

A new species of salamander (genus *Bolitoglossa*) from Costa Rica *

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Abstract: A new species of plethodontid salamander is described from a site along Río Quirí, a small tributary of the Río Grande de Orosi located near Tapantí, Cartago Province, Costa Rica. *Bolitoglossa gracilis* is a small, slender, brightly colored species that appears to be largely arboreal. The new species is a member of a species-rich salamander community. It is most similar in morphology to the smaller sympatric *Bolitoglossa diminuta* and the larger allopatric *Bolitoglossa subpalmata*. Furthermore, the allocation of the species originally described as *B. diminuta* is reconsidered and it is retained in this genus.

The northeasterly facing slopes of the valley of the Río Grande de Orosi—Río Reventazón system of eastern Costa Rica may house the richest salamander fauna in the tropics, in terms of number of species present. Wake (1987) reported 21 species of plethodontid salamanders from this region, and referred to the new species described here. Specimens are deposited in the Museo de Zoología (UCR) of the Universidad de Costa Rica and the Museum of Vertebrate Zoology (MVZ) of the University of California at Berkeley. Subsequent to the preparation of Wake's paper an additional species has been found, bringing the total to 22. The species described here is assigned to the genus *Bolitoglossa* on the basis of its lack of a sublingual fold. It is a slender, arboreal member of this genus, the largest of salamanders, and in reference to its habitus we name it

Bolitoglossa gracilis new species

Figure 1

Holotype: UCR 9378, an adult female from Río Quirí, about 1 km NE by road from the bridge crossing the Río Grande de Orosi near

Tapantí, Cartago Province, Costa Rica, at an elevation of approximately 1,280 m, taken by Jorge Blanco and Carlos Coles on November 3, 1984. The exact location is 9° 47' 30" N and 83° 47' 42" W.

Paratypes: UCR 4502, same locality as holotype; UCR 6857, Quebrada Casa Blanca, very near type locality, Tapantí, Cartago Province, Costa Rica; MVZ 200853, same locality as holotype; MVZ 200854; vicinity of Tapantí, Cartago Province, Costa Rica; MVZ 194888, Topotype.

Diagnosis: A small, slender species, snout to posterior angle of vent (SL; all measurements in mm) is 37.6 in the adult male and from 37.6 to 42.4 in the three adult females, with moderate numbers of maxillary (male 31, females 35-58) and vomerine (male 19, females 18-22) teeth; distinguished from the sympatric *Bolitoglossa diminuta* by its larger size and its distinctive color pattern of yellowish ground color with sparse and irregular dark brown markings on the head and trunk and a distinct, dark midventral stripe; from the sympatric *Bolitoglossa epimela* by its less fully webbed hands and feet

and lighter color; from *Bolitoglossa subpalmata* by its smaller adult size and more slender appearance, as well as a somewhat longer tail; from *Bolitoglossa minutula* by its larger hands and feet, with less webbed and more discrete digits; from *Bolitoglossa colonnea* by lacking an interorbital dermal ridge, having numerous maxillary teeth, and having only slightly webbed hands and feet. Other species of the genus which occur in this vicinity are much larger and have dark ground color.

Description of Holotype: An adult female with a somewhat truncated, rounded snout of moderate length. Nostril relatively small; labial protuberances of nasolabial groove short but moderately well-developed. Canthus rostralis short, slightly arched, distinct. Standard length 6.5 times head width; standard length 4.6 times snout-gular fold length. A deep groove below eye extends along full length of opening, following curvature of eye, but does not communicate with lip. Eye moderately large and protuberant. A very indistinct postorbital groove extends posteriorly from eye as shallow depression for 1.5 mm, then proceeds sharply ventrad at level of posterior end of mandible and extends across gular area as a weakly defined nuchal groove, parallel to the well defined gular fold. Vomerine teeth 18, arranged in a single row on each side extending to the lateral margin of the internal nares in a relatively flat arch. The teeth become directed toward the posterior vomerine patch, from which they are separated by a very small (0.2 mm) gap. Maxillary teeth 35, very small, extend about two-thirds through eye. There are three very small premaxillary teeth. Tail long, 1.26 times SL, rounded and with only slight basal constriction. Postiliac gland obscure. Limbs of moderate length, limb interval 3; SL 4.6 times forelimb; 4.5 times hind limb; 9.8 times foot width. Hands and feet slightly webbed, with two phalanges free of web on longest digits and all digits somewhat free of the web; all but the first digit have well developed subterminal pads. The fingers in order of decreasing length: 3, 2, 4, 1; toes in order of decreasing length: 3, 2, 4, 5, 1.

