of eye greater than internasal length *O. a. aeneus*
2. Diameter of eye less than internasal length *O. a. auratus*

It may be mentioned in passing that the genus *Alleidophis* (type species *worontzowi*; type locality, Amani River, Amazonas, Brazil) described by Prado in 1939 (p. 5, figured on p. 7) as being close to *Oxybelis* seems to bear not even superficial resemblance to any snake of the genus. *Alleidophis* may be a valid genus, but without more detailed knowledge of its anatomy, particularly of the skull and hemipenis, we would not attempt to place it.

In all probability the species *aeneus* is the most highly specialized member of the genus *Oxybelis*, as indicated by its more attenuated body and head. In skull modifications the South American race *aeneus* more closely approaches other representatives of the genus than does *auratus* of Mexico. The species *brevirostris* is perhaps the most primitive of the group and may approach the ancestral form which gave rise to *argenteus* and *fulgidus*. Of the latter two forms *argenteus* more closely resembles *aeneus* in habitus and skull characters, and *aeneus* and *argenteus* would appear to represent one branch of a diverging stock. The distributions of the four species suggest that the genus underwent its evolution in the region centering in Central America. The species *aeneus* has far the widest range of any form in the group and seems to be the most progressive and most adaptable form in the assemblage.

Imantodes gracillimus (Günther)

Dipsas gracillima GÜNTHER, 1895, Biologia Centrali-Americana, Reptilia and Batrachia, p. 177, pl. 56, fig. B; "southern Mexico."

Himantodes gracillimus BOULENGER, 1896, Catalogue of the snakes in the British Museum, vol. 3, p. 87.

Guiracoba, 1 (A.M.N.H. No. 64022).

A female of this uncommon snake was removed from the stomach of a moccasin, *Agkistrodon bilineatus* (A.M.N.H. No. 63743). One small area on the belly is slightly macerated, but the pattern and all scale characters can be determined with fair accuracy. Dorsal scale formula 17-17-14, ventrals 232 (with a possible error of one or two

scutes), anal plate divided, caudals 116+. Supralabials 8, fourth and fifth entering orbit, infralabials 10-11, nasal entire, loreal 1, preocular 1, postoculars 2, temporals 1+2. Body blotches approximately 40. Maxillary teeth 10+II.

REMARKS: This rare snake has hitherto been reported only from "southern Mexico," Acapulco in Guerrero, and from the Tres Marias Islands off the coast of Nayarit. The specimen salvaged from the stomach of the *Agkistrodon* has fewer ventrals than Boulenger (*supra cit.*) reports, but in all other characters it agrees well with his description. The pattern agrees with that of the snake depicted by Günther (*supra cit.*) in the plate accompanying his original description. A specimen from Escuinapa, Sinaloa (A.M.N.H. No. 3448), is present in the collection of the American Museum, although Taylor (1938b) apparently found no record for the state in the published accounts.

ELAPIDAE

Micruroides euryxanthus (Kennicott)

Elaps euryxanthus KENNICOTT, 1860, Proc. Acad. Nat. Sci. Philadelphia, p. 337; "Sonora."

Micruroides euryxanthus SCHMIDT, 1928, Bull. Antivenin Inst. Amer., vol. 2, p. 63.

Alamos, 1 (A.M.N.H. No. 64249).

Guiracoba, 1 (A.M.N.H. No. 63742).

A male and a female, respectively, with the dorsal scale formula 17-15-15, the reduction from 17 to 15 occurring between the area above the fifth to seventh caudals. Ventrals 221 (male) and 225 (female); caudals for each, respectively, 26 and 21. Anal plate divided. Supralabials 7, infralabials 7, preocular single, postoculars 2-2 on the female and 1-2 on the male, temporals 1+2. There are 11 black bands on the body of each, one black band on the tail of the female, and two bands on the tail of the male. Maxillary teeth consist of the paired fangs in each bone, followed on all four maxillae by two small solid teeth on the posterior end.

REMARKS: Although this snake was recorded many years ago from Batopilas in Chihuahua, there are few authentic records for Sonora, the present specimen apparently extending the known range somewhat southward. Doubtless it eventually will be found in Sinaloa, overlapping in range with *Mi-*

crurus diastema distans. The latter is now known in Sonora from a single specimen (M.V.Z. No. 28933) taken 2 miles east of Guirocoba.

Schmidt (*supra cit.*) diagnosed the genus as having but one tooth on the maxilla behind the paired fangs. Therefore, the presence of two solid maxillary teeth on our specimens has prompted us to extend our investigation. Examination of six specimens, in addition to those from Alamos and Guirocoba, discloses the fact that more than half the snakes in the series have two teeth behind the fangs. Since it may be possible to correlate this difference with other characters the following data are listed: Those having two teeth behind the fangs include specimens from Alamos, Guirocoba, and Las Chispas in Sonora, and from Solomonsville and Rosemont in Arizona. Those with a single tooth behind the fangs include specimens from Tucson, from "Pima County," and from Santa Cruz Village. Neither dentitional condition is confined to one sex.

CROTALIDAE

Agkistrodon bilineatus (Günther)

Ancistrodon bilineatus GÜNTHER, 1863, Ann. Mag. Nat. Hist., ser. 3, vol. 12, p. 364; Pacific coast of Guatemala; GÜNTHER, 1895, Biologia Centrali-Americana, Reptilia and Batrachia, p. 186, pl. 58, figs. A-B; BOULENGER, 1896, Catalogue of the snakes in the British Museum, vol. 3, p. 521.

Agkistrodon bilineatus TAYLOR, 1940, Univ. Kansas Sci. Bull., vol. 26, p. 486; GLOYD AND CONANT, 1943, Bull. Chicago Acad. Sci., vol. 7, p. 163, figs. 4, 11, 12.

Guirocoba, 3 (A.M.N.H. Nos. 63743-63745).

Three specimens, two of them badly mangled when captured, include two females and a male. Dorsal scale formula 25-23-21 on two specimens, doubtfully determined on the third. Ventrals 130 and 130 on two females, not determined on the male, anal entire, caudals 47 (+?), and 59 on females, each with the anterior 9 caudals undivided; the male has approximately 62 caudals, 4 to 14 undivided, the remainder divided. Supralabials 8-8, infralabials 10-11. Only the smaller female can be measured with reasonable precision and it is 610 mm. over all, the tail 121 mm. On two specimens, a male and

a female, the spine on the tip of the tail curves sharply downward.

REMARKS: The pattern characters of these specimens conform very closely to those depicted in Günther's (*supra cit.*) plate and to the descriptions given by Boulenger and by Taylor (*supra cit.*). The smaller specimen is slightly more brownish than the larger specimens which are blackish with whitish scales along the margins of ill-defined bands. Boulenger records ventral counts with extremes of 135-141, while Taylor reports a specimen, probably a female, from Nuevo Leon with 134. The two counts listed above are slightly lower. Heretofore this species has been known only as far north on the Pacific coast as Mazatlán, Sinaloa, the present specimens being the first for Sonora. Gloyd and Conant (*supra cit.*) have already listed the present record in their synopsis of American representatives of the genus.

STOMACH CONTENTS: The smallest specimen contained the adult *Imantodes gracilimus* described above.

FIELD NOTES: Hilton records that "This snake is called 'pichicuate,' and is the most feared reptile of the region. Natives who will bring in rattlers refuse to touch this snake, and only by offering quite a reward did I get a specimen, quite dead and battered, carried on the end of a long pole. They say that this snake strikes the whole length of the body in any direction by digging the pointed tail into the ground for an anchor. I interviewed two doctors who stated that they had treated and lost patients bitten by the 'pichicuate.'

"Natives attribute a sort of whistling noise to this snake. I have heard the noise and have tried to locate its source, but without success."

The name "pichicuate" was also known at Alamos where natives stated that the snake occurred. However, no specimens were obtained in the latter locality.

Crotalus basiliscus (Cope)

Plate 34, figures 1, 2

Caudisoma basilisca COPE, 1864, Proc. Acad. Nat. Sci. Philadelphia, p. 166; "Colima, Mexico."

Crotalus basiliscus KLAUBER, 1936, Trans. San Diego Soc. Nat. His., vol. 8, pp. 190, 249, figs. 60, 66, 76; GLOYD, 1940, Special Publ., Chicago

Acad. Sci., no. 4, p. 142, pl. 16, fig. 1.

Guircocoba, 1 (A.M.N.H. No. 63746).

Alamos, 5 (A.M.N.H. Nos. 64250-64254).

Hitherto the Mexican west coast rattlesnake has been known to occur as far north as central Sinaloa. The specimens listed above extend the northern limit of the range approximately 200 miles and constitute the first records for the state of Sonora.

Whereas these six individuals can be assigned to *basiliscus*, they bear closer resemblances to *C. molossus* than any specimens of *basiliscus* hitherto available. The entire series has been examined by the foremost students of the genus *Crotalus*, Dr. Laurence M. Klauber and Dr. Howard K. Gloyd, to whom we are indebted for pertinent information. The following summaries of data and the conclusions drawn are those of Dr. Klauber, who has generously permitted us to quote extensive passages from his letters. His views undoubtedly represent a more accurate

interpretation of the data than any we might have attempted.

In order to simplify comparisons, Dr. Klauber has tabulated pattern and scalation statistics for the available specimens of *C. basiliscus* and for Arizonan specimens of *C. m. molossus*. In the right-hand column individual counts for five males from Alamos and a juvenile female from Guircocoba are listed in the order of their catalogue numbers. Dr. Klauber supplies the additional information concerning the tabulations which follow. "The *basiliscus* statistics are based on about 63 males and 46 females; many are juveniles which always tend to spread the ranges because of aberrants which would not survive. The data for Arizonan *molossus* are based on about 51 males and 41 females. Oaxacan specimens of *basiliscus* are omitted from the data listed for the species." (Dr. Klauber's tabulation of characters follows.)

"CHARACTER TABULATIONS

(The central figure is the mean and outside figures indicate the range)

	<i>C. basiliscus</i>	Arizona <i>C. m. molossus</i>	Sonoran Specimens ¹
Scale rows	23- 27.4- 29	25- 26.9- 29	27, 27, 27, 25, 25, 25
Ventrals (M)	182-191.6-201	175-188.3-198	182, 185, 179, 185, 190
Ventrals (F)	189-196.7-206	179-193.1-201	192
Subcaudals (M)	24- 30.3- 37	22- 25.2- 29	26, 34, 30, 27, 33
Subcaudals (F)	18- 24.6- 29	18- 21.5- 26	25
Supralabials	11- 14.9- 18	14- 17.3- 20	14, 15; 17, 17; 16, 16; 17, 16; 16, 17; 16, 16; 13, 16; 16, 17; 17, 18; 16, 17; 16, 17; 17, 18;
Infralabials	13- 15.9- 20	15- 17.4- 20	32, 28, 33, 26, 28, 31
Body blotches	22- 32.9- 41	21- 31.6- 40	9, 8, 7, 6, 7, 8
Tail rings (M)	4- 8.6- 11	3- 5.6- 8 ¹	6"
Tail rings (F)	5- 6.6- 9	3- 5.6- 6 ¹	

Concerning the information thus summarized, Dr. Klauber comments:

- "Choices: *Scale rows*: favor *molossus* somewhat as 25 rows are more frequent in *molossus* than *basiliscus*.
Ventrals: favor *molossus* as some are rather low for *basiliscus*.
Subcaudals: strongly favor *basiliscus*; several are entirely too

high for *molossus*.
Labials: favor *molossus* slightly.
Body blotches: not much choice.
Tail rings: strongly favor *basiliscus*."

Additional notes on the pattern and scalation are added by Dr. Klauber, who finds the blotches in the Sonoran specimens "more clearly and definitely outlined than in the *basiliscus* available for comparative purposes. Also, several are open on the sides, especially [A.M.N.H.] No. 64251, and this *molossus* characteristic is not evident in the other

¹ "Often indeterminate."

basiliscus which I have seen. The Sonoran specimens lack the light blotch centers so characteristic of many *molossus*. Of course, the grayish-striped tails are quite characteristic of *basiliscus*, although occasionally they occur in *molossus*.

"The vertebral ridge and the scale bosses do not seem to me to be as prominent in the Sonoran specimens as they are in some *basiliscus* which, in turn, does not have these characteristics as prominently developed as they are in *durissus*."

We have not reproduced two curves plotted by Dr. Klauber, which indicate the relative sizes of the tails and of the individual segments in the rattles for *basiliscus*, *molossus*, and the Sonoran specimens. However, Dr. Klauber's discussion of these curves summarizes his conclusions as follows:

"So far as relative tail lengths are concerned, the Sonoran snakes are clearly *basiliscus*. Deviations as great as those shown from the regression lines which I had deduced from the other available specimens, would not be considered high for known *basiliscus*. In other words, deviations from the regression lines as great as those found in the Sonoran specimens are not abnormal. But it is shown that they are quite out of line for *molossus*.

"Turning to the rattles, while the Sonoran snakes have somewhat larger rattles than is usual in *basiliscus*, they do have the characteristic *basiliscus* slope in the rattle-number to rattle-size curve . . . quite different from that of *molossus*, especially toward the outer end. The reason two of the *basiliscus* points do not fall on the line is because of the inadequacy of the material at hand. However, the *basiliscus* curve is quite close to that of *durissus*, of which somewhat more specimens are available. All of this group have a peculiarly steep slope."

Of the five male specimens taken at Alamos, two were shipped to New York alive after they had been photographed by Dr. Klauber. When these specimens were preserved the hemipenes were everted, and these organs have been studied by Dr. Klauber who notes that "penial structures are the most important diagnostic characters in the case.

"Hemipenial characters of *molossus* and

basiliscus are as follows:

"*Molossus*: (Specimens from Arizona and New Mexico). The lobes are very short and blunt. They are only slightly tapering. The spines are short with small points. There are no spines in the crotch; the reticulated areas of the two sides meet in the crotch. About 20 to 30 major spines.

"*Basiliscus*: (Two specimens said to have come from Colima, type locality of *basiliscus*, but the locality data are uncertain.) The lobes are long and tapering, almost to points. There are many spines in the crotch, in patches facing each other. These spines are smaller than those on the outer shoulders with which they intergrade. There are about 60 to 70 major spines, which are much larger than those in *molossus*, and longer.

"The Alamos specimens have organs intermediate in characters between those of *basiliscus* and *molossus*, but much nearer the former, particularly with respect to the spines, which are large and prominent, although not quite so large as those of *basiliscus*. The spines are somewhat shorter and fewer in number; there are some in the crotch, but less than in *basiliscus*. The lobes are short and taper only slightly; in this they undoubtedly resemble *molossus*, which, on a comparative size basis, has the shortest and heaviest lobes of any rattlesnake. However, I am not sure that the Alamos specimens have been fully everted. If they are fully extruded, then there is almost enough difference from *basiliscus* to warrant subspecific distinction, and possibly recognition of intergradation with *molossus*. The Alamos specimens have about 30 major spines to the lobe—certainly less than *basiliscus*."

Dr. Klauber concludes, "Summing up all differences, and particularly several of the important ones, it is clear that your specimens are closer to *basiliscus* than to *molossus*, although they show some evidence of bridging the gap between the two."

Obviously more *basiliscus* material, particularly from critical areas, will have to be studied before definite conclusions can be reached. It may prove necessary to regard *molossus* and *nigrescens* as subspecies of *basiliscus*. We are pleased to leave the ultimate decision to those who have specialized in the study of the genus *Crotalus*.

TESTUDINATA

KINOSTERNIDAE

Kinosternon integrum Le Conte

Kinosternum integrum LE CONTE, 1854, Proc. Acad. Nat. Sci. Philadelphia, p. 183; "Mexico." Alamos, 8 (A.M.N.H. Nos. 64161-64168).

Guirocoba, 4 (A.M.N.H. Nos. 63755-63758).

