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A New Species of *Geophis* (Serpentes, Colubridae) from the State of Colima, Mexico

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While searching for spiders and scorpions in Mexico in 1965, Willis J. Gertsch and Richard Hastings obtained a few amphibians and reptiles, including a small snake that was found near the town of Tonila, Jalisco. The site where the snake was taken is, however, south of the Jalisco boundary, in Colima. This specimen proved to belong to the genus *Geophis,* but it also became apparent that it possessed an array of characters previously unreported for any species of the group. The snake evidently has affinities with species in the state of Michoacán. Nevertheless, the specimen from Colima differs in so many respects from those described that it is virtually certain that it represents an additional species. As a means of expressing our thanks to Dr. Gertsch for many useful specimens given to the Department over a period of years, as well as to credit him with the discovery of the species described below, we are naming it

Geophis gertschi, new species

Holotype: A.M.N.H. No. 94877, a male, presumably an adult, taken 2 miles south of Tonila, Jalisco, but in the state of Colima, at the northern extremity of the Distrito de Cuauhtémoc. The snake was found in moist soil beneath a rock by Willis J. Gertsch and Richard Hastings on August 28, 1965. The site where the snake was found lies at an elevation of

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approximately 1250 meters. Pines and oaks are the most conspicuous elements of the flora in the area.

DIAGNOSIS: The new species has its nearest affinities with those members of the genus that possess 15 rows of dorsal scales and an anterior temporal. In some respects the holotype resembles *Geophis maculiferus* and *Geophis incomptus,* species thus far represented in collections by few specimens, all from the state of Michoacán. *Geophis gertschi* differs from both of these species, however, in having (1) the first pair of infralabials widely separated by the mental, which is in broad contact with the anterior pair of chin

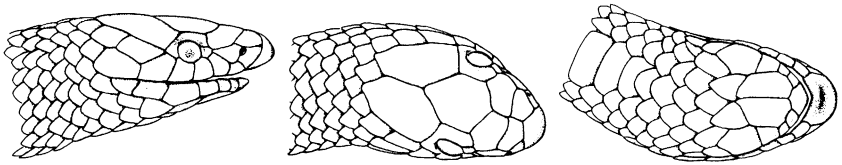

FIG. 1. *Left to right:* Lateral, dorsal, and ventral views of the head of the holotype of *Geophis gertschi.* × 5.

shields, (2) the supraoculars fused with the postoculars, (3) a pattern consisting of a faint middorsal stripe and traces of lateral stripes, and (4) fewer ventrals. The holotype of *G. gertschi* has six infralabials, whereas there are but five on the holotype of *maculiferus,* the only specimen anyone has reported. The number of supralabials may be of little diagnostic importance, for *incomptus* has either six or seven. The three species are compared in more detail in table 1.

DESCRIPTION OF HOLOTYPE

DIMENSIONS: The over-all length of the preserved specimen is 173 mm. The tail is 33 mm. in length and comprises 19.1 per cent of the total. The head is 3.5 mm. in width at its broadest, and 6.7 mm. in length from the tip of the snout to the posterior extremity of the lower jaw.

LEPIDOSIS: The width of the rostral is more than twice its height, and the portion visible from above exceeds the length of the suture between the internasals. The internasals and the prefrontals are less than half as wide as they are long, and the prefrontals extend laterally to the supraoculars, the preocular, and the posterior nasal. The length of the suture separating the prefrontals is less than half of the length of the frontal, which exceeds the distance separating it from the end of the snout. The nostril is situated near the upper end of the suture separating the anterior and posterior nasals. The apex of the wedge-shaped posterior nasal reaches

the preocular, which is slightly higher than long, and in contact with the supraocular. On both sides of the head the supraocular appears to have fused with the postocular. The diameter of the eye is contained 1.5 times in the distance separating it from the lower edge of the lip. The anterior temporal, which lies above the fifth supralabial, reaches the postocular (fused with the supraocular, as noted above), and behind it the posterior temporal is situated above the sixth supralabial. Of the six supralabials, the first and second are in contact with the posterior nasal, the second and third reach the preocular, the third and fourth extend to the eye, and the sixth is the longest. There are six infralabials, the first four of which extend to the anterior chin shields. The first pair of infralabials are widely separated by a shield-shaped mental that borders the anterior pair of chin shields. The posterior chin shields are slightly longer than broad and in contact for approximately a third of their length. They are separated from the first ventral by four rows of gular scales. There are 121 ventrals, separated by an undivided anal plate from 37 paired subcaudals.

