

The Taxonomic Status of *Bolitoglossa schmidti*, with Comments on the Biology of the Mesoamerican Salamander *Bolitoglossa dofleini* (Caudata: Plethodontidae)

JAMES R. MCCRANIE,¹ DAVID B. WAKE,² AND LARRY DAVID WILSON³

¹ 10770 SW 164th Street, Miami, Florida 33157

² Museum of Vertebrate Zoology, University of California, Berkeley, California 94720

³ Department of Biology, Miami-Dade Community College, Kendall Campus, Miami, Florida 33176

ABSTRACT.—The holotype of *Bolitoglossa schmidti* (Dunn) is compared to a series of *B. dofleini* (Werner) from Alta Verapaz, Guatemala, and to a series of recently collected Honduran specimens of this group. Due to the lack of significant differences between this holotype and the remaining specimens examined, we suggest that *B. schmidti* is a synonym of *B. dofleini*. A neotype is selected to replace the lost holotype of *B. dofleini*. The distribution of *B. dofleini* is the low and moderate elevations of the Caribbean versant from extreme northern Alta Verapaz, Guatemala, and Cayo District, Belize, to north-central Honduras. The material from Guatemala was found in cardamon plantations, in the vegetation at the base of these plants. *Bolitoglossa dofleini* exhibits striking sexual dimorphism. Males have a conspicuous mental gland, are much smaller in snout-vent length than the females (the 11 largest males from the Guatemalan locality average 63.5 mm, whereas the 25 largest females average 94.2 mm), and have a more defined neck. The females are more robust and have shorter limbs. The most common food items in stomachs of a sample of more than 100 specimens from Guatemala were ants, followed by beetles and millipedes.

Populations of large salamanders (females >100 mm SVL, males to 70 mm) of the genus *Bolitoglossa* in the lowlands and at moderate elevations of Guatemala, Belize, and Honduras are currently assigned to two species, *B. dofleini* (Werner) and *B. schmidti* (Dunn). Together with *B. yucatanana* (Peters), these taxa comprise the *B. dofleini* group (Wake and Lynch, 1976; Elias, 1984). Adult females of these species are relatively robust, with *schmidti* and *dofleini* being second in length only to *B. robusta* (Cope) and considerably more robust than that species.

Bolitoglossa schmidti was described by Dunn (1924) from the "mountains west of San Pedro [Sula], Honduras." Dunn compared this species only to *B. robusta* (Cope) of Costa Rica and Panama. Dunn and Emlen (1932) assigned to *B. schmidti* a second specimen collected in the same area as the holotype. Over the past 20 years, several specimens of salamanders of the *B. dofleini* group have been collected in the mountains near the type locality of *B. schmidti*. David B. Wake has long considered *B. schmidti* and *B. dofleini* to be the same taxon and has used

the name *B. dofleini* for specimens from northwestern Honduras (Feder et al., 1982). *Bolitoglossa schmidti* has continued to be listed, however, as a valid species within the *B. dofleini* group (Elias, 1984; Frost, 1985). The purpose of this paper is to review the taxonomic status of *B. schmidti*, and to present distributional and biological information on the poorly known *B. dofleini*.

We examined all known Honduran specimens of the *B. schmidti-dofleini* complex with reliable collecting data, including the holotype of *B. schmidti* (FMNH 4538), plus a large series of *B. dofleini* from Guatemala in the MVZ collection (see Appendix I).

All measurements were made to the nearest 0.1 mm with dial calipers under a dissecting microscope. Mean values are in parentheses. Abbreviations used are SVL (snout to posterior end of vent), TL (tail length), HL (head length; tip of snout to gular fold), HW (greatest head width), HLL (hind limb length; point of insertion of hind limb to tip of longest toe), and HFW (hind foot width; distance between outer edge of toe tip V to outer edge of toe tip I). Insti-

tutional abbreviations follow Leviton et al. (1985).

STATUS OF *BOLITOGLOSSA SCHMIDTI* (DUNN)

The holotype of *B. schmidti* (FMNH 4538) is an adult female with the following measurements and proportions: SVL 104.1 (107 according to Dunn, 1924); TL 85.0 (88 according to Dunn, 1924); TL/SVL 0.816; HL 23.7; HL/SVL 0.228; HW 16.3; HW/SVL 0.157; HLL 24.0; HLL/SVL 0.231; HFW 10.9; HFW/SVL 0.105. There are 42 vomerine teeth (both sides summed) in slightly irregular rows and 83 maxillary-premaxillary teeth. The feet are extensively webbed, with only the tips of digit III on the forelimbs and only the tips of digits II (outside only), III, and IV on the hind limbs free of webbing. In preservative, dorsal surfaces are medium brown with darker brown spots dorsolaterally on the body and tail; spots on the body are usually centered on the costal grooves. Ventral surfaces are uniformly medium brown.