Dr. Norman Hartweg, who has long been engaged in studies of the genus *Kinosternon*, generously examined the specimens listed above. He reports them to be referable to the species *integrum* which has hitherto been reported from no farther north than central Sinaloa.

The series taken at Alamos comprises specimens of various ages, including a juvenile. The largest specimen in the series is A.M.N.H. No. 64161 which has been skeletonized. Dimensions of the carapace are as follows: length 164 mm., width 112 mm., depth 63 mm., greatest diameter of skull 63 mm.

With the addition of *integrum* to the fauna of Sonora, no fewer than three species of the genus appear to be represented in that state, *sonoriensis* in the north, *K. flavescens stejnegeri* (Hartweg, 1938) in the central part of the state, and *integrum* in the Río Fuerte drainage. It may be anticipated that *integrum* will also be found to inhabit the Río Mayo river system, especially because the Alamos specimens were taken near the divide between the two drainages.

Hilton records that this species was far the commonest turtle at Guirocoba, and a similar abundance characterized the species in the Alamos region. Natives brought them in from a variety of sources, principally from old wells and pools along the edges of the arroyo.

EMYDIDAE

Pseudemys scripta hiltoni Carr

Pseudemys scripta hiltoni CARR, 1942, Amer. Mus. Novitates, no. 1181, pp. 1-4, figs. 1-3; Guirocoba, Sonora, Mexico.

Guirocoba, 4 (A.M.N.H. Nos. 63747-63750).

These specimens were referred to Dr. A. F. Carr, Jr., whose studies of the genus *Pseudemys* have contributed so much to our knowledge of these turtles. His description and discussion of the specimens leave little

need for comment, although for the purposes of this paper it may be added that the genus has hitherto been known from the mainland in Sinaloa, and from the cape region of Baja California. These specimens represent the first Sonoran record. A male in the series, A.M.N.H. No. 63750, has been transferred to the Museum of Comparative Zoölogy.

At Guirocoba, for an inexplicable reason, these turtles are known as "tortuga Juan" according to John W. Hilton. We failed to secure the species at Alamos, perhaps because of the somewhat smaller stream and the consequent absence of larger pools of running water.

Geoemyda pulcherrima pulcherrima
(Gray)

Emys pulcherrima GRAY, 1855, Catalogue of shield reptiles in . . . the British Museum (Natural History), pt. 1, Testudinata, p. 25, figs. 1-2; Mexico; GÜNTHER, 1885, Biologia Centrali-Americana, Reptilia and Batrachia, p. 6, pls. 7-8.

Geoemyda pulcherrima pulcherrima WETTSTEIN, 1934, Sitzber. Akad. Wiss. Wien, Math.-naturwiss. Kl., div. 1, vol. 143, p. 18.

Guirocoba, 6 (A.M.N.H. Nos. 63759-63761, 64520a, 64520b, 64520c).

Six specimens of this handsome turtle were secured by Hilton who states that the species is known as "tortuga colorado," doubtless having reference to the coral red markings on the head. A.M.N.H. Nos. 63759-63761 are preserved, and A.M.N.H. No. 64520 has been skeletonized; two specimens were exhibited alive in the Philadelphia Zoological Garden. The specimens agree in all details with the excellent colored plates in Günther's work (*supra cit.*). They constitute the first Sonoran record for the species which appears to occupy an extensive range on the west coast of Mexico.

These turtles while still alive were shipped to New York City where they were maintained for a period of several months. They fed readily when offered lettuce, and when given a choice of land or water they remained on land most of the time, despite the fact that they were capable swimmers. Two eggs were laid by one of the specimens on December 25. One was destroyed before it was discovered, but the other measured 37 mm. by 21 mm., and it had a leathery shell. In Colima the junior author noted that this

was the common terrestrial turtle of that region, and that it was found most frequently in humid woods. Other species of the genus are almost certainly aquatic or semi-aquatic.

***Terrapene klauberi* Bogert**

Text figure 13

Terrapene klauberi BOGERT, 1943, Amer. Mus. Novitates, no. 1226, pp. 1-7, figs. 1-13; Guirocoba, Sonora, Mexico.

Alamos, 2 (A.M.N.H. Nos. 63762-63763).

Guirocoba, 4 (A.M.N.H. Nos. 63751-63754, type and paratypes).

The four Guirocoba specimens, all females, have been described in some detail in the original description (*supra cit.*). To the original description the following notes may be added on the basis of A.M.N.H. No. 63753 which has been skeletonized. Phalanges in forefoot 2-2-2-2-2; in hind foot 0-3-3-3-2, the outer digit represented by a vestigial metatarsal, with some of the tarsals apparently fused at its base. The skull of the same specimen is also depicted (fig. 13) to show the absence of the bony temporal arch (referred to in many papers as the zygomatic arch).

In addition to the notes assembled for the type and paratype series, data are now available for specimens taken at Alamos. Both of these are apparently females like the former, but they are slightly larger than the specimens from Guirocoba. The pattern and coloration are essentially the same, with a few minor differences. The ovoid dots on a brown ground color are present but somewhat less conspicuous on both specimens, perhaps due to age and to the weathering of the carapace. The dots are absent from the

heads of both specimens; the skin of the neck and cheeks of A.M.N.H. No. 63763 is grayish brown, whereas on A.M.N.H. No. 63762 it is blackish. The pattern on the plastron of each is not unlike that of A.M.N.H. No. 63754 depicted in figure 9 of the original description (*supra cit.*).

Both of the Alamos specimens have the upper jaw overhanging and deeply notched.

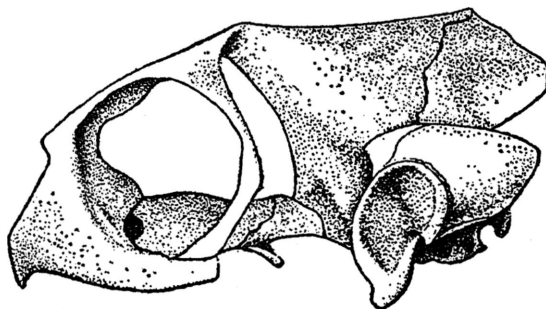


FIG. 13. Skull of *Terrapene klauberi* ($\times 2$), showing absence of bony temporal arch, A.M.N.H. No. 63753, paratype from Guirocoba, Sonora.

Faint traces of the medial keel of the carapace are evident, much as in the paratypes. The shells possess essentially the same contours and relative dimensions as the Guirocoba series, as may be observed from the data below, although the fourth vertebral lamina proves to be shorter than the first, and there are a few other minor differences in ratios that may be ascribed to the somewhat greater size and the presumed greater age of the Alamos specimens.

	A.M.N.H. No. 63762	A.M.N.H. No. 63763
Length of carapace (straight line)	149.0 mm.	149.0 mm.
Width of carapace at seventh marginal	115.5	116.0
Length of plastron (straight line)	145.0	142.0
Width of plastron at middle of femorals	84.5	81.5
Height of body at third vertebral lamina	65.5	63.0
Length of first vertebral lamina	34.0	35.0
Greatest width of first vertebral	34.5	27.5
Greatest width of third vertebral	45.0	40.5
Length of fourth vertebral	32.5	33.0
Width of fourth vertebral	44.0	39.0
Width of head	27.0	29.0
Depth of snout, nostril to cutting edge	10.0	12.5

Hilton records that this turtle was the least common of four species of turtles taken at Guirocoba. At Alamos it was evidently much less easily secured than either *Gopherus* or *Kinosternon*, and despite greater rewards offered we never succeeded in securing more than two specimens. Because individuals of the species apparently inhabit the hills which were covered with a dense vegetation during the rainy season when the collection was made at Alamos, this box turtle was certainly provided with ample cover in which to seclude itself.

At Guirocoba, according to Hilton, this species was known as the "tortuga del monte," and the name was readily recognized when we inquired concerning the species at Alamos. In captivity the Guirocoba specimens refused to eat lettuce which was eagerly devoured by *Terrapene c. carolina* and

Geoemyda p. pulcherrima in the same vivarium. Later the *T. klauberi* were offered bread which they ate without hesitation, while the other two species of turtle were only mildly interested.

TESTUDINIDAE

Gopherus agassizii (Cooper)

Plate 35, figures 1, 2, plate 36, figures 1, 2, plate 37, figures 1, 2

Xerobates agassizii COOPER, 1863, Proc. California Acad. Sci., vol. 2, p. 120; "Mountains near Fort Mojave, California."

Gopherus agassizii STEJNEGER, 1893, North Amer. Fauna, no. 7, p. 161; GRANT, 1936, Zoologica, vol. 21, pp. 225-229.

Alamos, 4 (A.M.N.H. Nos. 64157-64160).

Four adults include two males and two females. Dimensions of the specimens are herewith tabulated:

A.M.N.H. No.	SEX	CARAPACE LENGTH	CARAPACE WIDTH	SHELL DEPTH	HEAD WIDTH	DIAMETER OF HIND FOOT
64157	♂	228 mm.	157 mm.	95 mm.	35 mm.	34 mm.
64160	♂	217	140	79	32	30
64158	♀	202	153	79	30	27
64159	♀	223	147	81	31	29

REMARKS: Heretofore the desert tortoise has been reported only as far south in Sonora as La Posa (Taylor, 1938a). Consequently, these specimens from Alamos represent an extension of the range. All four individuals are somewhat darker in coloration than those we have seen from the Mojave and Colorado deserts, and furthermore they appear upon casual inspection to be relatively broad and flat. In order to determine whether or not any real differences exist, additional material belonging to all three species of the genus was examined. Measurements were made of the carapace length, carapace width, depth of body, width of head, and diameter of the hind foot, on 16 additional specimens of

G. agassizii from Arizona and California, on 13 *G. berlandieri* from Texas and Coahuila, and on 28 *G. polyphemus* from Florida and Georgia. The under surface of the foot was measured with calipers at the greatest diameter posterior to the insertion of the claws. The depth of the shell was taken at the middle of the body with the upper arm of the calipers on the center of the third vertebral lamina. Despite the concavity on the plastron of adult males, no conspicuous sexual dimorphism was apparent in the ratios calculated for the small samples, and consequently the sexes have not been considered separately in the tabulations below. Mean ratios are followed by extremes in paren-

RATIOS

	Plastron Width Plastron Length	Shell Depth Plastron Length	Hind Foot Diameter Head Width
<i>G. polyphemus</i>	.76 (.71-.94)	.41 (.36-.46)	.63 (.53-.78)
<i>G. berlandieri</i>	.80 (.75-.94)	.48 (.45-.57)	.69 (.62-.81)
<i>G. agassizii</i>	.74 (.68-.82)	.43 (.40-.46)	.98 (.85-1.15)
<i>G. agassizii</i> (Alamos series)	.69 (.65-.76)	.39 (.36-.42)	.94 (.88-.97)

theses, and the four *agassizii* from Alamos are tabulated separately from specimens of the species from Arizona and California.

Certain minor differences in proportions are apparent from these figures. It may be noted that the Alamos specimens are relatively wider and somewhat more depressed than the desert tortoises from Arizona and California. However, these are only mean differences; A.M.N.H. No. 64160 from Alamos, in proportion to the plastron length, is the flattest of 61 *Gopherus* examined, but the ratio of depth to length of a female (A.M.N.H. No. 64158) in the same series slightly exceeds the mean for *agassizii* from areas in the United States. Minor differences in the relative diameters of the hind foot are also apparent, but the larger series of *agassizii* from Arizona and California includes a number of juveniles which tend to have proportionately smaller feet than adults. Individual as well as ontogenetic differences are obviously present, so that more extensive series are desirable before much can be gained from statistical analyses of such data. The data presented suggest that a population inhabiting the Río Fuerte drainage system has become partly differentiated, but it scarcely seems worthy of taxonomic recognition. Dr. Loye Miller informs us that a few juveniles from the vicinity of Guáymas that he examined were considerably darker than Californian specimens of comparable dimensions. Therefore, adult individuals from the central portion of Sonora may be similar to those from Alamos. The latter resemble Floridian specimens of *G. polyphemus* in coloration, a fact which suggests that pigmentation may be associated in some manner with environmental factors.

Some years ago True (1882) called attention to differences between *polyphemus*, *berlandieri*, and *agassizii*, and he presented a key to the species of the genus. Since the publication of True's paper, no one appears to have modified his conclusions, although we are unable to verify all his statements. He separated *polyphemus* and *agassizii* from *berlandieri* on the basis of the shell being "twice as long as high" in the former, and "less than twice as long as high" in *berlandieri*. Nine of the 13 specimens of *ber-*

landieri which we examined fail to fit this description, although it may be noted in the tabulations above that this species does tend to be shorter in proportion to its depth than the other two species. The eastern species, *polyphemus*, tends to have a wide head and relatively small feet. The desert tortoise, *agassizii*, in contrast, has a relatively narrow head and exceptionally broad hind feet, with stronger limbs. Between the ranges occupied by these two species lies *G. berlandieri* with both a narrow head and small hind feet. In order to emphasize these differences ratios of the hind-foot diameter to head width were calculated, and the summarized data have been presented above.

True also mentioned differences in the shape of the snout. In both *agassizii* and *polyphemus* the contours of the head are not subject to much variation, but in *berlandieri* the snout is sometimes considerably less pointed than True's figure indicates. On the other hand, the angle of the alveolar ridges of the upper jaw in each species is relatively constant and characteristic. These ridges are depicted in plate 37.

True mentions a specimen of *polyphemus* from Brownsville, Texas, although this individual must have been wrongly identified or else the locality data were erroneous. Grant (1936) has outlined the range of *agassizii*, but the ranges of *berlandieri* and *polyphemus* have been stated from time to time with but dubious accuracy. Presumably there is a gap between the territory occupied by *berlandieri* in Texas and the range of *polyphemus* which is said to occur as far west as Arkansas. All evidence available at present indicates that three distinct species are represented, and this conclusion is further warranted by the fact that both *polyphemus* and *agassizii* lay spherical eggs, whereas those of *berlandieri* are elliptical.

Miller's (1932) paper dealing with the habits of *G. agassizii* in California provides an excellent summary for that area, but much remains to be discovered concerning the behavior of the species in other parts of the range. We did not observe any burrows in the vicinity of Alamos, nor can we find any records of burrows in the vicinity of Tucson. A single specimen was secured by the senior

author in Sabino Canyon in the foothills of the Santa Catalina Mountains north of Tucson, and another specimen was taken near the Agua Caliente Mountains, 15 miles to the east, in August, 1942. But in neither locality were burrows discovered. Whether in the southern portion of its range the desert

tortoise resorts to crevices rather than to burrowing can only be speculated. True considered it doubtful whether Berlandier's tortoise dug burrows, and so far no observations appear to have been reported which belie this supposition.

MEXICAN AMPHIBIANS AND REPTILES IN THE COLLECTION OF ROBERT T. MOORE

MR. ROBERT T. MOORE, Research Associate in Vertebrate Zoology, California Institute of Technology, has assembled extensive collections of various animals from a number of different areas in Mexico. Through his kindness we have been allowed the privilege of studying a small but interesting series of reptiles which we list herewith, along with brief descriptive notes. The bulk of this material comes from Ahome in northwestern Sinaloa; only a few forms from other localities are represented. While the collection contains no novelties, distributional data derived from it contribute to our knowledge of several poorly known species. There is also one amphibian, a toad, in the collection herein reported. All numbers listed below refer to specimens in the collection of Mr. Moore.

AMPHIBIA

Bufo compactilis Wiegmann

Bufo compactilis WIEGMANN, 1833, Isis, vol. 26, pt. 7, pp. 661-662; Mexico.
Arroyo Hondo, Chihuahua, 1 (R.T.M. No. 32).

A male with a snout-vent length of 55 mm. is the only amphibian in this collection.