Measurements (in mm): Head width 6.2; snout to gular fold (head length) 8.8; eyelid width 0.8; interorbital distance 1.4; anterior rim of orbit to nostril 1.1; horizontal orbital diameter 1.0; distance between vomerine teeth

and parasphenoid tooth patch 0.2; snout depth 1.1; distance separating internal nares 0.7; distance separating external nares 1.0; snout to posterior angle of vent (SL) 40.1; snout to anterior angle of vent 38.9; axilla to groin 23.2; tail length 50.6; tail width at base 3.6; tail depth at base 3.6; forelimb length 8.8; hind limb length 9.1; width of right foot 4.1; length from web of longest finger 0.8; length from web of longest toe 0.7.

Coloration (in life): (Parenthetic terms from Villalobos-Dominguez and Villalobos, 1947). The ground color of the head, body and tail are dark tan (XXX Olive), with darker bands and spots on the dorsolateral parts of the body and tail (XL Dark Olive). Ventrally the ground color of the body and tail is yellowish brown (XVI Buffy Citrine), lighter than the dorsum. There is a midventral longitudinal band or stripe of reddish brown (II Mahogany Red) and there are both dark brown spots (XL Dark Olive) and conspicuous cream pigmentation (XXX Ivory Yellow) on the tail. The flanks are intermediate in pigment between the ground colors of the dorsum and the venter, and become darker dorsally. The iris is golden (III Cadmium Yellow).

Coloration (in alcohol): The pattern is one of dark brownish black on gray. There is a "wormy" appearance on the head. Obscure dark marking occur in the costal grooves. Ventrally there are obscure whitish patches, and there is a distinct lightening toward the tail. The nasolabial protuberances are prominent and whitish, and there is a whitish spot on the snout. The venter has a distinct midventral darkening, forming an irregular band, and there is some dark ventrolateral streaking. The pigment is somewhat lightened behind the eyes on the back of the head and the neck. There is a weak dark eye stripe from the eye onto the shoulder.

Variation: Relevant measurements of the type series are present in Table 1. UCR 6857 is poorly preserved, but a kodachrome taken in life clearly shows the diagnostic features of the species; no measurements of this small specimen (approximately 22 mm SL) are given. Three adult females and one adult male are available, and all of the females are equal to or larger than the male in SL (37.6 to 42.4 mm). The very small maxillary teeth range from 35 to

TABLE 1
Measurements and data for Bolitoglossa gracillis

	Sex	Snout-Vent Length	Axilla-Groin Length	Head Width	Hindlimb Length	Forelimb Length	Tail Length	Teeth Maxillary	Vomerine	Limb Interval ^f	Foot Width
UCR 4502	♂	37.6	21.0	5.5	9.6	9.0	51.2	31	19	3	3.6
MVZ 200853	♀	42.4	23.8	6.0	9.5	8.8	reg.	58	22	3.5	4.1
UCR 9378	♀	40.1	23.2	6.2	9.1	8.8	50.6	35	18	3	4.1
MVZ 200854	♀	37.6	20.7	6.1	9.5	8.8	45.4	43	18	3	3.7
MVZ 194888	J	22.9	11.6	4.0	5.0	4.8	23.7	23	10	3.5	2.2