This specimen was compared to a large series of *B. dofleini* from Departamento Alta Verapaz, Guatemala. Comparative measurements, proportions, and tooth counts from 12 adult females of this Alta Verapaz series (MVZ 161609, 161612, 161620–21, 161623, 161627, 161630, 161638–39, 161641, 161643, 161645) are as follows: SVL 88.4–104.5 (94.5); TL/SVL 0.717–0.834 (0.791); HL/SVL 0.206–0.231 (0.220); HW/SVL 0.166–0.188 (0.176); HLL/SVL 0.236–0.255 (0.249); HFW/SVL 0.113–0.125 (0.118); vomerine teeth 37–67 (53.3), in irregular rows; maxillary-premaxillary teeth 71–90 (78.7). In the entire Guatemalan series the feet are extensively webbed with only the tips of digit III on the forelimbs and usually only the tips of digits III and IV on the hind limbs free of webbing. In preservative, all Guatemalan adults have medium to dark brown dorsal surfaces with darker brown irregular spots dorsolaterally, with the spots frequently centered on the costal grooves. Subadult females in the Guatemalan series also have pale spots or irregular markings laterally on the posterior portion of the body and dorsally and laterally on the anterior part of the tail. The holotype of *B. schmidti* is very similar in

morphology and color pattern to the adult females in the Guatemalan series, although the former does have slightly lower values for HW/SVL, HLL/SVL, and HFW/SVL.

The second specimen (MCZ 16287) assigned to *B. schmidti* (Dunn and Emlen, 1932) is a subadult female with the following measurements and proportions: SVL 76.7; tail incomplete; HL 18.0; HL/SVL 0.235; HW 13.0; HW/SVL 0.169; HLL 20.3; HLL/SVL 0.265; HFW 8.0; HFW/SVL 0.104. There are 43 vomerine teeth in irregular rows and 70 maxillary-premaxillary teeth. The feet are extensively webbed with only the tips of digit III on both the forelimbs and hind limbs free of webbing. In preservative, the dorsal surfaces are dark brown with black irregular spots dorsolaterally on the body that are usually centered on the costal grooves. Pale spots are also present on the posterior end of the body above the vent and on the dorsal surface of the anterior portion of the tail. This specimen is also very similar to the Alta Verapaz series in morphology and color pattern, including the pale spots seen in subadults of the Guatemalan series.

The recently collected material of the *B. dofleini* group, with reliable collecting data from northwestern Honduras, consists of nine adult females and several subadults. The following measurements, proportions, and tooth numbers were obtained for the nine adult females (KU 202996; MVZ 143706–07, 200422–25, 221181–82): SVL 101.5–125.9 (116.0); TL/SVL 0.792–0.842 (0.826, $n = 4$; remaining specimens have either broken or regenerated tails); HL/SVL 0.200–0.226 (0.214); HW/SVL 0.168–0.196 (0.181); HLL/SVL 0.222–0.262 (0.243); HFW/SVL 0.098–0.121 (0.108); vomerine teeth 41–65 (51.3), in irregular rows; maxillary-premaxillary teeth 80–122 (93.3). Webbing of the feet and color in preservative in this series do not differ from those of the holotype of *B. schmidti* or the Guatemalan adult females. Considerable overlap in proportions occurs between the Honduran series and the 12 adults from Alta Verapaz. The proportional ranges of this Honduran series also encompass two (HLL/SVL and HFW/SVL) of the three low values found in the holotype of *B. schmidti*.

When the adult females of the Honduran series are compared to those from Guatemala, the two series are found to have similar proportions, tooth counts, foot webbing, and color pattern. Furthermore, subadult females of both series resemble one another in proportions, tooth counts, foot webbing, and color pattern, including an apparent similar ontogenetic change in color pattern. Therefore, we conclude that the holotype of *B. schmidti* and the subadult female specimen assigned to *B. schmidti* by Dunn and Emlen (1932) are conspecific with the Guatemalan specimens of *B. dofleini* (sensu Stuart, 1943) and with the remaining Honduran material. We relegate *B. schmidti* (Dunn) to the synonymy of *B. dofleini* (Werner).