REPTILIA

Ctenosaura hemilopha (Cope)

Cyclura (*Ctenosaura*) *hemilopha* COPE, 1863, Proc. Acad. Nat. Sci. Philadelphia, vol. 15, pp. 105-106; "Cape St. Lucas," Baja California.
Ahome, Sinaloa, 1 (R.T.M. No. 349).

A female from Ahome permits us to report of this species in Sinaloa. The mid-dorsal row of enlarged scales is interrupted above the sacral region for a distance approximately equal to the length of the tibia. In other details the specimen agrees well with those described by Smith (1935, pp. 140-141).

Dipsosaurus dorsalis sonoriensis Allen

Dipsosaurus dorsalis sonoriensis ALLEN, 1933, Occas. Papers Mus. Zool. Univ. Michigan, no. 259, p. 4; Hermosillo, Sonora.
Rancho Costa Rica, Sonora, 1 (R.T.M. No. 306).

Near Bocoit (?), Sonora, 1 (R.T.M. No. 307).
Ahome, Sinaloa, 1 (R.T.M. No. 314).

These specimens, two males and one female, agree closely with Allen's original description. The Ahome specimen represents the first record for the state of Sinaloa.

Uta ornata lateralis Boulenger

Uta (*Phymatolepis*) *lateralis* BOULENGER, 1883, Ann. Mag. Nat. Hist., ser. 5, vol. 11, p. 342; Presidio, near Mazatlán, Sinaloa.
Ahome, Sinaloa, 3 (R.T.M. Nos. 341, 366, 378).

These three males have been reported on previously (Oliver, 1943).

Callisaurus draconoides brevipes Bogert and Dorson

Callisaurus draconoides brevipes BOGERT AND DORSON, 1942, Copeia, p. 173; Guiracoba, Sonora. Río de Choix (Río Fuerte drainage), Sinaloa, 1 (R.T.M. No. 31).

The single female is one of the paratypic specimens (*vide supra*).

Holbrookia maculata approximans Baird

Holbrookia approximans BAIRD, 1858, Proc. Acad. Nat. Sci. Philadelphia, vol. 10, p. 253; lower Río Grande.

Between Churo and Chiricahui, southwestern Chihuahua, 1 (R.T.M. No. 25).

The single specimen, a female, is referred to this race. The specimen was obtained at an altitude of 7500 feet. It is in rather poor condition but seems to fit most closely with *approximans*.

Phrynosoma solare Gray

Phrynosoma solaris GRAY, 1845, Catalogue of the . . . lizards in the . . . British Museum, p. 229; "California."

Forty-five miles southwest of Hermosillo, Sonora, 1 (R.T.M. No. 302).

Ahome, Sinaloa, 4 (R.T.M. Nos. 310, 312, 332, 358).

This well-known and distinct species of horned lizard has previously been known from as far south as Sonora. Comparisons with material from Arizona indicate no significant differences.

Sceloporus clarkii clarkii

Baird and Girard

Sceloporus clarkii BAIRD AND GIRARD, 1852, Proc. Acad. Nat. Sci. Philadelphia, vol. 6, p. 127; "Province of Sonora" (=southern Arizona).

Alamo Wash (35 miles northwest of Magdalena), Sonora, 1 (R.T.M. No. 309).

Mount Mohinora, southwest Chihuahua, 2 (R.T.M. Nos. 384, 387).

The two females collected on Mount Mohinora were obtained at an elevation of 8500 feet. They extend the range of the subspecies *clarkii* considerably to the south, latitudinally beyond the northernmost occurrence of *clarkii boulengeri*. However, the two forms appear to be separable, with *boulengeri* being a coastal form or foothill form, while *clarkii* occurs at higher elevations in the mountains. Intergradation occurs where the two come in contact at such localities as Alamos. The two females exhibit minor differences from more northern specimens but are not outside the limits of variation recorded by Smith (1939, p. 123).

Both females are adults and contain developing eggs. Pertinent details are: snout-vent length 88 and 94 mm.; dorsal scales 32 and 31; ventral scales 46 and 44; scales around middle of body 38 and 40; femoral pores 12 and 13.

Sceloporus clarkii boulengeri

Stejneger

Sceloporus boulengeri STEJNEGER, 1893, North Amer. Fauna, vol. 7, p. 180; Presidio, Mazatlán, Sinaloa.

Ahome, Sinaloa, 12 (R.T.M. Nos. 325, 327, 336, 339, 351, 354, 356, 360, 363, 368, 369, 380).

Yecorato, Sinaloa, 1 (R.T.M. No. 305).

The 12 Ahome specimens have 9 to 11 femoral pores, average 9.5. The single male from Yecorato has 11-12 femoral pores which decrease in size distally.

ANGUIDAE**Gerrhonotus kingii** (Gray)

Elgaria kingii GRAY, 1838, Ann. Mag. Nat. Hist., vol. 1, p. 390; unknown.

Near Chiricahui, Chihuahua, 1 (R.T.M. No. 26).

One female, collected at an elevation of 6000 feet, was found in the "Pine Association." The specimen agrees with those from

Arizona in details of scutellation but shows considerable differences in coloration from most of the northern specimens. This color difference is most pronounced in the over-all reduction of the darker pigment. The dark spots or markings on the head are reduced, the width and prominence of the dark cross bands are reduced, and the ventral maculation is nearly absent. A specimen taken in the Santa Rita Mountains of southern Arizona is similar in coloration.

TEIIDAE**Cnemidophorus sackii sackii** Wiegmann

Cnemidophorus sackii WIEGMANN, 1834, Herpetologia Mexicana, p. 28; Mexico.

Potreros, Chihuahua, 2 (R.T.M. Nos. 29, 30).

Ahome, Sinaloa, 43 (R.T.M. Nos. 313, 315, 316 [2], 318-324, 328-331, 333, 340, 342, 343, 345-348, 350, 353, 355, 357, 359, 361, 362, 364, 365, 367, 370-374, 376, 379, 381-383).

The two specimens from Potreros, Chihuahua, were collected at an elevation of 4100 feet. The Ahome series exhibit little variation in morphological details, nor is there much difference between specimens of this lot and those from Alamos and Guiracoba. The ontogenetic and sexual variation in color pattern is shown in the table below. These figures include the combined data from the three collections.

DORSAL PATTERN	MALES		FEMALES	
	No.		No.	
	specimens	Aver. size	specimens	Aver. size
Stripes only	4	82.2	16	74.6
Stripes and spots	21	83.2	18	81.0
Spots only	13	96.5	1	94.0

Eleven females contain developing eggs in the oviducts. While these data are limited, they indicate a correlation between size and total number of eggs. Three females between 65 and 70 mm. in snout-vent length contain an average of 2.66 eggs; five females between 70 and 80 mm. in snout-vent, 3.6 eggs; and three between 85 and 95 mm. in snout-vent length contain the mean number of 5.66 eggs.

COLUBRIDAE**Pituophis sayi affinis** Hallowell

Pituophis affinis HALLOWELL, 1852, Proc. Acad. Nat. Sci. Philadelphia, vol. 6, p. 181; New Mexico.

Ahome, Sinaloa, 1 (R.T.M. No. 338).

The single specimen, a male, has dorsal scales 29-33-23, ventrals 229, subcaudals 62, upper labials 8-7, lower labials 12-11, 1 preocular, and 3 postoculars.

This record represents the first authenticated occurrence of *affinis* within the state of Sinaloa. Stull (1940) indicates on her distributional maps that the form is present in the northeastern corner of the state but includes no locality records to substantiate this. Her maps indicate a foothill and plateau distribution in Sonora and Chihuahua, while this specimen from Ahome indicates that the subspecies ranges westward to the coast. Probably it occurs in suitable local habitats throughout the state of Sonora, just as it does in southern Arizona.

***Coluber flagellum piceus* (Cope)**

Bascanium piceum COPE, 1892, Proc. U. S. Natl. Mus., vol. 14, p. 625; Camp Grant, Arizona. Ahome, Sinaloa, 1 (R.T.M. No. 311).

This juvenile female has 17 rows of dorsals at mid-body, 203 ventrals, 98 subcaudals, 8 upper labials, 10 infralabials, 2 preoculars, 2 postoculars, and a temporal formula of $\frac{2+2+2}{2+3+2}$. The specimen has an over-all length of 847 mm., with a tail length of 204 mm. The anterior body bands are not prominent, but the other features of coloration agree with those characteristic of this form. This appears to be the second record for this subspecies in the state of Sinaloa, the previously known specimen having come from Altata.

***Coluber striolatus striolatus* Mertens**

Coluber striolatus MERTENS, 1934, Zoologica, vol. 32, p. 190; new name for *Coluber lineatus* Duméril and Bocourt, preoccupied by *Coluber lineatus* Linnaeus.

Masticophis lineatus ORTENBURGER, 1928, Mem. Mus. Zool. Univ. Michigan, vol. 1, p. 134, fig. 27, pl. 25.

Ahome, Sinaloa, 4 (R.T.M. Nos. 317, 334, 375, 377).

The four specimens are alcoholic skins with head and tail left intact. Consequently no adequate measurements can be given, and one

female is so badly damaged that no data on scutellation were obtained. Three specimens have 17 rows of dorsal scales at mid-body. Two males have 187 and 195 ventrals, while one female has 182 ventrals. Neither male gives complete caudal counts. One female with an uninjured tail has 112 caudals. All have 8 upper labials; two have 10 lower labials, and one has 11. The preoculars are two, and the postoculars are two in all specimens. Two specimens have temporals 2+2+3, while the third has $\frac{2+3+3}{2+3+2}$. The black markings on the scales tend to form a longitudinal dark line on the second row of dorsals in all four specimens, at least on the posterior third of the body.

***Salvadora bairdi* Jan**

Salvadora bairdi JAN AND SORDELLI, 1860, Iconographie général des ophidiens, vol. 1, pt. 2, pl. 3, fig. 2; Mexico.

Barranca del Cobre, Chihuahua, 1 (R.T.M. No. 24).

This female, collected at an elevation of 4000 feet, previously has been reported by Bogert (1939b, p. 189) under *Salvadora g. grahamiae*. This specimen has 17 dorsal scales at mid-body, 195 ventrals, and 108 subcaudals, 8 upper labials, 10 lower labials, oculars 2-2, and temporals 2+3.

Barranca del Cobre represents an extreme peripheral record for the form, and until more specimens are available from the intervening area it cannot be stated with certainty whether *Salvadora lineata* Schmidt is a subspecies of *bairdi* or not. Along the eastern edge of the plateau, in the state of Hidalgo and the Distrito Federal there is some evidence of intergradation in pattern characters. However, *bairdi* normally has one less maxillary tooth than *lineata*, and the overlap in counts from large series is not great.

***Salvadora hexalepis deserticola* Schmidt**

Salvadora hexalepis deserticola SCHMIDT, 1940, Publ. Field Mus. Nat. Hist., zool. ser., vol. 24, no. 12, p. 146; Government Spring, near Chisos Mountains, Brewster County, Texas.

Ahome, Sinaloa, 1 (R.T.M. No. 308).

Yecorato, Sinaloa, 1 (R.T.M. No. 302).

These specimens have been reported by Bogert (1939b, p. 194) as *Salvadora grammiae hexalepis*. They are referred to *deserticola* despite the high ventral count of the Ahome specimen (see remarks under Alamos and Guirocoba collections). This individual is a female with 17 dorsal scales at mid-body, 205 ventrals, injured tail, 9 upper labials, 10 lower labials, oculars 2-2, and temporals 2+3. The Yecorato specimen is a male with 17 dorsal scales at mid-body, 189 ventrals, 76 subcaudals, 9 upper labials, 10 lower labials, oculars 2-2, temporals 2+3.

***Drymarchon corais rubidus* Smith**

Drymarchon corais rubidus SMITH, 1941, Jour. Washington Acad. Sci., vol. 31, p. 474; Rosario, Sinaloa.

Ahome, Sinaloa, 1 (R.T.M. No. 337).

One male is represented in the collection. It has 17 dorsal scales at mid-body, 196 ventrals, tail incomplete, 8 upper labials, 8 lower labials, 1 preocular, 2 postoculars, and temporals 2+2.

***Gyalopion desertorum* (Taylor)**

Ficimia desertorum TAYLOR, 1936, Proc. Biol. Soc. Washington, vol. 49, p. 51; 12 kilometers northwest of Guáymas, Sonora.

Gyalopion desertorum SMITH AND TAYLOR, 1941, Jour. Washington Acad. Sci., vol. 31, p. 359.

Ahome, Sinaloa, 3 (R.T.M. Nos. 326, 335, 352).

The three specimens, two males and a female, represent the first record of this form for Sinaloa and a southern extension of the known range. All three specimens have the first upper labial fused with the nasal and have the anal undivided. The dorsal scales are 17 in all three. The two males have 128 and 130 ventrals, and both have 29 subcaudals; the female has 133 ventrals and 27 subcaudals. The upper labials are 7 on both sides in two, while one has 7-8; the lower labials are 6-7, 7, and 8. The preoculars are 1 and the postoculars 2 in all three specimens. The temporals are 1+2 in two and $\frac{1+2}{1+3}$ in the third. The males have 27 and 29 dark bands on the body; the female has 29 dark bands on the body. All have 6 bands on the tail. In the female the cross bands are narrower than in either of the males. From a comparison

with the Alamos and Guirocoba specimens, this seems to be due to individual variation and not attributable to sexual dimorphism.

***Hypsiglena torquata ochrorhyncha* Cope**

Hypsiglena ochrorhynchos COPE, 1860, Proc. Acad. Nat. Sci. Philadelphia, vol. 12, p. 246; Fort Buchanan, Arizona.

Ahome, Sinaloa, 1 (R.T.M. No. 344).

The single specimen, a female, has the characteristic dorsal pattern and coloration of *ochrorhyncha*. The dorsal scales at mid-body are 21, the ventrals 178, subcaudals 50, upper labials 8, lower labials 10, oculars 2-2, temporals 1+2. This specimen has an over-all length of 279 mm. and a tail length of 43 mm.

It is possible that specimens with the *torquata* pattern may occur at Ahome, and possibly the present specimen represents an intergrading population similar to that which we infer exists at Guirocoba. Heretofore the *ochrorhyncha* pattern has not been known to occur as far south as Sinaloa on the mainland, although we have herein reported a specimen from Clarion Island indicating an even more southerly insular distribution.

***Trimorphodon lambda* Cope**

Trimorphodon lambda COPE, 1886, Proc. Amer. Phil. Soc., vol. 23, p. 286; Guáymas, Sonora.

Willard Station, Sonora, 1 (R.T.M. No. 303).

This female specimen has 25-23-17 dorsals, 234 ventrals, 70 subcaudals, 9 upper labials, 13 lower labials, 3 preoculars, and 3+4 temporals. It has an over-all length of 876 mm. and tail length of 130 mm. It agrees closely with the details given by Smith (1941, p. 155).

Smith points out that penial characters serve to separate the mainland form from *lyrophanes* of the peninsula of Baja California. This character may, indeed, prove to be valid, but on the other hand there may prove to be sufficient variation in penial characters to make it necessary to reduce *lambda* to subspecific status under *lyrophanes*. Geographic isolation does not, of necessity, indicate complete differentiation, nor is it safe to assume that penial characters are any more stable than external characters.

SONORAN AMPHIBIANS AND REPTILES IN OTHER COLLECTIONS

THROUGH THE GENEROSITY of several individuals we have been supplied with lists of Sonoran specimens in the following institutions: the Museum of Comparative Zoölogy, the United States National Museum, the Stanford University Natural History Museum, and the Museum of Zoology, University of Michigan. We are particularly grateful to Dr. L. M. Klauber who undertook the task of tabulating material in the Museum of Vertebrate Zoology, University of California, the California Academy of Sciences, the San Diego Society of Natural History, and the specimens in his personal collection.

