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THE REPTILIAN FAUNA OF SAND DUNE AREAS OF THE VIZCAINO DESERT AND OF NORTH-WESTERN LOWER CALIFORNIA[1]

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UNTIL quite recently, our knowledge of the herpetology of Lower California rested mainly on collections made in the Cape region and the northern part of the peninsula while the lack of adequate collections from the central part or Vizcaino Desert area presented a serious gap, as Schmidt (1922) pointed out. Since then, Linsdale's (1932) report on the collection in the Museum of Vertebrate Zoology at the University of California has added much to our understanding of the distribution of reptiles in central Lower California, especially in the region between the 30° and 27° lat., designated by Nelson (1921) as the Vizcaino Desert district. Nevertheless, the reptilian fauna of the Vizcaino Desert proper was known only from a few specimens, which had been collected at some coastal points, namely Ballenas Bay, Abreojos Point, and San Bartolome Bay (Cope, 1896, 1889, 1900; Townsend, 1890; Dickerson, 1919; Schmidt, 1922; Klauber, 1930). The interior of the large sandy plain extending from lat. 27° to lat. 28° 30′ remained herpetologically unexplored. Thus, an investigation of the

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sand dune fauna of this area seemed to serve a double purpose. First, it was expected to furnish a better faunistic knowledge of the Vizcaino Desert, secondly, to aid in our comparative study of the ecology and adaptations of sand reptiles in widely distant desert areas.

In the early summer of 1934, I spent 4 weeks collecting in northern and central Lower California. The trip was made possible by a research grant from the University of California at Los Angeles, and by financial aid rendered by the Museum of Zoology of the University of Michigan, where part of the material has been deposited. During this journey, opportunity was taken to visit San Angel, a deserted ranch in a sand dune area near the eastern border of the Vizcaino Desert, 18 miles west of San Ignacio, at latitude 27° 17′. A week's collecting was done at this point (June 27 to July 4). A few hours on July 8 were spent in a coastal sand dune area just south of Miller's Landing (Automobile Club of Southern California, Outing Map, 1934) which is located in the northernmost extension of the Vizcaino Desert, at lat. 28° 29′. Another coastal sand dune area was found at Socorro, 22 miles north of Rosario at lat. 30° 20′, far north of the Vizcaino Desert, and part of the night of July 11 and the following morning were spent collecting there.

I wish to express my sincerest gratitude to the authorities of the University of California, and of the Museum of Zoology, University of Michigan, for the financial support of the expedition; to Dr. Ernest C. Moore, Vice-president and Provost of the University of California at Los Angeles, and to the Mexican authorities in Los Angeles, particularly to Consul Alejandro V. Martinez and Vice-consul Romero, for letters of recommendation which proved invaluable assets in the course of the undertaking; and to Mr. L. M. Klauber and Dr. Jean M. Linsdale for aid in the identification of specimens. Last, but not least, my thanks are due to my wife and to Mr. Alexander Grendon, my faithful companions on the trip, for their aid in collecting specimens.

Description of Localities and List of Species Collected

The Arroyo de San Angel runs fairly exactly south and finally opens into the Laguna de San Ignacio. In the rainy season, it contains running water, but at the time of our visit only a few pools of stagnant water remained. Groups of date palms, and of *Washingtonia,* and a fairly dense growth of mesquite (*Prosopia* sp.) provide shade for the freely roaming live stock. The west bank of the arroyo is formed by a fairly high mesa, the top of which is wind blown by the prevailing, often strong west winds, so that the soil there is very stony sand, with fine sand piled up on the lee side of the desert shrubs. The west winds have driven most of the fine, pale buff colored dune sand on the west bank of the arroyo, where it forms a uniformly slanting, steep face, deep and loose. On gentler inclines, one finds an undulating sandy territory with small dunes, as a whole slightly sloping towards the arroyo. The east bank of the latter is much lower, and is covered with sand of a coarser grain, mixed with stones and organic matter.

A few miles south of our headquarters at the deserted Ranchito de San Angel, we found level, strongly alkaline ground, apparently the bottom of a dry inlet, from which rose at intervals chains of sand dunes. The fauna there was the same as in the locality described above; the reptiles kept strictly to the sand dunes and avoided the alkaline plain. Because of the proximity of the Pacific Ocean, the climate of the Vizcaino Desert is not strictly that of a desert; in the mornings, the sky is often overcast with "high fog," and fairly high humidity prevails, but not later than 11 A.M. the sun is blazing, with air temperatures around 100 degrees. West winds are blowing in the mornings and especially strongly just after sunset.