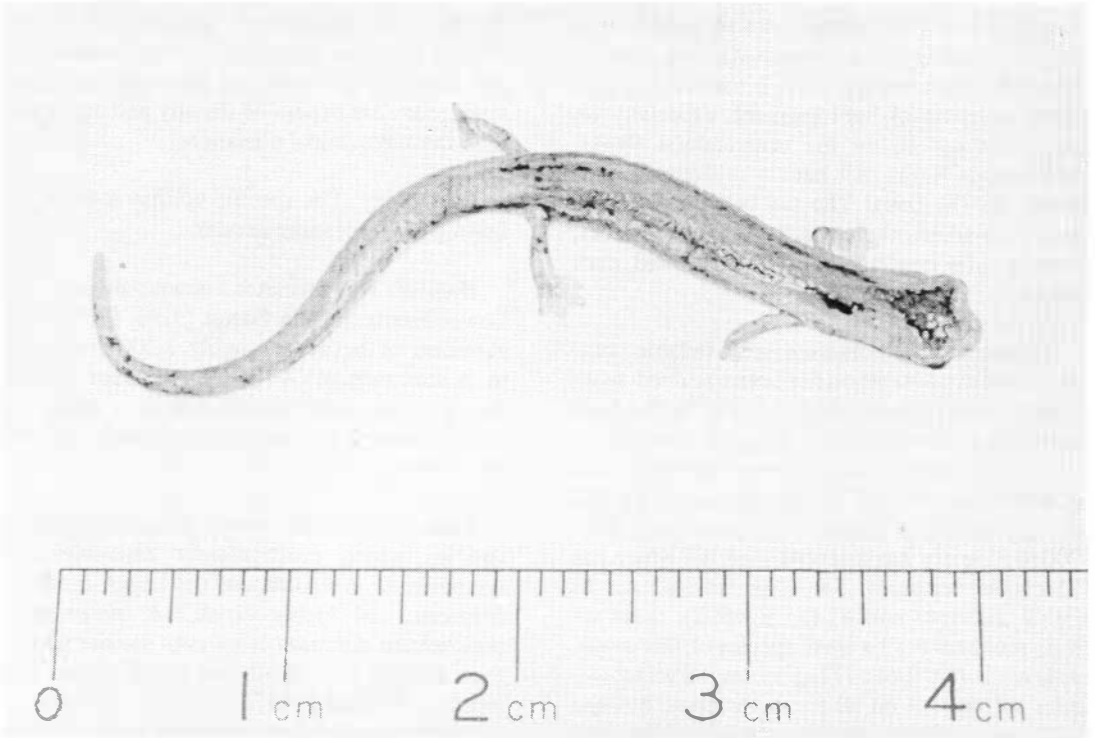


Fig. 1. MVZ 194888, a subadult (22.9 SL) male paratype of *Bolitoglossa gracillis* collected by Nancy Staub at the type locality of the species, Río Quirí, 1 km NE Río Grande de Orosi, near Tapantí, Cartago Province, Costa Rica, on March 7, 1985.

58 in the females; the male has 31 equally small teeth. Vomerine teeth range from 18 to 22. In the three adults with complete tails, tail length ranges from 1.2 to 1.4 times SL; a subadult (MVZ 194888) also has a tail that exceeds SL in length. Legs are short in the entire series, but the hands and feet are relatively broad with well developed digits mainly free from webbing and supplied with well developed terminal pads.

Coloration of the paratypic series is rather variable. Juveniles (Figure 1) were bright and yellowish in overall coloration. The individual figured had a color pattern in life of metallic yellow-silver, with black spots and flecks. A

triangle of dark pigment with the apex pointed posteriorly is present on the head, mainly behind the eyes. The light ground color darkens somewhat in the middle of the trunk, but lightens to a bright, lively yellow on the limbs and feet. The face in front of the eyes was bright yellow. A rather obscure black streak extended from the eye over the shoulder to form an obscure and interrupted lateral streak. Two silvery and coppery patches of pigment occurred on the dorsolateral aspects of the tail. The ventrolateral surfaces were bright silver in color and there was a midventral dark streak. The gular area was more copper than silver in coloration

and was darker than other surfaces. The eye was a dark golden color.

The other juvenile (UCR 6857) was also a bright, lively color in life, but it had distinct dorsolateral stripes made up of a more ventral dark brown line and a more dorsal golden yellow line, that stands in sharp contrast to the brown and to the golden tan of the dorsum. The venter was cream-colored with a darker mid-ventral region.

Adult specimens are darker in color, but all have been a lively golden tan to brown with brighter highlights. In preservative all show a relatively light venter with a variety of highlights or spots of light pigment, especially on the gular region, on the ventrolateral flanks, and on the limbs. All have a midventral dark streak on the belly. The tail is typically more boldly marked than more anterior surfaces, with greater contrast between light and dark pigment.

