

**Two new species of salamanders (genus *Bolitoglossa*) from southern Nicaragua
(Amphibia, Caudata, Plethodontidae)**

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Abstract

We describe two new species of *Bolitoglossa* from Nicaragua. *Bolitoglossa indio* n. sp. (holotype ♀: SMF 85867) is known from Río Indio, in the lowlands of the Río San Juan area, southeastern Nicaragua. *Bolitoglossa insularis* n. sp. (holotype ♀: SMF 87175) occurs on the premontane slopes of Volcán Maderas on Ometepe Island, southwestern Nicaragua. The new species are of unknown affinities but both differ from their congeners in colouration.

Key words: *Bolitoglossa indio* n. sp.; *Bolitoglossa insularis* n. sp.; Central America; Ometepe island; Río Indio; Río San Juan; Rivas; taxonomy; Maderas Volcano.

Zwei neue Salamanderarten (Gattung *Bolitoglossa*) aus Süd-Nicaragua (Amphibia, Caudata, Plethodontidae)

Zusammenfassung: Wir beschreiben zwei neue Arten der Gattung *Bolitoglossa* aus Nicaragua. *Bolitoglossa indio* n. sp. (Holotypus ♀: SMF 85867) wurde am Río Indio, im Río San Juan-Tiefland im Südosten Nicaraguas gefunden. *Bolitoglossa insularis* n. sp. (Holotypus ♀: SMF 87175) stammt aus dem Prämontanwald an den Hängen des Vulkanes Maderas auf der Insel Ometepe im Südwesten Nicaraguas. Beide neuen Arten lassen sich von ihren nächsten Verwandten anhand ihrer Färbung unterscheiden.

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Dos especies nuevas de salamandras (género *Bolitoglossa*) del sur de Nicaragua (Amphibia, Caudata, Plethodontidae)

Resumen: Describimos dos especies nuevas de *Bolitoglossa* provenientes de Nicaragua. *Bolitoglossa indio* n. sp. (holotipo ♀: SMF 85867) proviene de las cercanías del Río Indio, en las tierras bajas del Departamento de Río San Juan, sureste de Nicaragua. *Bolitoglossa insularis* n. sp. (holotipo ♀: SMF 87175) proviene de las laderas premontanas del Volcán Maderas en la Isla de Ometepe, Departamento de Rivas, suroeste de Nicaragua. Se desconocen las afinidades de las dos nuevas especies pero ambas difieren de sus congéneres en coloración.

Introduction

Bolitoglossa is the largest genus in the order Caudata, including about 16% of all recognized salamander species (PARRA-OLEA et al. 2004). *Bolitoglossa* also has the most extensive geographical range of any salamander genus, and most species occur in Middle America (WAKE & LYNCH 1976, PARRA-OLEA et al. 2004). Despite the fact that Nicaragua is the largest of the Middle American countries and includes both Nuclear and Lower Central American herpetofaunal components, its known salamander fauna, 6 species, is much poorer than those of both its neighboring countries Costa Rica, with 43 species of salamanders, 22 of which belong to *Bolitoglossa*, and Honduras with 24 species of salamanders, 14 of which belong to *Bolitoglossa* (AMPHIBIAWEB 2008).

In Nicaragua, only two species of salamanders of the genus *Bolitoglossa* are known (KÖHLER 2001), *B. mombachoensis* KÖHLER & McCRANIE 1999 and *B. striatula* (NOBLE 1918). Both species are members of the subgenus *Bolitoglossa* (*sensu* PARRA-OLEA et al. 2004), which contains 12 species: *B. alberchi* GARCÍA-PARÍS, PARRA-OLEA, BRAME & WAKE 2003, *B. flaviventris* (SCHMIDT 1936), *B. jacksoni* ELIAS 1984, *B. lignicolor* (PETERS 1873), *B. mexicana* (DUMÉRIL, BIBRON & DUMÉRIL 1854), *B. mombachoensis*, *B. mulleri* (BROCCHI 1883), *B. odonnelli* (STUART 1943), *B. platyactyla* (GRAY 1831), *B. salvinii* (GRAY 1868), *B. striatula*, and *B. yucatanana* (PETERS 1882).

During recent fieldwork in Nicaragua we collected two specimens of *Bolitoglossa* from Río Indio and Volcán Maderas, respectively, that have distinctive and unique coloration. We here describe these as two new species.

Materials and methods

All measurements were made with dial calipers under a dissecting microscope (Leica MZ 12) rounded to the nearest 0.1 mm, and with the dissecting microscope's ocular micrometer rounded to the nearest 0.01 mm.

Abbreviations used are SVL (snout-vent length; snout to posterior end of vent), TL (tail length; posterior end of vent to tip of tail), HW (greatest width of head), HL (head length; snout to gular fold), MT (maxillary teeth), VT (vomerine teeth), PT (premaxillary teeth).

Maxillary and vomerine tooth counts are both sides summed. Only complete, unregenerated tails were measured. Data was taken exclusively from adult specimens. The format for the description of the new species generally follows that of BRAME & WAKE (1963), KÖHLER & McCRANIE (1999), KÖHLER (2002), and GARCÍA-PARÍS et al. (2003).

Comparative data for several species of *Bolitoglossa* were taken from museum specimens examined by us (Appendix 1), morphometric data provided by J. R. McCRANIE (Appendix 2), and supplemented by published information (mostly from McCRANIE & WILSON 2002 and SAVAGE 2002, plus data from the original descriptions of the species in the subgenus *Bolitoglossa*). Some information on osteology has been derived from radiographs of the specimens.

Acronyms for museum collections follow those of LEVITON et al. (1985), except JS (Javier SUNYER field numbers of Nicaraguan specimens that will be deposited in the herpetological collections of the Fundación del Río San Juan FUNDAR, Managua, Nicaragua).