At San Angel, we collected *Bufo punctatus, Callisaurus crinitus, Uta stansburiana, Sceloporus magister rufidorsum, Cnemidophorus tessellatus, Leptotyphlops humilis cahuilae, Chilomeniscus cinctus,* and *Crotalus ruber.* We also saw two tracks of a slender, long, colubrid snake, probably *Coluber flagellum.*

At the northern extremity of Vizcaino Bay, just south of Miller's Landing, at 28° 29′ lat. begins a large chain of sand dunes which skirt the shore line for a considerable distance. The sand is a rather dark gray, without the yellow or buff tinge usually seen in desert sand. This color of the substratum is perfectly duplicated by the dorsal coloration of the population of *Callisaurus crinitus* living there. The sand in places abounds with sea shells (bivalves). Most of the dunes are solidified, but some of the largest ones are apparently moving. We collected 8 of the numerous *C. crinitus* and 1 *Cnemidophorus hyperythrus beldingi.* We saw a track of *Chilomeniscus,* and of a large colubrid snake.

Another range of coastal sand dunes was examined at Socorro, 22 miles north of Rosario. Most of our collecting was done in the lower, solidified dunes where there is a relatively rich plant growth. Of the high, barren, wandering dunes located inland, we investigated only the base. The reptiles collected there included: *Uta stansburiana, Sceloporus rufidorsum, Cnemidophorus hyperythrus, Chilomeniscus cinctus,* and *Crotalus confluentus oreganus.* The outstanding feature of this collecting place was the apparent abundance of *Chilomeniscus,* the tracks of which were present in every square yard for miles around.

Amphibians and Reptiles Collected, with Observations on Their Habits

Bufo punctatus Baird and Girard

One specimen of this toad, which is very common in the oasis of San Ignacio, was obtained about 10 P.M. on July 2, when it was hopping along on the sandy bottom of the Arroyo de San Angel.

Callisaurus crinitus Cope

This species is the commonest reptile of the sand dunes in the Vizcaino Desert. Twenty-three specimens were collected in

San Angel, and 8 at Miller's Landing. The latter record extends the known range of this species northward by almost one degree of latitude. From this series of 31 specimens and a series of 66 specimens of *Callisaurus draconoides carmenensis* from San Ignacio, only 20 miles distant from San Angel, it appears that these forms are quite distinct. *C. crinitus* averages smaller in size, the largest of 31 specimens measuring only 76 mm. from snout to vent, while many *C. d. carmenensis* exceed 80 mm. for the same measurement; the body of *C. crinitus* is somewhat more depressed. Its tail is relatively shorter and wider at the base, although all these differences are so slight that they are not clearly shown in the measurements given below.

	Snout to vent	Tail	Snout to ear	Width of head	Hind limb	Fore limb	4th hind toe	Width of body	Width of tail
Callisaurus d.	73	106	16	13–	68	36	31	17.3	10.2
carmenensis	82	115	17	13+	72	42	34	18	11+
3 ♂'s	72	100	15+	12+	68	38	31	16	10
C. crinitus	72	100	15+	12+	62	33	27	19	11
2 ♂'s	71	96	15+	12+	63	33	28	18+	11
C. d. carmen-	60	83	14–	11	58	32	24	16	9
ensis 2 ♀'s	64	83	14+	12	58	32+	24+	17–	10
C. crinitus ♀	60	79	14	11	58	32	24	17	10

The head of *C. crinitus* is slightly more flattened and longer, with the muzzle more pointed; the scales on the dorsal surface of the head and body are flattened, not as convex and bead-like as in *C. draconoides.* The *canthus labialis* is more perfectly developed in *C. crinitus,* similar to that of *Uma notata,* the upper labials being more completely fused to a shelf with a horizontal cutting edge. This is due to the ridges on the individual labials running almost horizontally, and in line with each other. In *C. draconoides* and in *C. ventralis* the upper labials are widely separated from each other, and their ridges slant more steeply, set diagonally on the scales, so that they are not at all continuous with each other. Consequently, the *canthus labialis* of these species appears scalloped when seen from above, while that of *C. crinitus* appears almost smooth.

The profile drawings of the heads of the 2 species in Schmidt's paper (1922: 646–647) show the differences in the structure of the *canthus labialis* quite well, but they fail to show the countersunk lower jaw, which is typical for *Callisaurus* and *Uma*.

The coloration of *C. crinitus* lacks the bright tints of *C. draconoides carmenensis;* the dorsal surface is gray drab with a varying amount of pattern; some specimens show a double row of small dorsal blotches or rings, lighter in the center, hardly discernible on the body, more clearly visible on the tail; others show no trace of these blotches on the body, but present only a uniformly reticulated or speckled appearance. The dorsal surface of the tail is drab or palest grayish yellow, with faint gray crossbars. The specimens from Miller's Landing have a slightly darker, neutral gray ground color, corresponding to the darker gray of the coastal sand dunes. In an especially brightly colored male, the light centers of the dorsal reticular pattern were pale pinkish orange towards the lateral outline of the body, where this color became confluent with the reddish orange axillary spot which is present in all specimens. In both sexes a sulphur yellow line or spot is found in the inguinal region, separating the drab dorsal surface from the ventral surface. In the female, all of the ventral side is pure white, except for a round spot of reddish orange on the throat fan, and the axillary spots of the same color mentioned above. In the male, the gular surface is bluish gray, rendering the reddish spot less conspicuous. The large blotches on the side of the body are greenish blue, lighter than the deep blue blotches of *C. d. carmenensis;* they are crossed in most specimens by 3 black oblique bars.

