

# American Museum Novitates

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PUBLISHED BY THE AMERICAN MUSEUM OF NATURAL HISTORY  
CENTRAL PARK WEST AT 79TH STREET, NEW YORK, N. Y. 10024

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NUMBER 2314

DECEMBER 28, 1967

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## New Salamanders of the Plethodontid Genus *Pseudoeurycea* from the Sierra Madre del Sur of Mexico

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The salamanders inhabiting the Sierra Madre del Sur are all members of the family Plethodontidae. At least four genera are represented, but only two of these are diversified. The range of one species extends into the state of Guerrero, where others will undoubtedly be discovered. The majority of the species are restricted to the mountains of Oaxaca, where several populations are evidently isolated, and in some instances well differentiated. Because many of the higher peaks in the Sierra were relatively inaccessible to collectors, however, the distributions of the salamanders in the region have remained obscure. Prior to 1960 nearly all the specimens in collections were from the humid Pacific slopes of the Sierra de Miahuatlán at the southern extremity of the state, or from Cerro San Felipe, which rises to an elevation of 3111 meters (10,207 feet), 12 kilometers north-northeast of the capital city, Oaxaca de Juárez. When I began field investigations in the state of Oaxaca in the summer of 1961, collections containing salamanders also had been obtained in the Sierra de Juárez, roughly 60 kilometers north-northeast of Cerro San Felipe, but few specimens were available from other portions of the Sierra Madre del Sur.

As I proceeded with my investigation during the summers of the en-

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During the past several years, I discovered that several areas once difficult to reach were now readily accessible. Numerous roads, particularly those constructed to gain access to unexploited stands of timber, extend into pine-oak woodland or cloud forests inhabited by salamanders. In central Oaxaca, where salamanders are restricted to montane habitats at elevations exceeding 2200 meters, members of the genera *Thorius* and *Pseudoeurycea* occupy extensive areas. Large samples of *Thorius* are easily obtained in some habitats, particularly in the meadows or *llanos* at elevations between 2600 and 2800 meters. Few species of *Pseudoeurycea* are abundant or easily collected, but the genus is more widely distributed and more diversified in Oaxaca than any other group of salamanders. Further exploration of the mountains will be required before ranges can be mapped in detail. Nevertheless, I have obtained enough information to reveal the general pattern of distributions. Insofar as I have been able to ascertain, all valid species of *Pseudoeurycea* in Oaxaca, with the notable exception of *P. bellii* and *P. cochranæ*, are allopatric. Systematic problems raised by my investigations in Oaxaca remain to be solved before I discuss distributions in detail. This account deals primarily with the new species of *Pseudoeurycea* discovered in collections from Oaxaca, and the status of two nominal species previously reported from the state. Distributions are pertinent to some aspects of the problems discussed below, but the significance of disjunct ranges, interspecies competition, and other phenomena associated with the diversification of the genus *Pseudoeurycea* will be discussed in a separate report.

#### ACKNOWLEDGMENTS

Several individuals have assisted in assembling the collections on which this report is based. Mr. and Mrs. Roy Jones, Mrs. Martha R. Bogert, Dr. John A. Moore, Dr. Stanley Salthe, Mr. Glenn Pollard, Mr. Greenfield Sluder, Mr. Godfrey Sluder, Mr. Patrick C. Peckham, Mr. Nicholas Bucknall, and Mr. James Scanlon participated in the work in the field. Mr. Roger Conant, Mr. Philip Regal, Dr. Guy G. Musser, and Dr. Walter Miller contributed specimens employed in the investigation. Dr. George B. Rabb helpfully compared specimens with holotypes in the Field Museum of Natural History when preliminary studies were undertaken, and later the holotypes from Oaxaca were lent through the courtesy of Mr. Hymen Marx. Dr. Jean Guibé courteously allowed me to examine the holotype of *Spelerpes sulcatum* Brocchi in the Museum National d'Histoire Naturelle, and paratypes or other specimens were lent by Dr. Charles F. Walker of the Museum of Zoology, University of Michigan, Dr. William E. Duellman of the University of Kansas,

and Dr. Douglas A. Rossman of Louisiana State University. Mrs. Isabelle Conant supplied a photograph of a living example of *Pseudoeurycea cochranae* from the Sierra de Miahuatlán, where it had been taken by Mr. Roger Conant. I am delighted to express my thanks to these individuals as well as to others who assisted in one way or another.

Finally, I am grateful to Dr. Rodolfo Hernández Corzo, Director General of the Departamento de Conservación de la Fauna Silvestre, who issued permits on behalf of the Secretaría de Agricultura y Gananería that enabled me to assemble collections in southern Mexico.

### SPECIES OF *PSEUDOEURYCEA* PREVIOUSLY REPORTED FROM OAXACA

When Taylor proposed the name *Pseudoeurycea* for one group of Mexican salamanders in 1944, he assigned 16 species (including one later placed in the genus *Chiropterotriton*) to the genus. Four of these, *bellii*, *cochranae*, *smithi*, and *unguidentis*, were listed among the species in Oaxaca by Smith and Taylor (1948), who indicated that 13 of the 16 species occurred in Mexico. More recently, in his excellent survey of the osteological characters of plethodontids, Wake (1966) has redefined the genus and listed 19 species. Three of these were described from Guatemala, one of which has since been reported from the Mexican state of Chiapas. Wake included *P. sulcata* (Brocchi, 1883) but omitted *P. cochranae* (Taylor, 1943), following Brame (1963), who had attempted to show that both names had been applied to the same species. Wake's list did not include one species from the mountains of central Oaxaca, which Regal (1966) had described as *P. juarezi* while Wake's report was still in press. Meanwhile, Dr. C. H. Lowe has informed me that the description of one additional member of the genus recently discovered in eastern Sonora awaits publication.

Not including the population in Sonora, therefore, 20 nominal species are currently grouped in the genus *Pseudoeurycea*. Four of these, *cochranae*, *juarezi*, *smithi*, and *unguidentis*, are restricted to the Sierra Madre del Sur of Oaxaca. The range of the fifth, *P. bellii*, extends westward into Guerrero, and northward to Tamaulipas. In Oaxaca *P. bellii* is widely distributed in the western half of the state, where its range widely overlaps that of *P. cochranae*. Thus far, however, neither of these species has been taken in the four areas where I have obtained specimens of *P. smithi*, namely, (1) the Sierra Aloápaneca, (2) the Sierra de Juárez on the opposite side of the Río Grande at the northern edge of its range, and south of the same river, (3) on Cerro San Felipe as well as in the mountains to the east, and (4) in the vicinity of Cuajimoloyas and El

Carrizal. In all four areas *P. smithi* is restricted to terrain above the elevation of 2700 meters, and the range is undoubtedly disjunct.

Minor differences are detectable when samples from the four populations are compared. The variations in samples comprising a total of 267 individuals, however, preclude recognition of subspecies. Moreover, the variability of *P. smithi* (Taylor, "1938" [1939]) raises doubts concerning the validity of *P. unguidentis* (Taylor, 1941a), since both species were described on the basis of specimens from the same area. Taylor diagnosed the species described as *Bolitoglossa unguidentis* as differing from the species described as *Oedipus smithi* in having longer limbs, costal grooves that lack black pigment, and a head that is somewhat longer and narrower. The premaxillary teeth of adult males were described as being bifid, like those of *P. smithi*, but "the inner projections of the teeth do not form the same type of inflated lobe (see figures)." The figures to which Taylor referred depict four premaxillary teeth, two of which were identified as those of *unguidentis*, and the others as those of *smithi*.

An examination of the teeth on several adult males in the series I obtained in Oaxaca reveals a wide range of variation. The shape of the lobes or cusps depends in part on whether the teeth on the premaxilla are median or lateral in position. The anterior cusp of those near the middle of the series is commonly longer and recurved, whereas those at the edge are often nearly equal in length, and directed downward. Teeth of the sort believed to be diagnostic of *unguidentis* occur in adult males that in other respects conform to *smithi*. I have examined the holotype of *Bolitoglossa unguidentis*, now No. 100045 in the collection of the Field Museum of Natural History, and it differs from any adults of *P. smithi* recently obtained only in having the digits touch when the limbs are adpressed. This condition is characteristic of juveniles of *smithi*, however, and the aberrant condition of the holotype can be attributed to its retention of juvenile characters. The other characters that Taylor listed in his diagnosis fall within the variations encountered in a series of *smithi* from one site on the north slope of Cerro San Felipe. The holotype of *unguidentis* shares most of the characters of *smithi*, including an extraordinarily large premaxillary fontanelle (as shown in X-ray photographs of the holotypes of both species). Accordingly, I assign *Bolitoglossa unguidentis* to the synonymy of the species that Taylor described earlier as *Oedipus smithi*, and later (1944) referred to the genus *Pseudoeurycea*.