We created the map (Fig. 7) using DIVA-GIS and Adobe Photoshop. We took the distribution points from BRAME & WAKE (1963), VILLA (1972), KÖHLER (2001), McCRANIE & WILSON (2002), SAVAGE (2002), McCRANIE et al. (2006), and the museum specimens listed in the Appendix. If situated very close to each other, we combined the original distribution points to yield one single point in our map.

Results

Bolitoglossa indio n. sp.

(Figs. 1, 3, 4)

Holotype ♀: SMF 85867, a female from Dos Bocas de Río Indio (11°2'54.8" N, 83°52'48.4" W), 25 m elevation, Departamento de Río San Juan, Nicaragua. Collected on 19. VI. 2006 by Javier SUNYER, Andreas HERTZ, Sebastian LOTZKAT,

Lenin OBANDO, Darwin MANZANAREZ, Roberto C. MUÑOZ, and Porfirio SANDOVAL. Field tag number JS 600. — No paratypes.

Etymology: The specific name *indio* is used as a noun in apposition in reference to the type locality.

Diagnosis: A moderately small, robust *Bolitoglossa* with the following combination of characteristics:



Fig. 1. Holotype of *Bolitoglossa indio* (SMF 85867) in life. (a) dorsal view; (b) ventral view. **Fig. 2.** Holotype of *Bolitoglossa insularis* (SMF 87175) in life. (a) dorsal view; (b) ventral view.

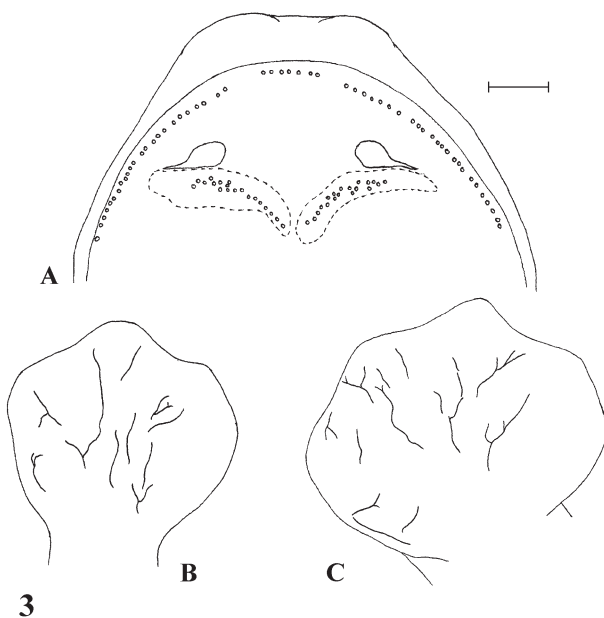


Fig. 3. Ventral view drawings of the holotype of *Bolitoglossa indio* (SMF 85867), showing (a) the roof of the mouth with the premaxillary, maxillary, and vomerine teeth as well as the labial protuberances; and the complete webbing of (b) right hand; (c) right foot. Scale bar = 1 mm.

digits completely webbed, one pair of pale dorsolateral stripes irregular in outline on brown ground colour, unmarked ventral surfaces, relatively high ratios VT/SVL (81.2%) and MT/SVL (102.5%), relatively broad head (HW/SVL 16.5%), tail moderate in size (TL/SVL 74.4%), and a relatively high number of premaxillary teeth (7). *Bolitoglossa indio* can be distinguished from the other species in the subgenus *Bolitoglossa* by the following characteristics (condition for *B. indio* in parentheses): *Bolitoglossa alberchi*, *B. jacksoni*, *B. mulleri*, *B. salvinii*, and *B. yucatanana*: presence of extensive black colouration on the body and tail (absence of black colouration). *Bolitoglossa flaviventris*: distinctive series of broad dark brown dorsal spots on yellow ground colour (one pair of pale dorsolateral stripes on brown ground colour); absence of speckling and mottling (presence of speckling and mottling in head, dorsum and laterals). *Bolitoglossa lignicolor*: absence of a pair of broad dorsolateral pale stripes (presence); HL/SVL in females 20.9–23.7% (24.1); HW/SVL in females 13.8–16.2% (16.5); MT/SVL 43.5–78.3% (102.5); VT/SVL 29.6–62.2% (81.2); 6 or fewer premaxillary teeth (7). *Bolitoglossa mexicana*: dorsal colouration generally consists of well demarcated cream longitudinal stripes contrasting with black background colour, with a middorsal orange-red longitudinal stripe usually present (dorsal coloura-

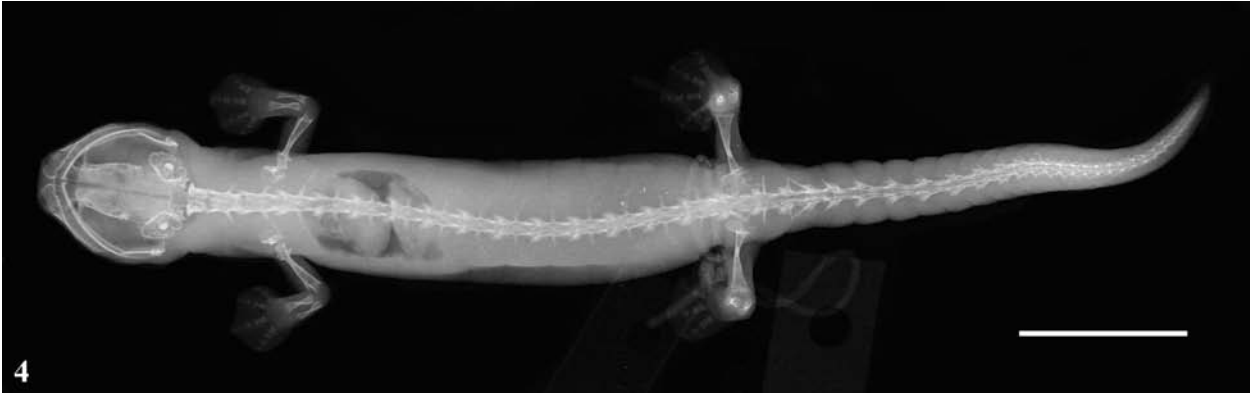


Fig. 4. X-ray of the holotype of *Bolitoglossa indio* (SMF 85867), SVL 46.8 mm. Scale bar = 10 mm.