Because many wide-ranging species or genera will have to be studied as a whole before the status of Sonoran populations can be determined, we have made no effort to examine all the specimens on these lists. However, we have tabulated data for specimens of some species hitherto not reported from Sonora, and in other instances we have relied upon identifications supplied. The following annotated list, therefore, will serve to document the following species included in table 1 presented earlier in the present paper.

Eleutherodactylus augusti (Dugés)

Hylodes augusti DUGÉS, 1879, in Brocchi, Bull. Soc. Philom. Paris, vol. 3, no. 1, p. 21; Guanajuato, Mexico; BROCCHI, 1882, Étude des batraciens. Mission scientifique au Mexique et dans l'Amérique Centrale, pt. 3, sect. 2, p. 52, pl. 16, figs. 1, 1a-c.

Eleutherodactylus augusti SLEVIN, 1931, Copeia, p. 140; KELLOGG, 1932, Bull. U. S. Natl. Mus., no. 160, p. 100.

Eleutherodactylus tarahumaraensis TAYLOR, 1940, Copeia, p. 250, text fig. 1; Mojárichic, Chihuahua, Tarahumara Mountains at 6900 feet elevation.

A single Sonoran specimen is present in the Museum of Vertebrate Zoology. This individual, M.V.Z. No. 28878, was secured by Seth B. Benson 2 miles east of Guirocoba, April 10, 1939. Benson has noted on the field tag that it was "caught in a mouse trap under a rock near water."

The specimen is somewhat desiccated, but

the following dimensions can be recorded: snout to vent 54 mm.; width of head 23 mm.; length of leg 78 mm.; length of tibia 26 mm.; length of foot 35 mm. In coloration this specimen more closely resembles the frog depicted by Taylor (*supra cit.*) as *tarahumaraensis* than it does *E. augusti* as depicted by Brocchi (1882, *supra cit.*). Our decision to assign the Sonoran specimen to *augusti* rather than to Taylor's form, which we consider a synonym of *augusti*, may be explained as follows:

Slevin (*supra cit.*) recorded a specimen some years ago from the Santa Rita Mountains of southern Arizona that was identified as *augusti*, and his identification was confirmed by both Dr. Doris M. Cochran and Dr. Remington Kellogg. Kellogg had available for comparison several specimens from Nayarit, Jalisco, and Guanajuato, as well as a specimen of uncertain provenance in Mexico, secured by Paul Rühling. The latter specimen is available in the American Museum of Natural History (A.M.N.H. No. 12567). It is a large, gravid female, with a snout to vent length of 75 mm., the maximum reported by Kellogg (*supra cit.*, p. 101). The body is somewhat wider than the head, a condition which may be ascribed to mature eggs in the ovaries. In pattern characters it is not unlike the Sonoran specimen, nor is it greatly different from the specimen described by Taylor from Chihuahua.

If this Mexican specimen is truly representative of *augusti*, as we believe it to be despite the fact that it does not closely resemble the frog in Brocchi's plate (1882 *loc. cit.*) in pattern characters, there seems to be no basis for retaining *tarahumaraensis*. Kellogg (1932, p. 100) notes that a juvenile of *augusti* differs in coloration from adults, and in skeletal characters we find little difference between the large female from Mexico, the Sonoran specimen, and the Chihuahuan specimen described by Taylor. Using our data and the dimensions supplied in the description of *tarahumaraensis* we have calculated ratios in order to ascertain the basis of Taylor's statement that the Chi-

huahuan specimen is related to frogs of the *augusti* group, but "differs in having longer, slenderer legs." Ratios follow:

	<i>tara- humaraensis</i> type	M.V.Z. No. 28778	A.M.N.H. No. 12567
Foot/snout vent	0.67	0.64	0.60
Tibia/snout vent	0.52	0.48	0.47
Leg/snout vent	1.48	1.44	1.30

Obviously these differences are so slight that adequate series and statistical analyses would be required to prove them to be significant. Moreover it is not impossible that they can be attributed to ontogenetic changes. The Chihuahuan frog is further differentiated from other members of the *augusti* group in having "a slender, rather than a toad-like body." Obviously the habitus of frogs will vary with preservation techniques, as well as with sex; a gravid female is more likely to have a "toad-like body" than an immature female or a male with comparable skeletal dimensions. Ratios of head width/snout-vent length calculated for the three frogs, in the same order as in the tabulation above, provide ratios of 0.41, 0.42, and 0.42, respectively. Only when the ontogenetic variations in proportion are known will it be possible to assign individual specimens with complete assurance, and only then can it be ascertained whether or not any real differences between populations exist.

Under these circumstances the recognition of an additional form in Chihuahua with our knowledge in its present state seems to us to be premature, particularly when the type locality lies between that of *augusti* and that of *latrans* described by Cope in 1880. Kellogg (1932, p. 101) notes that there are "no constant structural differences that will distinguish specimens" of these two forms, and that *augusti* and *latrans* unquestionably are closely related. Full specific status for *latrans* is, therefore, open to some doubt, and material that must eventually become available from Coahuila can be expected to throw even more doubt upon the status of *latrans*.

Elaphe chlorosoma (Günther)

Coluber chlorosoma GÜNTHER, 1894, Biologia Centrali-Americana, Reptilia and Batrachia, p.

115, pl. 41; Atoyak and Amula in Guerrero, and San Ramon in Jalisco.

Elaphe chlorosoma SMITH, 1941, Copeia, p. 134.

Thirty miles north of Guáymas, 1 (C.A.S. No. 63101).

Through the kindness of Mr. Joseph Slevin we have been able to examine a specimen of this snake from Sonora, thus adding another species to the fauna known for the state.

The specimen is an adult female 1465 mm. in total length; the tail, with a small portion of the tip missing, measures 284 mm. Dorsal scale formula 33-37-32. Ventrals 284, anal divided, caudals 100+. Supralabials 8-8, the fourth and fifth entering the orbit; infralabials 11-11. Preoculars 1-1, postoculars 2-2, temporals 3+4. In preservative the snake appears to be nearly uniformly gray, with the color of the dorsum extending onto the edges of the ventrals. Black bases on the dorsal scales are not conspicuous, perhaps because the specimen was originally preserved in formalin. However, lighter borders on the scales of the lower rows are apparent, particularly at mid-body. There are 19 teeth in the right maxilla and 18 (?) in the left.

REMARKS: This Sonoran specimen appears to have a higher number of mid-dorsal scale rows and many more ventrals than any previously reported. Likewise no other specimens reported seem to be so large. But on the whole these differences scarcely warrant recognition of a northern population, certainly not until specimens from the Santa Rita Mountains in Arizona have been studied. Scale count data for the latter seemingly have never been published.

Three specimens from Mexico have been available for comparisons. These include A.M.N.H. No. 64501, a female, probably from the state of Colima, A.M.N.H. No. 19770, a juvenile male taken near Hostotipaquillo, Jalisco, and A.M.N.H. No. 19838, a juvenile female from the Distrito Federal. The more important data for these specimens may be summarized as follows:

A.M.N.H. No.	64501	19770	19838
Scale rows	31-33-21	30-33-21	35-37-23
Supralabials	8-8	—	9-9
Ventrals	269	261	275
Caudals	98	125	101
Total length	1053 mm.	715 mm.	555 mm.

The specimen from Jalisco was taken by Paul R  thling who notes that it was greenish in life. It was found dead in the trail and the head is smashed, with portions of the upper part missing although the mandibles are intact. The pattern is not unlike that on the large specimen from Sonora. The Colima (?) individual, received through the courtesy of Mr. R. Marlin Perkins, is well preserved, and the black bases on the dorsal scales, most of which are flanked by white margins, are rather conspicuous. The juvenile from Distrito Federal has a rather well-defined pattern consisting of approximately 69 or 70 irregular blotches. On the body the pattern is reminiscent of that on *Arizona elegans occidentalis*; the markings on the head conform very closely to those depicted by Taylor (1940a, p. 459, fig. 5) for a specimen from Michoac  n of somewhat smaller dimensions that he originally referred to *E. mutabilis*.

Smith (*supra cit.*) has suggested that the type of *mutabilis* is an albino specimen referable to *E. triaspis*, and that small Mexican specimens with dorsal blotches, such as Taylor's specimen from Michoac  n, represent the juvenile pattern of *chlorosoma*. This is certainly a possibility despite G  nther's statement that a small individual "only half the size" of the largest of three cotypes (which was 49 inches long) was without a trace of spots. Smith describes a specimen from Colima 656 mm. in length (about 26 inches) as having the pattern indistinct on the posterior part of the body. Our Jalisco specimen, only 59 mm. longer shows no trace of a pattern.

The few data available suggest the possibility that two forms may be represented. Our adult specimen, presumptively from Colima, possesses 18 and 19 maxillary teeth in the right and left jaws, respectively; the specimen from Colima which Smith describes has 21 maxillary teeth. Similarly our specimen from the Distrito Federal has 21-22 maxillary teeth. Thus, the two small specimens with blotches have more maxillary teeth than adults without blotches. However, this may be only the result of chance sampling; until more specimens become available for study Smith's solution of the problem tentatively may be assumed valid.

Arizona elegans occidentalis Blanchard

Arizona elegans occidentalis BLANCHARD, 1924, Occas. Papers Mus. Zool. Univ. Michigan, no. 150, p. 1; La Jolla, California.

Two specimens, Nos. 16478, 16479, in the San Diego Society of Natural History, are assigned to this form by Dr. L. M. Klauber. The specimens were secured at Punta Pe  asco on the northwestern coast of Sonora.

Drymobius margaritiferus fistulosus Smith

Drymobius margaritiferus fistulosus SMITH, 1942, Proc. U. S. Natl. Mus., vol. 92, p. 393; Miramar, Nayarit.

A single specimen, No. 28930 in the Museum of Vertebrate Zoology, has been examined by Dr. Hobart M. Smith, and (*in litt.*) he has generously advised us that "it seems to be typical enough of *D. m. fistulosus*; the black color surrounds the light spots on the scales completely over most of the body."

Micrurus diastema distans (Kennicott)

Elaps distans KENNICOTT, 1860, Proc. Acad. Nat. Sci. Philadelphia, p. 338; "Batosegachie" [=Batosegachic], Chihuahua.

Micrurus diastema distans SCHMIDT, 1933, Publ. Field Mus. Nat. Hist., zool. ser., vol. 20, p. 39.

A specimen in the Museum of Vertebrate Zoology, University of California, No. 28933, was taken by Seth B. Benson, 2 miles east of Guirocoba, May 1, 1939. This individual is a male with a length over all of 780 mm., the tail (108 mm.) comprising 0.14 of the total length. Supralabials 7, preocular 1, postoculars 2, temporals 1+1+2. Ventrals 213, anal divided, caudals 48. Triads on the body, including that on the neck, are 12, with 4 black rings on the tail (the seventh triad on the body is on the left side of the snake only).

This specimen agrees in most details with a specimen (A.M.N.H. No. 62264) taken in 1939 by the senior author 12 miles southeast of Los Mochis in Sinaloa. However, the Sinaloan specimen is a female with 232 ventrals and 41 caudals. Curiously enough it is precisely like the Sonoran specimen in having 12 triads, with the seventh confined to the

left side of the body, but there are but three black bars on the tail. The female measures 880 mm., with the tail comprising 0.1 of the total length.

Schmidt (*supra cit.*) gives the range of this form as "Sinaloa to southern Sonora, and the Pacific drainage of Chihuahua," although he mentions no Sonoran specimens. Whether

this represents the first record for the state is uncertain, but it is of interest in that it demonstrates the probable overlap¹ of the genera *Micrurus* and *Micruroides*.

¹ A specimen of *M. d. distans*, No. 2089 in the collection of the University of California, Los Angeles, was taken at Guirocoba in December, 1944. Thus an actual overlap in range occurs.

AMPHIBIANS AND REPTILES WHOSE OCCURRENCE IN SONORA IS PROBABLE

THE SPECIES AND SUBSPECIES listed below include (1) those whose occurrence in Sonora can reasonably be expected on zoogeographic grounds, and (2) those listed in the past on doubtful bases. The list is by no means exhaustive. Pending the time when sufficient material is available to settle many of the problems involved, the inclusion or omission of many forms on the list of Sonoran amphibians and reptiles is, of necessity, an arbitrary matter. Because the fauna of Arizona is much better known than that of either Sinaloa or Chihuahua the bulk of the names on the list below refer to species currently known from the United States.

Taylor (1938b) has assembled a list of 61 species reported from Sinaloa, not all of which are based upon satisfactory identifications, as he notes. To this list he adds about a half dozen names, some of which are proposed in his text although earlier records presumably referred to the same species. The name *Trimorphodon biscutatus*, for example, in all likelihood was erroneously applied to the same species described by Taylor as *T. paucimaculatus*. Taylor's list, which omitted such records as that for *Crotalus stejnegeri* (type locality, Plomosus, Sinaloa) and *Coluber flagellum piceus*, was not claimed to be complete. However, it may be observed that of roughly 60 or 70 species reported by him, about two-thirds of them (or their synonyms) are now known from Sonora. Undoubtedly other forms will eventually be found in Sonora, including representatives of the genera *Hypopachus*, *Tropidodipsas*, and *Lepidodeira*¹ not included below. Genera known from Sinaloa but less likely to occur in Sonora are *Crocodilus*, *Iguana*, and *Geagras*. The introduced gecko *Peropus* is another possibility not included in the list which follows.

AMPHIBIA

Bufo cognatus Say

Bufo cognatus SAY, in James, 1823, Account of

¹ *Leptodeira ephippiata*, based on a specimen from Alamos, Sonora, was described by Smith and Tanner (Copeia, 1944, p. 131) while this paper was in press.

an expedition . . . to the Rocky Mountains, . . . under . . . Major Stephen H. Long, vol. 2, p. 190, footnote; Arkansas River, Prowers County, Colorado.

Whereas this toad is not uncommon in the vicinity of ditches and rivers along the Mexican border we can find no record for Sonora. However, if specimens reported by Kellogg (1932, p. 44) from Durango are correctly assigned, the species must occur in Sonora.

Bufo compactilis Wiegmann

Bufo compactilis WIEGMANN, 1833, Isis, vol. 26, pt. 7, p. 661; Mexico.

Kellogg (1932, p. 47) reports this toad from Sonora, without definite locality. Perhaps it should be included in the list of species known from the state. There is no reason to doubt that it occurs there, although in parts of its range it is confused with *woodhousii*. In southwestern United States the habitat of this toad either overlaps that of *woodhousii*, or some erroneous records have been reported. It is not impossible that the two forms occasionally hybridize.

Bufo insidiator Girard

Bufo insidiator GIRARD, 1854, Proc. Acad. Nat. Sci. Philadelphia, vol. 7, p. 88; Chihuahua, Mexico; KAUFFELD, 1943, Amer. Midland Nat., vol. 29, p. 343.

Under the name *Bufo debilis*, Campbell (1934, p. 3) recorded this species from the Huachuca Mountains in Arizona, and more recently Kauffeld (*supra cit.*) has reported a specimen from the vicinity of Tombstone, "30 miles south of Cochise." In view of the fact that Taylor (1938b) has reported specimens from Zacatecas, it is reasonable to suppose that the species occurs in northeastern Sonora.

