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## A MORPHOLOGICALLY DISTINCT NEW SPECIES OF *PSEUDOEURYCEA* (CAUDATA: PLETHODONTIDAE) FROM THE SIERRA MADRE ORIENTAL OF PUEBLA, MÉXICO

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**ABSTRACT:** A new species of *Pseudoeurycea* is described from cloud forests of the Sierra Madre Oriental of Puebla, México. The new species is distinguished from all other *Pseudoeurycea* by its small size, stout body, short tail, large nostrils, presence of characteristic glandular convergent ridges on the pelvic region and the tail, and by its distinctive limb structure, with very small hands and feet that are extensively webbed and bear prominent but short and pointy middle digits. The only apparent close relative of this species is *P. praecellens*, from which it differs by the position and distribution of the dorsal and caudal glands, body proportions, nostril size and coloration. All specimens of the new species were found in cloud forest, under a canopy of *Liquidambar*, *Quercus*, and *arborescent* ferns, as well as in a coffee grove. The elevational range for the species is narrow, between 905 and 1400 m, unusually low elevations for *Pseudoeurycea*.

**Key words:** Caudata; Mexico; New species; North America; Plethodontidae; *Pseudoeurycea*; Taxonomy

### INTRODUCTION

The genus *Pseudoeurycea*, with 37 described species, of which all but three are endemic to Mexico, is one of the largest assemblages of neotropical salamanders. The taxon was proposed by Taylor (1944) and has been fully stable since its initial diagnosis. The addition of new species, mostly based on morphological grounds (Adler, 1996; Bogert, 1967; Canseco-Márquez and Parra-Olea, 2003; Lynch and Wake, 1989; Lynch et al., 1983; Parra-Olea et al., 2001; Parra-Olea et al., in press *a,b*; Pérez-Ramos and Saldaña-de la

Riva, 2003; Wake and Campbell, 2001), has not changed the basic phylogenetic structure of the genus. However, the transfer of *Pseudoeurycea parva* to *Ixalotriton* (Parra-Olea, 2002), and the transfer of *Parvimolge praecellens* to *Pseudoeurycea* (Wake and Elias, 1983), represent important modifications affecting the diagnosis of *Pseudoeurycea*. The recent use of molecular techniques has shown that a dramatic reorganization of *Pseudoeurycea* is needed. Mitochondrial DNA (mtDNA) data support inclusion of the morphologically distinctive species of *Lineatriton* within *Pseudoeurycea* (Parra-Olea and Wake, 2001). Otherwise, these complex results render *Pseudoeurycea* paraphyletic. A comprehensive

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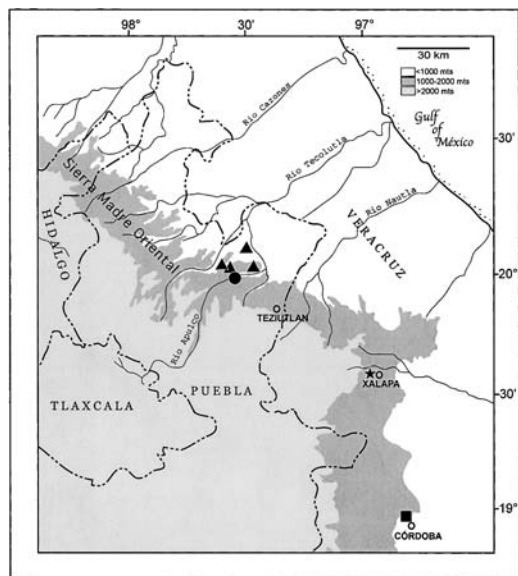


FIG. 1.—Map of the Sierra Norte de Puebla region and adjacent areas showing the distribution of *Pseudoeurycea quetzalanensis*. The circle corresponds to the type locality, Xocoyolo, 1400 m, Municipio de Cuetzalan del Progreso. Triangles correspond to other localities where the species have been collected (see list of paratypes). Star indicates type locality of *Parvimolge townsendi*. Square indicates type locality of *Pseudoeurycea praecellens*.

mtDNA study, including most species of the genus (Parra-Olea, 2002), suggests that the genera *Ixalotriton* and *Parvimolge* are also close relatives of *Pseudoeurycea*, although the taxa remain reciprocally monophyletic (Parra-Olea, 2002).