It will be noted that I have used the name *P. cochranæ* rather than the name *sulcata*, as advocated by Brame (1963), who later questioned this conclusion (as Regal, 1966, noted). When Brame examined the

holotype of *Spelerpes sulcatum* Brocchi (1883), relatively few specimens of *P. cochranæ* were available. Moreover, he was perhaps biased by the belief that the holotype of *sulcatum* came from Oaxaca. When I re-examined the holotype, however, more than 50 specimens of *P. cochranæ* were at hand for comparison. As Brame reported, the dimensions of the holotype of *sulcatum* closely approximate those of *cochranæ*, and no significant differences in the dentition could be detected. The proportions and dentition in *cochranæ* are subject to enough variation to make it difficult to employ such characters in diagnoses. Structures most readily described in qualitative terms proved to be more important. The concavity of the snout, and the protuberances bordering the nasolabial grooves on the holotype of *sulcatum*, were far more pronounced than they were on any specimen of *cochranæ* examined. No salamander from Oaxaca had the combination of characters possessed by the holotype of *sulcatum*. Comparisons with specimens from other areas, however, revealed the holotype to be virtually identical with female *Pseudoeurycea cephalica* from the Distrito Federal. The collector may have visited Oaxaca, but it is more than probable that the holotype came from the vicinity of Mexico City. I have no qualms, therefore, in relegating *spelerpes sulcatum* Brocchi, 1883, to the synonymy of *Pseudoeurycea cephalica* (Cope, 1865).

### DESCRIPTIONS OF NEW SPECIES

The holotypes and paratypes of two of the species herein described were discovered in the summer of 1966. The holotype of the third, the only specimen known to be represented in collections, was obtained on the moist Pacific slope of the Sierra de Miahuatlán. The species evidently occurs at much lower elevations than any other member of the genus known from Oaxaca. The specimen lacks a tail, and in other respects it was evidently mutilated prior to capture. Nevertheless, it has such extraordinarily short limbs, small feet, and other characters that readily distinguish it from other members of the genus that its description seems warranted.

While my wife, Martha R. Bogert, and I were carrying out investigations in the mountains of Oaxaca, the residents of the state were unfailingly friendly and courteous. Among those who facilitated our investigations, however, no one was more hospitable or tolerant than our gracious and knowledgeable hosts in Oaxaca de Juárez, Roy and Anita Jones. The enthusiasm, fortitude, and perseverance displayed by Anita when she accompanied us on trips into the rugged back country of Oaxaca won our gratitude and admiration. As an acknowledgment of

her assistance, therefore, I am associating Anita's name with the species discovered near San Vicente Lachixío.

***Pseudoeurycea anitae*, new species**

**HOLOTYPE:** An adult female, A.M.N.H. No. 76365, taken by C. M. Bogert on July 24, 1966, 0.3 kilometer west of San Vicente Lachixío, a village in the Distrito de Sola de Vega, situated at an elevation of approximately 2100 meters in the Sierra Madre del Sur of Oaxaca.

**PARATYPES:** An adult female, A.M.N.H. No. 76367, and a juvenile, A.M.N.H. No. 76366, obtained in the immediate vicinity of the type locality on August 6, 1966, by C. M. Bogert and Godfrey C. Sluder. The holotype and the paratypes were all found beneath rocks within 20 meters of a sinkhole that evidently leads to subterranean passages in the limestone.

**DIAGNOSIS:** A salamander of moderate dimensions, scarcely exceeding a snout-vent length of 50 mm., that differs from its congeners in having whitish, nearly immaculate or faintly mottled ventral surfaces, and a dorsal pattern consisting of a median brownish area flanked by irregular rows of black dots on a gray ground color. In contrast, the ventral surfaces of other members of the genus comparable in size normally are either black, slate gray, or dusky yellow, with or without mottling. The pale lower surfaces characteristic of adults of the larger species, *P. smithi*, are yellowish rather than whitish, and more heavily pigmented; dots, when present on the dorsum of *smithi*, are small and inconspicuous. The limbs of adult *smithi* of both sexes normally are proportionately shorter than those of *P. anitae*, which resembles one other Oaxacan species, *P. juarezi* Regal (1966), in having the toes touch or slightly overlap when the limbs are adpressed to the body.

*Pseudoeurycea anitae* differs from both *smithi* and *juarezi*, as well as from most other species in the genus, in the position and the arrangement of the vomerine teeth. Those in each series are irregularly arranged in short, feebly curved rows, roughly perpendicular to the median axis. The series on the right is widely separated from that on the left, whereas in most other members of the genus the rows of vomerine teeth curve inward and meet in a V-shaped configuration. Largely because the two series of vomerine teeth of *anitae* are not confluent, they are widely separated from the two patches of parasphenoid teeth, which are separated but convergent anteriorly.

The protuberance bordering the nasolabial groove of *anitae*, well developed on the mature female holotypes, as well as on the juvenile, is presumably more strongly developed on males. Protuberances of the sort

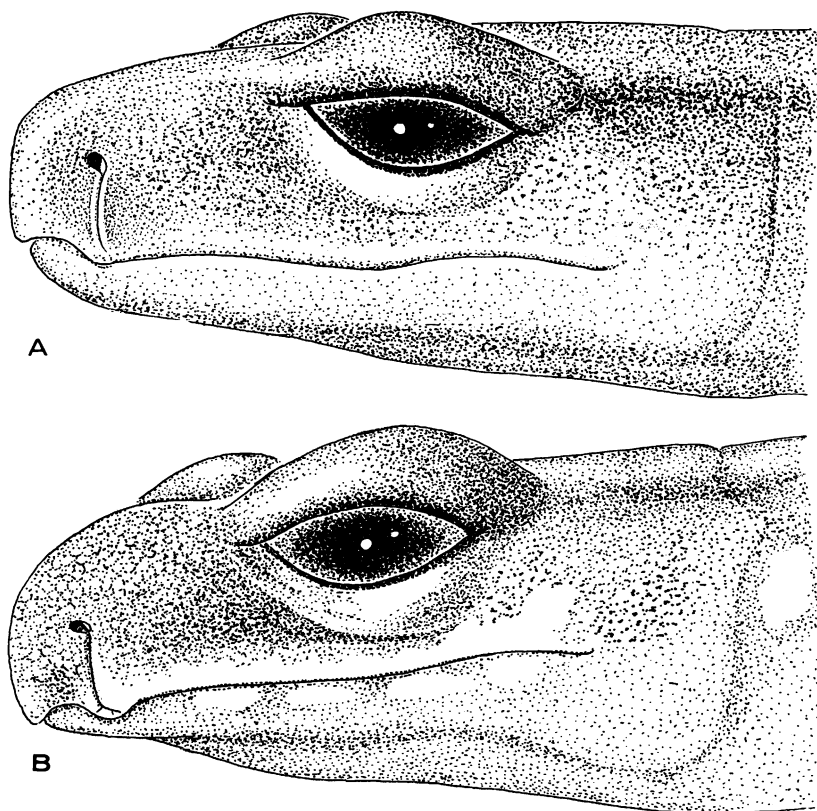


FIG. 1. Latero-anterior view of the head of *Pseudoeurycea anitae*. A. Adult female, holotype, A.M.N.H. No. 76365. B. Adult female paratype, A.M.N.H. No. 76367.

are lacking on females and juveniles of *cochranae*, however, and barely evident on mature males. Aside from the differences in the teeth and the nasolabial protuberances, the dark ventral surface of *cochranae*, black, slate gray, with or without mottling, along with proportionately shorter limbs, readily distinguishes it from *anitae*.