The specimen collected by Kauffeld is now A.M.N.H. No. 50914 in the collection of the American Museum of Natural History. This specimen, an adult female with mature eggs in the oviducts, compares favorably in coloration and pattern with Zacatecan specimens depicted by Taylor (*supra cit.*), particularly

the individual depicted by him as figure 9 of plate 45. Taylor states that *B. debilis*, with which Kellogg (1932) synonymized *insidior*, inhabits "Eastern Texas and Tamaulipas," whereas *insidior* occupies an extensive range from Kansas and New Mexico southward through Texas and the adjoining states in Mexico to Durango and Zacatecas. We have compared the Arizonan specimen with individuals from Archer, Presidio, McLennan, and Bexar counties, Texas. Presumably some of these specimens would be referable to *debilis*, if Taylor's views are correct. Obviously there are differences in pattern and pustulation, but there is no conspicuous difference aside from these between the Arizonan and Texan specimens. The specimens from Archer County in northern Texas are certainly the same species as that from the other Texan counties, including Bexar which lies immediately north of Atascosa County where the toads depicted as *debilis* in figures 5 and 6 of Taylor's plate 45 were taken. If *insidior* can be removed from the synonymy of *debilis*, we strongly suspect that it represents a subspecies of the latter. Furthermore, if our specimen from Bexar County is properly assigned to *debilis*, it is obvious that the form has a wider range than Taylor's statement implies, probably including Oklahoma and Kansas to judge only by a photograph of a Kansan specimen, and the proximity of Archer County to Oklahoma. "San Diego County, Texas," where the toad in figure 4 of Taylor's plate was reputedly taken, seems to be non-existent; possibly the specimen came from San Diego, in Duval County.

Unless the type or other specimens from Chihuahua more closely resemble the Arizonan and Zacatecan individuals than Texan specimens, the applicability of the name *insidior* to the former is open to considerable question. Taylor does not compare *debilis* with *insidior*, but compares each separately with *kelloggi* from Mazatlán. The latter evidently is a valid form inhabiting the coastal plain from Mazatlán at least as far south as Acaponeta in Nayarit where the specimens (A.M.N.H. Nos. 43877-43878) were secured by one of us in November, 1939.

Hyla wrightorum Taylor

Hyla wrightorum TAYLOR, 1938, Univ. Kansas

Sci. Bull., vol. 25, p. 436; 11 miles south of Springerville, Apache County, Arizona.

Paratypes of this species include specimens from Arizona, New Mexico, and Chihuahua. Unquestionably it occurs in the northeastern portion of Sonora at higher elevations. Campbell (1934, p. 6) records a specimen (as *Hyla eximia*) from the "head of Miller Canyon, at an elevation of about 8,500 feet" in the Huachuca Mountains near the international boundary.

Rana tarahumarae Boulenger

Rana tarahumarae BOULENGER, 1917, Ann. Mag. Nat. Hist., ser. 8, vol. 20, p. 416; Sierra Tarahumare, northwestern Mexico.

The known locality records for this frog indicate that further collecting will certainly demonstrate its presence in Sonora. Campbell (1934, p. 9) has reported it from Peña Blanca Springs, 3 miles north of the international boundary in Santa Cruz County, Arizona. Since then it has been taken in New Mexico, and there is no reason to doubt that it ranges southward on the edge of the plateau, through Durango. We take this opportunity to report a southern extension of the range, based upon A.M.N.H. Nos. 12533-12534 taken at Oblatos, Jalisco, by Paul R  thling. These specimens have been compared with individuals from New Mexico and Arizona in the Museum of Zoology, University of Michigan.

Rana catesbeiana Shaw

Rana catesbeiana SHAW, 1802, General zoology, vol. 3, pt. 1, p. 106, pl. 33; South Carolina.

As noted in a previous section of this paper, the bullfrog, introduced in Arizona several years ago, was observed in considerable numbers along the Santa Cruz River a few miles north of Nogales. Presumably it has penetrated farther upstream, and its occurrence in northern Sonora is altogether probable.

Microhyla mazatlanensis Taylor

Microhyla mazatlanensis TAYLOR, 1943, Univ. Kansas Sci. Bull., vol. 29, p. 355; 2 miles east of Mazatl  n, Sinaloa.

Taylor's decision to regard four narrow-mouthed toads from Sinaloa as representatives of a new species throws some doubt on

the identity of our specimens from Guirocoba. Four specimens taken by Allen (1933, p. 3) at Noria in north central Sonora were referred by him to *Gastrophryne texensis*, now a synonym of *M. olivacea*. The latter name was applied by Campbell (1934, p. 6) to specimens taken 3 miles north of the international boundary at Peña Blanca Springs, Santa Cruz County, Arizona. Taylor diagnosed *mazatlanensis* as being "related to *olivacea* but distinctly smaller in size." Our specimens from Guirocoba include individuals of both sexes which fall close to the maximum snout to vent length reported for *olivacea*. Taylor's Sinaloan specimens are but 5 mm. shorter, but as nearly as we can determine the coloration of our Guirocoba specimens more nearly approaches that of *olivacea*. An additional form, *M. usta*, is already recorded from Presidio de Mazatlán. Thus, no fewer than three species are presumed to exist within a rather limited region, and further material is obviously required before satisfactory conclusions can be drawn. At present we can neither confirm nor deny the validity of *mazatlanensis*.

REPTILIA

Sauromalus obesus (Baird)

Euphryne obesus BAIRD, 1858, Proc. Acad. Nat. Sci. Philadelphia, vol. 11, p. 253; Fort Yuma, California.

Sauromalus obesus BURT AND MYERS, 1942, Stanford Univ. Publ. Biol. Sci., vol. 8, p. 33.

Whereas Burt and Myers refer a specimen from Punta Peñasco on the northeastern coast of Sonora to *obesus*, specimens from the same locality in other collections have been tentatively identified as *S. townsendi* on lists provided by museums having specimens. We have been unable to examine material from Punta Peñasco, and consequently we cannot attempt to settle the question. Schmidt (1922, p. 644) points out that *townsendi* in several respects is intermediate between *hispidus* of Angel de la Guarda Island and *obesus* of the mainland farther north. Because mainland specimens from the vicinity of Guáymas have been referred to *townsendi* it is a reasonable assumption that this form intergrades with *obesus* somewhere along the coast of Sonora. With the type locality at Fort Yuma it would be astonishing if *obesus*

did not occur in northwestern Sonora. Hence our omission of it is provisional.

Taylor's (1938a, p. 477) inclusion of *Sauromalus hispidus* in the list of species inhabiting low mountains in the Guáymas region is evidently a mistake; in his systematic account in the same paper he records only *S. townsendi*.

Crotaphytus dickersonae Schmidt

Crotaphytus dickersonae SCHMIDT, 1922, Bull. Amer. Mus. Nat. Hist., vol. 46, p. 638; Tiburón Island, Gulf of California.

Crotaphytus collaris dickersonae ALLEN, 1944, Occas. Papers Mus. Zool. Univ. Michigan, no. 259, p. 7.

If *dickersonae* proves to be a valid form, it presumably occupies a range similar to that of *Sauromalus townsendi*. Allen (*supra cit.*) mentions specimens taken at Hermosillo and at a locality 40 miles north of Guáymas and notes that: "If the range of variation in *dickersonae* is not so great as to preclude its recognition as a valid subspecies, it appears that the present specimens may be referred to it." Taylor (1938a), however, refers a specimen taken 61 miles south of Nogales to *Crotaphytus collaris baileyi*. Abundant material from Sonora and Tiburón Island will be required before the status of Sonoran populations can be determined satisfactorily. Provisionally we prefer to omit *dickersonae* from the list of Sonoran reptiles.

Uta ornata symmetrica Baird

Uta symmetrica BAIRD, 1858, Proc. Acad. Nat. Sci. Philadelphia, vol. 11, p. 253; Fort Yuma, Imperial County, California.

Urosaurus ornatus symmetricus MITTLEMAN, 1942, Bull. Mus. Comp. Zool., vol. 41, p. 142, pl. 4.

Whereas Mittleman (*supra cit.*) includes Sonora within the range of this subspecies, it is not clear whether specimens from the state are properly referred. Until the status of the form and the applicability of the name can be investigated on a more intelligible basis, we prefer to omit it from the list of forms known from Sonora.

Uta graciosa Hallowell

Uta graciosa HALLOWELL, 1854, Proc. Acad. Nat. Sci. Philadelphia, vol. 7, 1854, p. 92; "Lower California" meaning southern California; GLOYD, 1937, Bull. Chicago Acad. Sci., vol. 5, p. 108.

Urosaurus ornatus graciosus MITTLEMAN, 1942, Bull. Mus. Comp. Zool., vol. 41, p. 144, pl. 7.

This lizard is relatively common in the vicinity of Yuma, Arizona, on both sides of the Colorado River. Mittleman (1942, p. 129) indicates the presence of this form in Sonora on his map, but his text (p. 145) proves that this was purely supposition. Nevertheless the species undoubtedly occurs south of the border, possibly in a considerable area in the northwestern corner of Sonora. Furthermore its range is not nearly so restricted to the territory adjacent to the Colorado River as Mittleman's map indicates the range. Gloyd (*supra cit.*) has reported a specimen from Ajo in Pima County, Arizona, and westward *graciosa* has been taken at Palm Springs, Riverside County, as well as in eastern San Diego County.

Mittleman's decision to place *graciosa* as a subspecies of *ornata* is not supported by any data that can be construed as evidence of intergradation; specimens taken by the senior author near Yuma are in no way intermediate between *graciosa* and *ornata*. Hence we consider the former to be a distinct species.

Sceloporus poinsettii Baird and Girard

Sceloporus poinsettii BAIRD AND GIRARD, 1852, Proc. Acad. Nat. Sci. Philadelphia, vol. 6, p. 126; Rio San Pedro of the Rio Grande del Norte, and the province of Sonora; SMITH, 1939, Publ. Field Mus. Nat. Hist., zool. ser., vol. 26, p. 223.

Van Denburgh (1922, pp. 32, 329), as *Sceloporus torquatus poinsettii*, lists this form from "Sonora." Presumably this was on the basis of one of the cotypes, the actual origin of which is uncertain. Smith (*supra cit.*) omits Sonora from the range, although he lists specimens from Montezuma Mountain, near Colonia Dublan not far from the border, in the state of Chihuahua. The species must occur in eastern Sonora.

Holbrookia pulchra Schmidt

Holbrookia pulchra SCHMIDT, 1921, Amer. Mus. Novitates, no. 22, p. 1; Carr Canyon, 5200 feet, Huachuca Mountains, Arizona; SCHMIDT, 1922, Bull. Amer. Mus. Nat. Hist., vol. 46, p. 716, pl. 59.

As in the case of all other species occurring in the Huachuca Mountains, this form must occur in northeastern Sonora. Schmidt (1922,

supra cit.) suggests that *pulchra* may prove to be subspecifically related to *elegans*. This seems altogether probable, and if it proves to be so the distributional picture will be considerably clarified. *H. elegans elegans* of coastal Sinaloa conceivably intergrades somewhere near the southern border with *H. e. thermophila*, and this lowland form in turn may intergrade with *pulchra* along the foothills in northeastern Sonora. Schmidt notes that *pulchra* occurs in the Huachuca Mountains between elevations of 4600 and 6200 feet.

Because *pulchra* has often been confused with *H. maculata approximans*, it is possible that some Sonoran records for the latter are actually based upon specimens of *pulchra*. In any case there would seem to be three distinct species in Sonora, *elegans*, *maculata*, and *texana*, and the genus is possibly comprised of only these three species, at least two of which are polymorphic.

Callisaurus draconoides ventralis (Hallowell)

Homalosaurus ventralis HALLOWELL, 1852, Proc. Acad. Nat. Sci. Philadelphia, vol. 6, p. 179; New Mexico west of Rio Grande.

We are inclined to doubt that populations on the peninsula of Baja California (with the possible exception of *C. crinitus*) are specifically distinct from those on the mainland to the north or from those on the Sonoran mainland. Intergrading populations in all likelihood exist in California and Arizona, *draconoides* of the cape with *gabii* in northern Baja California, and the latter with *ventralis* in Arizona. To the south, in Sonora, *ventralis* must, in turn, intergrade with *inusitatus*, while *brevipes* of southern Sonora and northern Sinaloa can scarcely be more than subspecifically distinct from *inusitatus*. If these somewhat speculative views are correct, *ventralis* would be expected in northern Sonora. Taylor (1938a), it may be noted, refers specimens from 25 miles south of Nogales to *inusitatus*, along with specimens taken farther south around Guáymas.

Uma notata notata Baird

Uma notata BAIRD, 1858, Proc. Acad. Nat. Sci. Philadelphia, vol. 11, p. 253; "Mojave Desert" in error for Colorado Desert, either in California or Arizona.

Uma notata notata HEIFETZ, 1941, Copeia, p. 101.

The Sonoran race *U. notata cowlesi* differs from Arizonan *U. n. notata* principally in mean differences in the femoral pore count and in the relative size of the ventrolateral black blotch (Heifetz, *supra cit.*). At present no specimens from the region between Punta Peñasco and localities in extreme southwestern Arizona are known, although there is no reason to doubt that the species occurs there. Unquestionably populations in extreme northwestern Sonora will prove to be closer to typical *notata*.

***Cnemidophorus tessellatus*
tessellatus (Say)**

Ameiva tessellata SAY, in James, 1823, Account of an expedition . . . to the Rocky Mountains, . . . under . . . Major Stephen H. Long, vol. 2, p. 50; Arkansas River, near Castle Rock Creek, Colorado.

Cnemidophorus tessellatus tessellatus BURT, 1931, Bull. U. S. Natl. Mus., no. 154, p. 146.

Our inclusion of *Cnemidophorus melanostethus* Cope rather than *C. t. tessellatus* in the fauna of Sonora represents nothing more than an arbitrary decision. Burt (*supra cit.*) considered the latter a synonym of the former. Allen (1933, p. 10) lists *C. t. tessellatus* from three Sonoran localities, but comments on the fact that the coloration is typical of *melanostethus*. Taylor (1938a) identifies specimens taken between Nogales and Guáymas as *melanostethus* without mentioning *C. t. tessellatus* except for inclusion of reference to Allen's paper in the synonymy for Sonora.

Whereas the coloration of Sonoran specimens supposedly agrees with that of the type of *melanostethus* (inferred from Burt's discussion, 1931, pp. 157-164), Burt maintains that the nature of the variation in other populations referred by him to *C. t. tessellatus* precludes any possibility of recognizing *melanostethus*. However, Burt's concept of the subspecies as a taxonomic unit is not that of many other taxonomists, and until some other worker reviews the genus *Cnemidophorus*, or at least the species in the *tessellatus* group, no satisfactory decision can be reached. It may be noted, however, that most workers are in agreement in considering

melanostethus to be closely related to *tessellatus*. If *melanostethus* is valid, presumably it will be recognized as a subspecies of *tessellatus*, not as a sympatric species. Hence we question the inclusion of Sonora in the range of *tessellatus* as stated by Stejneger and Barbour (1943) when *melanostethus* is recognized in the same work.

***Eumeces obsoletus* (Baird and Girard)**

Plestiodon obsoletum BAIRD AND GIRARD, 1852, Proc. Acad. Nat. Sci. Philadelphia, vol. 6, p. 129; valley of the Rio San Pedro of the Rio Grande del Norte.

Eumeces obsoletus TAYLOR, 1936, Univ. Kansas Sci. Bull., vol. 23, p. 305, figs. 47-48, pl. 24.

Taylor reports numerous records of this species from southeastern Arizona, some of them near the international boundary at the south end of the Huachuca Mountains. Because the species is also known from central Chihuahua, it would be little short of remarkable if it were not eventually found in Sonora. Ash Creek, which Taylor (*tom. cit.*, p. 318) suggests is a canyon in the Huachuca Mountains, probably refers to the village by that name near the San Carlos River in Graham County, Arizona.

***Leptotyphlops dulcis dissectus* (Cope)**

Stenostoma dulce COPE, 1883, Proc. Acad. Nat. Sci. Philadelphia, vol. 35, p. 11; Lake Valley, New Mexico.

Leptotyphlops dulcis dissectus KLAUBER, 1940, Trans. San Diego Soc. Nat. Hist., vol. 9, p. 112.

Klauber (*supra cit.*) records specimens of this race within a few miles of the Mexican border in southeastern Arizona. Farther to the southeast the subspecies is known from the Big Bend region of Texas, as well as from southern Coahuila. The lack of specimens from northeastern Sonora and from Chihuahua can be attributed only to the inadequate herpetological exploration of these two states.