The holotype of *B. dofleini* is presumed to have been destroyed in World War II. Dunn (1926) had not examined the type, but he nonetheless confidently assigned it to *B. yucatanana*, presumably on the basis of the brief description of Werner (1903). Later, Dunn visited Munich and reported his findings to K. P. Schmidt (letters in Field Museum). Dunn was convinced that he saw the type of *dofleini* (letter of 15 February 1940) and that it belonged to what is now known as *B. mulleri* (Brocchi). He even reported a number for the type, ZSM 1288/0. However, his notes suggest that he mistook one of the three specimens that Werner reported as "*Spelerpes variegatus*" as the type of *dofleini*. We record this information because future workers may find Dunn's explicit notes and think that we did not take into account the only recorded observations, since the original description, of Werner's now lost specimens. Stuart (1943) correctly assigned to *B. dofleini* specimens from Alta Verapaz that matched the original description, and his assignment has not been questioned. Our material perfectly fits Werner's description. In order to stabilize the taxonomy, we accordingly assign MVZ 161627 as the neotype of *Spelerpes dofleini* Werner 1903. This specimen is nearly identical in size to the original type. It is an adult female with the following measurements: SVL 88.4, TL 67.0, HL 19.8, HW 16.2; forelimb length 18.3, HLL 22.5, distance across body at insertion of forelimbs 16.1, HFW 10.2, number of costal folds uncovered when limbs

addressed to trunk 2.5. The specimen is from Finca Volcán, 25 km (by rd.) NW Senahú, Depto. Alta Verapaz, Guatemala, elevation 875 m, collected by T. J. Papenfuss and R. L. Seib between July 16 and 20, 1978. It is a stout-bodied, robust animal with a broad, flat head and small eyes. Its dorsal ground color is tan mottled with gray and dark brown. Dark brown patches and spots are present in the upper parts of the costal grooves, especially on the posterior two-thirds of the trunk. The head is mainly dark brown, streaked with gray and tan. The venter is flat gray, ranging from pale gray on the belly to dark gray on the throat, and there are some conspicuous darker gray spots, especially on the subcaudal surface. The dorsum of the tail has golden-tan highlights around its base. The hind limb insertions are also tan. This is a non-gravid female with small ova. The hands and feet are broad and extensively webbed, but the webbing is emarginate between its broadly pointed digital tips.

NOTES ON THE DISTRIBUTION AND
BIOLOGY OF *BOLITOGLOSSA DOFLEINI*
(WERNER)

Distribution.—Low and moderate elevations of the Caribbean versant from extreme northern Alta Verapaz, Guatemala, and Cayo District, Belize, to north-central Honduras. See Appendix I for a list of localities for the species.

Biology.—This species was long known from only a handful of specimens. In the 1970's, Berkeley field teams discovered that the species was extraordinarily abundant in cardamon plantations at Finca Volcán, Guatemala. Salamanders were found in the vegetation at the base of the plants. Heavy applications of pesticides and fertilizers are made in this region, and frogs and toads are virtually absent, yet the salamanders were abundant.

The species displays striking sexual dimorphism. The Finca Volcán samples are sufficiently large to permit comparisons. Males have a conspicuous mental gland, so any salamander larger than the smallest male with a mental gland is taken as an adult female. A sample of 100 adult females ranges in SVL from 52 to 105 mm (69.7), s.

d. 17.1. A sample of 56 males ranges in size from 45 to 70 mm (53.8), s. d. 5.8, in SVL. The 25 largest members of the female sample range in size from 88 to 105 mm SVL (94.2), s. d. 4.6. In contrast, the 11 largest members of the male sample range in size from 58 to 70 mm (63.5), s. d. 3.7, in SVL. Females are not only much larger than males, they also have a more robust habitus and shorter limbs. Males have a more defined neck than females, and have substantially longer limbs and slenderer bodies. When the forelimbs and hind limbs are adpressed to the body, 2.5 to 3 costal folds are left uncovered in the 25 largest females (2.7), s. d. 0.31, whereas in males the limbs may overlap and the range is from -1 to +1 (0.14), s. d. 0.67. The males and females are so distinct as to appear to belong to different species, and they display a sexual dimorphism greater than that of any other salamander species known to us.