**DESCRIPTION OF HOLOTYPE:** The holotype is a sexually mature female, as indicated by the presence of eggs in the oviducts. Viewed from above, the snout is rounded, but the lower anterior surface of the portion projecting beyond the lower jaw is slightly concave between the nasolabial protuberances (fig. 1). Each feebly curved nasolabial groove descends from the posterior concavity of the nostril to a projection on the lip, where the terminus of the groove is feebly bifurcated. The plicate lining

of the vent is slightly rugose where it meets the margins of the opening. A dorsal furrow, not conspicuous in the living animal, is barely evident in the preserved specimen. The 13 costal grooves, including indistinct grooves in the axilla and groin, disappear above the flanks of the trunk.

The tail, nearly round in cross section at the marked constriction near its base, is increasingly compressed toward the tip. The length of the tail comprises approximately 93 per cent of the distance between the snout and the posterior angle of the vent. The width of the head, twice that of its depth, is equal to the distance between the angle of the mouth and the axilla, and contained 5.6 times in the snout-vent length (or equal to 17.6% of the snout-vent length). The distance from the snout to the gular fold is 23.8 per cent of the distance between the snout and the posterior angle of the vent. The length of the eyelid is slightly less than the distance separating the anterior angles of the eyes. The eyes are much more widely separated than the nares. An ill-defined groove extends from the posterior angle of the eyelid, traverses the vertical groove from the angle of the jaws, and terminates on the groove that extends upward from the gular fold almost to the midline of the neck.

The sublingual fold is well developed, with a free edge extending on the floor of the mouth to the anteriormost teeth on the dentaries. The teeth of each vomerine series, 12 on the left, and 12 on the right, are arranged irregularly along a curve that is roughly perpendicular to the median axis; each series extends laterally beyond the choana. The distance separating the rows approximates 50 per cent of the length of the individual rows. The parasphenoid teeth are arrayed in diagonal rows in patches nearly confluent anteriorly; the distance separating the teeth from those on the vomers is approximately twice as great as that separating the right and left series of vomerine teeth. There are 26 teeth on the right maxilla, 27 on the left. The total number of maxillary and premaxillary teeth is 59, of which six are on the premaxilla. When viewed at suitable magnifications, inner and outer cusps are discernible on the teeth of the premaxilla, on most of those on the maxillae, and on some of the teeth on the vomer and the parasphenoid. When vacant sockets are included, there are 26 teeth in the right dentary, 28 in the left. The teeth, whether bicusped or simple, are narrowly tipped with brown.

The limbs are well developed, and, when adpressed, the toes overlap a distance approximately half the width of an intercostal space. The phalangeal formulas are normal, 1-2-3-3-2 and 1-2-3-2. The digital formula for the toes is  $1>5>2>4>3$ ; for the fingers,  $1>4>2>3$ . The webbing on the toes extends along the edges of the proximal phalanges



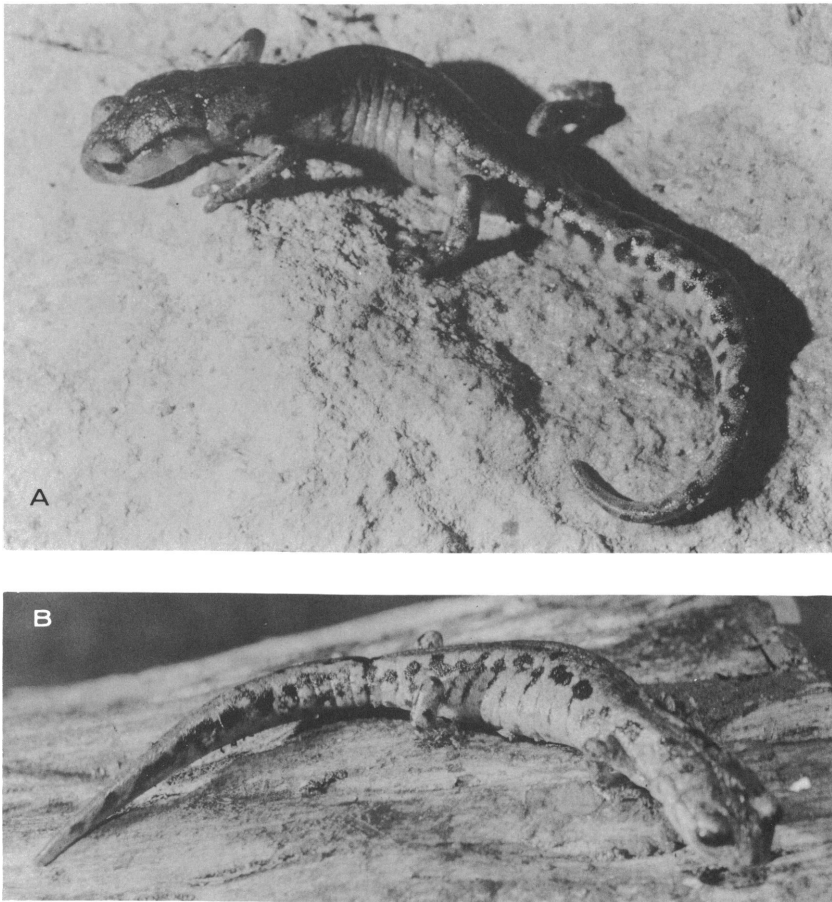


FIG. 2. *Pseudoeurycea anitae*. A. Adult female, holotype. B. Adult female paratype.

of the three middle digits, and the second and third digits of the hand. Little more than the fleshy pad of the inner finger and the inner toe extends beyond the webbing (fig. 8B). The pads on the under side of the tips of the other fingers and toes are nearly round, and feebly cupped on the under side.

The upper surface of the head, the middle of the trunk, and the tail are dark brown (appreciably paler prior to preservation). On the head and neck the dark coloration extends downward to the darkly pigmented groove that extends posteriorly from the corner of the eye, but below the groove the skin is sparsely pigmented. The dark middorsal region

of the neck, trunk, and tail is flanked by two irregular series of dark spots or bars (more conspicuous prior to preservation; see fig. 2), the lower row of which is on a light gray background. The spots vary in size and shape; two are paired near the midline on the anterior of the trunk, and one small spot extends obliquely almost to the midline on the right side. The costal grooves are somewhat more heavily pigmented than the folds, and, anterior to the insertion of the hind limbs, dark lines bordering the grooves extend downward from the spots. Magnification reveals minute black dots, melanophores unevenly distributed on the venter and the under side of the tail. There are a few melanophores along the lower lip, but the throat is immaculate white, without melanophores. The uneven distribution of melanophores on the belly and the under side of the tail produces faint mottling. Melanophores are thinly distributed on the lower surfaces of the limbs, and absent from the feet, but the dorsal surfaces of the feet and limbs are brownish, except for a few dark spots on the limbs.

Measurements, in millimeters, are as follows: snout to posterior angle of vent, 50.0; from vent to tip of tail, 42.3; the head width, 8.8; distance from the snout to gular fold, 11.9; from snout to eye, 2.5; from angle of mouth to middle of arm insertion, 8.9; length of eyelid, 4.5; interorbital distance, 4.3; internarial distance, 2.3; axilla to groin, 25.7. Length of forelimb, 13.3; length of hind limb, 14.9.

VARIATIONS IN THE PARATYPES: The adult female, A.M.N.H. No. 76367, slightly smaller than the holotype, taken at the type locality on August 6, contains more fully developed eggs (approximately 3 mm. in diameter) in the oviducts. It has a snout-vent length of 46.7 mm., and a tail 36.4 in length that comprises 77 per cent of the snout-vent length. The dimensions and other characters of the holotype and the paratypes are given in table 1. The pattern of the adult female paratype is essentially the same as that of the holotype. The throat and venter are white, but the under side of the tail is faintly mottled owing to the uneven distribution of the scattered melanophores. The dark spots on the trunk are somewhat larger and more conspicuous, perhaps because the reddish brown middorsal area is somewhat paler than it is in the holotype. Few spots extend to the dorsal surface of the tail of the adult paratype, and the lateral margins of some on the flanks of the trunk are fused.

The snout-vent length of the juvenile paratype, A.M.N.H. No. 76366, is 24.3 mm., and the tail, 18.4 mm. in length, comprises 75 per cent of the snout-vent length. Aside from being ill defined, the dorsal pattern of the juvenile, though finely mottled prior to preservation, is essentially like that of the adults. The venter of the juvenile is more heavily sprin-

kled with melanophores, and some are present on the throat and the lower surfaces of the limbs. Under magnification, melanophores beneath the pads on the feet are discernible, but the translucent pads are white. The protuberance bordering the nasolabial groove is nearly as well developed on the juvenile as it is on the adult females.