Osteology: No skeletons are available but some useful information has been obtained from x-rays. The holotype has a typical *Bolitoglossa* vertebral column, with an atlas, 14 trunk, 1 sacral, 2 caudosacral and 40 caudal vertebrae. It is possible that the tail is regenerated; if so, this species probably has a very long tail. MVZ 200853 clearly has a regenerated tail which has 25 caudal vertebrae. The other adults have 38 (MVZ 200894) and 42 (UCR 4502); these are high numbers for a small species of this genus. A juvenile (UCR 6857) has 34 caudal vertebrae. Ribs are present on all trunk vertebrae but the last, but are also missing on one side of the next to last vertebra in UCR 4502. The transition from caudosacral to caudal vertebrae is marked by elongate transverse processes borne at the extreme anterior end of the first caudal vertebra which are swept strongly in an anterior direction and terminate at a level equivalent to the midpoint of the last caudosacral vertebra. There is no overlap of the transverse processes of these adjacent vertebrae. Transverse processes on the caudal vertebrae quickly regress toward the tail tip in the slender tails, and are nearly absent past caudal vertebra 12 to 15. The processes gradually move from an anterior to a more midcentral position.

The skull is solidly formed, with well articulated elements. The frontal processes of the premaxillary arise separately and remain so; they are unexpanded distally and there is a broad

premaxillary fontanelle. The nasal bones are large and well articulated, and there is no indication of prefrontal bones. If a frontal- parietal fontanelle is present in the adults it is very small. The vomers do not touch on the midline and have relatively long and well developed tooth bearing preorbital processes. There are no septomaxillary bones.

Limb bones are well developed but there is no tibial spur. Phalangeal formulae are 1-2-3-2 for digits and 1-2-3-3-2 for toes, the generalized number for neotropical salamanders (Wake, 1966). Terminal phalanges of the longest fingers and toes are large and relatively well developed; they are expanded distally and are longer than the subterminal phalanges.

Etymology: The specific epithet is from the Latin *gracilis* meaning slender.

Habitat: This species is known only from the Lower Montane Rain Forest (Tosi 1969) at an elevation of between roughly 1,200 and 1,500 m. A specimen, MVZ 194888, was captured during the day under a moss mat on a small tree branch near a stream approximately 10 cm above the ground.

Comparisons: *Bolitoglossa gracilis* is a slender species which most closely resembles the sympatric *B. diminuta* and the larger, more widespread, and highly variable *B. subpalmata*. *Bolitoglossa diminuta* is an even smaller species than *B. gracilis* (the unique adult is but 31.1 mm SL; Robinson 1976). It has a different color pattern and more extensively webbed hands and feet than does *B. gracilis*. In direct comparisons the two species are dissimilar in several proportional features, but the small samples do not permit a statistical analysis. *Bolitoglossa diminuta* has a less discrete neck, smaller eyes, hands and feet with less evident subterminal digital pads than does *B. gracilis*. There is no question but that *B. gracilis* is appropriately assigned to *Bolitoglossa* on the basis of the structure of the hands and feet, the caudosacral region and the absence of a sublingual fold, but the status of *B. diminuta* has been questioned since the time of its discovery. Robinson (1970) reported that *B. diminuta* shared a number of characteristics with *Chiropterotriton*, and when Wake and Elias (1983) revised the latter genus they placed *diminuta* in the new genus *Nototriton*. Further evaluation of *Noto-*

triton and study of previously unavailable radiographs of the holotype of *diminuta* lead us to reassign the species to *Bolitoglossa*. The relatively stout and expanded terminal phalanges are like those of *Bolitoglossa* rather than resembling the slender and more pointed elements typical of *Nototriton*. Furthermore, *diminuta* lacks a sublingual fold, the absence of which is a diagnostic feature of *Bolitoglossa* among the neotropical genera. The caudosacral region is typical of *Bolitoglossa* alpha (Wake and Lynch, 1976), with elongate and anteriorly swept transverse processes on the first caudal vertebra. Finally, the trunk vertebrae do not have the relatively compact, nearly opisthocoelous centra which are usually present in *Nototriton*.