tion consisting of less contrasting pattern, no middorsal orange-red longitudinal stripe); TL/SVL 78.0–111.9% (74.4); HL/SVL in females 19.8–23.0% (24.1); HW/SVL 11.1–15.4% (16.5); MT/SVL 48.2–94.0% (102.5); VT/SVL 27.0–68.3% (81.2). *Bolitoglossa mombachoensis*: presence of narrow, pale brown stripes on ventral surfaces of body (absence); HW/SVL 13.3–15.5% (16.5); MT/SVL 54.5–88.9% (102.5); vomerine teeth 14–28 (38); VT/SVL 25.0–56.8% (81.2); 5 or fewer premaxillary teeth (7). *Bolitoglossa odonnelli*: a pair of dorsolateral pale brown stripes that are clearly delimited (dorsolateral pale brown stripes irregular in outline and mostly bordered by spots or shades darker than the dorsal ground colour); TL/SVL 88–118% (74.4); HL/SVL 19–23% (24.1); HW/SVL 13–15% (16.5); maxillary teeth 22–42 (48); MT/SVL 37–71% (102.5); vomerine teeth 11–35 (38); VT/SVL 33–56% (81.2); 6 or fewer premaxillary teeth (7). *Bolitoglossa platydactyla*: single broad mid-dorsal pale swath on a generally dark ground colour (a pair of broad pale dorsolateral stripes on brown ground colour). *Bolitoglossa striatula*: absence of a pair of broad dorsolateral pale stripes (presence); presence of narrow stripes on dorsum, venter, or both (absence); TL/SVL 84.2–112.8% (74.4); HL/SVL 20.3–23.7% (24.1); HW/SVL 12.6–15.2% (16.5); MT/SVL 35.4–96.2% (102.5); vomerine teeth 13–37 (38); VT/SVL 24.0–79.9% (81.2). We provide a comparison of selected morphometric and dentitional characters in *Bolitoglossa indio*, *B. insularis*, *B. lignicolor*, *B. mexicana*, *B. mombachoensis*, *B. odonnelli* and *B. striatula* in Tab. 1.

Description of the holotype: Female as indicated by the presence of cloacal folds; size moderate (SVL 46.8 mm); snout truncate in dorsal aspect, broadly rounded in profile; labial protuberances relatively well defined; head broad (HW/SVL 16.5%), relatively flat, and well demarcated from body; eyes moderate in size, slightly protuberant, not visible beyond margin of jaw when viewed from below; postorbital groove distinct, incomplete, not reaching well-defined subocular groove; gular fold distinct, extending dorsolaterally to about lower level of eye; groove at posterior end of mandible

shallow, disconnected ventrally; sublingual fold absent; maxillary teeth 48, extending to about level of center of eye; vomerine teeth 38, in long, irregular, arched series extending laterally slightly beyond level of outer border of choanae; premaxillary teeth 7, not enlarged, located just posterior to upper lip and anterior to line of maxillary series; tail nearly cylindrical to slightly triangular anteriorly, becoming conical for about distal half of its length; tail moderate in size (TL/SVL 74.4%), slightly constricted basally; limbs slender, moderately long, adpressed limb interval about 3.5 costal folds; digits completely webbed, lacking subdigital pads, those digits projecting slightly from web are broadly rounded and the longest digit has a more pointed tip than other digits; relative length of digits on forelimbs I<II=IV<III, those on hind limbs I<V<II<IV<III.

Measurements of the holotype (in mm): Head width 7.7; head length 11.3; head depth at posterior angle of jaw 3.6; eyelid length 3.5; eyelid width 1.9; anterior rim of orbit to snout 3.5; horizontal orbital diameter 2.5; interorbital distance 2.7; distance between vomerine teeth and parasphenoid teeth 0.5; snout to forelimb 13.3; distance separating external nares 2.6; nostril diameter 0.25; snout projection beyond mandible 0.6; SVL 46.8; snout to anterior angle of vent 43.9; axilla to groin 24.5; tail length 34.8; tail width at base 4.3; tail depth at base 4.3; forelimb length (to tip of longest digit) 10.4; hind limb length (to tip of longest digit) 10.9; shoulder width 5.9; width of right hand 3.8; width of right foot 5.1.

Colouration in life: Dorsal surfaces of head, body and anterior half of tail brown, those of head with numerous small dark brown spots; a pair of broad, irregular, sometimes interrupted pale brown dorsolateral stripes extending from posterior to upper eyelids to base of tail (right side) or around mid-tail length (left side), delimited mostly by dark brown irregular shadings which can also be present in lesser densities on the brown dorsum and in the pale brown dorsolateral stripes; lateral surface of tail and body (below the dark brown shadings surrounding both broad pale brown dorsolateral stripes) brown; all ventral surfaces unmarked; ventral surfaces

of body and tail light grayish brown, fading to a lighter gray in the area around chest; ventral surface of head reddish brown; dorsal surfaces of limbs and distal half of tail dark brown; ventral surfaces of limbs, hands and feet grayish brown; pale gray labial protuberances.

Osteology: 14 trunk vertebrae; 28 unbranched caudal vertebrae; transverse processes of first caudal vertebrae long, overlapping the processes of the second caudosacral vertebrae; skull well formed with parietals and frontals separated from paired counterparts by small gap, but without a notable dorsal fontanelle; premaxillary spines arise separately and do not come into contact, long and relatively stout; prefrontals present; vomer bodies in close apposition, preorbital processes long and straight; phalangeal formulae 1-2-3-2 and 1-2-3-3-2; terminal phalanges very small, barely if at all expanded at tips; metacarpals 3 and 4 and metatarsals 1 and 5 more broadened and flattened than others; strong size gradient along digits with terminals typically shortest; terminal phalanges of longest digits of pes have grown slightly laterally, following the margin of the web; tibial spurs not evident.