**DISTRIBUTION:** It is conjectural whether *Pseudoeurycea anitae* occurs on the surface far from the limestone sink where the holotype was discovered. The pale coloration of the dorsum and the greatly reduced pigmentation on the ventral surfaces of the three specimens obtained, in sharp contrast to the heavily pigmented venters on the majority of the species assigned to *Pseudoeurycea*, suggest that *P. anitae* is an inhabitant of caves. A vertical crevice, 20 to 30 cm. in width, at the lower end of the steep-sided sinkhole at the type locality evidently leads to an underground passage. A second sinkhole scarcely 30 meters to the east presumably drains into the same subterranean channel, but a much larger sink on the opposite side of the road to the north has apparently become partly clogged with silt. The residents of San Vicente Lachixio plant corn around the columnar outcroppings of limestone that remain in the shallow depression where the run-off from the ridge to the north has deposited silt. If the drainage of the three sinks is confluent below the surface, as seems probable, the water draining from the sinkholes may have dissolved enough limestone to form a cavern large enough to support salamanders under moist conditions when surface environments are dry.

Walker (1955) has noted that *Pseudoeurycea scandens*, a species occasionally found under rocks, in bromeliads, or in cavities in trees in the humid forests near Rancho Cielo in Tamaulipas, is more often encountered in caves, where it frequents crevices and crannies well above the floor. Relatively long limbs are presumably associated with scansorial habits, and the toes of *P. scandens* touch or overlap when the limbs are adpressed. In having proportionately long limbs, the species evidently resembles *P. anitae*, but the broad feet and the pads on the digits of *P. scandens* are more highly developed. Nevertheless, it seems probable that *P. anitae* occasionally frequents the walls of caves.

In its retention of the dull blackish coloration more characteristic of its congeners, *P. scandens* seems to be less highly specialized than *P. anitae*. Most species of *Pseudoeurycea* are terrestrial or partly fossorial, as far as known, though others are partly or largely arboreal, and individuals of some of the terrestrial species occasionally are found under bark a meter or so above the ground. Those with relatively short limbs appear to be ill adapted to climb. *Pseudoeurycea cochranae*, a moderately short-limbed inhabitant of the pine-oak forests west of the type locality of *P. anitae*,

was most often found under logs. The only individuals found above the soil surface were in horizontal position beneath the bark of logs lying on the ground. Specimens of *P. cochranæ* were obtained scarcely 200 meters to the west of the limited area to which *P. anitæ* seems to be restricted. Repeated searches of the area failed to reveal the presence of *cochranæ* in the immediate vicinity of the sinkhole. Neither species could be found in or around sinkholes to the east of San Vicente Lachixío. It seems improbable that *P. cochranæ* and *P. anitæ* are sympatric. If *P. anitæ* normally remains in caves, the two species may prove to be sympatric under exceptional conditions, but normally they are probably restricted to separate habitats.

The type locality of *Pseudoeurycea anitæ* is situated near the southern extremity of a ridge shown on some maps as the Sierra de Cuatro Venados. This range extends southward from the Continental Divide to form the western border of the Valle de Oaxaca, which lies on the Pacific drainage. The second species herein described was discovered in an area east of the Valle de Oaxaca, on the Atlantic drainage. The name selected for this species refers to the whitish protuberances on the lips that bear some resemblance to a mustache when the male holotype is viewed from the front.

### ***Pseudoeurycea mystax*, new species**

**HOLOTYPE:** A.M.N.H. No. 76363, adult male, taken 0.9 kilometer east-northeast of Ayutla, Oaxaca, in the Distrito de Villa Alta, on July 26, 1966, by C. M. Bogert. **AlloTYPE:** A.M.N.H. No. 76362, a female taken at the type locality by Godfrey C. Sluder on the same date as the holotype. Both specimens were found beneath rocks in an area bordering a creek (locally known as the Río Alacrán) that flows through a narrow, steep-sided ravine at an elevation of approximately 6400 feet (*ca.* 2050 meters). The rocky terrain bordering the stream supports a dense vegetation consisting of shrubs and trees, mostly alder. Pines, oaks, and *madroño*, however, were the dominant plants on the less humid slopes on each side of the ravine.

**DIAGNOSIS:** A salamander of moderate size, perhaps not greatly exceeding an over-all length of 85 mm. (snout to posterior angle of vent, 47.5 mm. in the holotype), that differs from nearly all other species of *Pseudoeurycea* in having only one phalanx in the fifth toe, which barely projects beyond the webbing (figs. 3A, 8A). The transverse processes on the three vertebrae anterior to the constriction of the tail are far more strongly developed than in other members of the assemblage. Moreover, the transverse processes on the first caudal vertebra curve noticeably

backward, whereas those on the third caudal vertebra are more sharply inclined anteriorly toward the main axis of the centrum than those on the second vertebra, in contrast (as far as can be ascertained) to the condition characteristic of other species of the group (see fig. 4). The most conspicuous elements of the pattern, the white lichen-like blotches,<sup>1</sup> irregular in size and shape, and unevenly distributed on the tail and occasionally represented on the posterior flanks of the trunk, are equally distinctive. In addition, the bifurcated terminus of each nasolabial groove on the male encompasses an intricate network of shallower grooves on the broad protuberance of the lip that extends beyond the lower jaw.

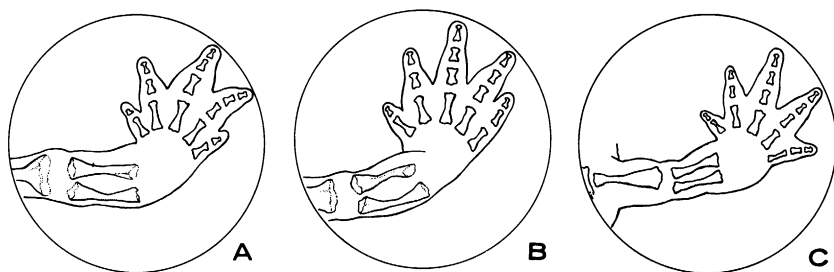


FIG. 3. Right hind feet as drawn from roentgenograms. A. *Pseudoeurycea mystax*, showing the loss of the distal phalanx from the outer toe. B. *Pseudoeurycea anitae*. C. *Pseudoeurycea cochranae*.

Furthermore, each of the costal grooves is continuous across the dorsum, following a sigmoid pattern, the median apex of which forms an acute angle that is directed anteriorly, as shown in figure 7B. Sigmoid links connecting costal grooves on opposite sides of the body are occasionally discernible in preserved examples of other species of *Pseudoeurycea*, although on most salamanders of the genus the costal grooves ordinarily fade out as they approach the dorsum. In *P. mystax*, however, the sigmoid connections are readily seen in living as well as in preserved specimens.

**DESCRIPTION OF HOLOTYPE:** The specimen is an adult male on which the snout is bluntly rounded as viewed from above, but the nasolabial protuberances that extend beyond the level of the lower jaw on each side of the snout are separated by a concavity on the under side of the snout (fig. 6). A pale dot on the chin marks the position of the mental gland. A middorsal groove that becomes apparent near the level of the third costal groove is increasingly broader and deeper posteriorly, where

<sup>1</sup> Absent from the tail of juvenile obtained at the type locality in June, 1967.

it terminates at the weakly marked constriction at the base of the tail. At its base the depth of the laterally compressed tail is approximately one-third greater than its width; a median furrow on the under side of the tail is broadest near the third segment, but narrower toward the base. The furrow is continuous with the depression bordering the vent, the lips of which extend posteriorly almost to the constriction. Papillae on the lining of the vent are largely restricted to the anterior portion of the orifice.

