

## A NEW SPECIES OF *CYCLORAMPHUS* (ANURA, LEPTODACTYLIDAE) FROM THE ATLANTIC FOREST, BRAZIL

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**ABSTRACT:** We describe a new species of *Cycloramphus* from Ribeirão Grande in the Atlantic Forest of the State of São Paulo, Southeastern Brazil. The new species is characterized by the presence of an inguinal gland in adult males, feet not webbed, smooth skin, relatively small eyes, and massive jaw adductor muscles. The general aspect of body, conferred by a combination of a relatively short body and hind limbs, reduced eyes, and the massive aspect of head, suggests fossorial habits. Based on these characters, the new species is presumed to be closely related to the *Cycloramphus bolitoglossus* group, previously allocated to the genus *Craspedoglossa*.

**Key words:** Anura; Atlantic Forest; Brazil; *Cycloramphus*; Leptodactylidae; New species

FROGS of the neotropical genus *Cycloramphus* are endemic to the Atlantic rainforests of Brazil, one of the most threatened ecosystems in the world (Heyer, 1983a,b; Myers et al., 2000). Formerly extending along the eastern coast of Brazil, the Atlantic Forest has been intensely disturbed in the last 500 yr. In its southern part, at the State of São Paulo, where the largest portion of the pristine forest is found, a maximum of 7% of the original coverage remains, mostly on areas of sharp relief (Leonel, 2001). Intensive surveying in the area during recent years and the consequent increasing rate of discovery of new species suggest that we are still far from cataloguing the anuran species of the remnants in the State of São Paulo (Haddad, 1998; Pavan et al., 2001; Pombal and Haddad, 1999).

*Cycloramphus* are found in areas of sharp relief in the Atlantic Forest and are always associated with small streams and forest floors (Bokermann, 1951; Heyer and Maxson, 1983; A. Lutz, 1929; B. Lutz, 1947). The 25 species currently recognized in the genus (Haddad and Sazima, 1989; Heyer, 1983a,b, 1988) have also been the object of studies that focused on their relationships, distribution, and speciation (Bokermann, 1951; Heyer, 1983a; Heyer and Maxson, 1983).

Some years ago, we received from Francisco L. Franco a specimen of a frog collected on the forest floor at Ribeirão Grande (24° 05' S, 48° 21' W), State of São Paulo. Although at the

time it was considered a new leptodactylid related to the *Cycloramphus/Zachaenus* complex, we deferred description pending the collection of additional specimens. Since then, several other individuals have been collected at nearby localities, which has enabled us to describe the new species.

The presence of an inguinal gland in males and its general morphology, indicative of fossorial habits, indicate that this new frog is related to representatives of the *Cycloramphus bolitoglossus* group (Heyer, 1983a), previously placed in the genus *Craspedoglossa*. In this paper, we describe this new species.

### MATERIALS AND METHODS

Morphological data follow Heyer (1983a) with the addition of hand length (measured ventrally on the left hand from the wrist to the distal tip of digit III) and the inner metatarsal tubercle length. The sex was determined by the presence of the inguinal gland in males and its absence in females. Sexual maturity was inferred by the development of the inguinal gland in males and by the presence of ovarian eggs in females. The abbreviations used for the measurements are snout–vent length (SVL), head length (HL), head width (HW), eye–diameter (ED), eye–nostril distance (EN), interorbital distance (ID), hand length (HAL), femur length (FL), tibia length (TL), foot length (FOL), length of the inner metatarsal tubercle (IMT). Abbreviations used for museums are MNRJ (Museu Nacional, Rio de Janeiro) and MZUSP (Museu de Zoologia da Universidade de São Paulo).

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FIG. 1.—*Cycloramphus acangatan*, living holotype (MZUSP 126900), adult male, SVL 42.9 mm, from Ribeirão Grande, São Paulo. Photograph by F. L. Franco.

#### SPECIES DESCRIPTION

##### *Cycloramphus acangatan* sp. nov.

*Holotype*.—MZUSP 126900, adult male (Figs. 1, 2), from municipality of Ribeirão Grande (24° 05' S, 48° 21' W), São Paulo, Brazil, collected by F. L. Franco on 28 September 1997.

*Paratypes*.—MZUSP 126896, a subadult male from the type locality, collected by F. L. Franco between 23–27 August 1997; MZUSP 126897–99, an adult male and two adult females from the type locality, collected by F. L. Franco on 28 September 1997; MZUSP 93264–65 and 126901–03, Parque Estadual Intervalas (24° 15' S, 48° 24' W), State of São Paulo, Brazil, collected by M. T. Rodrigues on 3 December 1997 and between 13–19 November 2001, respectively; MZUSP 124997–125000, São Bernardo do Campo (23° 48' S, 46° 29' W), São Paulo, Brazil, collected by A. C. Monteiro–Leonel, V. K. Verdade, and V. X. Silva between 16–27 October 2001; MZUSP 124962–96, Piedade (23° 43' S, 47° 24' W), São Paulo, Brazil, collected by A. C. Monteiro–Leonel, V. K. Verdade, and V. X. Silva between 5–16 January 2002; MZUSP 127577–90, Cotia (23° 37' S, 46° 56' W), São Paulo, Brazil, collected by M. Dixo between December 2001 and February 2002; MZUSP 127591–93, Ibiúna (23° 41' S, 47° 15' W), São Paulo, Brazil, collected by M. Dixo on 22 February 2002; and MZUSP 127653–55, Juquitiba (23° 52' S, 47° 01' W), São Paulo, Brazil, collected

by A. C. Monteiro–Leonel, D. Pavan, and V. K. Verdade between 6–17 May 2002.