Natural history notes: The holotype was found active at 1300 h on leaf litter at ground level in undisturbed lowland wet forest.

Range: Known only from the type locality.

***Bolitoglossa insularis* n. sp.**

(Figs. 2, 5, 6)

Holotype ♀: SMF 87175, a female from Volcán Maderas (11°27'38" N, 85°30'56" W), 800 m elevation, Isla de Ometepe, Departamento de Rivas, Nicaragua. Collected on 30. VII. 2007 by Javier SUNYER, Billy M. ALEMÁN, and Silvia J. ROBLETO. Field tag number JS 1083. — No paratypes.

Etymology: The specific name *insularis* means “of islands” in Latin, in reference to its presumed restricted distribution to the premontane slopes of the southern volcano on Ometepe Island, the largest island in Nicaragua, which is situated in the western part of the freshwater Lake Nicaragua or Cocibolca.

Diagnosis: A moderately large, robust *Bolitoglossa* with the following combination of characteristics: digits completely webbed; dorsal colouration relatively homogeneous brown with dark brown mottling and a single pair of non-delimited dorsolateral shadings which are moderately darker than dorsal ground colour; ventral surfaces of body and tail pale brown mottled with dark brown spots; ventral surfaces of head reddish brown with dark brown spots, with a pair of narrow ventrolateral stripes suggested by the absence of dark brown spots; eyes in females well visible beyond margin of jaw when viewed from below; and a relatively high number of premaxillary teeth (7). *Bolitoglossa insularis* can be further distinguished from the other species in the subgenus *Bolitoglossa* by the following characteristics (condition for *B. insularis* in parentheses): *Bolitoglossa alberchi*,

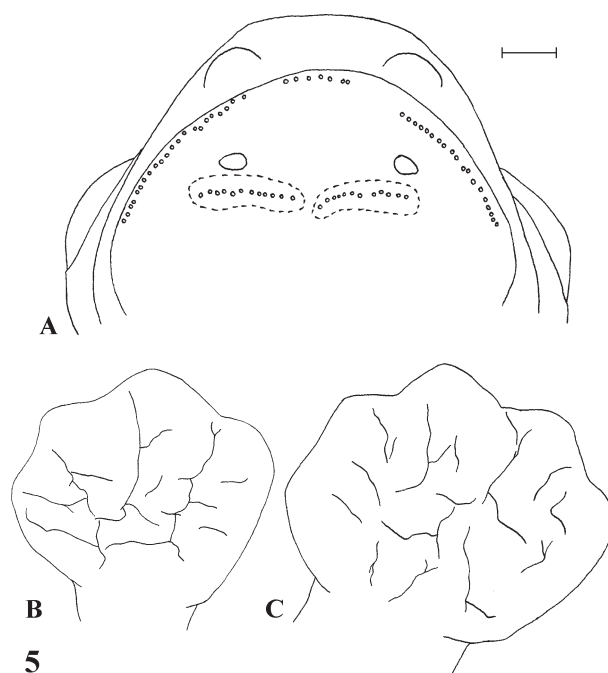


Fig. 5. Ventral view drawings of the holotype of *Bolitoglossa insularis* (SMF 87175), showing (a) the roof of the mouth with the premaxillary, maxillary, and vomerine teeth, as well as the labial protuberances and eyes; and the complete webbing of (b) left hand; (c) left foot. Scale bar = 1 mm.

B. jacksoni, *B. mulleri*, *B. salvinii*, and *B. yucatanana*: presence of extensive black colouration on the body and tail (absence of black colouration). *Bolitoglossa flaviventris*: distinctive series of broad dark brown dorsal spots on yellow ground colour and absence of mottling throughout the trunk and most of the tail (abundant dark brown dorsal mottling on brown ground colour). *Bolitoglossa indio*: presence of a pair of broad dorsolateral pale brown stripes (absence); ventral surfaces unmarked (ventral surfaces with abundant dark brown mottling); eyes not visible beyond margin of jaw when viewed from below in females (eyes visible); TL/SVL 74.4% (86.4); HW/SVL 16.5% (14.1); MT/SVL 102.5% (63.4); VT/SVL 81.2% (35.5). *Bolitoglossa lignicolor*: ground colour of ventral surfaces dark (light grayish brown); 6 or less premaxillary teeth (7). *Bolitoglossa mexicana*: contrasting dorsal colouration generally consisting on pale brown, bright and black colouration (non-contrasting relatively homogeneous dorsal brown colouration); ground colour of ventral surfaces dark (light grayish brown). *Bolitoglossa mombachoensis*: usually, presence of pale brown dorsolateral stripes (absence); presence of narrow, pale brown stripes on ventral surfaces of body (absence); 5 or less premaxillary teeth (7). *Bolitoglossa odonnelli*: presence of a pair of broad dorsolateral pale brown stripes (absence); TL/SVL 88–118% (86.4); MT/SVL in females 37–60% (63.4); VT/SVL in females 37–56% (35.5); 6 or fewer premaxillary teeth (7). *Bolitoglossa platydactyla*: presence of a single broad mid-

Tab. 1. Comparison of selected morphometric and dentitional characters in *Bolitoglossa indio*, *B. insularis*, *B. lignicolor*, *B. mexicana*, *B. mombachoensis*, *B. odonnelli*, and *B. striatula*. — Abbreviations: SVL = snout–vent length; TL = tail length; HL = head length; HW = head width; MT = maxillary teeth; VT = vomerine teeth; PT = premaxillary teeth. Range in dentitional characters is followed by mean value and one standard deviation in parentheses. Maxillary and vomerine tooth counts are both sides summed. Only complete, unregenerated tails were measured. Data were only taken from adults. — ⁽¹⁾ ranges up to 0.26 (SAVAGE 2002); ⁽²⁾ ranges from 11 (STUART 1943); and ⁽³⁾ ranges from 0.84 (MCCRANIE & WILSON 2002).

