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Preliminary data on the natural history and intraspecific variation of the endangered salamander *Bolitoglossa spongai* in the Venezuelan Andes

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Among the most difficult amphibians to observe in Venezuela are, without doubt, salamanders. Five species of urodeles are known from Venezuela (BARRIO-AMORÓS 2004, 2009), all of which are members of the genus *Bolitoglossa*, subgenus *Eladinea* (PARRA-OLEA et al. 2004). Additional species are expected to be described soon. One known species occurs in the Coastal Range (*B. borburata* TRAPIDO, 1942) and the others are known from the Andes: *B. aff. altamazonica* (COPE, 1874) from the Táchira piedmont; *B. guaramacalensis* SCHARGEL, GARCÍA-PÉREZ & SMITH, 2002 from Guaramacal in Trujillo state; *B. orestes* BRAME & WAKE, 1962, Sierra de la Culata in Mérida state; and *B. spongai* BARRIO-AMORÓS & FUENTES-RAMOS, 1999, from the Páramo el Tambor and surroundings in Mérida state.

BARRIO-AMORÓS & FUENTES (1999) described *Bolitoglossa spongai* from specimens collected in the late eighties by MANUEL GONZÁLEZ SPONGA and his wife at La Carbonera. The geographically closest congener to *B. spongai* is *B. orestes*, occurring in the Sierra de la Culata. Páramo El Tambor (Fig. 1) is an isolated remnant of La Culata harboring its own endemics. Since the original description of *B. spongai*, the species has been the subject of speculation regarding its conservation status. BARRIO-AMORÓS & FUENTES (1999) stated that not encountering secretive salamanders is not a clear signal of decline. BARRIO-AMORÓS (2001) considered *B. spongai* as likely to be endangered in a near future, while BARRIO-AMORÓS & FUENTES-RAMOS (2004) observed the species to be more common than previously expected. YOUNG et al. (2004), STUART et al. (2008) and the Venezuelan Red Book (RODRÍGUEZ & ROJAS-SUÁREZ 2008) mention the species as EN (Endangered).

From 24 to 31 July 2008, during a project estimating the current population status of *Aromobates meridensis* (Anura, Dendrobatidae), we stayed at Estancia La Bravera (8°38'30"N, 71°22'59"W, 2352 m a.s.l.). Estancia La Bravera functions as a private reserve protecting the cloud forest and its biota from deforestation and agrochemical pollu-

tion. Cloud forest (Fig. 2) forms a belt surrounding the Páramo El Tambor (Fig. 1), which is like an island, separated from the rest of the Sierra La Culata by a valley with



Figure 1. Páramo el Tambor and surroundings, natural macrohabitat of *Bolitoglossa spongai*.

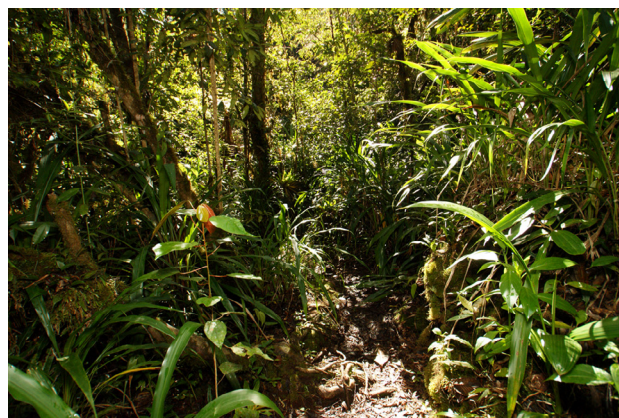


Figure 2. Cloud forest habitat at La Bravera (see text for location).



Figure 3. *Bolitoglossa spongai*. a) Female 05, with regenerated tail; b) Female 30 on type 1 plant (*Pittcairnia*), diagonally descending; c) Female 11 on type 2 plant (*Cavendishia*), diagonally ascending; d) Female 23 on type 2 plant (*Clusia*), horizontal. Also representative of pattern E.

intense anthropogenic activity (deforestation, cultivation, cattle farming). During four nights (24, 26, 28 and 29 July), we walked paths within the property, in cloud forest (Fig. 2), in order to observe amphibians and biodiversity in general. Each walk lasted about two hours, whereby a total of 16 hours was spent searching (counting two hours per night per four nights per two persons).

The first night we walked a path of about 800 m, from late evening at dusk (19:15) until night (21:20h). Temperature was 14.5°C. Weather conditions were cloudy and the forest floor was wet, because the previous days experienced occasional rain; that day no rain fell but occasional drizzling occurred during our walk. We observed 14 *Bolitoglossa spongai*. This fact has no precedent in nocturnal observations of that species (or other *Bolitoglossa*) in Venezuela and reflects a much higher abundance than previously expected. When searching for salamanders during daytime, under logs or bark, it is normal to find one or just a few. Our personal records had been five (CLBA) and four (JG), always under moss, during morning hours.