The 5 males from Miller's Landing all have 3 distinct crossbars; among the males from San Angel there are 3 specimens with 3 complete bars, and 2 in which the third bar is indicated by dorsal and ventral spots; 2 specimens have 3 bars on one side and 2 on the other; 1 specimen has 2 bars followed by a black spot. The third crossbar, or, in its absence, the second bar is elongated from its caudoventral angle, so as to separate completely the blue blotch from the white color of the midline. Among 40 male *C. d. carmenensis* from San Ignacio, 38 specimens have 2 crossbars, and only 2 specimens have a small black spot behind the second bar on one side of the body. The second crossbar is not elongated posteriorly, but ends at the middle of the length of the blue blotch.

The consistent difference in the coloration, as well as in structural features, of specimens from localities only 20 miles apart indicates that there is not so close a relationship between the two forms as Linsdale (1932) assumed. *C. crinitus* has been reported from the Magdalena plain (Schmidt, 1922), and thus it seems possible that it is an originally southern form which has evolved from *C. d. draconoides* and has migrated along the chain of coastal sand dunes from the Magdalena plain to the north. Closely related to *C. draconoides* as it may be, it certainly deserves recognition as a distinct species. In its specialized habitat relations and corresponding anatomical adaptations as well as habits, it resembles *Uma notata* which, because of more highly developed sand adaptations, is awarded generic distinction. *C. crinitus* does not curl its tail high up over the back, as the other species of the genus do, but only raises it off the ground when running rapidly, like most other lizards. Such differences in habits may be used for instantaneous identification of closely related species in the field, as pointed out concerning the reptiles of New Britain by Hediger (1934).

In the sand dunes of the Vizcaino Desert, *C. crinitus* occupies the place in the biota which in a similar habitat in the Colorado Desert is filled by *Uma notata.* Like the latter, this sand lizard is frequently found buried in the sand and suddenly flees at great speed when one approaches. Especially amazing was the seemingly effortless speed at which these lizards ran up the deep, loose sand of the very steep bank of the Arroyo de San Angel. Although the sand flowed downhill in broad streams at the slightest disturbance, the lizards seemed to encounter no difficulty. The much elongated feet and toes, which distribute the small weight of the animal over a relatively large area, and the fringes along the toes are undoubtedly of great significance (Mosauer, 1932*a*). In running the bursts of speed are usually short; the lizard stops at the edge of an adjacent bush, often behind it, but just as often on the side nearest to the intruder, and, remaining motionless, looks back at him over its shoulder. Thus it offers a relatively easy target and is much more easily collected than *Cnemidophorus tessellatus* with which it shares its habitat. On the other hand, the pale color of *Callisaurus* is in such perfect agreement with that of the sand that at some distance one sees only its shadow flitting over the dunes; if one loses sight of the fleeing lizard, one can locate it only with the greatest difficulty once it has come to rest.

C. crinitus rapidly buries itself in the loose sand in a manner similar to that described for *Uma* (Mosauer, 1932*a*).

The food of this species, as shown by the stomach contents of 16 specimens examined, consists almost exclusively of small insects. Ants do not play the important rôle expected; the main bulk of the food is made up of small beetles. Other stomach contents included small winged insects of the Hymenoptera, Diptera, and Neuroptera, small grasshoppers, insect larvae, a small cicada, and in 2 specimens some small flower buds. Whether this vegetable matter was taken as food *per se,* or only accidentally, in the process of capturing an insect seated on the plant, is impossible to decide. The latter explanation, however, seems more probable because of the overwhelmingly larger amount of purely insect food.

Uta stansburiana Baird and Girard

This ubiquitous little lizard was found to be common at San Angel in bushes and especially on rocks and rock walls; it was also collected in the low shrubbery along the shore of Vizcaino Bay near Miller's Landing, and in the dunes at Socorro. Nothing need be said about the habits of this well-known species.

Sceloporus magister rufidorsum Yarrow

Several specimens of this extremely robust and bristly lizard were collected at San Angel, where it frequented the palm trunks and mesquite of the arroyo and the rock wall of the corral. No specimens were seen in the sand dunes. An especially large male, which was brought back alive, possesses a conspicuous throat fan which is clearly visible even when the animal is in no way excited. When irritated this specimen shows a defense mechanism similar to that of crocodiles and monitor lizards; it contracts the longitudinal muscles of the side from which it is threatened, thus suddenly arching the body sidewise and whipping the tail towards the source of irritation. Because of the painfully sharp points of its scaly armor, this lizard is doubtlessly well protected by such a maneuver.