| Species | Sex | SVL | TL/ SVL | HL/ SVL | HW/ SVL | MT | MT/ SVL | VT | VT/ SVL | PT |
|----------------------|---------------|---------------|-----------------------------|----------------------------|---------------|------------------------|---------------|-------------------------------------|---------------|--------------------|
| <i>B. indio</i> | ♂ | — | — | — | — | — | — | — | — | — |
| | ♀ (n = 1) | 46.8 | 0.74 | 0.24 | 0.16 | 48 | 1.03 | 38 | 0.81 | 7 |
| <i>B. insularis</i> | ♂ | — | — | — | — | — | — | — | — | — |
| | ♀ (n = 1) | 64.7 | 0.86 | 0.22 | 0.14 | 41 | 0.63 | 23 | 0.36 | 7 |
| <i>B. lignicolor</i> | ♂ (n = 12) | 47.3– 67.7 | 0.77– 1.08 | 0.21– 0.24 ¹ | 0.14– 0.18 | 23–45 (33.7 ± 7.1) | 0.44– 0.78 | 18–40 (27.8 ± 6.4) | 0.30– 0.62 | 0–6 |
| | ♀ (n = 11) | 45.5– 81.2 | 0.67– 1.02 | 0.21– 0.24 | 0.14– 0.16 | 24–60 (38.9 ± 11.1) | 0.45– 0.76 | 22–42 (30.0 ± 6.2) | 0.31– 0.62 | |
| | ♂ (n = 16) | 50.6– 64.1 | 0.96– 1.12 | 0.20– 0.24 | 0.11– 0.15 | 32–47 (38.3 ± 5.3) | 0.53– 0.85 | 15–32 (21.3 ± 3.9) | 0.27– 0.54 | |
| <i>B. mexicana</i> | ♀ (n = 25) | 52.7– 82.0 | 0.78– 1.09 | 0.20– 0.23 | 0.11– 0.15 | 34–67 (42.2 ± 7.0) | 0.48– 0.94 | 20–41 (28.8 ± 5.1) | 0.28– 0.68 | 0–7 (3.1 ± 2.3) |
| | ♂ (n = 10) | 45.0– 57.5 | 0.84– 0.97 | 0.20– 0.25 | 0.13– 0.15 | 30–40 (34.3 ± 4.2) | 0.59– 0.74 | 14–27 (19.4 ± 5.3) | 0.30– 0.50 | 4–5 (4.4 ± 0.5) |
| | ♀ (n = 24) | 46.5– 66.0 | 0.74– 0.98 | 0.20– 0.25 | 0.13– 0.15 | 29–52 (38.6 ± 6.5) | 0.55– 0.89 | 14–28 (21.5 ± 3.8) | 0.25– 0.57 | 0–4 (2.8 ± 1.4) |
| <i>B. odonnelli</i> | ♂ (n = 6) | 54.7– 60.9 | 0.97– 1.18 | 0.20– 0.23 | 0.13– 0.15 | 22–42 (31.2 ± 6.9) | 0.39– 0.71 | 20 ² –28 (25.2 ± 2.8) | 0.33– 0.49 | 3–6 (4.3 ± 1.0) |
| | ♀ (n = 6) | 60.5– 68.3 | 0.88– 1.00 | 0.19– 0.22 | 0.13– 0.15 | 24–40 (33.3 ± 6.3) | 0.37– 0.60 | 26–35 (29.5 ± 3.3) | 0.37– 0.56 | 0–2 (1.0 ± 0.9) |
| | ♂ (n = 16) | 44.0– 58.5 | 0.88 ³ – 1.06 | 0.21– 0.24 | 0.13– 0.15 | 24–48 (32.6 ± 6.7) | 0.46– 0.90 | 13–31 (23.5 ± 5.1) | 0.24– 0.64 | 3–7 (4.6 ± 1.4) |
| <i>B. striatula</i> | ♀ (n = 24) | 46.3– 66.0 | 0.90– 1.13 | 0.20– 0.24 | 0.13– 0.15 | 19–58 (40.3 ± 11.7) | 0.35– 0.96 | 16–37 (29.2 ± 5.7) | 0.25– 0.80 | 1–7 (3.9 ± 1.6) |

dorsal pale swath on a generally dark ground colour (absence). *Bolitoglossa striatula*: variable number of well delimited stripes on dorsal surfaces (a single pair of non-delimited, moderately darker than dorsal ground colour dorsolateral shadings, in a dorsal pattern otherwise homogeneously brown with dark brown mottling); usually, presence of dark stripes on venter (absence); TL/SVL in females 90.5–112.8% (86.4). We provide a comparison of selected morphometric and dentition characters in *Bolitoglossa indio*, *B. insularis*, *B. lignicolor*, *B. mexicana*, *B. mombachoensis*, *B. odonnelli*, and *B. striatula* in Table 1.