During recent field trips to the Sierra Norte de Puebla, along the Atlantic slopes of the Sierra Madre Oriental, we collected a series of a small, stout, small-footed species of *Pseudoeurycea*, which cannot be referred to any other known species based on its unique external morphology. The only species that shares a general morphological resemblance is *P. praecellens*, a species of controversial status known from the unique holotype (see Discussion). In this paper we describe the new species from Puebla and discuss its relationships based on morphological data.

#### MATERIALS AND METHODS

The species description follows the format used by Lynch and Wake (1989) for other species of *Pseudoeurycea*, and includes the

same basic characters and measurements. Larger measurements were taken using a dial caliper (to the nearest 0.1 mm), whereas measurements of feet, toes, and some head dimensions (e.g., additional measurements of the holotype), as well as tooth counts (ankylosed teeth only), were taken under a stereoscopic microscope. All measurements are in mm. The distance from the tip of the snout to the posterior end of the vent is treated as standard length (SL). Color notes are based on living and preserved specimens.

Specimens that were cleared and double-stained for bone and cartilage were processed by following a procedure modified by Wassersug (1976). Osteological comparisons were performed using published data, a single specimen of the new species (EBUAP 1203), and two cleared and stained skeletons of *Pseudoeurycea aurantia* (IBH 13797–13798), a species of the *P. juarezi* group (Canseco-Márquez and Parra-Olea, 2003).

#### SPECIES DESCRIPTION

##### *Pseudoeurycea quetzalanensis* sp. nov.

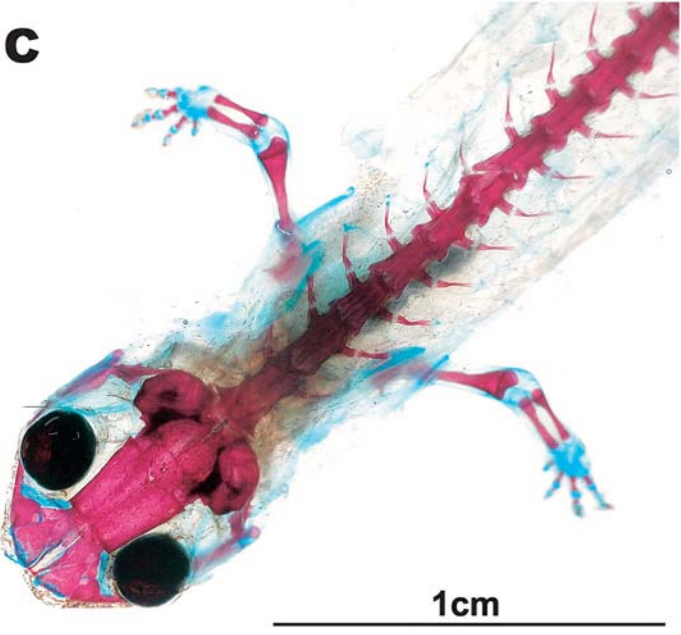
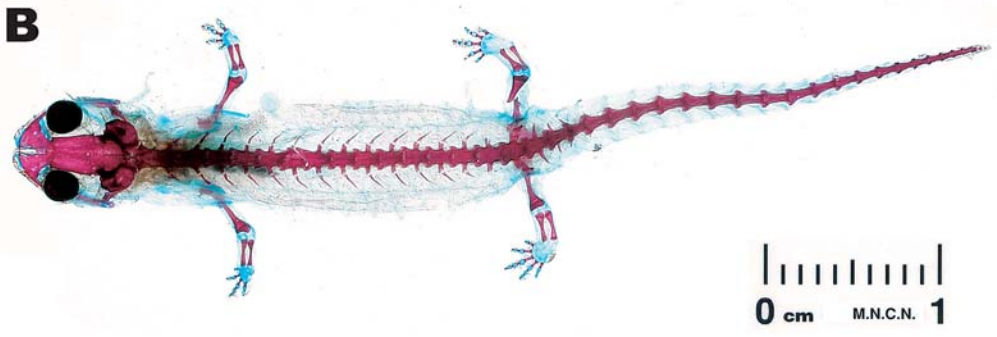
Cuetzalan salamander