***Leptotyphlops humilis segregus* Klauber**

Leptotyphlops humilis segregus KLAUBER, 1939, Trans. San Diego Soc. Nat. Hist., vol. 9, p. 67; Chalk Draw, Brewster County, Texas; KLAUBER, 1940, *ibid.*, vol. 9, p. 140.

The distribution of this form through Coahuila, southern Texas, and southern Arizona

(Klauber, 1940, *supra cit.*) indicates that it must likewise be expected in northeastern Sonora.

Leptotyphlops humilis cahuilae Klauber

Leptotyphlops humilis cahuilae KLAUBER, 1931, Trans. San Diego Soc. Nat. Hist., vol. 6, p. 339; Yaqui Well, San Diego County, California; KLAUBER, 1940, *ibid.*, vol. 9, p. 134.

The presence of this race of the worm snake just north of the Sonoran border along the Colorado River indicates that it is to be expected on the Mexican side. In connection with our discussion of *L. h. dugesii* in an earlier section of this paper, we have assumed that an old record (based upon a specimen that was lost in the fire of 1906 in the California Academy of Sciences) from Horcasitas was probably referable to *L. h. humilis*. Dr. L. M. Klauber (*in litt.*) suggests that it might have been referable either to *humilis* or to *cahuilae*. Thus, our inclusion of *L. h. humilis* in the list of Sonoran reptiles is arbitrary and provisional.

Phyllorhynchus browni browni
Stejneger

Phyllorhynchus browni STEJNEGER, 1890, Proc. U. S. Natl. Mus., vol. 13, p. 152; Tucson, Arizona.

Phyllorhynchus browni browni KLAUBER, 1940, Trans. San Diego Soc. Nat. Hist., vol. 9, p. 204.

The known distribution of the species in Arizona, as mapped by Klauber (*supra cit.*), and the type locality (Alamos) of an additional subspecies described herein make it apparent that *P. b. browni* must occur in northern Sonora.

Phyllorhynchus decurtatus perkinsi
Klauber

Phyllorhynchus decurtatus perkinsi KLAUBER, 1935, Bull. Zool. Soc. San Diego, no. 12, p. 11; Dry Lake, San Diego County, California; KLAUBER, 1940, Trans. San Diego Soc. Nat. Hist., vol. 9, p. 207.

Records of *P. d. perkinsi* from southwestern Arizona and of *P. d. nubilus* from Alamo Muerto in western Sonora (Klauber, 1940, map, p. 196) indicate that intergradation between the two is to be expected between these two regions. Doubtless, however, pure *P. d. perkinsi* occurs south of the international border.

Thamnophis rufipunctatus (Cope)

Chilopoma rufipunctatum COPE, in Yarrow, H. C., 1875, Report upon the geographical explorations and surveys west of the 100th meridian, in charge of . . . Wheeler, vol. 5, p. 544; southern Arizona.

Thamnophis rufipunctatus SMITH, 1942, Zoologica, vol. 27, p. 121.

Smith (*supra cit.*) records a specimen from "Sonora?" in the United States National Museum. Other records published by Smith, from Chihuahua to the east and from Durango to the south, indicate that its occurrence in Sonora is to be expected.

Natrix valida (Kennicott)

Regina valida KENNICOTT, 1860, Proc. Acad. Nat. Sci. Philadelphia, p. 334; Durango, Mexico.

Natrix valida valida COPE, 1862, Proc. U. S. Natl. Mus., vol. 14, p. 670.

Mr. Roger Conant has kindly called our attention to an old Sonoran record for this species. Cope (*supra cit.*) gives the range as "Lower California, Sonora." It is not certain whether this was pure supposition or possibly a *lapsus calami* for Durango, the type locality. In 1939 the senior author found this species to be abundant along the river at Acaponeta in Nayarit, and a few specimens, perhaps hibernating, were found under rocks along the edge of the river at Culiacán in Sinaloa. Conant advises us that the latter locality represents the most northern mainland record for the species that can be corroborated by specimens now extant. However, it is not beyond the realm of possibility that *valida* occurs near the mouth of the Río Mayo or in the lower portion of the Río Fuerte in southern Sonora and northern Sinaloa, respectively.

Lampropeltis triangulum gentilis
(Baird and Girard)

Ophibolus gentilis BAIRD AND GIRARD, 1853, Catalogue of North American reptiles in the . . . Smithsonian Institution, pt. 1, p. 90; North Fork, Red River, near Sweetwater Creek, Wheeler County, Texas.

Lampropeltis triangulum gentilis BLANCHARD, Bull. U. S. Natl. Mus., no. 114, p. 165.

The single specimen known from Apache, Cochise County, Arizona, indicates that there is a possibility of the occurrence of this

kingsnake in northeastern Sonora. Elsewhere in the present paper we have commented upon the dubious possibility that *gentilis* intergrades with *nelsoni*.

Salvadora grahamiae grahamiae
Baird and Girard

Salvadora grahamiae BAIRD AND GIRARD, 1853, Catalogue of North American reptiles in the . . . Smithsonian Institution, pt. 1, p. 104; "Sonora" (= southern Arizona).

Whereas the type locality was given as "Sonora" it has been noted (Bogert, 1939, p. 199) that the present boundary between Sonora and Arizona was not established until 1853 at the time of the Gadsden Purchase. As yet no specimens with reliable data appear to have been taken south of the international border, although the late F. N. Blanchard secured a specimen at the south end of the Huachuca Mountains within a mile or so of Mexico. Hence it is a reasonable assumption that the species exists at elevations above 4000 feet in the northeastern portion of Sonora.

***Lampropeltis pyromelana* (Cope)**

Ophibolus pyromelanus COPE, 1866, Proc. Acad. Nat. Sci. Philadelphia, p. 305; Fort Whipple, Arizona.

Lampropeltis pyrrhomelaena BLANCHARD, 1921, Bull. U. S. Natl. Mus., no. 114, p. 231.

Whereas Blanchard (*supra cit.*, p. 238) indicates the range of this form as extending through eastern Arizona and northeastern Sonora into Chihuahua, no actual specimens from Sonora appear to have been examined. However, there can be no doubt that it occurs in the mountainous regions of northeastern Sonora. The series recently described by Taylor (Copeia, 1940, p. 253) as *Lampropeltis knoblochi*, from Mojárichic in the Sierra Madre of Chihuahua, will probably prove to be subspecifically related to *pyromelana* when specimens are available from the intervening area. Sonoran specimens may, in fact, prove to be either form. Blanchard (*supra cit.*, p. 232) indicates two Chihuahuan localities on his map, but on page 235 he mentions but a single specimen as a "Skin. Probably of this species." The presence of *knoblochi* in Chihuahua farther to the west suggests that this skin may now be assigned to Taylor's "species."

Rhinocheilus lecontei lecontei
Baird and Girard

Rhinocheilus lecontei BAIRD AND GIRARD, 1853, Catalogue of North American reptiles in the . . . Smithsonian Institution, pt. 1, p. 120; San Diego, California.

Rhinocheilus lecontei lecontei KLAUBER, 1941, Trans. San Diego Soc. Nat. Hist., vol. 8, p. 296, pl. 12, fig. 1.

Klauber (*supra cit.*) includes four records of this form from localities very nearly on the border of southern Arizona. Thus there can be no doubt whatever that it occurs in Sonora. Similarly Klauber (*tom. cit.*, p. 318) records intergrades between *clarus* and *antoni* from the vicinity of Nogales, and, because of the nature of intergradation between these forms, *clarus* would be expected in Sonora. The race *R. l. tessellatus* seems not to be represented by specimens taken farther west than Hidalgo County in southwestern New Mexico (Klauber, *tom. cit.*, map, p. 330), but if the distribution of this subspecies follows the distributional pattern of other reptiles known from Texas, Coahuila, and New Mexico, the occurrence of *tessellatus* in northeastern Sonora can be anticipated.

***Conopsis nasus* Günther**

Conopsis nasus GÜNTHER, 1858, Catalogue of colubrine snakes in the British Museum (Natural History), p. 6; "California" (in error); TAYLOR AND SMITH, 1942, Univ. Kansas Sci. Bull., vol. 28, p. 329.

The specimen reported by Taylor and Smith (*supra cit.*) from Mojárichic in the Sierra Madre Occidental of Chihuahua indicates that the species may be expected from eastern Sonora where few collections have been made.

***Gyalopion canum* Cope**

Gyalopion canum COPE, 1860, Proc. Acad. Nat. Sci. Philadelphia, p. 243; Fort Buchanan, Arizona; SMITH AND TAYLOR, 1941, Jour. Washington Acad. Sci., vol. 31, p. 361.

Recorded from the vicinity of the Santa Rita Mountains (Fort Buchanan, if the type actually was taken there and not merely shipped from the fort) and Montezuma Cañon, Huachuca Mountains, as well as from New Mexico and Texas to the east, this species can scarcely be absent from Sonora. The

species *desertorum* known from the southern part of the state and in northern Sinaloa seems to be more closely allied to *quadrangularis* of central Sinaloa as far as pattern characters are concerned. Smith and Taylor (*supra cit.*) have discussed the relationships, and on the basis of present knowledge there is no difficulty in separating the three forms. However, the extent of variation is unknown for *quadrangularis* which appears to be represented in collections by the type only. It is not impossible that *desertorum* may prove to be a subspecies or a synonym of *quadrangularis* when specimens from central Sinaloa are forthcoming.

***Tantilla yaquia* Smith**

Tantilla yaquia SMITH, 1942, Zoologica, vol. 27, p. 41; Guasaremos, Rfo Mayo, Chihuahua.

The type locality of this species is scarcely 4 miles from the boundary of Sonora, so the species must occur in the state.

***Tantilla wilcoxi wilcoxi* Stejneger**

Tantilla wilcoxi STEJNEGER, 1902, Proc. U. S. Natl. Mus., vol. 25, p. 156; Fort Huachuca, Arizona.

Tantilla wilcoxi wilcoxi SMITH, 1942, Zoologica, vol. 27, p. 40.

The recent record of this species in Chihuahua (Smith, *supra cit.*) indicates that the species probably ranges southeastward through Sonora from the type locality in the Huachuca Mountains.

***Sonora semiannulata semiannulata*
Baird and Girard**

Sonora semiannulata BAIRD AND GIRARD, 1853, Catalogue of North American reptiles in the . . . Smithsonian Institution, pt. 1, p. 117; vicinity of the Santa Rita Mountains, Arizona (originally given as "Sonora, Mexico").

Sonora semiannulata semiannulata STICKEL, 1943, Proc. Biol. Soc. Washington, vol. 56, p. 119.

Originally listed as from "Sonora," the type, like that of *Salvadora grahamiae*, probably came from the portion of Arizona that was part of the Mexican state prior to the Gadsden Purchase. Thus Stickel's decision to restrict the type locality to the vicinity of the Santa Rita Mountains seems to be justifiable. However, there are probably no reptiles in

these mountains that do not occur south of the international border, and Stickel observes that "Its discovery in the Sierra Madre Occidental of Mexico is to be expected." Hence the species can be anticipated in Sonora.

***Chionactis occipitalis annulatus* (Baird)**

Lamprosoma annulatum BAIRD, 1859, U. S. and Mexico boundary survey, vol. 2, pt. 2, p. 22; Colorado Desert.

Chionactis occipitalis annulatus STICKEL, 1943, Proc. Biol. Soc. Washington, vol. 56, p. 123 (misprinted "p. 128" in separata).

In his recent summary of the forms in the genus *Chionactis*, as reinstated by him, Stickel (*supra cit.*) notes that, "This snake has not yet been recorded from Mexico, but it undoubtedly occurs both in northern Baja California and northwestern Sonora."

***Micrurus fulvius tenere*
(Baird and Girard)**

Elaps tenere BAIRD AND GIRARD, 1853, Catalogue of North American reptiles in the . . . Smithsonian Institution, pp. 22 and 156; San Pedro of Rio Grande and New Braunfels, Texas.

Micrurus fulvius tenere SCHMIDT, 1933, Publ. Field Mus. Nat. Hist., zool. ser., vol. 20, p. 40.

A single specimen in the collection obtained by F. Robinette in "northern Sonora" and deposited in the American Museum of Natural History by Carl Lumholtz includes a specimen (A.M.N.H. No. 3926) of this species. The identification has been confirmed by Mr. Karl P. Schmidt. However, in view of the fact that no specimens are known from northern Mexico west of Coahuila or from the United States west of Texas, we prefer to consider the record doubtful until additional specimens are secured. All other species represented in the Lumholtz collection could reasonably be expected in northern Sonora, however, and it is not impossible that *M. f. tenere* ranges across Coahuila into eastern Sonora. Such a distribution is not without parallels among other forms known from southeastern Arizona.

***Sistrurus catenatus tergeminus* (Say)**

Crotalus tergeminus SAY, in James, 1823, Account of an expedition . . . to the Rocky Mountains, . . . under . . . Major Stephen H. Long, vol. 1, p. 499; no definite type locality.

Crotalophorus Edwardsii BAIRD AND GIRARD, 1853, Catalogue of North American reptiles in the . . . Smithsonian Institution, pt. 1, p. 15.

Sistrurus catenatus tergeminus GLOYD, 1940, Special Publ. Chicago Acad. Sci., no. 4, p. 36.

This species has been included in lists of Sonoran reptiles for some years on the basis of the specimen secured in "Sonora" by J. D. Graham. Like other "Sonora" specimens reported by Baird and Girard (*op. cit.*) the specimen may have been taken in Arizona. Gloyd (*supra cit.*) accepts the locality data attached to a specimen from Fort Huachuca, and since the species ranges eastward through southern Texas it is not impossible that it will be found in northeastern Sonora.

***Crotalus lepidus klauberi* Gloyd**

Crotalus lepidus klauberi GLOYD, 1936, Occas. Papers Mus. Zool. Univ. Michigan, no. 337, p. 2, pl. 1, fig. 1; Carr Cañon, Huachuca Mountains, Cochise County, Arizona.

This small rattlesnake is not uncommon in the Huachuca Mountains and, although records to the south are principally from the eastern slopes of the Sierra Madre Occidental, its apparent absence on the west can be ascribed only to inadequate exploration by herpetological collectors. *Crotalus stejnegeri*, known from the foothills of the Sierra Madre in southern Sinaloa as well as in Durango, conceivably might range northward into southeastern Sonora.

TESTUDINATA

***Lepidochelys olivacea* (Eschscholtz)**

Chelonia olivacea ESCHSCHOLTZ, 1829, Zoologischer Atlas, pt. 1, p. 2, pl. 3; Manila Bay, Philippine Islands.

Lepidochelys olivacea CARR, 1942, Proc. New England Zool. Club, vol. 21, p. 2, pl. 5.

A specimen identified as this species, No. 26170 in the Museum of Vertebrate Zoology, was taken at the north end of Tiburón Island. Thus the occurrence of this turtle in the Gulf of California is established, and probably it visits the shores of Sonora. Similarly, *Eretmochelys squamata* has been taken off the coast of Baja California, and it can be expected in the gulf.

***Platypeltis emoryi* (Agassiz)**

Aspidonectes emoryi AGASSIZ, 1857, Contributions to the natural history of the United States, vol. 1, p. 407, vol. 2, pl. 6, figs. 4 and 5; Rio Grande River, near Brownsville, Texas.

Trionyx emoryi LINSDALE AND GRESSITT, 1937, Copeia, p. 222.

The exclusion of this turtle from the list of reptiles known from Sonora is essentially an academic matter, since the species is known from the Colorado River delta 7 miles east of Cerro Prieto in Baja California (Linsdale and Gressitt, *supra cit.*). Indubitably it is found on the Sonoran side of the river, and it would not be astonishing if it were found in other rivers draining into the Gulf of California.