Description of the holotype: Female as indicated by the presence of cloacal folds; size moderate (SVL 64.7 mm); snout rounded in dorsal aspect, rounded in profile; labial protuberances well defined; head relatively narrow (HW/SVL 14.1%), relatively flat, and only slightly demarcated from body; eyes moderate in size, slightly protuberant, well visible beyond margin of jaw when viewed from below; postorbital groove indistinct; subocular groove distinct; gular fold distinct, extending dorsolaterally to about lower level of eye; groove at posterior end of the mandible shallow, connected ventrally as a very poorly defined depression anterior to gular

fold; sublingual fold absent; maxillary teeth 41, extending to about level of center of eye; vomerine teeth 23, in straight to slightly arched series extending laterally to (left side) or slightly beyond (right side) level of outer border of choanae; premaxillary teeth 7 not enlarged, located just posterior to upper lip and anterior to line of maxillary series; tail conical, becoming slightly flattened laterally for about distal half of its length; tail moderate in size (TL/SVL 86.4%), with an early stage of tail autotomy; limbs slender, moderately long, adpressed limb interval about 3.5 costal folds; digits completely webbed, lacking subdigital pads, those digits projecting slightly from web are rounded and the longest digit has a more pointed tip than other digits; relative length of digits on forelimbs I<IV<II<III, those on hind limbs I<V<II=IV<III.

Measurements of the holotype (in mm): Head width 9.1; head length 14.0; head depth at posterior angle of jaw 5.3; eyelid length 4.1; eyelid width 2.2; anterior rim of orbit to snout 3.6; horizontal orbital diameter 2.9; interorbital distance 3.2; distance between vomerine teeth and parasphenoid teeth 0.65; snout to forelimb 18.1; distance separating external nares 3.4; nostril diameter 0.33; snout projection beyond mandible

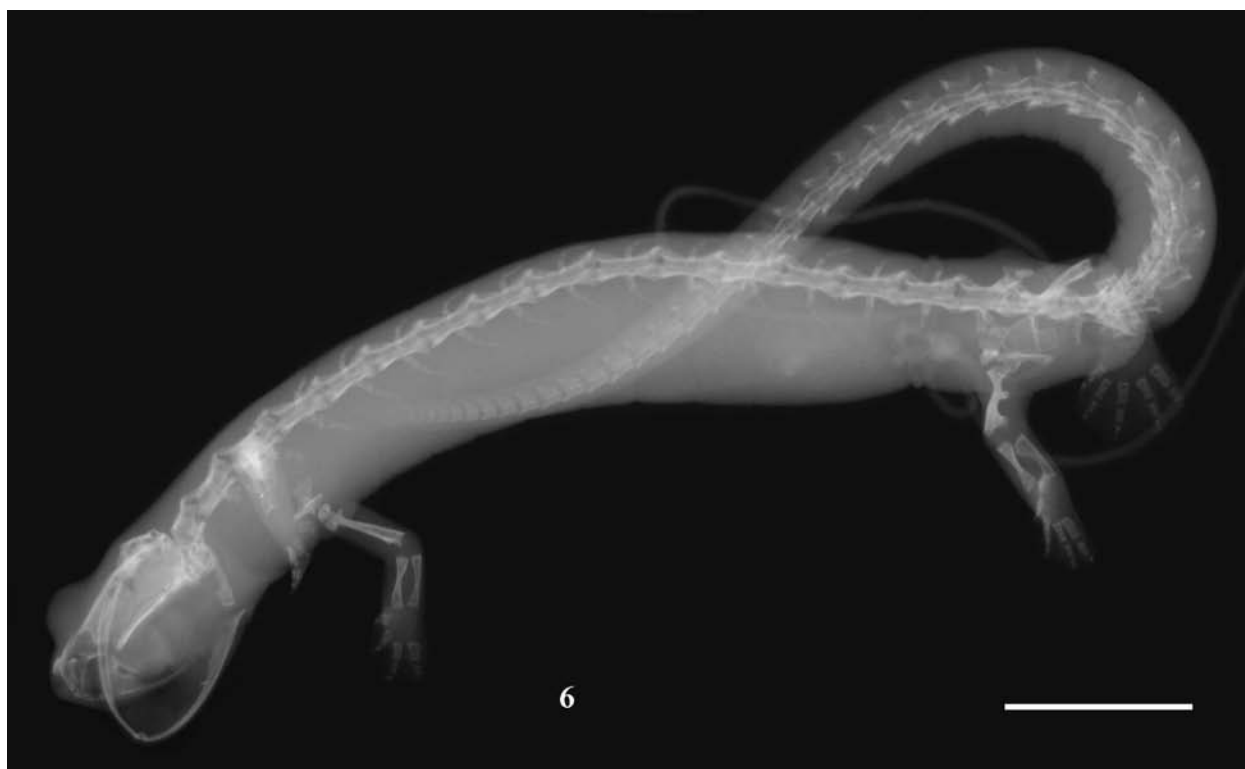


Fig. 6. X-ray of the holotype of *Bolitoglossa insularis* (SMF 87175), SVL 64.7 mm. Scale bar = 10 mm.

0.5; SVL 64.7; snout to anterior angle of vent 61.5; axilla to groin 38.2; tail length 55.9; tail width at base 5.8; tail depth at base 5.5; forelimb length (to tip of longest digit) 12.7; hind limb length (to tip of longest digit) 13.2; shoulder width 7.8; width of right hand 4.9; width of right foot 6.7.

Colouration in life: Dorsal surfaces of head, body and tail brown with numerous small dark brown spots; two weakly defined, non-delimited, dark brown dorsolateral shadings extending from just behind forelimb insertions almost to groin; lateral surfaces of head, body and tail dark brown; all ventral surfaces except those of hands and feet mottled with small dark brown spots; ventral surface of body, limbs, and tail light grayish brown; ventral surfaces of head reddish brown, with a pair of narrow ventrolateral stripes suggested by absence of dark brown spots; dorsal surfaces of limbs dark

brown; ventral surfaces of hands and feet homogeneously brown; pale brown labial protuberances.

Osteology: 14 trunk vertebrae; 35 caudal vertebrae; transverse process of first caudal is relatively short and stout, not extending far forward; skull well developed with only slight dorsal fontanelle, processes of premaxilla arise and remain separated; prefrontals appear to be present; vomer bodies very widely separated, preorbital processes long, straight; phalangeal formulae 1-2-3-2 and 1-2-3-3-2; terminal phalanges very small, barely if at all expanded at tips, some pointed; tibial spurs not evident.