Salamandra de Cuetzalan

*Holotype*.—IBH 14208: an adult male collected at Xocoyolo, 1400 m, Municipio de Cuetzalan del Progreso, Puebla, México, 19° 58' N, 97° 32' W, 3 October 2001 (M. García-París and G. Parra-Olea) (Fig. 1).

*Paratypes*.—Six specimens from the state of Puebla, México: MZFC 16533: Cuichat, 4 km SSE Tzicuilan, 1120 m, 20° 00' N, 97° 30' W, 15 November 1998 (L. Canseco-Márquez *leg.*); MZFC 16534: Octimaxal Norte, 905 m, 20° 02' N, 97° 30' W, 4 March 1998 (G. Gutiérrez-Mayén *leg.*); MZFC 16535: 2 km NE Xocoyolo, near Vista Hermosa, 1345 m, 19° 58' N, 97° 32' W, 3 August 1998 (L.-E. Chong-Alcaraz *leg.*); EBUAP 1201: 2 km NNE Xocoyolo, 1265 m, 19° 59' N, 97° 33' W, 24 March 1998 (S. Larios-Guzmán *leg.*); EBUAP 1202: 3.5 km N Cuetzalan, 1120 m, 1 August 1998 (L.-E. Chong-Alcaraz *leg.*); EBUAP 1203: 4 km SE San Miguel Tzinacapan, Montaña Calaxapota, 1040 m, 20° 00' N, 97° 33' W, 27 April 98 (L. Canseco-Márquez *leg.*) (cleared and stained) (Fig. 1).

*Diagnosis*.—A plethodontid salamander of the tribe Bolitoglossini included in the genus



*Pseudoeurycea*. This species is distinguished from all other *Pseudoeurycea* by its combination of small size, short and stout body, short tail, characteristic glandular convergent ridges on the pelvic region and the tail (Fig. 2A), enlarged nostrils in males, and apparent absence of mental gland in males, and by its distinctive limb structure, in particular very small hands and feet that are almost fully webbed with prominent, triangular-pointed, short middle digits (Fig. 3). The only apparent close relative of this species is *P. praecellens*, from which it differs by the position and distribution of the dorsal and caudal glands, body proportions and coloration. According to the original description (Rabb, 1955) and the holotype (examined), *P. praecellens* lacks the pelvic and tail glandular ridges, has marked dorsolateral glands, is less robust and has a general brownish-black dorsal coloration, including the tail.

*Description*.—Small sized, stout *Pseudoeurycea* with relatively marked sexual dimorphism. Male: SL in three males 32.1–39.3 ( $\bar{x}$  = 34.5); head relatively narrow (17% SL), elliptically shaped; medium sized, prominent, almost tubular nostrils, clearly distinct from the contour of the head; snout almost emarginated between the nostrils; eyes large and prominent, laterally oriented; a marked ridge (*canthus rostralis*) joins the eye with the nostrils. No mental gland visible. Space between the eyes almost flat. Nasolabial glands very prominent in adult and subadult males. Maxillary teeth 59–61 ( $\bar{x}$  = 59); premaxillary teeth 2–5 ( $\bar{x}$  = 4), enlarged in adult males; vomerine teeth in long rows, 26–32 ( $\bar{x}$  = 29). Costal folds 13, counting one each in axilla and groin. Limbs slender and relatively long, digits separated by no more than one costal interspace when limbs appressed to side of trunk; narrow hands largely webbed, without subterminal pads; the first digit of the hand barely visible and totally included in the webbing, third digit very prominent, triangularly shaped and with a pointed tip; second digit prominent, also triangular. Feet relatively broad, almost fully webbed, with the first and