Cnemidophorus hyperythrus beldingi Stejneger

A specimen of this lizard was collected in the sand dunes at Miller's Landing. It possesses a blue throat and 3 dorsal stripes, while of 31 specimens from San Ignacio none showed these characteristics. Mr. Jean M. Linsdale referred this specimen tentatively to the subspecies *C. h. beldingi.* A specimen from Socorro also shows 3 dorsal stripes and was referred by Mr. Linsdale to the same subspecies.

Cnemidophorus tessellatus tessellatus (Say)

Three specimens from San Angel represent this species in the collection from the Vizcaino Desert. The dorsal surface is light grayish brown with large and distinct black markings arranged in the pattern typical for the species. The tail is not reddish or pinkish, as in *C. rubidus,* and no light mid-dorsal line is present, as described for *C. bartolomas.* The largest specimen shows well-defined black spots on the sides of the head and a few black spots on the gulars, while the ventral and subcaudal surface is almost pure white. The 2 juvenile specimens show diffuse black lateral head markings, but have a pure white ventral surface from chin to tip of tail. The specimens are from the region in which *C. bartolomas* might be expected; it appears that this species has been described from slightly differing specimens of *C. tessellatus* and should be referred to the synonymy of the latter, as Burt (1931) suggested.

This whip-tailed lizard was found to be fairly common throughout the vicinity of San Angel and in other parts of the Vizcaino Desert. One large specimen was observed busily investigating the surroundings and the floor of the deserted palm hut which served as our living room and laboratory. Scratching with its forelegs in the search of insects, and slipping in and out among the old palm leaves on the ground, it appeared quite unconcerned about our presence and even our attempts to noose it, attempts which were frustrated simply by the lizard's restless movements. In the sand dunes, the tracks of this species were often seen and easily recognized by the sharp, linear, straight mark which the tail leaves in the sand. *Cnemidophorus* is relatively rarely seen and is more difficult to collect than *Callisaurus crinitus,* which starts off with a spectacular rush, but often stops in plain sight on the open sand, while *Cnemidophorus* remains under cover, sneaks off quietly unless pressed too hard, and keeps moving until in safety.

Leptotyphlops humilis cahuilae Klauber

The worm snakes collected at San Angel were kindly examined by Mr. L. M. Klauber who referred them to his subspecies *cahuilae.* In a personal letter he stated:

> Specimens are high in dorsal scale counts . . . and in ratio of body length to body diameter. Both of these criteria tend to divorce them from the Cape San Lucas form *Leptotyphlops humilis slevini.* They are likewise higher in dorsal counts than the coastal form, *L. h. humilis;* and in addition they differ from that form in having five light instead of seven dark dorsal scale rows.

L. h. cahuilae was described by Klauber (1931) from specimens from the Colorado Desert; the present record constitutes a considerable extension of the range of the subspecies.

At San Angel in 3 evenings 5 specimens of *Leptotyphlops* were collected in the sand hills, 4 of them by following their typical tracks. These little burrowing snakes regularly emerge on the surface at or shortly after nightfall, and travel about for some time. They use the horizontal undulatory type of locomotion (Mosauer, 1932*b* and *c*) and thus leave tracks somewhat similar to those of *Sonora* and *Chilomeniscus*. Because of its cylindrical body, however, which lacks the ventrolateral edges of the other snakes, *Leptotyphlops* encounters more side slipping in its movement, which is therefore less efficient and shows typical signs of "skidding" in the tracks. Moreover, the fine spur at the end of the worm snake's tail drags in the sand and leaves a sharp, sinuous line in the track, which identifies it at once. All the specimens were found on the surface of the sand, the first one when it was entering a crack in the woody trunk of a desert shrub, the second out in the open, and the 3 others within bushes.

Leptotyphlops does not seem to travel parallel to and just below the surface of the sand, as does *Chilomeniscus*. Although it is apparently common in the sand dunes, it is not particularly well adapted to a subarenaceous life. As I have pointed out before (Mosauer, 1932*a*), true "sand swimmers" are characterized by a wedge-shaped head with a sharp labial edge, as shown well in *Chilomeniscus*. Quite in bearing with the rounded snout of *Leptotyphlops* is its relatively slow mode of slipping into the sand, whereby the head is pushed in with some effort and with side-to-side movements. The worm snakes progress along the edge of the cage by alternately flexing and straightening short sections of their bodies, aided by caterpillar motion. Undoubtedly it is this same combination which serves *Leptotyphlops* in passing through narrow crevices and passages under ground. The fine spur at the end of the tail is pushed into the ground and furnishes a fulcrum. The worm snake's movements on the surface are surprisingly quick and agile, not at all sluggish as one might expect of the tiny blind burrower. It is especially sensitive to tactile stimuli—the gentlest touch on the body will cause undulatory motions of great rapidity. Among the other sense organs, the tongue seems to be of great importance; it is frequently touched to the sand, leaving tiny but distinct double imprints. In captivity the specimens appear quite often on the surface, raise the fore part of the body vertically, and wave it, head pointed straight up.