*Diagnosis*.—A moderately sized species of *Cycloramphus* (adult females 44–48 mm, adult males 33–43 mm SVL) with unwebbed feet, smooth skin, short and robust limbs, small eyes (eye diameter about 22% of head length), and strong massive jaw adductor muscles that confer a “big head” aspect to these frogs.

*Comparisons with other species*.—The other species of *Cycloramphus* that lack foot webbing are *C. catarinensis* Heyer, *C. diringshofeni* Bokermann, *C. eleutherodactylus* (Miranda-Ribeiro), *C. granulosus* A. Lutz, *C. valae* Heyer, and the species of the *bolitoglossus* group (*C. bolitoglossus* [Werner], *C. carvalhoi* Heyer, *C. migueli* Heyer, and *C. stejnegeri* [Noble]). *Cycloramphus acangatan* is larger (SVL of adult males 33–43 mm and females 44–48 mm) than *C. diringshofeni* (males to 31 mm) and smaller than *C. carvalhoi* (males to 62 mm). The dorsum is smooth in *C. acangatan* and granular in *C. bolitoglossus*, *C. catarinensis*, *C. eleutherodactylus*, *C. granulosus*, and *C. valae*. The mandible is more slightly projected at the mandibular symphysis in *C. acangatan* than in *C. catarinensis*, *C. eleutherodactylus*, and *C. granulosus*. The hind limbs of *C. acangatan* are shorter (FL 35–37% SVL) than those of *C. catarinensis* (FL 41–47% SVL), *C. diringshofeni* (FL 45% SVL), *C. eleutherodactylus* (FL 42–48% SVL), *C. granulosus* (FL 42–46% SVL), and *C. valae* (FL 42–49% SVL). The jaw adductor musculature is highly voluminous in *C. acangatan* but not in *C. bolitoglossus*, *C. carvalhoi*, *C. catarinensis*, *C. diringshofeni*, *C. eleutherodactylus*, *C. granulosus*, and *C. valae*. *Cycloramphus acangatan* most resembles *C. migueli* and *C. stejnegeri*. The head is narrower (HW 40–44% SVL) in *C. acangatan* than in *C. migueli* (HW 46% SVL). The snout in profile is sloping in *C. acangatan* and almost vertical in *C. migueli*. *Cycloramphus migueli* also has dark stripes on the arms, thighs, tibia, and feet, which are absent in *C. acangatan*. The reduced fringes on the inner edge of the second and third fingers of *C. acangatan* are absent in *C. migueli*. *Cycloramphus acangatan* has smaller eyes (ED 18–21% HL) and shorter fingers than *C. stejnegeri* (ED 26–27% HL). In addition to the characters presented above, *C. acangatan* also differs from all the other