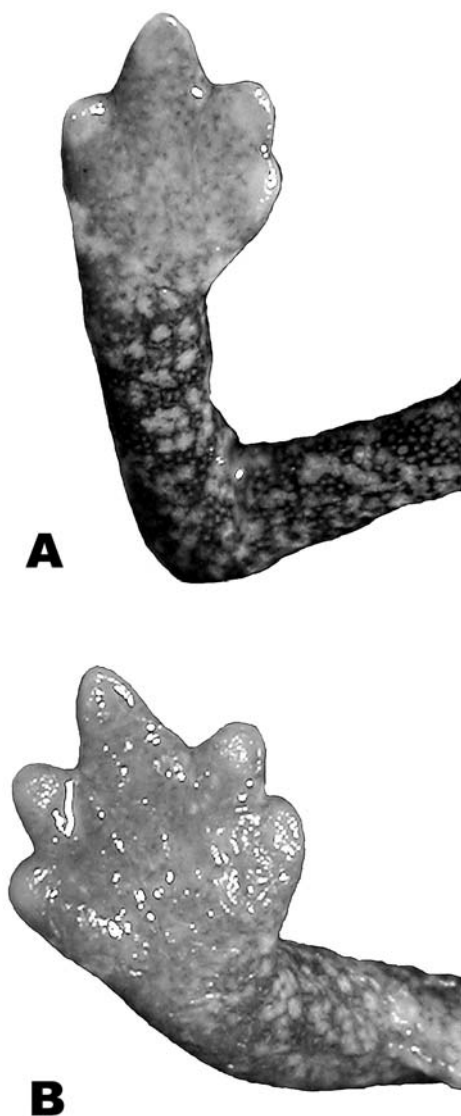


FIG. 3.—(A) Detail of the right hand of *P. quetzalanensis* (MZFC 16535). Note the extent of the webbing and shape of digits. (B) Detail of the right foot of *P. quetzalanensis* (MZFC 16535).

fifth toes included in the webbing; third toe very prominent and triangular; second and fourth less prominent but also triangular. Digits in order of decreasing length: fingers

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FIG. 2.—(A) *Pseudoeurycea quetzalanensis*. Holotype (IBH 14208) in life. (B) Cleared and double stained specimen for bone and cartilage of *P. quetzalanensis* (EBUAP 1203). (C) Detail of the head and the anterior portion of the body of a cleared and double stained specimen of *P. quetzalanensis* (EBUAP 1203).

3-2-4-1; toes 3-4-2-5-1. Dorsal skin roughened. Tail stout and short, 72–90% SL, markedly tapered. Skin of the tail rugose dorsally, with convergent, short glandular ridges that are prominent and arranged longitudinally all over the dorsal surface, starting on the pelvic region; tail section markedly quadrangular. Female: SL in four adult females 31–41 ( $\bar{x}$  = 38.2). Nostrils much less prominent than in males, snout almost quadrangular, not emarginated between nostrils. Canthus rostralis evident. Nasolabial glands not as prominent as those in adult males, but well developed. Maxillary teeth 48–68 ( $\bar{x}$  = 61); premaxillary teeth 11–14 ( $\bar{x}$  = 12) not enlarged; vomerine teeth in long rows, 19–28 ( $\bar{x}$  = 24). Adpressed limbs fail to meet by one or two costal interspaces. Glandular ridges poorly marked or absent, and when present, less developed than in the male. Tail section subcylindrical.

*Coloration in life.*—Dorsal coloration black slate to dark brown with light grayish to bluish markings on the sides. Tail and dorsal portions of the limbs reddish-brown, markedly contrasting with trunk lateral coloration (Fig. 2A). Tip of the tail light brown. Glandular ridges chestnut-brown. Head black with an occasional light-brown, diffuse, large irregular spot extending from behind the eyes to the snout. Lateral coloration dark with numerous small silver-bluish dots, sometimes at high density, yielding a metallic bluish coloration to the flanks. Ventral coloration black with light silvery small spots covering most of the belly. Ventral side of hands and feet, throat and tail brown marbled with black.