We took pictures of all specimens showing the original positions, pointing out the temperature of each night, position relative to the forest floor and to the plant where they were, and the horizontality of the specimen. Table 1 shows the parameters of the observations made that night.

We did not see the animals conducting any activity. All were exposed on the dorsal surface of different types of leaves (see below) from 30 to 200 cm above the forest floor.

None reacted to our presence, even when we were touching the plant or trying to clear the surroundings to obtain a clear photograph. The fact that the salamanders were so exposed and without fear of our approach might indicate that they may not have specific predators. The snakes known in the area are two species of semi-fossorial *Atractus*, which feed on worms, *Micrurus mipartitus* that could be a possible predator for salamanders on the ground but it is mainly diurnal, and *Chironius monticola*, which is a diurnal rodent predator. We did not see any defensive behavior, as is often seen in other plethodontids observed (*Pseudoeurycea longicauda* adopts a specific defensive posture elevating the tail and becoming sticky, and *P. belli* releases a brownish secretion from its parotoid glands; pers. obs. on captive specimens). In two cases, when observing the animal and disturbing it trying to identify its sex, the only method of escape was to roll on itself falling to the forest floor and staying immobile so that its cryptic colouration made it hard to find. Two salamanders, however, bore regenerated tails, one with approx. 70% missing (Fig. 3a), and another with approx. 40% missing; this could be indicative of predation attempts. One large female regurgitated an insect (Dermaptera) after we handled it.

The next night (26 July) we took the same path, but observed only five animals. Conditions were similar to the first night, with a heavy rain from 10:00h to 16:00 h, and the forest floor wet, with humidity around 90% (taken from a non-professional hygrometer at the posada). Tempera-



Figure 4. *Bolitoglossa spongai*. a) Vertical position of female 24; b) Female 06, on a type 3 plant (fern), vertically ascending. Also representative of pattern E; c) Close-up showing the rhomboidal marking typical of the species; d) Female showing Pattern A (see also Fig. 3b).

ture that night was 11.1°C, colder than the previous night. We observed two males, two females, and one juvenile. All were located at heights from 50 to 200 cm.

The night of the 28 July, following a wet day (rain from 16:00 to 18:40 h), we took another path of about 700 m, and

observed seven animals, two males and five females. Two salamanders, a male and a female were seen on the same plant, separated from each other by 40 cm, but no reproductive activity was apparently intended.



Figure 5. *Bolitoglossa spongai*. a) Female showing Pattern B; b) Female showing Pattern B; c) Female showing Pattern C; d) Male showing Pattern D.

The last night after a day without rain, walking only 400 m on a new path, we observed four individuals, one male and three females. All were situated between 40 and 130 cm above the forest floor. None was conducting any activity.

Comparisons among all the pictures taken showed that no salamander was observed more than once.

From this preliminary data we draw a few tentative conclusions. *Bolitoglossa spongai* is a nocturnal species, which hides during the day under moss, fallen branches, or under the bark of rotting logs. Activity starts at dusk (about 19:15 h in July in the area), and probably continues all night long. Their movements are extremely slow, and we never observed any animal engaged in any active display. After one hour, one individual might still be in the same position, have moved a few cm, or have disappeared, meaning that it was able to walk away or drop to the ground, out of sight. No body flip behavior was observed (as for *B. colonnea* in Costa Rica by LEENDERS & WATKINS-COLWELL 2003). The preferred substrate is a particular type of plant with long leaves as in the Bromeliaceae (*Pittcairnia*; type 1; Fig. 3b); followed by plants (type 2) with short leaves not exceeding 16 cm in length, like Ericaceae: *Cavendishia* (Fig. 3c), or Clusiaceae: *Clusia* (Fig. 3d). The least chosen plant substrate are ferns (Pteridophyta; type 3; Fig. 4b). The salamander's favorite position is horizontal on the leaf (36.6%; Fig. 3d), followed by diagonally ascending (26.6%; Fig. 3c) and diagonally descending (23.3%; Fig. 3b), vertically ascending (10%), and the least seen position was vertical (3.3%; Fig. 4a). The perch height above the ground ranges

from 30 to 200 cm, with a mean of 82.6 cm. The sex ratio in 28 adult animals was 1F:1.3M (16 females, 12 males). We cannot assess any decline of the species, as stated for other Neotropical salamanders (ROVITO et al. 2009).

Variation. *Bolitoglossa spongai* was described from nine specimens, and the variation noted at that time was limited (BARRIO-AMORÓS & FUENTES 1999). We have observed a considerable variation in the sample reported and in additional specimens observed during other visits. We photographed in total 50 *Bolitoglossa spongai*, in which we have noticed five patterns. In *B. spongai*, as noted in the original description, white metallic irregular spots are common along the body and tail. They may be present in all patterns. There is another feature that is always visible, although sometimes subdued, i.e., a dark rhombus on the dorsal side of the head (Fig. 4c).