DENTITION: There are 13 teeth on the right maxilla, and 12 on the left. From front to back the teeth are progressively larger, those at the rear being somewhat more strongly recurved, and lance-shaped. The teeth on the dentary are short, stout, and slightly recurved, and those at the front of the bone are somewhat larger than those at the rear. There are 15 teeth on the left dentary, the only one examined.

HEMIPENIS: Owing to the small size of the snake, it proved to be difficult to make a wholly satisfactory examination of the copulatory organ. It extends to the level of the thirteenth subcaudal, terminating in two short symmetrical lobes that arise at the twelfth. The sulcus spermaticus can be traced to the confluence of the lobes, where it terminates. It is impossible to discern any bifurcation of the sulcus; if such remains, it is at most a vestige, for there is no trace of a sulcus on either of the lobes. Enlarged spines are present on the portion of the hemipenis situated above the fourth to the seventh caudals, but the spines are replaced distally by reticulated calyces.

PATTERN AND COLORATION: The dorsum is grayish brown, with a dark middorsal stripe as wide as the median row of scales extending from the nape to the end of the tail. On the edges of the scales in the third and fourth row are faint traces of lateral stripes. The venter and under side of the tail are light gray, paler than the dorsum, but the dark coloration extends onto the edges of the ventrals and subcaudals.

DISCUSSION

The data supplied in table 1 reveal characters that readily distinguish

TABLE 1

COMPARISON OF THE SPECIES OF *Geophis* WITH 15 SCALE ROWS AND AN ANTERIOR TEMPORAL
(Alternate Condition or Range Indicated in Parentheses.)

	G. gertschi Holotype ♂	*G. maculiferus* Holotype ♂	*G. incomptus*[a] Holotype + 14
Infralabials	6	5	7 (6)
Number of infralabials touching anterior chin shields	4	3	4
Infralabial touching posterior chin shields	4th	3rd	4th
First pair of infralabials	Separated by mental	In contact	In contact
Posterior chin shields	Longer than broad, in contact for anterior third of their length	Broader than long, in contact throughout length	Variable
Postoculars	Fused with supraocular	1, not fused	2 (1)
Preocular	Reaches supraocular (not fused with loreal)	Separated from supraocular (fused with loreal)	Separated from supraocular (fused with loreal)
Prefrontal	Separated from eye by supraocular and preocular	Reaches eye	Reaches eye
Frontal	Longer than wide, extending beyond anterior edge of eye	Wider than long, barely reaching anterior level of the eye	[Proportions not described], barely reaches anterior level of the eye

TABLE 1—(*Continued*)

	G. gertschi Holotype ♂	*G. maculiferus* Holotype ♂	*G. incomptus* Holotype + 14
Secondary temporals	1	2	2
Parietal	Length equals distance from end of snout	Longer than distance from end of snout	Length equals distance from end of snout
Ventrals	♂ ♂ 121	142	149.3 (146–153)
	♀ ♀ —	—	162.4 (150–154)
Subcaudals	♂ ♂ 37	30	36.0 (35–37)
	♀ ♀ —	—	32.5 (29–34)
Dorsal coloration	Grayish, with middorsal stripe and traces of lateral stripes	Uniformly gray-brown to violet-brown	Olive-brown, black tips on scales
Ventral coloration	Light gray, with darker color of dorsum extending to outer edges of ventrals	Uniformly whitish	Ventrals and subcaudals whitish, with black anterior margins
Maxillary teeth	12–13	18	12
Ratio, tail length/body length	♂ ♂ 23.6	15.0	19.6–20.7
	♀ ♀ —	—	15.4–18.8

[a] Data from Duellman (1959, 1961).

Geophis gertschi from the two congeners it most closely resembles. Until additional specimens of all three species become available, it cannot be ascertained which characters are truly diagnostic. At present relatively few species of *Geophis* are represented in collections by large series, and consequently it is difficult to evaluate differences. Variations are commonly encountered, even in small samples taken at the same locality. As in other groups of fossorial or semifossorial snakes, the contiguous scales that are fused in some species of *Geophis* are not fused in others. The supraocular is evidently fused with the postocular in the holotype of *G. gertschi.* As a result, a single scale borders the upper and posterior margins of the eye and extends downward to the supralabials. It is questionable whether this condition will prove to be characteristic of the species. A separate postocular is probably normal in *G. gertschi* as well as in *G. maculiferus,* though two postoculars are normal in *G. incomptus,* as indicated in table 1.

When two scutes are coalesced into one, authors are confronted with a choice of terms. The configuration of the sutures suggests that the loreal is fused with the postnasal in *G. gertschi,* but it seems to have fused with the preocular in both *maculiferus* and *incomptus.* In the original description of each of these two species, the scale between the postnasal and the eye is designated as the "loreal"; in table 1 we use the term "preocular" to designate the scale anterior to the eye, regardless of whether it is separate or fused with the loreal.