*Coloration in alcohol.*—General coloration dark chocolate to black with a chestnut-colored dark tail, lighter toward the tip. Dorsal sides of head, hands, and feet light brown; some specimens have the base of the limbs light brown; a pale mark is occasionally present between the eyes. Ventral coloration black covered by silver-bluish small spots, forming a reticulated pattern. Ventral side of hands and feet, posterior half of the tail and throat light brown also with some whitish spots. In some specimens, the ventral white-bluish spots entirely cover the flanks.

*Description of the holotype (measurements in mm).*—Male, with no mental gland. Head width 6.4; head depth 2.9; eyelid length 2.7; eyelid width 1.6; anterior rim of orbit to snout

1.7; interorbital distance 2.7; distance between corners of eyes 6.0; snout to forelimb 12.1; nostril diameter 0.2; distance between external nares 1.6; projection of snout beyond mandible 0.6; snout to gular fold 8.9; width across shoulders 4.9; snout to posterior angle of vent 32.8; snout to anterior angle of vent 31.2; axilla to groin 16.2; tail length 30.6; tail depth at base 3.9; tail width at base 4.0; forelimb length 9.2; width of hand 2.2; hind limb length 9.3; width of foot 3.0; length of longest (third) toe 1.6; length of fifth toe 0.1. Numbers of teeth: premaxillary 2; maxillary 30/31; vomerine 15/13. Color pattern as previously described, with a dark brown dorsal coloration densely covered by light bluish markings on the sides (Fig. 2A). The bluish markings extend slightly over the dorsum. Tail and dorsal portions of the limbs reddish-brown. Tip of the tail light brown.

*Variation.*—No marked differences in coloration have been observed, but the light spot on the head may not be well marked. In some specimens the glandular ridges of the tail are not prominent. Males differ from females by the presence of marked nasolabial protuberances, enlarged nostrils and fewer premaxillary teeth. No mental gland is apparent.

*Distribution.*—*Pseudoeurycea quetzalanensis* has been collected in the Municipality of Cuetzalan del Progreso in the State of Puebla, Mexico (Fig. 1). All the specimens have been found at a narrow elevational range between 905 and 1400 m, an unusually low elevation for *Pseudoeurycea*. The only other species of the genus that occur below 1000 m are members of the *P. bellii* complex and *P. werleri*.

*Natural history.*—This species occurs in cloudforest, under a canopy of *Liquidambar*, *Quercus*, and arborescent ferns, and in coffee groves. They have been found under moss in rock walls, inside and under rotten tree fern and tree logs, under stones, and in leaf axils. The species has been collected in March and April and from August to October. The co-occurring species of salamanders include *Bolitoglossa platydactyla*, *Pseudoeurycea lynchi*, and an undescribed species of *Chiropetrotriton* (Canseco-Márquez et al., 2000; Parra-Olea et al., 2001). They are slow moving animals that barely move when disturbed.

*Etymology.*—The specific epithet *quetzalanensis* is derived from the name of the Cabecera Municipal of the region where the

species occurs, the village of Cuetzalan del Progreso. The spelling Cuetzalan is a recent corruption of Quetzalan, the Nahuatl word meaning "near the *quetzales* (Trogonidae: *Pharomachrus mocinno*)" originally used as the name for the village as San Francisco Quetzalan (Aguilar Lara, 1988).