Figure 6. Distribution map of *Bolitoglossa spongai* in the Venezuelan Andes.

Pattern A (Figs. 3b, c, 4d): Typical: the pattern reported for the holotype and the most abundant (64 %; 18 males, 12 females, two juveniles). It consists of a pale to dark brown dorsum, sometimes with a few ill-defined darker spots or stripes, darker flanks, and not well delimited, white metallic marks on any part of the animal.

Pattern B (Figs. 5a, b): Plain: dorsal colour variable, ranging from dark bluish gray to pale gray with slightly darker tail; from pale to dark brown; patternless without noticeable spots; in some cases there may be one or two spots; flanks of the same colour as dorsum. 28% of the individuals have this pattern, 4 males, 8 females and two juveniles.

Pattern C (Figs. 4a, 5c): Bicolour: Dorsum orange brown, without spots or stripes; flanks pale to dark gray, almost black, with or without spots. 2% of the sample had this pattern (one female).

Pattern D (Fig. 5d): Striped: dorsal colour ranging from orange brown to pale yellowish; flanks can be grayish, with a well-marked delimitation between them and the dorsum, or no delimitation at all. The stripes are longitudinal only on the dorsum, short or long, black. 2% exhibited this pattern (one female).

Pattern E (Figs. 3d, 4b): Spotted: on a dark background, grayish to bluish, spots of different shapes and colours can be seen; they are different from the specific white metallic spots. In Fig. 4b it is possible to discern white speckles, as well as larger ameba-like brown spots along the body. 4% of the sample showed this pattern (two females).

In the series of specimens we could observe at night and in daytime, we did not notice any colour or skin texture changes, as LEENDERS & WATKINS-COLWELL (2003) did for *B. colonnea* in Costa Rica.

Conclusion. *Bolitoglossa spongai* is an endemic species from the El Tambor massif, an isolated mountain in the southwesternmost section of the Sierra de la Culata. Its altitudinal range extends from 2000 to 2700 m. Its probable distributional range covers no more than 119 km (Fig. 6). The GAA (YOUNG et al. 2004) and STUART et al. (2008) considered the species as Endangered, while the Venezuelan Red Book (RODRÍGUEZ & ROJAS-SUÁREZ 2008) consid-

Table 1. Parameters taken in this study. The sex was determined by the presence of nasolabial protuberances in males, which can be easily observed. Measurements were taken in the field without touching or disturbing the animal, so they are approximations and must not be taken for any concrete calculation; they are expressed in mm. DFF is the distance of the animal to the forest floor given in cm, and was determined with a tape measure from the ground to the animal. The position on the substrate was determined as follows: H: horizontal; V: vertical=VA, with the head up; VD= with the head down; D: in diagonal, DA: Diagonal ascendant, with its head higher than the rest of the body; DD: Diagonal descendent, with the head looking down; following the inclination is the approximate angle respect to a horizontal axis. The plant types are defined as follows: 1: Bromeliaceae: *Pittcairnia*, 2: Ericaceae: *Cavendishia*, 3: Pteridophyta.

Ind	sex	Size (mm)	DFF (cm)	position	plant
01	fem	45+45	100	H	1
02	male	35+45	60	H	1
03	fem	42+40	50	DA-45°	2
04	male	40+45	50	DD-20°	1
05	fem	40+20	40	H	1 stem
		(regenerated)			
06	fem	40+35	150	VA	3
07	male	35+37	60	H	1
08	male	45+50	50	H	1
09	male	40+25	80	H	1
		(regenerated)			
10	male	40+45	60	DD-15°	1 stem
11	fem	40+40	70	DA-35°	2
12	male	45+45	50	DA-30°	1
13	juv	escaped	40	DA-50°	1
14	fem	55+50	160	DA-35°	1
15	fem	50+50	110	H	1
16	male	45+45	70	DA-25°	2
17	fem	50+45	200	DA-35°	1
18	male	45+45	110	DD-25°	1
19	juv	25+25	50	H	2
20	male	35+40	50	VD	1
21	fem	35+35	40	DD-10°	1
22	fem	40+35	30	H	2
23	fem	40+40	50	H	2
24	fem	40+35	120	VA	2
25	male	30+40	100	H	2
26	fem	45+40	180	VA	2
27	fem	32+35	50	DA-25°	1
28	male	35+30	40	DD-25°	1
29	fem	50+45	80	DD-20°	1
30	fem	42+43	130	DD-15°	1

ers it regionally Vulnerable (VU D2). We now believe that more censi and monitoring must be done on *Bolitoglossa spongai* and other species of Venezuelan salamanders to identify their population status. The understudied Venezuelan Andean salamanders appear to be more common than suggested by evaluations made to date. However, methodical censi on salamanders are difficult to conduct, and individuals are observed only under favorable climatic conditions.

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