Natural history notes: The holotype was found active at 1700 h at 1.5 m height on a thin branch of a bush in undisturbed premontane moist forest. At the time it was found, there was no rain although it was cloudy and fog was occasionally present.

Range: Known only from the type locality.

Discussion

The only species of *Bolitoglossa* that occurs in sympatry with *B. indio* is *B. striatula* (IUCN 2007). Most other species of the subgenus *Bolitoglossa* (*B. alberchi*, *B. flaviventris*, *B. jacksoni*, *B. mulleri*, *B. odonnelli*, *B. platydactyla*, *B. salvinii* and *B. yucatanana*) are endemic

to more or less small areas well north of Nicaragua; *B. mexicana* occurs from Mexico to Honduras and although its occurrence in northern Nicaragua is likely, its southernmost known distribution is approximately 400 km NW from the type locality of *B. indio*; *B. lignicolor* oc-

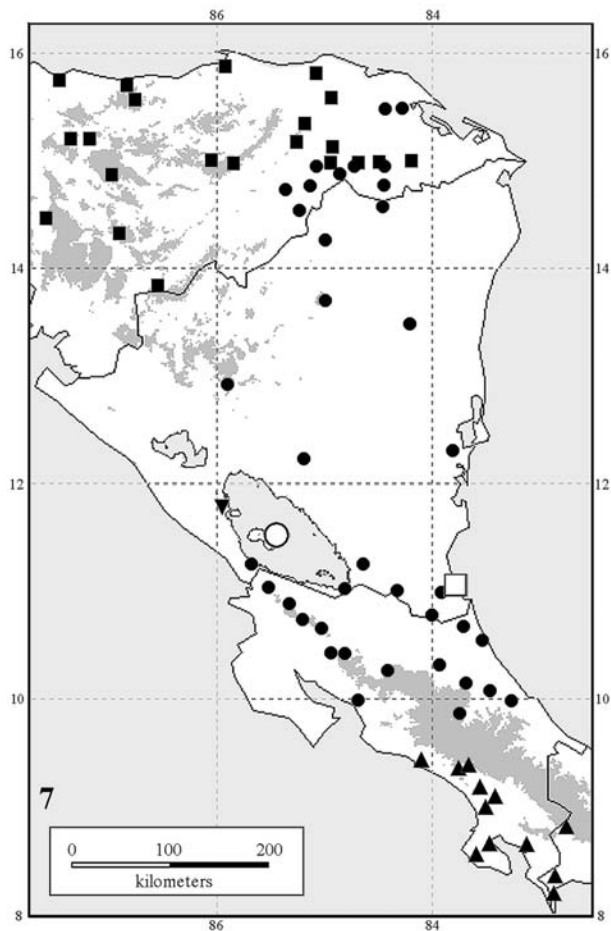


Fig. 7. Map showing localities for several members of the subgenus *Bolitoglossa* that are known to occur in Nicaragua and its neighboring countries Honduras and Costa Rica, including the two new species described herein. Solid squares = *B. mexicana*; solid circles = *B. striatula*; upright triangles = *B. lignicolor*; inverse triangle = *B. mombachoensis*; open square = *B. indio*; open circle = *B. insularis*.

occurs in the Pacific low and premontane areas of southern Costa Rica and western Panama; and *B. mombachoensis* is restricted to the highlands of Volcán Mombacho in western Nicaragua (Fig. 7).

Bolitoglossa insularis is the only salamander species known to occur on the island of Ometepe. In addition, it is the only species of *Bolitoglossa* recorded in Nicaragua exclusively at a mid-premontane elevation (despite substantial searching especially at lower and also at higher elevations on the island). *Bolitoglossa mombachoensis* is known from high-premontane elevations from 1040–1345 m (KÖHLER & McCRANIE 1999), and *B. striatula* ranges in Nicaragua from the lowlands up to approximately 770 m (VILLA 1972).

The colouration of *Bolitoglossa indio* is most similar to that of *B. odonnelli* and of those *B. mexicana* that have only two broad pale dorsolateral stripes (see description of colouration of six specimens of *B. mexicana* from Departamento Cortés, Honduras, in McCRANIE &

WILSON 2002:123, approximately 700 km NW of type locality of *B. indio*). However, in *B. indio* the dorsolateral pale stripes are not as clearly delimited in outline as in *B. odonnelli* and *B. mexicana*.

The colouration of *Bolitoglossa insularis* is most similar to that of *B. mombachoensis* and *B. striatula*. *Bolitoglossa mombachoensis* is extremely variable in colouration (JANSEN & KÖHLER 2001): it normally presents pale brown dorsolateral stripes, but can also be remarkably similar in dorsal and lateral aspect to *B. insularis* (see Fig. 7 in KÖHLER 1998, and Fig. 112 in KÖHLER 2001). However, all examined specimens of *B. mombachoensis* display a variable number of thin, pale brown stripes on the ventral surfaces, a characteristic absent in *B. insularis*. Specimens of *B. striatula* have a variable number of dark or pale brown stripes on the dorsal surfaces of body (normally on the neck and limbs, and sometimes on the tail). In addition, most *B. striatula* have a variable amount of fine dark brown stripes on the ventral surfaces, although occasional individuals may have an immaculate venter (SAVAGE 2002:138). The specimen we have examined that is most similar to *B. insularis* is *B. striatula* SMF 77790, which has a very similar unstriped ventral surface. SMF 77790 also has dark brown mottling on the dorsal surfaces and a relatively fewer dorsal stripes. However, those stripes that are present on the dorsum are defined and delimited in outline (see photograph of *B. striatula* SMF 77790 in Fig. 5 in KÖHLER & McCRANIE 1999, and Fig. 115 in KÖHLER 2001). In contrast, narrow stripes are absent from both dorsal and ventral surfaces of *B. insularis* and the only defined stripe present is the single pair of broad, dark brown lateral stripes.