Food was not accepted in captivity, but when water was offered, the specimens drank eagerly for several minutes. When the snakes were collected, or when handled afterward, they ejected a clear, watery, odorless fluid from the anus.

The live worm snakes were translucent so that part of the viscera showed as dark spots. The ground color varied in different specimens from Light Brownish Vinaceous to Brownish Vinaceous (Ridgway), with a silvery lustre which was stronger on the ventral surface. The snout was lighter, pinkish, and the otic region reddish.

Chilomeniscus cinctus Cope

The 7 specimens in my collection show the same tendency toward variation in pattern which Linsdale (1932) pointed out. The variation concerns the color of the dark cross bands (Light Seal Brown to Black), their number (19–26 on the body), their extent (present on the dorsal scales only, or extending to the gastrosteges, or forming complete rings), their width, and the light ground color between the dark markings (Sulphur Yellow to Reddish Orange). The shape of the head also shows slight variations, for example, in the length of the rostral.

Chilomeniscus cinctus is very common in stretches of loose sand in central and north central Lower California and regularly appears on the surface shortly after nightfall. Numerous tracks were observed at San Angel, on the fine dune sand as well as on the coarser sand of the arroyo. Several tracks could be seen every morning within a radius of a few yards from our sleeping bags. On sandy places in the oasis of San Ignacio, *Chilomeniscus* is also common, and it was found to be especially abundant at Socorro, where hundreds of tracks were seen.

When the snake is travelling on the surface, by means of its typical horizontal undulatory motion, it leaves a track very similar to that of *Sonora occipitalis* (Mosauer, 1933), which the snake itself resembles to a startling degree. Before I knew that I had *Chilomeniscus* and not *Sonora* before me, I entered in my log book: "In this region *Sonora* seems to have the habit of traveling flush with or just below the surface of the sand." This contrasted with the habits of *Sonora,* as I had observed them in Coachella Valley, where this snake always travelled across open sandy stretches on the surface and entered the soil only in shrub-covered hillocks. The apparent discrepancy was explained when it was discovered that it was *Chilomeniscus* which left these regular sinuous grooves, accompanied on either side by a sand wall; the tracks are perfect replicas of those of *Chalcides sepoides* (Mosauer, 1928, 1932*a*.)

Chilomeniscus proceeds in the sand as easily as on it, and slips from sight as if there were no resistance whatsoever, a fact which bespeaks of the perfection of the snake's structural adaptations. While *Sonora* usually takes the shortest route from one bush to another, and frequently seeks refuge in preexistent burrows, *Chilomeniscus* leaves a bewildering maze of tracks, which circle around the base of desert shrubs and cross and recross themselves time and again. This feature renders it very difficult to trace an individual track to the end, where the snake is usually found buried in the loose sand just under the surface, with the head exposed or not. When thus buried, *Chilomeniscus* is not coiled, but lies in the shape of a regular sinuous curve. In captivity, the specimens often displayed caterpillar motion, which is not surprising in a snake of short, stout habitus.

The differences in the habits of *Sonora occipitalis* and *Chilomeniscus cinctus,* pointed out above, are paralleled by differences in the structural adaptations. *Sonora* is well fitted for the life of a sand burrower, but *Chilomeniscus* is still more highly specialized. The latter's head is so much depressed that the pin-point-like eyes are fully visible from above, as are the nostrils; these are so placed between a large shield, composed of fused nasal and internasal, and the postnasal, that sand grains cannot enter them easily when the snake pushes its way through sand. In *Sonora,* the head is not quite as much flattened, so that eyes and nostrils face more sidewise. The *canthus labialis,* the edge present on rostral and upper labial shields, is also sharper in *Chilomeniscus.* This *canthus* forms the cutting edge of the wedge-like head and separates a slightly convex upper surface from a plain lower surface. The latter is formed by the small lower jaw fitting snugly into the frame provided the ventral parts of the upper labials and large rostral. As discussed in a previous paper (Mosauer, 1932*a*) the "countersunk" arrangement of the mandible eliminates any resistance that would be offered by a protruding lower jaw. The other adaptations of a typical subarenaceous reptile, as enumerated in that article, are present in *Chilomeniscus:* the head is small, not set off from neck or body; the body is covered by smooth, highly polished scales which reduce the friction in the sand to the possible minimum. A ventrolateral edge runs along either side of the body on the gastrosteges, which reduces the amount of skidding in the horizontal undulatory motion. By muscular activity the ventral surface between the 2 edges can be drawn in and converted into a shallow trough, a feature typical for "sand swimmers."