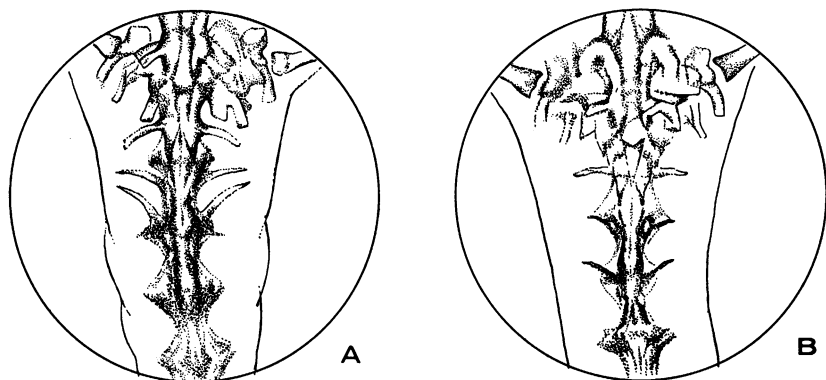


FIG. 4. Pelvic region as drawn from roentgenograms. A. *Pseudoeurycea mystax*, illustrating the distinctive processes on the vertebrae at the base of the tail. B. *Pseudoeurycea cochranae*.

The tail length comprises slightly less than 80 per cent of the snout-vent length. The width of the head is approximately one-third greater than its depth, and slightly less than the distance separating the angle of the mouth from the middle of the forearm at its insertion; the head width is contained 6.3 times in the snout-vent length (or equal to 15.6% of the distance between the snout and the posterior angle of the vent). The distance from the snout to the gular fold is 22.3 per cent of the snout-vent length. The eyes are separated anteriorly by a distance one-third greater than the length of the eyelid, which is slightly longer than the distance between the nostrils. A groove from the posterior angle of the eye traverses the groove from the angle of the jaws, descending at a slight angle to its terminus on the groove that extends upward from the gular fold.

The thin, free margin of the sublingual fold extends to the base of the teeth at the anterior ends of the dentaries. The vomerine teeth, 15 on each side, are arrayed somewhat haphazardly in rows that curve inward

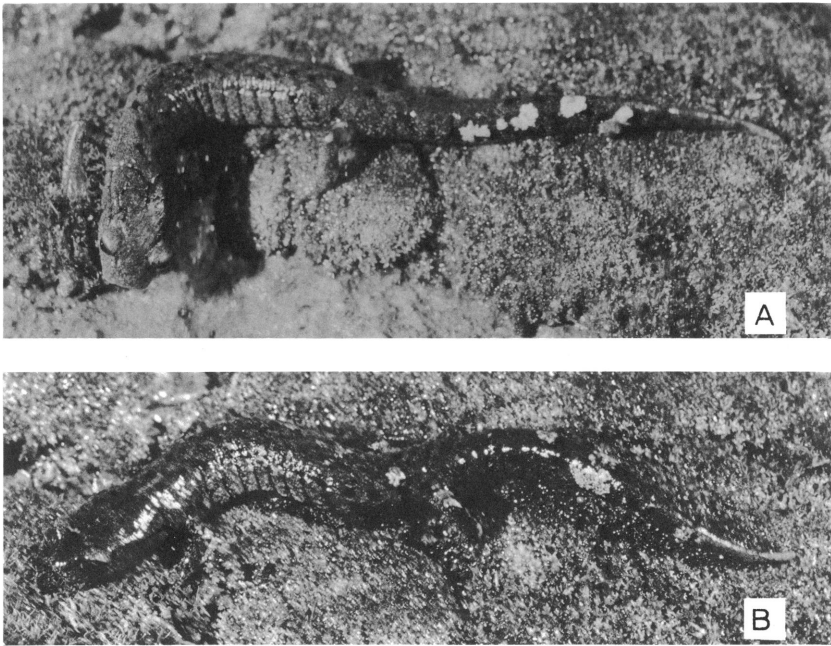


FIG. 5. *Pseudoeurycea mystax*. A. Adult male, holotype. B. Adult female paratype.

and backward. The posterior ends of the paired rows of vomerine teeth almost meet to form an apex where they are separated from the paired patches of parasphenoid teeth. The two patches of parasphenoid teeth tend to converge anteriorly, but nevertheless remain separated throughout their length. The maxillary teeth, 29 on the right, 30 on left, are directed inward rather than downward at the front of the jaw, particularly where the swollen nasolabial structures project beyond the edge of the mouth. One enlarged, bicusped tooth on a swollen pedestal near the middle of the premaxilla is more nearly vertical in position, but it does not pierce the lip; the clawlike outer cusp on the tooth curves sharply inward above a smaller cusp that is also recurved. Apparently some of the sockets near the middle of the premaxilla are vacant, but it seems probable that there are six sockets on the bone. A second enlarged tooth, situated behind and to the right of the one nearest the lip, has clawlike cusps that are shorter and less strongly recurved; apparently this tooth was coming into place but had not yet become ankylosed when the holotype was preserved. There are 32 teeth in each dentary. Some, if not most, of the teeth on the dentaries, the para-

sphenoids, the vomers, the maxillae, and the lateral portions of the premaxilla, are feebly bicusped and faintly amber in color at the tips. The clawlike cusps on the enlarged teeth, however, are clear and virtually transparent.

The moderately short, relatively weak limbs, when adpressed, are separated by two costal folds between the outstretched toes. The phalangeal formulas are 1-2-3-3-1, and 1-2-3-2; the digital formulas are  $5 < 1 < 2 < 4 < 3$ , and  $1 < 4 < 2 < 3$ , respectively. The webbing on the toes extends to the base of the proximal phalanges on the inner digits, but little more than the pad on the under side projects beyond the webbing on the inner toe and the inner finger. The outer toe is vestigial, but a circular pad is present on the plantar surface. The outer finger is broader than the inner finger and more strongly developed, as shown in figure 8A.

Markings readily apparent on the living animal (fig. 5) were largely obscured after it had been fixed in formalin and stored in ethyl alcohol. As preserved, the holotype superficially appears to be uniformly slate gray on the dorsal surfaces of the head, trunk, and base of the tail. Detailed examination, however, reveals pale gray, unevenly distributed blotches on the middle portion of the tail, more on the left side than on the right. The blotches, irregular in size and shape, are largely restricted to the sides of the tail, but the position of one is dorsal, and the distal third of the tail is faintly pinkish. The dorsal surfaces of the limbs and feet are faintly mottled with pink or light reddish brown. The ventral surfaces of the trunk and tail are dark gray, almost black, without markings, but the lower surfaces of the feet and limbs, as well as the gular fold, are appreciably paler. Anterior to the gular fold the color on the throat fades from dark to light gray, except for the white dot that marks the position of the mental gland. The margins of the mouth are slightly paler than the throat, and the pale area encompasses the snout and the nasolabial protuberances.

While the holotype was alive, its dorsal ground color was gray, with faint traces of pink on the dorsum, especially on the snout. Black dots, round on the body but somewhat tear-shaped and paired on the midline of the neck, were scattered, some in more or less linear arrangement, along the dorsum. Dots similar in size and color to those on the dorsum were present on the flanks anterior to the insertion of the hind limbs. All dots were situated on costal grooves, which were darker than the costal folds. A few black dots were present on the tail, where much larger white blotches, largely confined to the lateral surfaces, were far more conspicuous. The white blotches were partly bordered by black. The upper portion of the blotch nearest the tip of the tail was