SUMMARY AND CONCLUSIONS

1. A TOTAL OF 124 species and subspecies are reasonably well authenticated as occurring within the boundaries of Sonora (including two marine species which visit the shores of the state), and the presence of at least 35 or 40 more can be anticipated, with some likelihood that a total of approximately 180 will eventually be found. The total number of full species now represented is 111, included in 64 genera representing 22 families.

2. Of the 20 families known to be represented on land or in fresh water in Sonora the following elements can tentatively be recognized: 1 Holarctic, 13 Old Northern, and 10 South American. Of 10 South American families represented in Sonora only 16 genera have evolved, in contrast to 13 Old Northern families represented by 45 genera. In part at least, the greater differentiation of the Old Northern fauna can be attributed to its longer existence in North America, and the meager differentiation of the South American family elements may be partly due to their post-Miocene influx.

3. From an analysis of the faunal elements, as represented by species and genera, it is suggested that these have entered Sonora by way of five main dispersal routes: (1) from the south along the narrow coastal plain (tropical forms); (2) from the south along the Sierra Madre Occidental (stenohygic but eurythermic forms); (3) from the east across the continental divide via the lower valleys across the dissected northern end of the Sierra Madre (plains elements, and lowland forms from the eastern coastal plain); (4) from the northwest (Colorado Desert and Baja Californian elements); and (5) to a limited extent from the north, pushing southward from the mountains of eastern Arizona and New Mexico (Arizona plateau elements).

4. The effectiveness of the desert as a barrier to dispersals of amphibians and reptiles is indicated roughly by the presence of but 32 species in Sonora that are represented in Arizona, California, and Baja California, in

contrast to 65 species which are found only on the eastern side of the desert in Sonora, or in Arizona as well. (An additional six species are present in both Sonora and Baja California but absent from either Arizona or California on the basis of present knowledge.)

5. Only three species (two of them aquatic) represented in Baja California as well as on the mainland are apparently absent north of the Gulf of California. It is suggested that these three species may have ranged north of the gulf in the past, rather than that they crossed the gulf, which appears to have been an insurmountable barrier in the dispersals of terrestrial amphibians and reptiles.

6. Criticism of the biotic regions in Sonora, as mapped by various authors, is presented, with the suggestion that a clearer understanding of distributional phenomena can perhaps be gained by plotting life zones and dispersal routes.

7. In general the results of our limited exploration of southern Sonora, particularly the Río Fuerte drainage system, are in agreement with the conclusions drawn by Gentry whose botanical survey of the Río Mayo basin immediately to the north indicates that "the barrancas of southern Sonora have been penetrated by many species and genera which are associated with tropical vegetation—with an interpenetration of subtropical and desert life forms" (Forest Shreve, in the introduction to Gentry's, 1942, paper).

8. Taxonomic conclusions incidental to this report may be summarized under the following headings:

A. In addition to *Pseudemys scripta hiltoni* Carr, *Terrapene klauberi* Bogert, *Callisaurus draconoides brevipes* Bogert and Dorson, all of which were first described elsewhere, the collections herein reported include two new forms, *Phyllorhynchus browni fortitus* and *Pseudoficimia hiltoni*.

B. The following names have been assigned to synonymies:

<i>Eleutherodactylus tarahumaraensis</i> Taylor	= <i>Eleutherodactylus augusti</i> (Dugés)
<i>Leptodactylus occidentalis</i> Taylor	= <i>Leptodactylus melanonotus</i> Hallowell
<i>Thamnophis vicinus</i> Smith	= <i>Thamnophis eques eques</i> (Reuss)
<i>Salvadora hexalepis celeris</i> Smith	= <i>Salvadora hexalepis deserticola</i> Schmidt
<i>Hypsiglena slevini</i> Tanner	= <i>Hypsiglena torquata ochrorhyncha</i> Cope
<i>Coluber acuminatus</i> Wied	= <i>Oxybelis aeneus aeneus</i> (Wagler)
<i>Oxybelis microphthalmus</i> Barbour and do Amaral	= <i>Oxybelis aeneus auratus</i> (Bell)
<i>Oxybelis potosiensis</i> Taylor	= <i>Oxybelis aeneus auratus</i> (Bell)

C. The following forms, currently placed as species, are assigned as races:

Phyllodactylus homolepidurus Smith as a race of *P. tuberculatus* Wiegmann
Eutaenia sumichrasti Cope as a race of *Thamnophis eques* (Reuss)
Hypsiglena ochrorhyncha Cope as a race of *Hypsiglena torquata* Günther

D. *Coluber striolatus*, placed as a subspecies of *Masticophis* [*Coluber*] *flagellum* by Smith, overlaps in range with, and occurs in the same habitat as, *Coluber flagellum piceus*. Accordingly it has been removed from subspecific status and is again ranked as a full species.

E. The snake described as *Procinura aemula* by Cope and placed by Boulenger and others in *Scolecophis* is referred to the genus *Sonora*.

F. The generic name *Toluca* of Kennicott, recently revived, is again referred to the synonymy of *Conopsis* Günther.

G. The collections forming the basis for this report, including four species that have been described as new elsewhere, indicate that the following species and subspecies should be added to the fauna of Sonora:

1. *Bufo mazatlanensis*
2. *Eleutherodactylus augusti*
3. *Leptodactylus melanonotus*
4. *Agalychnis dacnicolor*
5. *Hyla baudinii*
6. *Rana pustulosa*
7. *Anolis nebuloides*
8. *Cnemidophorus sexlineatus sackii*
9. *Callisaurus draconoides brevipes*
10. *Heloderma horridum*

11. *Eumeces callicephalus*
12. *Leptotyphlops humilis dugesii*
13. *Phyllorhynchus browni fortitus*
14. *Thamnophis eques eques*
15. *Elophe chlorosoma*
16. *Drymarchon corais rubidus*
17. *Drymobius margaritiferus fistulosus*
18. *Lampropeltis triangulum nelsoni*
19. *Coluber striolatus striolatus*
20. *Salvadora hexalepis deserticola*
21. *Leptophis diplotropis diplotropis*
22. *Pseudoficimia hiltoni*
23. *Sonora aemula*
24. *Hypsiglena torquata torquata* (intergrade? with pattern of)
25. *Imantodes gracillima*
26. *Micrurus diastema distans*
27. *Agkistrodon bilineatus*
28. *Crotalus basiliscus*
29. *Kinosternon integrum*
30. *Geomyda p. pulcherrima*
31. *Pseudemys scripta hiltoni*
32. *Terrapene klauberi*

H. The following species, chiefly on the basis of specimens in the collection of R. T. Moore, are herein reported from Sinaloa for the first time:

Ctenosaura hemilopha
Dipsosaurus dorsalis sonoriensis
Phrynosoma solare
Pituophis sayi affinis
Gyalopion desertorum
Hypsiglena torquata ochrorhyncha
Imantodes gracillima

I. The first record of *Hypsiglena torquata ochrorhyncha* on Clarion Island is reported. *Bufo kelloggi* is added to the fauna of Nayarit, and *Rana tarahumarae* to the fauna of Jalisco.

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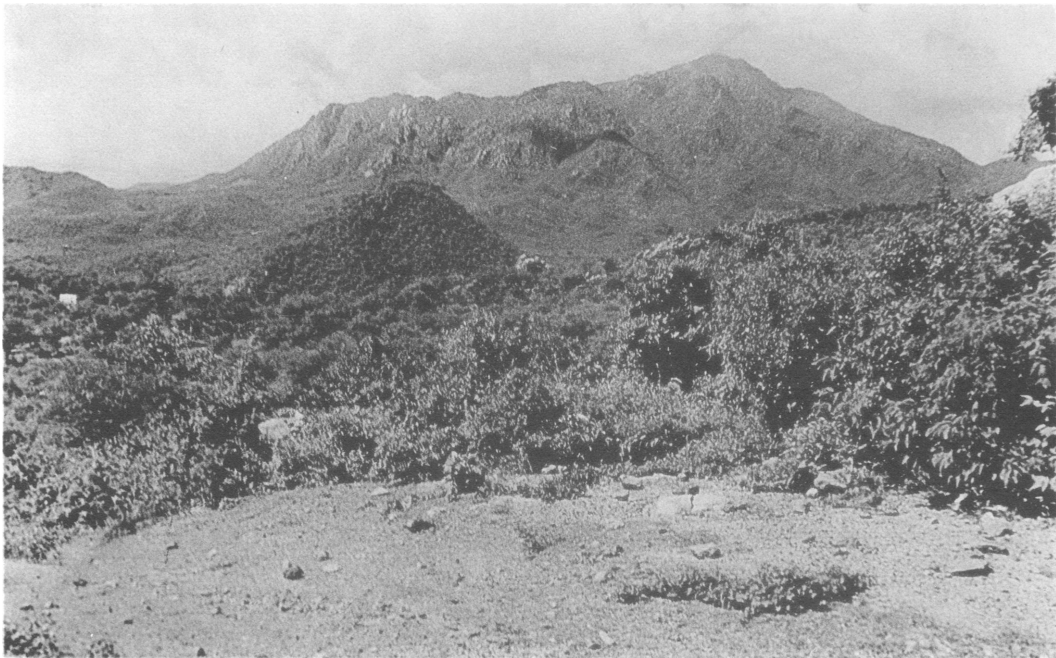
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1. Eastern slope of the Sierra de Alamos. The town of Alamos lies at the foot of the mountain immediately beyond the hill in the foreground



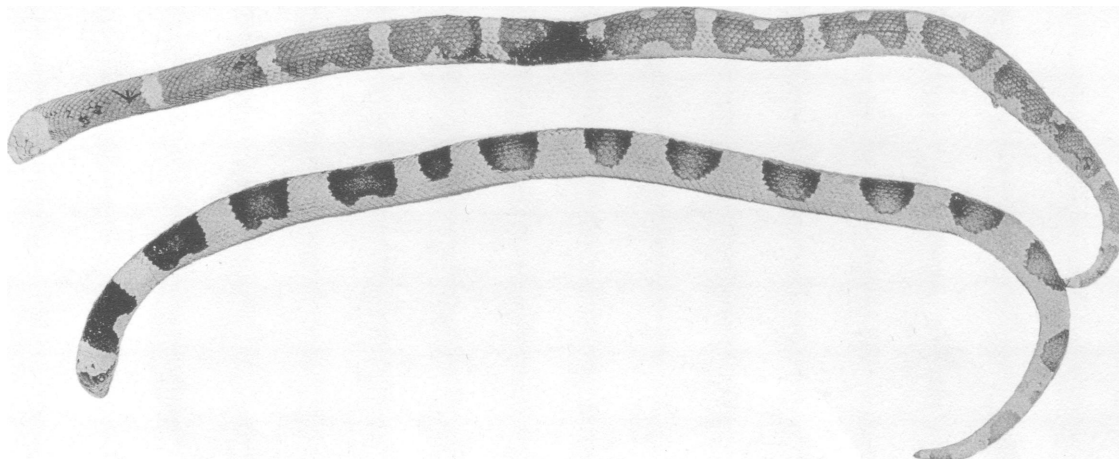
2. Arroyo de los Alamos. Such arenicolous lizards as *Callisaurus* are apparently confined to these limited open spaces



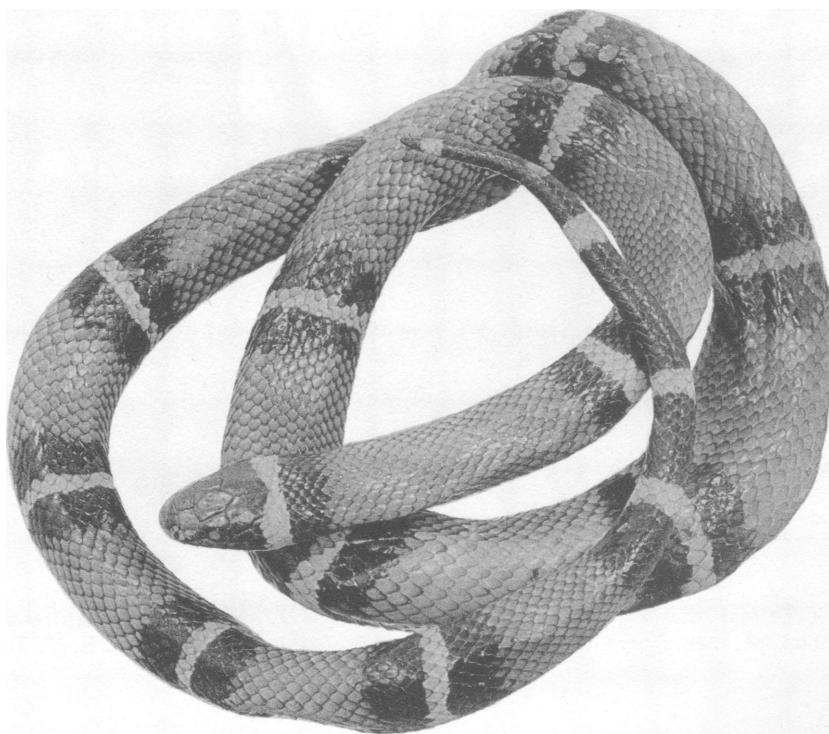
1. Adult female *Agalychnis dacnicolor*, the "rana verde" of Mexicans at Alamos. Photograph of freshly captured animal



2. Native habitation, in partly cleared area of Short-tree Forest on the outskirts of Alamos



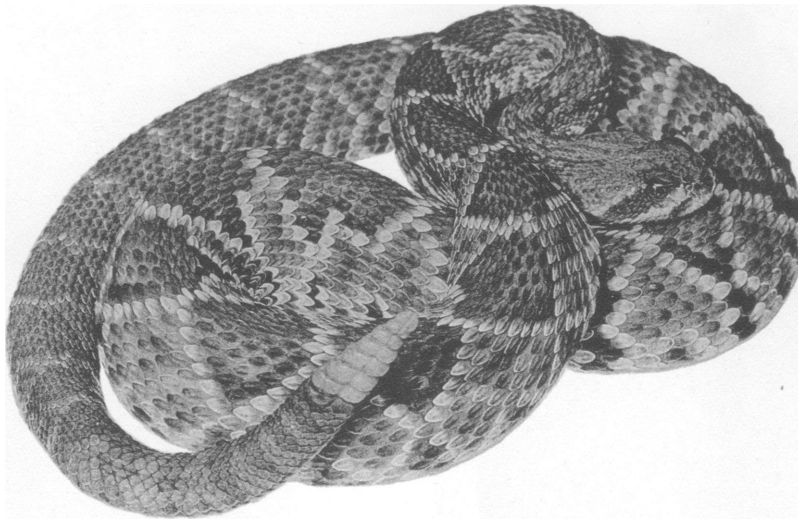
1. The type of *Phyllorhynchus browni fortitus*, A.M.N.H. No. 64239 (upper), compared with a specimen of *P. b. browni* (lower) of similar dimensions. Owing to the red-sensitive film used, the brown blotches of *browni* appear to be darker than the slate-colored blotches of *fortitus*. To the human eye the values are reversed