Altogether, the degree of adaptive specialization of *Chilomeniscus* compares favorably with that of such a typical subarenaceous reptile as *Chalcides sepoides* from the sandy wastes of the Sahara Desert.

In captivity, the specimens refused food, although several kinds of insects and insect larvae, the most likely natural prey, were offered. The snakes drank eagerly, however, when water was provided.

Crotalus ruber Cope

A specimen of the red rattler was found in the arroyo at San Angel on July 1, just after nightfall. Its track was discovered on the sand at the base of the west bank of the arroyo; it led into a bush on the other side of which the snake was discovered after a time, just coming into the open. Apparently the rattler had continued unconcernedly on its way, while I was circling the bush, looking for the continuation of the track. Even when approached and captured the snake remained quiet. From the track it could be seen that it had used a caterpillar type of locomotion.

Crotalus confluentus oreganus Holbrook

A specimen was captured at night in the brush-covered low dunes at Socorro. Several tracks of other specimens were seen.

A Herpetological Faunal List of the Vizcaino Desert

While heretofore the reptilian fauna of the Vizcaino Desert has been known only from coastal points, the present collection makes it possible to compile a list for the whole area. Much more collecting would have to be done, however, before such a compilation could claim any degree of completeness. In the following, species are included which were taken in the sandy-loamy flat stretch of the Vizcaino Desert, traversed by the automobile road on the way from El Arco Mine to San Ignacio, but which have not been discussed in this paper. I have also included species (in brackets) which have not yet been collected in the Vizcaino Desert but which are almost certain to occur there, since they are found at San Ignacio and usually frequent a sandy or sandy-loamy habitat. The locality records from the published accounts and from the present collection are listed; the latter records are italicized.

Bufo punctatus Baird and Girard (*San Angel*).

Dipso-saurus dorsalis dorsalis (Baird and Girard) (*Los Angeles Corral*).

Callisaurus crinitus Cope (Ballenas Bay, Abreojos Point, San Bartolome Bay, Santo Domingo, *San Angel, Miller's Landing*).

Callisaurus ventralis gabbii Cope (*20 miles north of Los Angeles Corral*).

[*Callisaurus draconoides carmenensis* Dickerson] (*San Ignacio,* Calmalli).

Uta stansburiana Baird and Girard, including *U. parva* Dickerson (San Bartolome Bay, *San Angel*).

Sceloporus magister rufidorsum Yarrow (*San Angel*).

Phrynosoma coronatum jamesi Schmidt (San Bartolome Bay, 30 and 20 miles north of San Ignacio, *20 miles north of Los Angeles Corral*).

Cnemidophorus tessellatus tessellatus (Say), including *C. bartolomas* Dickerson (San Bartolome Bay, Abreojos Point, *San Angel*).

Cnemidophorus hyperythrus beldingi Stejneger (*Miller's Landing*).
Leptotyphlops humilis cahuilae Klauber (*San Angel*).
Coluber piceus (Cope) (San Bartolome Bay).
[*Coluber flagellum frenatum* (Stejneger)] (*San Ignacio*).
[*Salvadora grahamiae hexalepis* (Cope)] (*San Ignacio*).
[*Phyllorhynchus decurtatus decurtatus* (Cope)] (*San Ignacio*).
Pituophis vertebralis (Blainville) (San Bartolome Bay).
Chilomeniscus cinctus (Cope) (Ballenas Bay, *San Angel*).
Crotalus ruber (Cope) (Turtle Bay, San Bartolome Bay, *San Angel*).

A Comparison of Reptiles from the Sand Dunes in the Vizcaino Desert and from Other Sand Deserts

In a previous paper (Mosauer 1932*a*), I pointed out that among reptiles inhabiting loose sand it is possible to distinguish cursorial species which spend most of their time on the surface, and subarenaceous species which swim in sand like fish in water. A continuous series of intergradations connects the extremes of the cursorial and the burrowing types; the anatomical adaptations always closely correspond to the respective habits of the reptiles. The typical cursorial forms show structural features which facilitate their running over the loose sand. If they habitually retreat into burrows for their periods of inactivity, they do not show other adaptations, but if they bury themselves in the loose sand, the first step is made which eventuates in truly subarenaceous reptiles, whose activities take place to a great extent under the surface, and whose adaptations reduce friction in cutting through the sand.

It is interesting to see how the ecological niches in the biota of widely distant sand deserts are filled by representatives of different genera, families, or even suborders. The close similarity attained by relatively unrelated reptiles through convergent adaptations to similar environments and habits is perhaps nowhere more strikingly illustrated than in the sand deserts of the world.