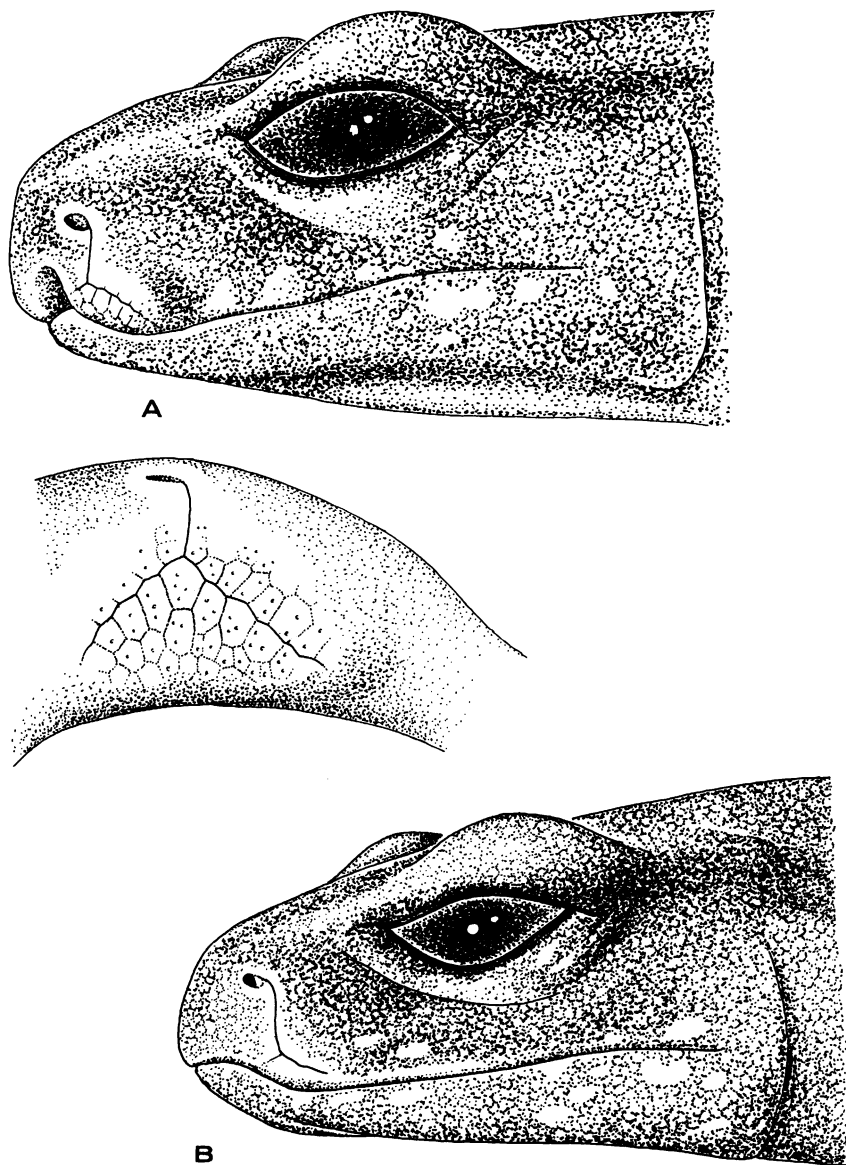


FIG. 6. *Pseudoeurycea mystax*. A. Latero-anterior view of the head of the male holotype, showing the structures on the nasolabial protuberances and the details of reticulum at the terminus of the nasolabial groove, as viewed from below. B. Anterolateral view of the head of the female allotype.

white, but the lower anterior end of the same blotch was pink. The dorsal surfaces of the distal portion of the tail and the limbs were pale brown or slightly pink. The ventral surfaces were subject to fewer changes following preservation. When the holotype was alive, however, its belly was appreciably darker than its dorsum.

Measurements, in millimeters, follow: snout to posterior angle of vent, 47.5; from vent to tip of tail, 37.8; head width, 7.4; distance from snout to gular fold, 10.7; from angle of mouth to middle of arm insertion, 8.7; from snout to anterior angle of eye, 3.0; length of eyelid, 2.7; inter-orbital distance, 4.7; internarial distance, 2.8; distance from axilla to groin, 24.4; length of forelimb, 11.0; of hind limb, 13.0.

DIFFERENCES NOTED IN ALLOTYPE: Aside from differences attributable to allometric changes or to sexual dimorphism, the female is similar to the male holotype. The markings of the holotype and allotype are essentially the same, but the female has fewer white blotches on the tail. Moreover, a white blotch was present on one side of the trunk anterior to the hind limbs of the female, whereas such blotches were restricted to the tail of the holotype. The female is the smaller of the two, and its tail is proportionately shorter, comprising 64 per cent (rather than 79.5%) of the snout-vent length. The lining of the vent is plicate, without the papillae characteristic of males. The snout lacks the nasolabial protuberances, although the area bordering the bifurcation in the nasolabial groove is slightly swollen. The presence of fewer teeth on the maxilla, vomer, and dentary can be attributed to the smaller size of the female, which also lacks the enlarged teeth with recurved cusps noted on the male holotype. Roentgenograms reveal no important differences in osteological characters, although skeletal structures appear to be proportionately more robust in the male than in the female, but this is not necessarily to be construed as evidence of sexual dimorphism. These differences are perhaps associated with the age or size of the individual, or attributable to variation. The solution to such problems awaits the acquisition of larger series.

HABITAT: The loss of the distal phalanx in the outer toe, modifications in the transverse processes on the vertebrae above the vent, and the elaborate structure of the nasolabial protuberance on the male suggest that *Pseudoeurycea mystax* is somewhat more specialized than most other species in the group. The relatively simple structure of the nasolabial groove of the female, as compared to that of the male, points to the probability that such structures play a significant role in sex recognition or other elements of the courtship. The modifications in the feet and the distinctive pattern, however, are presumably adaptations to the some-

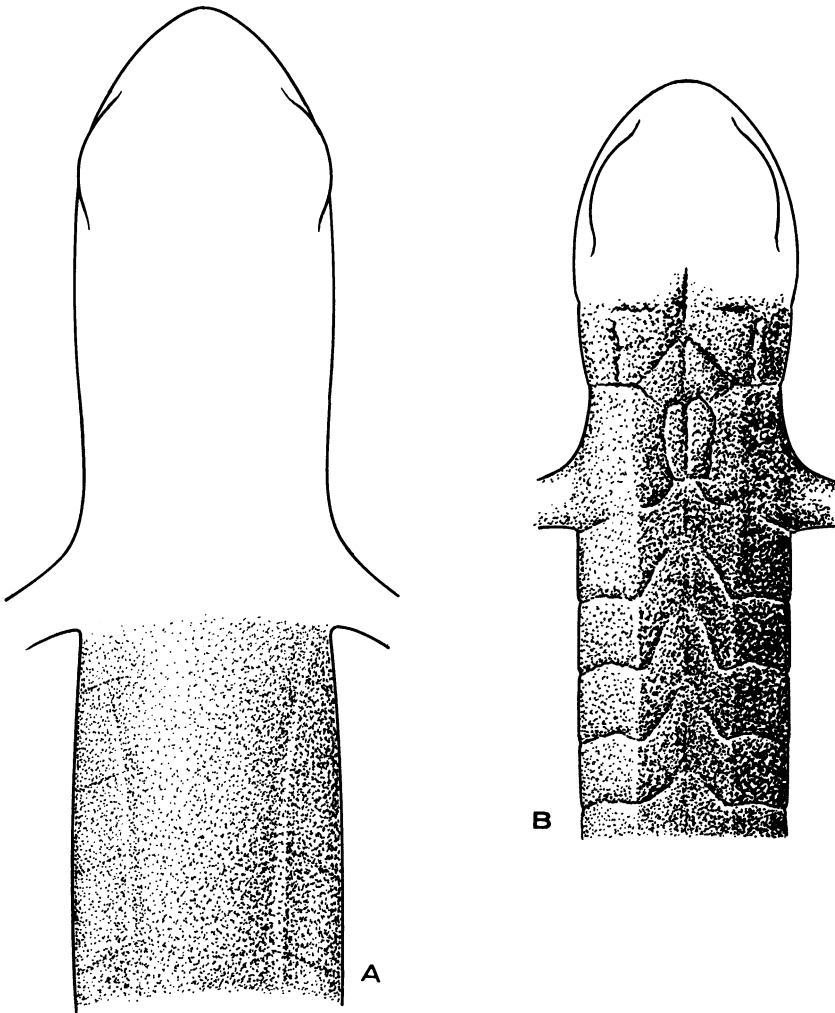


FIG. 7. Dorsal aspect of the anterior portion of the trunk. A. *Pseudoeurycea cochranae*. B. *Pseudoeurycea mystax*.

what specialized environment prevailing in the rocky ravines of the Sierra Madre del Sur in the vicinity of Ayutla. The village is situated on the steep Atlantic slopes of the Continental Divide, which rises to elevations above 2300 meters immediately to the south of the type locality.