The apparent similarities between *Bolitoglossa indio*, *B. odonnelli* and *B. mexicana* on the one hand and between *B. insularis*, *B. striatula* and *B. mombachoensis* on the other hand suggest that both *B. indio* and *B. insularis* are members of the subgenus *Bolitoglossa* (sensu PARRA-OLEA et al. 2004). However, we refrain from formally placing this species in this subgenus (previously referred to as the *Bolitoglossa mexicana* species group; GARCÍA-PARÍS et al. 2000; 2003) until tissue samples and molecular data are obtained and analyzed. It is conceivable that *B. indio* could be a member of *Eladinea* and *B. insularis* a member of *Pachymandra*, based on tail and skull traits, but the narrow head of *B. insularis* argues against such an assignment.

Salamanders are typically found active at night, but sometimes they can also be found active during the coolest times of the day, especially in the event of rain, mist, or high humidity. During daytime, they are normally found inactive hidden in very humid places like tank bromeliads, in or under rotten logs, under fallen leaves, beneath moss, in dead basal ramifications of giant ferns, in the axils of large-leaved plants, etc. In contrast, the holotype of *Bolitoglossa indio* was found active on leaf litter at ground level at the hottest time of the day with no rain nor fog. Therefore, it is probable that SMF 85867

had fallen from its perch or was disturbed from a ground level hiding place at the time it was found.

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Appendix 1

Comparative material examined

Bolitoglossa lignicolor: PANAMA: Chiriquí: 8 Km NE Río Sereno, Finca CASA (8°52'17.0" N, 82°47'43.4" W), 1210 m: SMF 85059.

Bolitoglossa mexicana: HONDURAS: Atlántida: Quebrada La Muralla, PN Pico Bonito: SMF 77630; Colón: RB Río Plátano, El Ocotillal, headwaters of Río Plátano (15°22' N, 85°13' W) 450–470 m: SMF 85935–36; Francisco Morazán: El Paraíso, RB El Chile: SMF 79460; Gracias a Dios: RB Río Plátano, Raudal Kiplatara (15°36' N, 84°57' W), 130–160 m: SMF 85932–33; RB Río Plátano, Crique Unawás (15°7' N, 84°55' W), 250 m: SMF 85937; Olancho: Quebrada de Las Marías, 11.5 km NNE La Colonia (15°18' N, 85°21' W), 660 m: SMF 78748.

Bolitoglossa mombachoensis: NICARAGUA: Granada: Volcán Mombacho (11°50.02' N, 85°58.75' W), 1150 m: SMF

78293–94, 78297–304, 78306–07; Volcán Mombacho, near lower antenna (11°49.99' N, 85°58.77' W), 1100 m: SMF 78714–24; Volcán Mombacho, above upper antenna, 1225 m: SMF 79604.

Bolitoglossa odonnelli: GUATEMALA: Alta Verapaz: Finca El Volcán, 25 km NW (by road) Senahu (15.48333° N, 89.86667° W), 875 m: MVZ 161030–36, 161038–39, 161045–46, 161081.

Bolitoglossa platydactyla: MEXICO: Orizaba: SMF 1305–06; Tampico: SMF 29630.

Bolitoglossa salvinii: EL SALVADOR: San Salvador: Instituto Tropical: SMF 79386. — GUATEMALA: SMF 1308; Quetzaltenango: Coatepeque, Hotel “Las Gardenias” (14°41'35.9" N, 91°51'7.5" W), 530 m: SMF 84541.

Bolitoglossa striatula: NICARAGUA: Atlántico Norte: Alamikamba (13°30.081' N, 84°13.642' W), 130 m: SMF 77790; PN Saslaya, El Carrillón, 400 m: SMF 82868; Krin Krin, 5 km W confluence Río Waspuk and Río Coco: JS 1183, SMF 87179; Jinotega: RB Bosawas, Kulum Kitang (14°19.80' N, 84°56.25' W), 180 m: SMF 87180; Río San Juan: Bartola (10°58.37' N, 84°20.35' W), 30 m: SMF 82095; Dos Bocas de Bartola, El Almendro (10°59'43.9" N, 84°16'37.5" W), 75 m: SMF 87177; near confluence Río San Juan and Río Sarapiquí (10°42'50.2" N, 83°56'4.7" W), 20 m: SMF 83191; Caño El Venado, near Dos Bocas de Río Indio (11°2'14.7" N, 83°53'7.3" W), 10 m: JS 633, SMF 87178; Río Frío, Fundeverde, Senda Peter (11°4'55.8" N, 84°45'11.0" W), 80 m: JS 378, SMF 87176.

Appendix 2

Morphometric data provided by J. R. McCRANIE.

For a more precise location of the following names of Honduran places, see the Gazetteer in McCRANIE & WILSON (2002: 553–578).

Bolitoglossa mexicana: HONDURAS: Atlántida: Tela district: MCZ 10214; Colón: Cerro Calentura: FMNH 236378; Copán: 2 km N of Santa Rosa de Copán: MVZ 163799–800; Cortés: El Jaral: FMNH 4539–42; 1.6 km W of El Jaral: LACM 47620; Finca Fé: LACM 45254, 45300–04; La Lima: LACM 47621; Cofradía: AMNH 45337–38, 45340–41; near Peña Blanca: MVZ 187203–04; 8 km W of Peña Blanca: MVZ 163794–95; 9.7 km W of Peña Blanca: MVZ 163792; 3.1 km SE of Peña Blanca: MVZ 163793; Olancho: Subirana Valley: MCZ 21241; about 15 km N of San Francisco de La Paz: UTA A-19826; La Colonia, 11.5 km (airline) of Quebrada de Las Marías: USNM 530574–78.

Bolitoglossa striatula: HONDURAS: Olancho: Quebrada El Mono: USNM 535819; Río Kosmako: USNM 538568–69.

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