Among the lizards, the extreme cursorial type is represented in the Sahara Desert by the members of the genus *Acanthodactylus,* which possess fringes along their toes, but show no indication of a burrowing snout—their digging is done with the legs only, almost in the fashion of a digging dog. In the sand deserts of the southwestern United States, as well as in the Vizcaino Desert, a somewhat corresponding place in the biota is taken by *Cnemidophorus,* which, however, shows no structural adaptations to a sandy habitat; even the desert whiptail (*Cnemidophorus tessellatus*) is not restricted to sandy stretches and remains in bushes much of the time.

Among the snakes, the exclusively cursorial, fast running *Psammophis* of the Sahara may be compared to the red racer (*Coluber flagellum frenatum*) which represents this type in the Colorado Desert and probably in the Vizcaino Desert also. In these cases we find again that the snake of the Sahara is a typical sand reptile while the red racer occurs in a variety of habitats. The solenoglyph snakes on both continents have gone a step further in fitting themselves for a life on loose sand by evolving the peculiar sidewinding locomotion, used by *Cerastes cornutus* and *C. vipera* in the Sahara, and by *Cortalus cerastes* in the deserts of the Southwest (Mosauer 1928, 1932*b* and *c*). Again, the snake in the Sahara has progressed beyond its American counterpart by its unique mode of burying itself. No snake of this type is found in the Vizcaino Desert—the particular niche remains unoccupied.

Uma notata of the Californian sand deserts is an outstanding example of cursorial sand lizards which are active on the surface only, but bury themselves habitually and frequently in the sand, and correspondingly approximate the subarenaceous forms in some structural specializations. *Callisaurus crinitus* takes the place of *Uma* in the Vizcaino Desert and resembles it surprisingly in habitat, habits, and adaptations. *Callisaurus,* however, only shows the initial stages of a specialization which is much more complete in *Uma.* It shows the beginning of a complex which involves a flattening and broadening of the body and of the base of the tail, a shortening of the extremities and of the tail, a loss of the irregular pattern of blotches in favor of a uniform ocellated or reticular pattern, and finally the development of a sharp *canthus labialis,* a countersunk lower jaw, and fringes of spinous scales on the toes. *Callisaurus crinitus* differs only slightly in general habitus from the other members of its genus which are not restricted to a habitat of loose sand. In bearing with the retention of a speedy cursorial habitus is the behavior of this lizard; when disturbed it does not dive as readily into the sand as *Uma,* but rather tends to escape by rapidly running on the surface.

The most highly specialized of all sand reptiles are the burrowing or subarenaceous forms. Strangely enough, the corresponding ecological niche is occupied in the Sahara and the American deserts by representatives of the two suborders of the Squamata: by the lacertilian family Scincidae in the Sahara, by members of the Colubridae in America. The short, robust *Scincus officinalis,* with its broad, flat, shovel-like feet, which lives the life of a mole in the sand, naturally lacks a counterpart among the ophidians. The much elongated *Chalcides sepoides* with its vestigial extremities, however, approximates the shape of a snake; in its habits and adaptations it is a duplicate of *Chilomeniscus* of the Vizcaino Desert. The latter is better fitted for a subarenaceous life than is *Sonora occipitalis* which occupies a similar position in the sand dune biota of the Colorado Desert, but does not habitually swim below the surface of the sand. Remarkable as the convergent similarity of these snakes of different genera is, the slight difference in their habits is nevertheless definitely correlated with structural differences; *Chilomeniscus* has progressed further in both regards towards a strictly subarenaceous life.

Leptotyphlops, undoubtedly a regular member of the sand dune fauna in the Vizcaino Desert, is not restricted to that environment, since it is a snake of burrowing habits in firmer soil as well as in loose sand. It resembles in this regard the sand boa *Eryx* of the African and Asiatic deserts.

It is an open question whether the number of well adapted sand reptiles and the perfection of their specialization in any desert is indicative of the geological age of that sand dune area. Possibly the size of the sandy area and the concurrent amount of isolation are solely responsible for the number of well fitted sand reptiles differentiated in that region. In the Sahara, *Acanthodactylus, Scapteira, Scincus officinalis* and *Chalcides sepoides* among the lizards, *Eryx jaculus, Psammophis, Coluber diadema, Echis,* and *Cerastes* among the snakes, make up an imposing list of sand reptiles, which speaks for the extent of the area with its factor of isolation and possibly also for a considerable geological age of this desert. In the sand deserts of the southwestern United States, the list of sand reptiles is much smaller, *Uma notata, Sonora occipitalis,* and *Crotalus cerastes* being the only specific arenophil forms. In the Vizcaino Desert, where the extent of loose sand is relatively limited, the list is decreased to only two forms, *Callisaurus crinitus* and *Chilomeniscus cinctus.*