Similar losses or reductions in the scutes on the head occur in fossorial and semifossorial snakes that have evolved independently in widely separated regions. Such snakes are commonly smaller than their terrestrial relatives. Though fossorial modifications may obscure evidence of affinity, some burrowing snakes retain characters that permit them to be grouped generically with terrestrial species. In such instances the fossorial species are invariably smaller than their terrestrial congeners. The reductions in the number of head scutes, scale rows, and teeth characteristic of burrowers might be construed as an indirect effect of selection favoring smaller size. This explanation scarcely seems tenable, for the smaller species of *Geophis* seem to be no more highly specialized than the larger members of the group.

The loss or coalescence of head scutes is presumably advantageous to snakes in subterrestrial environments, where sutures tend to add to the friction when a snake propels itself through the soil. The unpaired scutes on the head, the rostral and the frontal, may be modified in size or shape, but they do not fuse with contiguous scutes. The paired scutes more often fuse with those behind or in front of them rather than with those lateral to them. The nature of the variations encountered suggests

that it may be a matter of chance whether the loreal is fused with the nasal, the internasal, or the preocular, even though the same scutes usually are coalesced in the majority of the individuals in any deme. If merely the loss of a suture is advantageous, it is functionally unimportant whether the loreal is coalesced with the scale in front of it or the one behind it. Selection may therefore lead to either condition. The scales contiguous to the eye have fused in similar fashion; though two postoculars may have been normal in the ancestral *Geophis*, they are often fused in several species. Supraoculars are greatly reduced in some species, and even absent from individuals, but they are rarely fused with the postoculars as they are in the holotype of *G. gertschi.*

The number of supralabials varies from four to seven in *Geophis*, and similar conditions prevail in the majority of the fossorial colubrids in Africa and Asia. Terrestrial species commonly possess more labials as well as more rows of dorsal scales. The majority of the fossorial genera in Africa and Asia possess 15 scale rows throughout the length of the body, and most terrestrial and aquatic colubrids have from 17 to 25 or more scale rows at midbody, but the number diminishes posteriorly. The reduction in the number of scale rows is characteristic of snakes that diminish in diameter toward the base of the tail. In nearly all fossorial snakes the diameter of the body is relatively uniform behind the head to the base of the tail, which is proportionately shorter than it is in terrestrial colubrids.

Many of the characters encountered in *Geophis* are duplicated in *Calamaria,* an Asiatic assemblage of colubrids that may have evolved earlier. Despite numerous similarities, *Calamaria* is perhaps more highly specialized than *Geophis.* The snakes of the genus *Calamaria* are unusual among fossorial colubrids in possessing only 13 rows of dorsal scales. Mexican species of *Geophis* may have either 15 or 17, and Duellman (1959) noted that the number of scale rows on one individual assigned to *Geophis petersi* alternates erratically between 15 and 17. The species with 17 rows may be closer to the ancestral *Geophis* in this respect, but those with 15 scale rows often retain cephalic scutes that have been lost by some of the species with 17 rows. It is questionable whether all the species with 15 rows were derived from the same ancestor. Snakes with 15 scale rows have probably evolved and become diversified independently in separate regions. Errors in description have led to some confusion on this score. The species *G. cancellatus* from the state of Chiapas was correctly described as having 15 scale rows, according to Hartweg (1959), though it was inadvertently included in a key with the Mexican members of the genus that have 17 rows of dorsal scales.

Little can be said concerning the adaptive significance of reduction in the number of maxillary teeth. The number of teeth does not seem to be correlated with size, but uncertainties will remain until larger samples are available. *Geophis maculiferus* possesses an exceptionally large number of teeth, probably more than are likely to be found in either of its nearest relatives (table 1). The teeth of snakes are subject to adaptive modification, though reductions in the number of teeth on the maxilla of fossorial snakes may be more directly associated with modifications of the snout that facilitate progression in subterrestrial environments. The snout is modified on snakes of the Ceylonese genus *Aspidura*, though these snakes retain more teeth on the maxilla than many terrestrial species. *Aspidura trachyprocta* preys largely on earthworms, which may be true of *Geophis* (see below), and the maxillary teeth of snakes in both genera are relatively short and closely set. In contrast, slug-eating snakes such as *Contia tenuis* and *Duberria lutrix* have rather long, slender teeth that are widely spaced.