No salamanders could be found on the steep slopes bordering the

precipitous ravine where the type specimens were found. Another species, *Pseudoeurycea cochranæ*, was taken approximately 15 kilometers to the west. This salamander may occur in wooded areas near the type locality, but it would be expected in the wooded mountain slopes rather than in the narrow ravine. The vegetation bordering the creek on the rock-strewn floor of the ravine was moderately dense. In some areas enough silt and vegetable debris had accumulated in the crevices between the rocks to support bushes and a few trees of moderate size. Moss covers much of the terrain, but lichens were present on rocks where light penetrated the growth. A few meters above the site where both salamanders were found, the creek poured over a cliff that could not be readily scaled. The nearly vertical walls of the ravine below the waterfall supported lichens, as well as ferns, bromeliads, and other plants that become rooted in small crevices. Scansorial salamanders might forage on such cliffs, but the short, stout feet of *Pseudoeurycea mystax* are ill adapted for climbing. It may be inferred that these salamanders are terrestrial. Presumably they seek their prey on the floor of the ravine, where the white blotches on the tail would blend with the lichen-covered rocks. The outline of the body under such conditions would be obscured; hence the markings on the dorsum and flanks of the trunk and tail would afford protection from owls or other predators that depend heavily on vision in locating their prey. A salamander with short, blunt toes is conceivably better adapted than one with long, slender toes to move about on terrain comprised of rocks and vegetation. It is doubtful whether salamanders excavate burrows, but perhaps the modified feet of *Pseudoeurycea mystax* permit it to enlarge passages beneath rocks.

RELATIONSHIPS: The photograph of a paratype of *Pseudoeurycea firscheini* reproduced with the original description of the species (Shannon and Werler, 1955) reveals a pattern that bears some resemblance to that of *P. mystax*. Both species have black dots on the posterior flanks of the trunk, but the white flecks on the tail of *firscheini* are much smaller and less conspicuous. The limbs are evidently similar in color, but more strongly mottled in *P. firscheini*. The sex of the holotype of *firscheini* was not mentioned in the description, but its snout-vent length is virtually identical with that of the holotype of *P. mystax*. The nasolabial groove of *P. firscheini* was described only as being "fine but distinct." The description of the holotype indicated that it had 14 costal grooves and relatively large feet with slender toes. All specimens were found in bromeliads "from 7 to 20 feet above the ground," indicating that the species is at least partly scansorial. *Pseudoeurycea mystax* has fewer teeth in each series than Shannon and Werler reported for *firscheini*. Detailed

comparison will undoubtedly reveal additional differences attributable to wholly independent trends in the adaptive modifications of the two species. The few distinctive features that the two species share, however, suggest derivation from a common ancestor. If so, selection has resulted in marked divergence following the initial isolation of separate populations.

Shannon and Werler (1955) suggested that the specimens they described as *P. firscheini* were perhaps intergrades between *P. leprosa* (Cope) and *P. nigromaculata* (Taylor). This suggestion was based on the assumption that *leprosa* represents the "high mountain form and *nigromaculata* the low." Smith and Taylor (1948) indicated that the range of *leprosa* extends eastward from the state of Mexico to western Veracruz. However, they listed the type locality as Orizaba, which is situated below, rather than at an elevation above, the site where the specimens described as *P. firscheini* were obtained. Orizaba may have been the shipping point rather than the actual source of the specimens that Cope described. Taylor (1944) considered *nigromaculata* to be related to *cephalica* as well as to *leprosa*, but until more detailed information is available concerning the anatomy, distributions, and habitats of the species in the genus, any effort to group them may prove to be misleading.

The third species here described is from the Sierra de Miahuatlán, the southernmost subdivision of the Sierra Madre del Sur that extends along the Pacific Ocean in the state of Oaxaca. In recognition of the tireless efforts that my friend and colleague, Mr. Roger Conant, has devoted to his herpetological investigations while serving as Curator of Reptiles, Director of Public Relations, and more recently as Director, of the Philadelphia Zoological Garden, the distinctive species from southern Oaxaca will bear his name.

#### ***Pseudoeurycea conanti*, new species**

HOLOTYPE: A.M.N.H. No. 13811, adult female, "found under rubbish in a cafetal" at Pluma Hidalgo, Distrito de Pochutla, Oaxaca, on June 23, 1920, by Paul D. R. Rùthling. The type locality is at an approximate elevation of 900 meters on the humid Pacific slope of the Sierra de Miahuatlán.

DIAGNOSIS: A salamander that differs from other members of the genus in having proportionately shorter limbs (when limbs are adpressed the tips of the digits are separated by four costal folds), and short toes (fig. 8C). When the length of the hind limb is added to that for the forelimb, the total approximates 71 per cent of the distance separating the axilla from the groin; data for other species reveal that

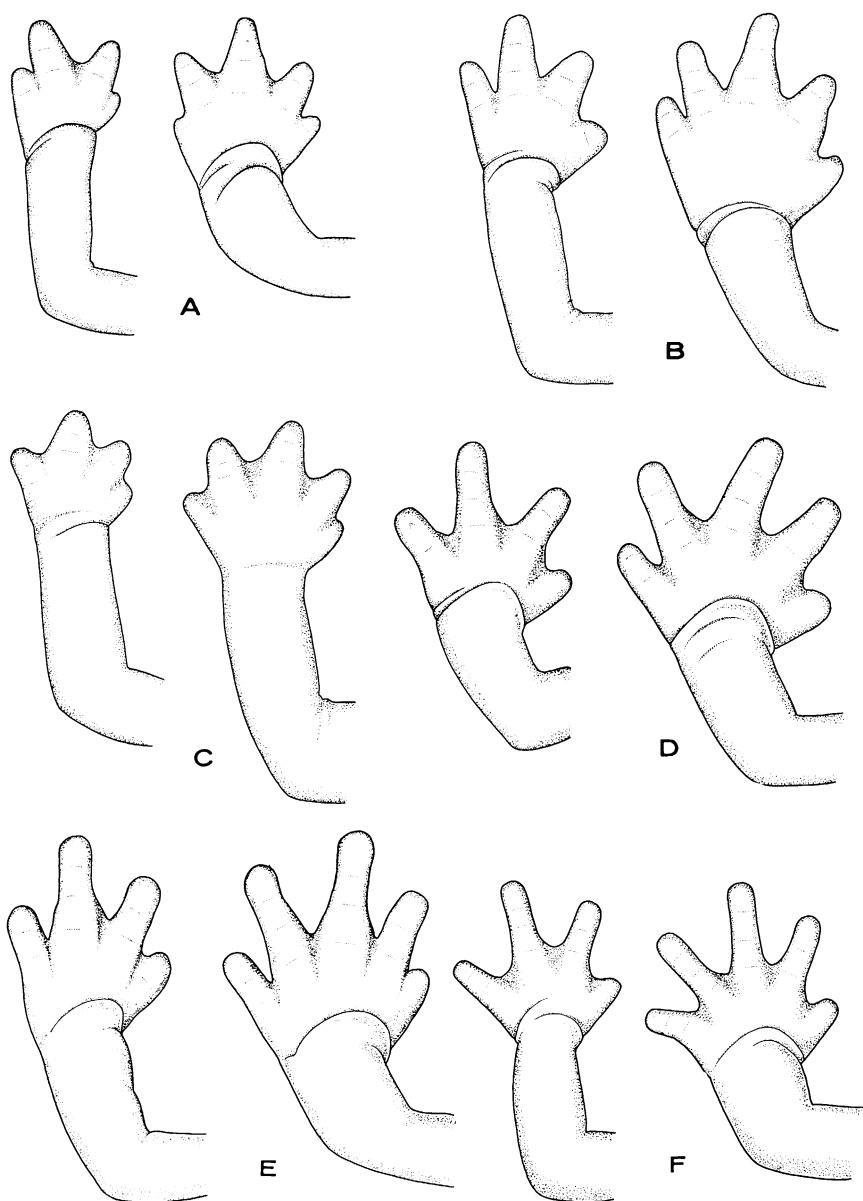


FIG. 8. Hands and feet of salamanders of the genus *Pseudoeurycea* from the Sierra Madre del Sur of Oaxaca. A. *P. mystax*. B. *P. anitae*. C. *P. conanti*. D. *P. cochranae*. E. *P. juarezi*. F. *P. smithi*. One additional species, *P. bellii*, is not illustrated.

the combined lengths of hind limb and forelimb comprise from 80 to 112 per cent of the snout-vent length. The snout-vent dimensions of the holotype of *Pseudoeurycea conanti* closely approximate those of the holotype of *P. nigromaculata* (Taylor, 1941b), but the latter species is described as having no more than two costal folds separating the digits on the adpressed limbs. The two species are similar in having nine teeth on the premaxilla, whereas it is exceptional for other species of the genus to have more than six. Taylor (1941b) described *P. nigromaculata* as having from 47 to 54 teeth on the maxilla, whereas there are but 38 teeth on the maxilla of *P. conanti*. The holotype of *conanti* has a deep transverse groove (nearly as conspicuous as the gular fold behind it) that extends from one angle of the lower jaw to the other. Faint traces of this groove occur in other species of the genus, but it appears to be a distinctive characteristic of *P. conanti*. There was an obtuse angle in the nasolabial groove (intact only on the left side of the holotype), which descended downward for approximately two-thirds of the distance between the nostril and the edge of the mouth, and thence backward at approximately the same angle as that shown in figure 6B for the posterior ramus of the bifurcated groove observed on the allotype of *P. mystax*. No bifurcation was detectable in the groove of the female holotype of *P. conanti*. Males of the species may prove to have nasolabial protuberances comparable to those observed in the holotype of *P. mystax* (fig. 6A).