#### DISCUSSION

Based on comparisons among the holotype of *P. praecellens*, its original description (Rabb, 1955) and the type series of *P. quetzalanensis*, and mostly on the basis of similarity of hands and feet, and general morphology, we tentatively consider *P. quetzalanensis* and *P. praecellens* to be close relatives, and regard them as distantly related to all other known *Pseudoeurycea*. *Pseudoeurycea quetzalanensis*, together with *P. praecellens*, are the smallest members of the genus *Pseudoeurycea*, with adult sizes smaller than 41 mm (SL). Both species share a common foot shape with almost fully webbed hands and feet with short, pointed middle digits (Fig. 3). They have pronounced dorsal glands, stout bodies and tapered tails. However, patterns or morphological evolution in tropical salamanders are characterized by high levels of homoplasy and, therefore, detailed phylogenetic studies including the use of molecular data are needed to support any hypothesis of relationships. *Pseudoeurycea quetzalanensis* and *P. praecellens* likely share a common habitat since both are known from the lowland forests on the Atlantic versant of the Sierra Madre Oriental, in the states of Puebla and Veracruz, respectively.

The description of the enigmatic *P. praecellens*, was based on a single specimen collected in the cloud forests of the State of Veracruz (Rabb, 1955). *Pseudoeurycea praecellens* was first assigned to the genus *Parvimolge*, based on its general shape, small size, and presence of dorsal glands (Rabb, 1955). Wake and Elias (1983) transferred the species to the genus *Pseudoeurycea*, but since then its phylogenetic position has remained obscure. Wake and Elias' (1983) action was mainly based on the large size (compared to *Parvimolge*) and the presence of prefrontal bones in a series of specimens collected from near Teocelo (Veracruz) which were tentatively assigned to *P. praecellens* (Wake et al., 1992). After examination of the holotype of *P.*

*praecellens*, we conclude that the Teocelo specimens are not *P. praecellens*. Instead, they represent an undescribed species of *Pseudoeurycea* related to *P. cephalica*, as Wake et al. (1992) have suggested.

*Parvimolge* is thus represented by a single species, *Pa. townsendi*, which is related to the *Pseudoeurycea* clade on both morphological (Tanner, 1952; Rabb, 1955; Uzzell, 1961; Wake, 1966) and molecular grounds (Parra-Olea, 2002). Based on their morphology, especially the presence of dorsal clusters of glands, and foot structure, a close relationship among *P. quetzalanensis*, *P. praecellens* and *Parvimolge* is possible. However *Parvimolge* is a diminutive taxon with very small feet and hands, relatively slender body, longer tail and short limbs (Wake and Elias, 1983). The cleared and stained specimen of *P. quetzalanensis* (Fig. 2B,C) does not show the osteological characters that are diagnostic of *Parvimolge*, which include fused intermedium and ulnare; distal tarsal five fused to tarsal four, and both articulated with centrale; and the lack of fused frontal processes of the premaxillary. In *P. quetzalanensis*, as well as in the other *Pseudoeurycea*, the intermedium and ulnare are not fused, distal tarsal five and tarsal four are not fused, the frontal processes of the premaxillary are fused, and prefrontal bones, although reduced, are present.

At a first glance, *P. quetzalanensis* shows a general appearance that resembles that of *Bradytriton silus* Wake and Elias, 1983. Stout body, short limbs, and relatively short tail are traits shared by both taxa. However, *P. quetzalanensis* differs from *B. silus* in many characters. The small hands and feet of *Bradytriton* are highly distinctive, in that they are extremely reduced in size, with several elements fused such as ulnare plus intermedium, and distal tarsal 4 and distal tarsal five. These bones are not fused in *P. quetzalanensis*. *Bradytriton* also shows a particular type of mental gland, not marked externally, but well developed internally (Wake and Elias, 1983), these internal structures as well as any external indication of mental gland are lacking in the single adult male examined of *P. quetzalanensis*.

*Pseudoeurycea quetzalanensis* and *P. praecellens* differ markedly from all other *Pseudoeurycea* and allied taxa, and may represent

a distinct, independent lineage that evolved in the lowlands of the Sierra Madre Oriental. While the taxonomy of *Pseudoeurycea* is undergoing a major revision (Parra-Olea, 2002), with multiple clades to be taxonomically dissociated from the core of the genus, we consider that *P. praezellens* and *P. quetzalensis* should be retained within *Pseudoeurycea* until molecular data are available.

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