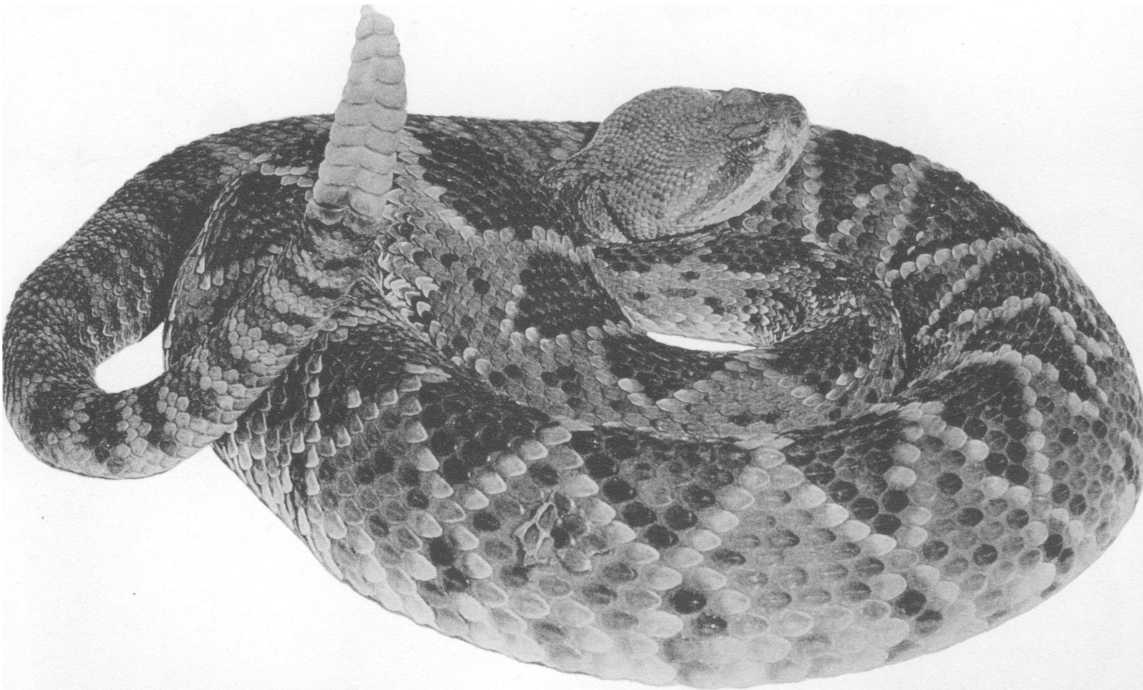
2. The Mexican west coast kingsnake, *Lampropeltis triangulum nelsoni*. Adult female, from preserved specimen A.M.N.H. No. 63713, from Guirocoba, Sonora



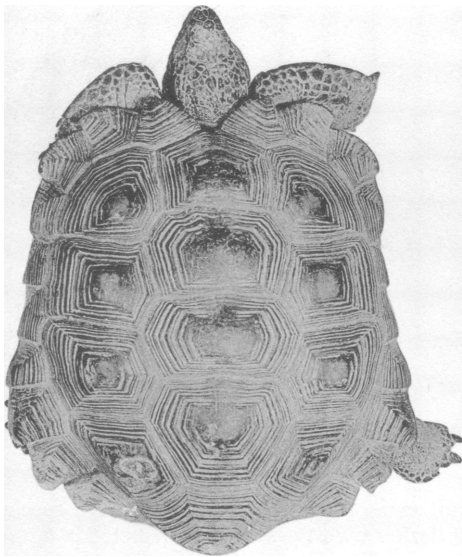
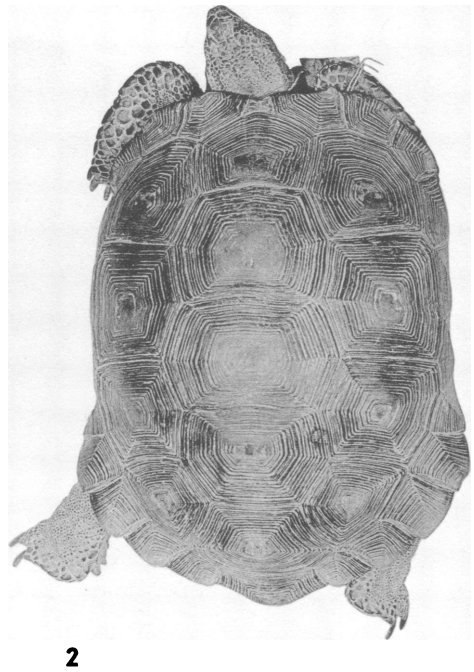
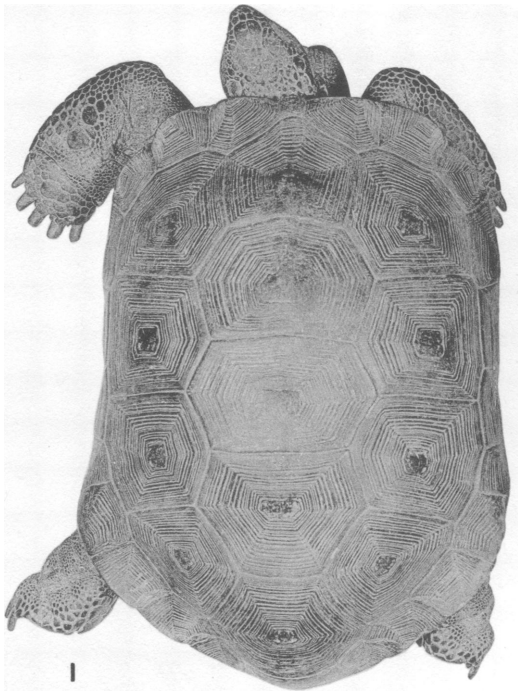
Type of *Pseudoficimia hiltoni*, A.M.N.H. No. 63717, approximately natural size, alcoholic specimen, from Guirocoba, Sonora. (Photograph courtesy of Dr. E. H. Taylor.)



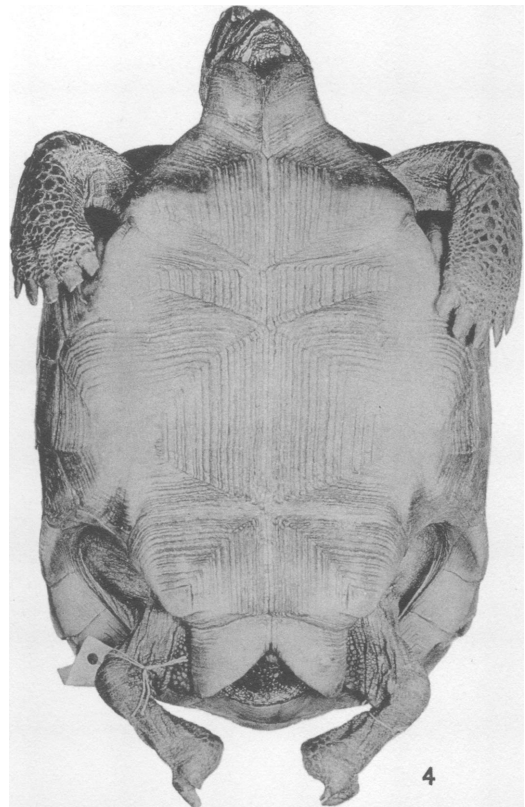
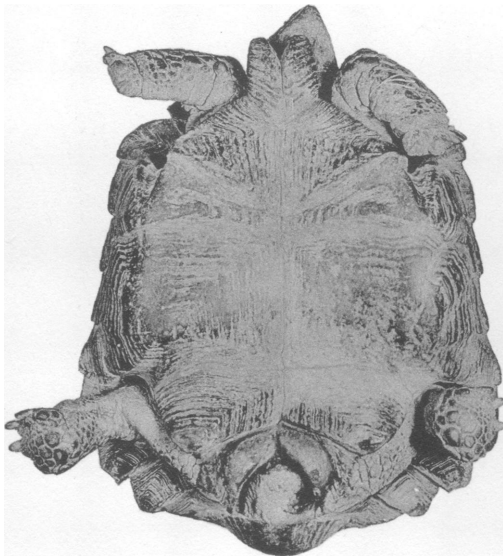
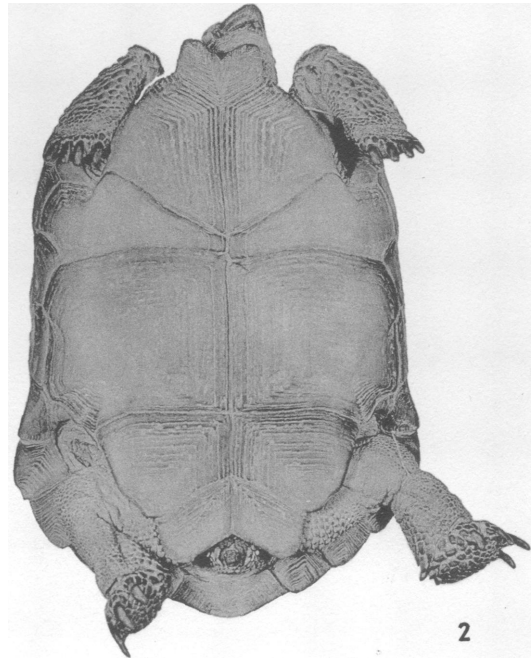
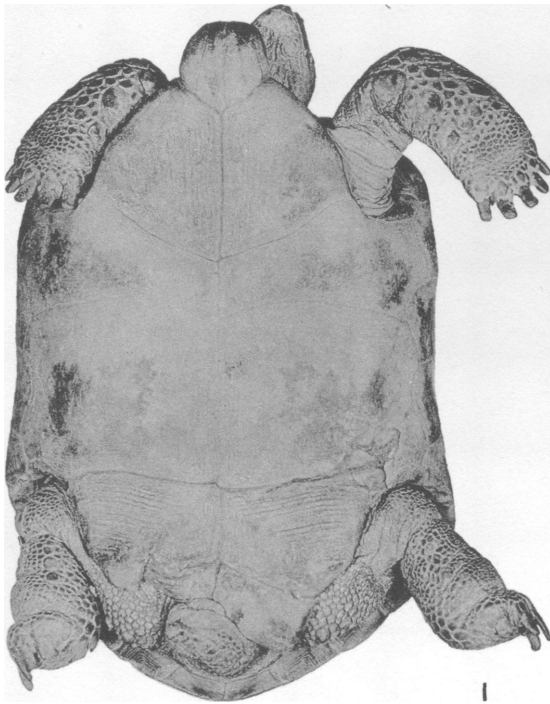
1. Mexican west coast rattlesnake, *Crotalus basiliscus*, sub-adult male, A.M.N.H. No. 64253, live specimen taken at Alamos, Sonora. (Photograph courtesy of Dr. Howard K. Gloyd.)



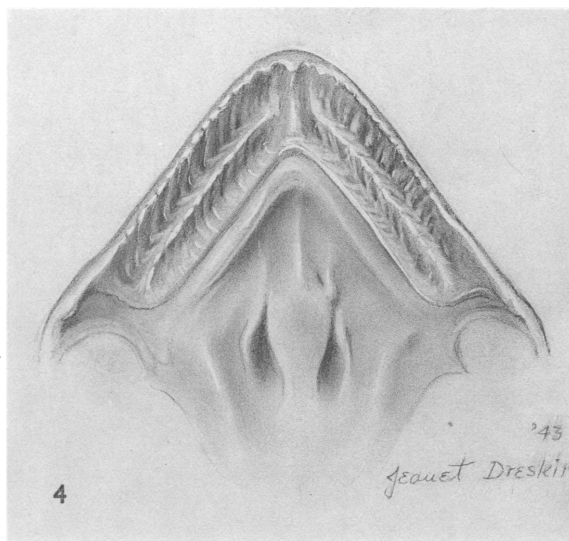
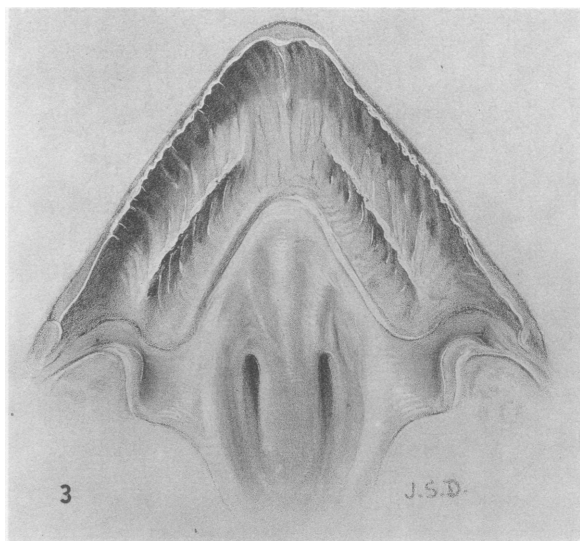
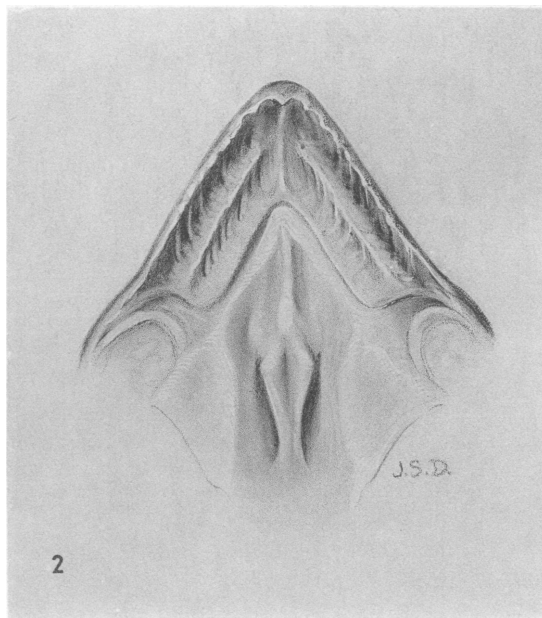
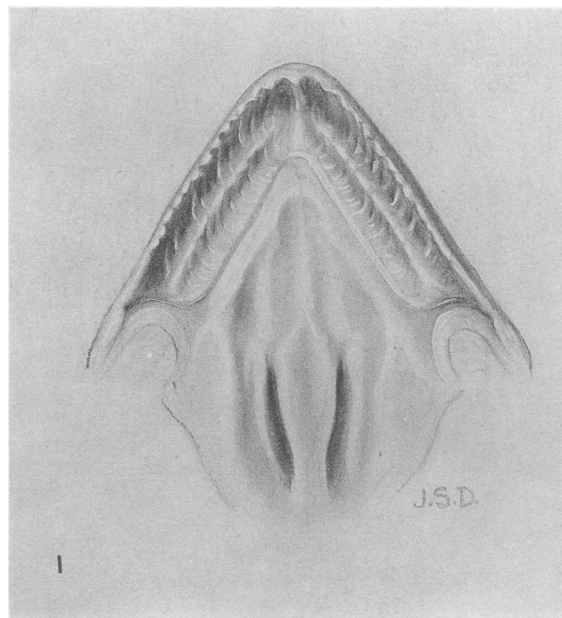
2. Mexican west coast rattlesnake, *Crotalus basiliscus*, adult male, A.M.N.H. No. 64254, live specimen taken at Alamos, Sonora. This individual is larger and somewhat darker than the specimen depicted in figure 1. (A.M.N.H. photograph by Thane Bierwert.)



Dorsal views of representative specimens of *Gopherus*: 1, *G. agassizii*, from Alamos, Sonora, A.M.N.H. No. 64157; 2, *G. agassizii*, from Coyote Mountains, Arizona, A.M.N.H. No. 2436; 3, *G. berlandieri*, from "Texas," A.M.N.H. No. 8855, nuchal missing; 4, *G. polyphemus*, from Tampa, Florida, A.M.N.H. No. 64741



Ventral views of representative specimens of *Gopherus*: 1, *Gopherus agassizii*, from Alamos, Sonora, A.M.N.H. No. 64157; 2, *G. agassizii*, from Coyote Mountains, Arizona, A.M.N.H. No. 2436; 3, *G. berlandieri*, from "Texas," A.M.N.H. No. 8855, nuchal plate missing; 4, *G. polyphemus*, from Tampa, Florida, A.M.N.H. No. 64741



Drawings of palates of *Gopherus*, to show differences in the angle of the alveolar ridges in representative specimens. 1, *G. agassizii*, from Alamos, Sonora, A.M.N.H. No. 64156; 2, *G. agassizii*, from Coyote Mountains, Arizona, A.M.N.H. No. 2436; 3, *G. berlandieri*, from Padre Island, Texas, A.M.N.H. No. 64845; 4, *G. polyphemus*, from Tampa, Florida, A.M.N.H. No. 64741