Food in the stomachs of more than 100 individuals was analyzed by Robert Seib and results are available from David B. Wake. Ants are the commonest food item by frequency of occurrence (more than 50% of stomachs). Beetles and millipedes were the next commonest items (less than 20% of the stomachs). Stomachs also included a few annelids and some pebbles.

Acknowledgments.—We thank the following curators for the loan of material: J. E. Cadle (ANSP), A. Resetar (FMNH), J. E. Simmons (KU), D. A. Rossman (LSUMZ), and J. P. Rosado (MCZ). J. Lee provided information on the distribution of *B. dofleini* on the Yucatan Peninsula. We thank R. Seib for permitting us to use some of his data.

LITERATURE CITED

- Duellman, W. E. 1963. Amphibians and reptiles of the rainforests of southern El Petén, Guatemala. Univ. Kansas Pub. Mus. Nat. Hist. 15:205–249.
- Dunn, E. R. 1924. New salamanders of the genus *Oedipus* with a synoptical key. *Field Mus. Nat. Hist., Zool. Ser.* 12:95–100.
- . 1926. The salamanders of the family Plethodontidae. Smith College, Northampton, Massachusetts. viii + 441 p.
- , and J. T. Emlen, Jr. 1932. Reptiles and amphibians from Honduras. *Proc. Acad. Nat. Sci. Philadelphia* 84:21–32.
- Elias, P. 1984. Salamanders of the northwestern highlands of Guatemala. *Contrib. Sci., Nat. Hist. Mus. Los Angeles Co.* 348:1–20.
- Feder, M. E., T. J. Papenfuss, and D. B. Wake. 1982. Body size and elevation in Neotropical salamanders. *Copeia* 1982:186–188.
- Frost, D. R. (ed.). 1985. Amphibian species of the world. A taxonomic and geographical reference. Assoc. Syst. Coll., Lawrence, Kansas. v + 732 p.
- Leviton, A. E., R. H. Gibbs, Jr., E. Heal, and C. E. Dawson. 1985. Standards in herpetology and ichthyology: Part I. Standard symbolic codes for institutional resource collections in herpetology and ichthyology. *Copeia* 1985:802–832.
- McCoy, C. J. 1991. Additions to the herpetofauna of Belize, Central America. *Carib. J. Sci.* 26:164–166 [1990].
- Stuart, L. C. 1943. Taxonomic and geographic comments on Guatemalan salamanders of the genus *Oedipus*. *Misc. Publ. Mus. Zool., Univ. Michigan* 56: 1–33.
- . 1948. The amphibians and reptiles of Alta Verapaz, Guatemala. *Misc. Publ. Mus. Zool., Univ. Michigan* 69:1–109.
- Wake, D. B., and J. F. Lynch. 1976. The distribution, ecology, and evolutionary history of plethodontid salamanders in Tropical America. *Nat. Hist. Mus. Los Angeles Co., Sci. Bull.* 25:1–65.
- Werner, F. 1903. Ueber Reptilien und Batrachier aus Guatemala und China in der zoologischen Staatssammlung in München nebst einem Anhang über seltene Formen aus anderen Gegenden. *Abh. K. Bayer. Akad. Wiss.* 22:343–384.

APPENDIX I

List of localities and museum numbers for specimens examined of *Bolitoglossa dofleini*, with reliable literature records added. Elevational summaries, based upon the listed records, are also given for each country when known.

BELIZE. Cayo District: Chiquibui Branch of the Macal River, S of Granos de Oro Camp (CM: McCoy, 1991).

GUATEMALA (140-ca. 1000 m). Alta Verapaz: Chinajá (KU: Duellman, 1963); Finca La Esperanza, 3.5 km SE San Miguel Tucurú (MVZ 150636); Finca Los Alpes (KU: Duellman, 1963; UMMZ: Stuart, 1948); Finca Volcán (MVZ 158487, 161601–789, 163938, 168949; UMMZ: Stuart, 1943).

HONDURAS (650–1370 m). Copán: Quebrada Grande (KU 202996; MVZ 221181–82). Cortés: Finca Naranjito (KU 194182; LSUMZ 36591); mountains W San Pedro Sula (FMNH 4538; MCZ 16287; MVZ 143706–07, 200422–25); 10 airline km W San Pedro Sula (MVZ 137800, 196468 [cleared and stained]). Yoro: Portillo Grande (FMNH 34681); Yoro (ANSP 29159–60).