DESCRIPTION OF HOLOTYPE: A plicate lining in the vent, the absence of a mental gland, and the lack of any protuberance bordering the recurved nasolabial groove indicate that the holotype is a female. The presence of eggs maturing in the oviducts leaves no doubt that the individual is sexually mature. Despite the absence of a tail, which evidently parted at the basal constriction, the length of 56 mm., measured from the snout to the posterior angle of the vent, suggests that the dimensions of the species are those of the moderately large members of the genus. The maximum snout-vent lengths of the species in Oaxaca are given in table 2. Eggs in the oviducts may account in part for the stout body of the holotype, which is nearly cylindrical, although the ventral surface is flattened. There is little constriction at the neck, however, and the depth of the head is only slightly less than its width. Shallow depressions above the trunk vertebrae may be construed as vestiges of a dorsal furrow. A deep, transverse groove connects the angles of the mouth, leaving a sort of collar between it and the gular fold. There are 13 costal grooves on the trunk, but those in the axillary region are barely discernible; near the middle of the trunk the grooves curve slightly backward before they become indiscernible where they approach

TABLE 1  
DIMENSIONS (IN MILLIMETERS) AND DENTITION OF HOLOTYPE AND PARATYPES OF NEW SPECIES OF *Pseudoeurycea* FROM OAXACA

	<i>P. anitae</i>		<i>P. mystax</i>		<i>P. conanti</i>	
	Holotype Female A.M.N.H. No. 76365	Paratype Female A.M.N.H. No. 76367	Paratype Juvenile A.M.N.H. No. 76366	Holotype Male A.M.N.H. No. 76363	Allotype Female A.M.N.H. No. 76362	Holotype Female A.M.N.H. No. 13811
Snout to posterior angle of vent	50.0	46.7	24.3	47.5	42.0	56.0
Tail length	42.3	36.4	18.4	37.8	27.0	—
Snout to gular fold	11.9	12.0	6.8	10.7	9.3	12.3
Snout to axilla	17.0	15.9	9.2	14.8	13.2	17.4
Axilla to groin	25.7	24.7	12.3	24.2	21.5	31.0
Head width	8.8	8.8	4.7	7.4	7.0	9.1
Distance from angle of mouth to middle of forelimb insertion	8.9	7.6	5.0	8.7	7.6	9.0
Width of foot	5.6	5.0	2.6	3.6	3.2	4.0
Interorbital distance	4.3	4.2	2.8	4.7	3.0	—
Internarial distance	2.3	2.5	1.4	2.8	2.0	—
Length of forelimb	13.3	11.3	6.8	11.0	9.0	10.0
Length of hind limb	14.1	13.9	7.0	13.0	10.0	12.0
Premaxillary teeth	6	8	8	6	6	9
Maxillary teeth	26-27	29-28	17-20	29-31	25-26	?-37
Vomerine teeth	12-12	12-13	8-8	15-15	14-12	21-21
Teeth in dentary	26-28	29-31	?-?	32-32	27-25	?-38



the shallow vertebral depressions. Where the tail parted at the constriction behind the vent, the skin is drawn in so that the tissue is exposed in a circular area slightly less than half of the diameter of the tail. The terminus of the body above the vent is only slightly higher than wide, suggesting that the base of the tail was nearly round in cross section.

The width of the head barely exceeds the distance between the angle of the mouth and the middle of the forelimb at its insertion. The width of the head is slightly more than one-sixth of the snout-vent length, or 16.2 per cent of the distance from the snout to the posterior angle of the vent. The distance from snout to gular fold is approximately 22 per

TABLE 2

MAXIMUM DIMENSIONS (IN MILLIMETERS), FROM SNOUT TO POSTERIOR ANGLE OF VENT,  
RECORDED FOR THE SPECIES OF *Pseudoeurycea* IN OAXACA

	Females	Males
<i>P. anitae</i>	50	—
<i>P. bellii</i>	115	111
<i>P. cochranae</i>	65	52
<i>P. conanti</i>	56	—
<i>P. juarezi</i>	50	51
<i>P. mystax</i>		47
<i>P. smithi</i>	88	88

cent of the snout-vent distance. The length of the eyelid is roughly two-thirds of the distance separating the anterior angle of the eyes. The right side of the head was too badly mutilated in the holotype for other measurements on the head to be obtained, but the groove that extends posteriorly from the posterior angle of the eye was evidently not well defined.

The free edge of the sublingual fold extends forward to the inner margins of the teeth on the anterior ends of the dentaries. The relatively stout vomerine teeth, 21 on each side, are irregularly set and closely packed in rows that curve posteriorly but fail to meet at the midline, where they are separated by a distance equal to the diameter of the choanal openings. The teeth at the rear of the vomerine series are separated from those in the paired patches of the parasphenoids, which diverge widely at their posterior ends, but tend to converge anteriorly, even though they remain separated throughout their length.

The right maxilla is incomplete, but there are 37 teeth on the left maxilla, nine teeth on the premaxilla, and 38 teeth on the left dentary. The total number of teeth on the maxillae and the dentary must have

been approximately 83. Most of the teeth were observed to be bicusped, and the tips are faintly amber-colored when viewed under magnification.

The limbs are relatively weak when compared with those of other species, and shorter in proportion to the length of the trunk; toes on adpressed limbs are separated by four costal folds. The toes are relatively short and bluntly rounded, webbed to the base of the distal phalanx on all but the third toe. The phalangeal formulas are normal, 1-2-3-3-2 on the hind limbs, and 1-2-3-2 on the forelimbs, as revealed in roentgenograms. The digital formula is  $1<5<4<2<3$  for the feet and  $1<4<2<3$  (fig. 8C) for the hands, where the webbing is scarcely indented between the first and second fingers. The toes are relatively flat, without fleshy pads on the plantar surface.

Insofar as can be ascertained from the preserved holotype, both dorsal and ventral surfaces of the head and body were uniformly black or dark slate gray, without a light margin on the gular fold. The hands and feet, however, are somewhat paler, brownish rather than black on the preserved specimen.

**HABITAT:** The short limbs and blunt, spadelike toes of the holotype, together with its nearly cylindrical body, strongly suggest fossorial habits. It remains to be ascertained whether the species burrows in soil, humus, or decaying vegetation. It seems probable that the mutilated individual obtained by Rütthling had sought shelter "under debris" after it had been inadvertently removed from its normal habitat. The specimen was found in a *cafetal* or coffee plantation, where the natural environment had undoubtedly been disturbed. Detailed information is unavailable, but if land was being cleared or if workmen were excavating in the vicinity of the site where the salamander was found, the salamander may have been brought to the surface in this fashion. This would explain the loss of the tail and the other mutilations incurred by the salamander, and perhaps its inability to seek cover in its normal habitat.

It is pertinent to note that two salamanders taken farther inland and at higher elevations in the Sierra de Miahuatlán conform closely to specimens of *Pseudoeurycea cochranae* obtained in mountains in the central and western portions of Oaxaca. Taylor (1949) has referred to the specimen taken near the eastern edge of the Sierra de Miahuatlán. The second specimen of the species, A.M.N.H. No. 68923, taken by Mr. Roger Conant on August 13, 1962, was found 7 miles (via road) north of Suchixtepec, at an elevation of approximately 2400 meters, in the Distrito de Miahuatlán.

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