Little information of value concerning the structure of the hemipenis in *Geophis* has been published. Neither Hartweg (1959) nor Legler (1959) mentioned the copulatory organ of the species he described. Duellman (1959) provided a brief description of the hemipenis of *G. incomptus*, merely stating that it is "covered with spines, those on the basal part moderate in size; distally spines are smaller and more slender." Taylor ("1941" [1942]) did not mention the sex of the holotype of *G. maculiferus*, and, though Duellman (1961) stated that it was a female, it proves to be male. We have examined the hemipenis of the holotype, but we are unable to find any significant differences between the copulatory organs of *G. maculiferus* and those of *G. gertschi*. Both species retain vestiges of two lobes, though it was impossible to discern any bifurcation in the sulcus.

Other species of *Geophis* examined reveal intermediate stages. The hemipenis of *G. multitorques* retains vestiges of the lobes, which extend to the twelfth subcaudal, but the sulcus spermaticus bifurcates at the level of the tenth subcaudal. The hemipenis of *Geophis dubius* extends to the thirteenth subcaudal but bifurcates at the tenth, and the sulcus spermaticus bifurcates at the seventh. Within the genus, therefore, the lobes may be either vestigial or well developed, and the sulcus spermaticus may be bifurcated or single. The situation is far more complex, therefore, than Savage (1960) realized, for he stated unequivocally that "in *Geophis* these organs are not bilobed." Others have made equally erroneous statements. It is questionable whether such characters afford a valid basis for separating *Geophis* from *Atractus*, though a thorough

study of the hemipenes of the various species of *Geophis* may reveal characters that will serve to delineate groups at the subgeneric level.

The majority of the other species of *Geophis* in Mexico that retain the anterior temporal have 17 rather than 15 rows of dorsal scales. One of the paratypes of *G. aquilonaris*, a species with 15 scale rows known from a few specimens taken at the northern periphery of the range of the genus in Chihuahua, has an anterior temporal on each side, according to Legler (1959). It is pertinent to note that the three species normally possessing the anterior temporal and 15 rows of scales are thus far represented in collections only by specimens taken in the region where *G. gertschi* was discovered. The species described by Taylor ("1941" [1942]) as *G. maculiferus* remains known only from the holotype, "taken under a rock on a hillside about a kilometer north of the village of Cício [=Tzitzio]," which is situated at an elevation of approximately 2000 meters, scarcely 175 miles to the east of the type locality of *G. gertschi.* The third species, *G. incomptus*, described by Duellman (1959) is known only from the vicinity of Dos Aguas, Michoacán, a lumber camp situated in pine-oak forest at an elevation of 2100 meters. Duellman (1961) placed the locality in the Sierra de Coalcomán, "22 kilometers west-northwest of Aguililla." The mountains in this area, shown on most maps as the Sierra Espino del Diablo, are approximately 75 miles southeast of the place where *G. gertschi* was found. Much of the intervening terrain is at lower elevations, however, on the headwaters of the Río Coahuayana.

It is improbable that each of these three species is restricted to the immediate vicinity of its type locality. Nevertheless, several of the Mexican species are unknown outside the area where they were first discovered, and the ranges of the few that are somewhat more widely distributed appear to be disjunct. It is conjectural whether annectant populations will be found in the region inhabited by *maculiferus, incomptus,* and *gertschi.* The few characters they share point to affinities, and they form a reasonably compact group. Insofar as can be ascertained from the samples now available, however, they are sufficiently well differentiated to warrant recognition at the species level.

Fossorial or semifossorial snakes are commonly restricted in distribution. Demes or local populations often tend to diverge more rapidly among burrowers than among terrestrial snakes, though fossorial snakes display various degrees of vagility. All members of *Geophis* are small, secretive snakes adapted in ways that permit them to forage beneath the surface. The habits of most species are obscure. A few species are known to prey upon earthworms. Whether all members of the genus are adap-

tively specialized as predators on earthworms remains to be ascertained. These small snakes are ordinarily encountered, however, only in forested areas, sometimes in wet logs, but more often beneath rocks or logs where the soil is sufficiently moist to attract earthworms. Many areas appear to be unsuitable for either prey or predator. Terrain affording suitable habitats for *Geophis* is rarely continuous over wide areas, and disjunctions in the habitat are doubtless responsible for the isolation or near isolation of many populations.

ACKNOWLEDGMENTS

We are indebted to Dr. Willis J. Gertsch and Mr. Richard Hastings for preserving and documenting the small snake from Colima that led us to undertake an investigation of the species of *Geophis* inhabiting this portion of Mexico. We also thank Dr. Hobart M. Smith who generously allowed us to examine the type specimen of *Geophis maculiferus*, now No. 25078 in the collection of the University of Illinois Museum of Natural History.

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