We have not found *B. subpalmata* as low as 1,200 m in the Talamanca Range, but it does occur that low on the northeasterly facing slopes of the Cordillera Central, so it is theoretically possible that *B. gracilis* is assignable to that species. We think it unlikely for several reasons. First, based on our fragmentary evidence *B. gracilis* matures at a smaller body size. MVZ 194888 already has well developed, expanded and pigmented testes (but no clear mental gland) at a size (22.9 mm SL) at which *B. subpalmata* is immature. Second, *B. gracilis* is a slenderer, much more brightly colored species than is *B. subpalmata*. Finally, MVZ 200853 has 58 maxillary teeth at a body size of but 42.4 SL, a higher number than one would expect in a *B. subpalmata* of this size (Brame, 1965; Vial 1966; unpublished data). But there are populations of *B. subpalmata* from the Cordillera Central in which one encounters occasional individuals of similar morphology (but not coloration) to *B. gracilis*. However, the population we name *B. gracilis* is very different from the nearby populations (ca. 15 km by air) of *B. subpalmata* in morphology, life zone, and coloration.

It is less difficult to differentiate *B. gracilis* from its other sympatric associates. *Bolitoglossa epimela* is a bigger species with larger and much more fully webbed hands and feet and darker coloration. *Bolitoglossa robusta* is substantially larger and is nearly solid black in coloration in the Tapantí region, with an indication of an obscure dorsal stripe. *Oedipina poelzi* is an elongate, semifossorial form with a very long tail and relatively short and slender limbs. There are two species of *Nototriton* at or very near the type locality. *N. picadoi* and *N. richardi* are

both very slender, diminutive species which have less prominent eyes, longer tails, and much smaller limbs, hands, feet, and digits than *B. gracilis*.

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RESUMEN

Se describe una nueva especie de salamandra plethodontida de una localidad a la orilla del Río Quirí, un pequeño tributario del Río Grande de Orosi cerca de Tapantí, Provincia de Cartago, Costa Rica. *Bolitoglossa gracilis* es una especie pequeña, delgada, de coloración llamativa que parece ser principalmente arbórea. La nueva especie es un miembro de una comunidad de salamandras bastante diversa. En su morfología es más parecida a *B. diminuta*, una especie simpátrica más pequeña y a *B. subpalmata* de mayor tamaño y alopátrica. Además, se considera que la especie descrita originalmente como *Bolitoglossa diminuta* debe mantenerse en este género.

REFERENCES

- Brame, A. H. 1965. Redescription of the Costa Rican salamander *Magnadigita cerroensis* with remarks on *Magnadigita subpalmata*. Abh. Ber. Naturkd. Vorges. Magdeburg 11: 105-118.
- Robinson, D. C. 1976. A new dwarf salamander of the genus *Bolitoglossa* (Plethodontidae) from Costa Rica. Proc. Biol. Soc. Washington 89: 289-294.
- Tosi, J. A., Jr. 1969. República de Costa Rica. Mapa Ecológico., San José, Costa Rica.
- Vial, J. L. 1966. The taxonomic status of two Costa Rican salamanders of the genus *Bolitoglossa*. Copeia 1966: 669-673.
- Villalobos-Dominguez, C. & J. Villalobos. 1947. Atlas de Colores. Librería El Ateneo, Buenos Aires.
- Wake, D. B. 1966. Comparative osteology and evolution of the lungless salamanders, family Plethodontidae. Mem. So. Calif. Acad. Sci. 4: 1-111.

Wake, D. B. 1987. Adaptive radiation of salamanders in Middle American cloud forests. Ann. Missouri Botanical Garden (72 ms pages).

Wake, D. B. & P. Elias. 1983. New genera and a new species of Central American salamanders, with a review of the tropical genera (Amphibia, Caudata,

Plethodontidae). Contrib. Sci. Nat. Hist. Mus. Los Angeles Co. 345: 1-19.

Wake, D. B. & J. F. Lynch. 1976. The distribution, ecology, and evolutionary history of plethodontid salamanders in tropical America. Sci. Bull. Nat. Hist. Mus. Los Angeles Co. 25: 1-65.