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PLATE I

FIG. 1. Ventro-lateral view, *Sonora occipitalis.*
FIG. 2. Ventral view, *Sonora occipitalis.*
FIG. 3. Slightly ventro-lateral view, *Callisaurus draconoides.*

ERRATUM

Occ. Papers Mus. Zool. Univ. Mich., No. 329

Plate I, Figure 3. For "*Callisaurus draconoides*" substitute *Callisaurus crinitus.*

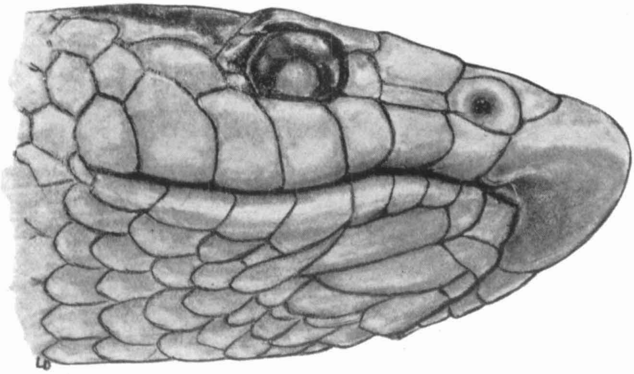

FIG. 1

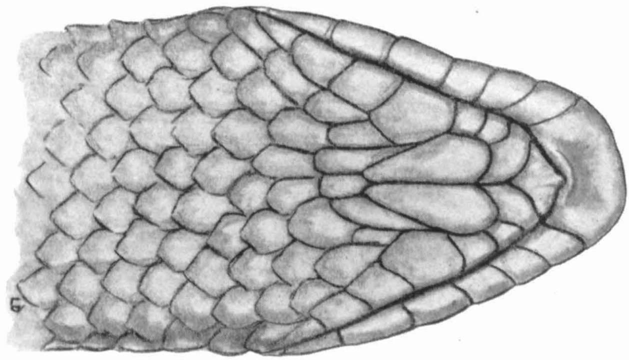

FIG. 2

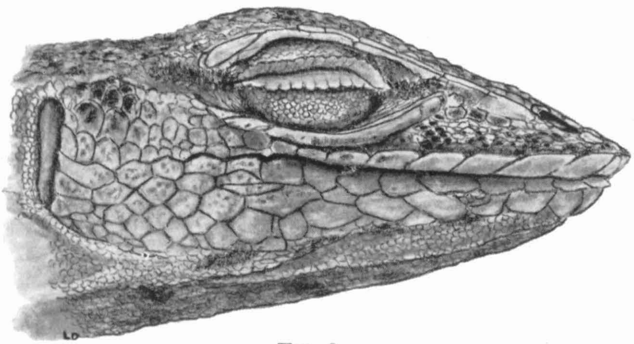

FIG. 3

PLATE II

FIG. 1. Ventro-lateral view, *Chilomeniscus cinctus.*

FIG. 2. Ventral view, *Chilomeniscus cinctus.*

FIG. 3. Tracks of *Chilomeniscus,* ''swimming'' just below the surface.

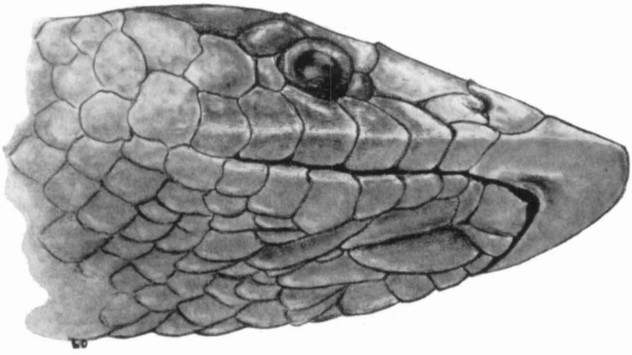

FIG. 1

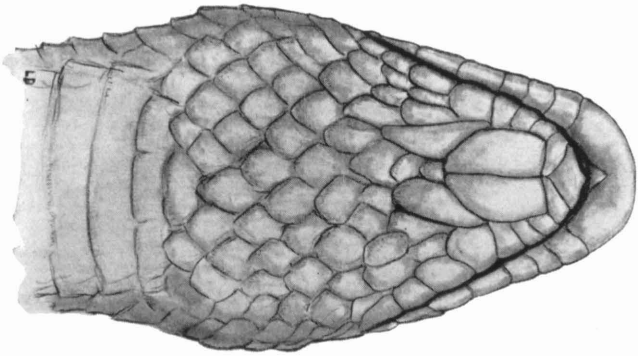

FIG. 2

FIG. 3