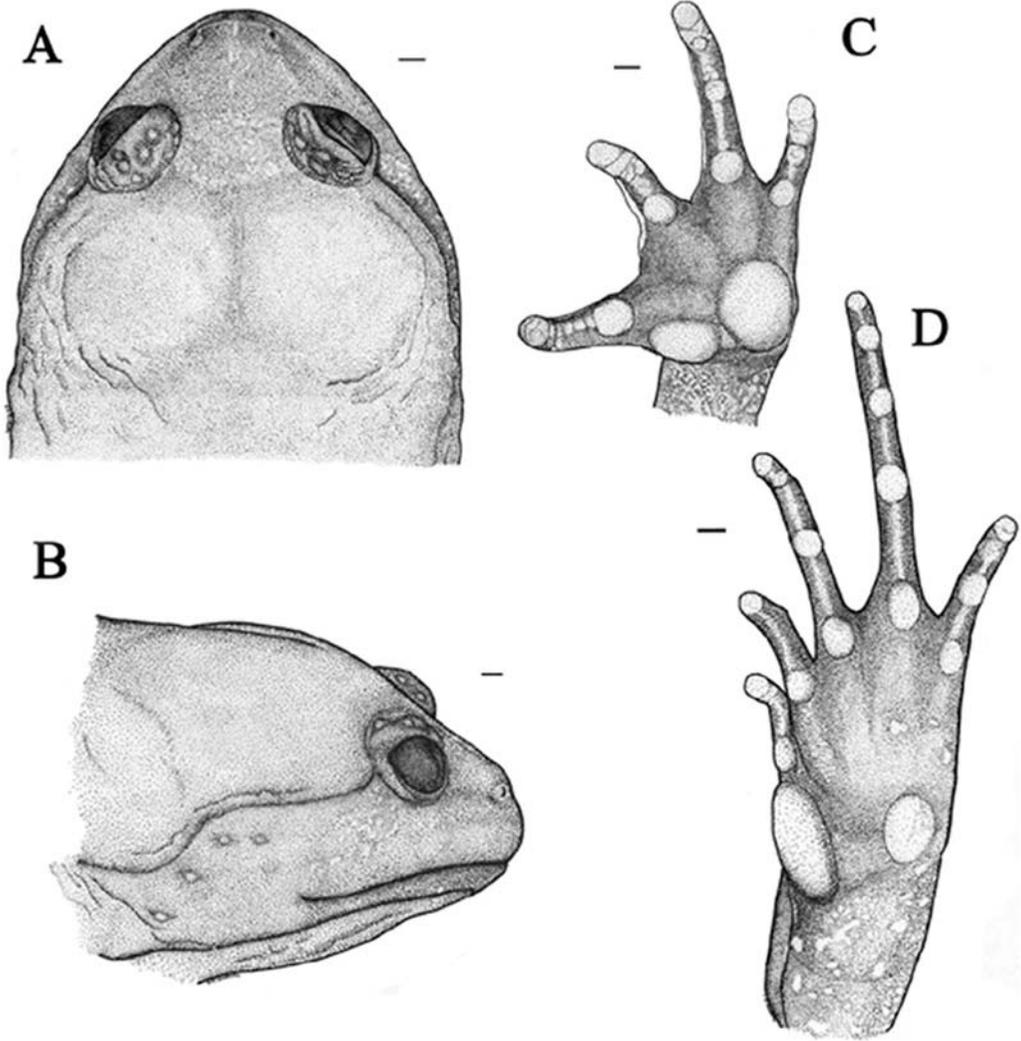


FIG. 2.—*Cycloramphus acangatan*, MZUSP 126900 (holotype). (A) Dorsal and (B) lateral view of head; ventral view of (C) hand and (D) foot. Scale 1 mm.

species of the *bolitoglossus* group in the snout profile (Fig. 3).

*Description of holotype.*—Body elliptical in dorsal view; head slightly wider than long; jaw muscles massive; eyes dorsolateral, small, diameter equal to the eye–nostril distance; nostril small, protuberant, directed laterally; snout rounded in dorsal view and sloped in profile; canthus rostralis indistinct; loreal region concave; mandibulae slightly projected at mandibular symphysis; vomerine teeth in short series in medial contact posteriorly and between choanae; tympanum not visible ex-

ternally; supratympanic fold evident, extending from posterior corner of eye to shoulder; vocal fold or slit absent. Inguinal gland conspicuous, rounded, and flattened in external view. Forelimbs and hindlimbs short and robust; thumbs lacking asperities; reduced fringes on inner edge of digits II and III; outer metacarpal tubercle rounded, flat, about twice as large as flat and ovoid inner metacarpal tubercle; digital tips not expanded; inner metatarsal tubercle flat and triangular, three times as large as outer metatarsal tubercle; tarsal fold absent. Skin smooth on dorsum and

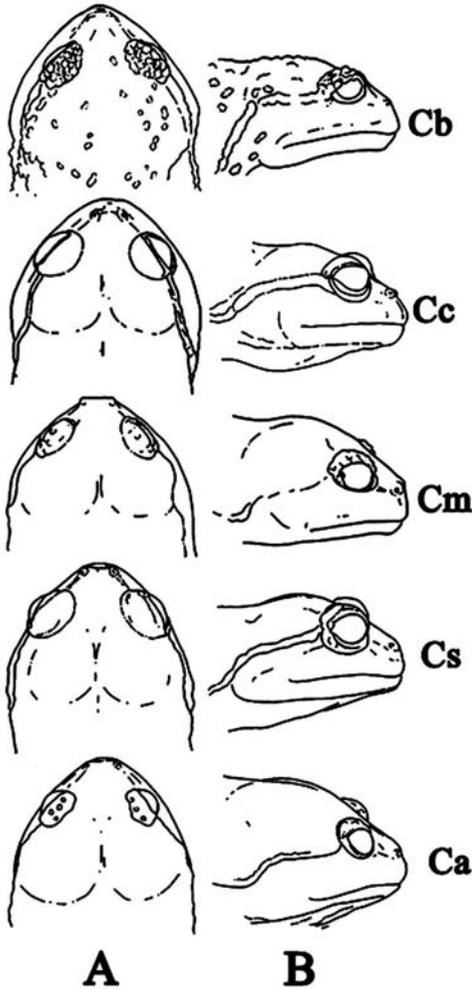


FIG. 3.—Schematic drawing of the snout profile of the species of the *Cycloramphus bolitoglossus* group in dorsal (A) and lateral (B) views. Ca—*C. acangatan*; Cb—*C. bolitoglossus*; Cc—*C. carvalhoi*; Cm—*C. migueli*; and Cs—*C. stejnegeri*.

venter, becoming slightly granular along flank and in vicinity of head; small tubercles on eyelids; scattered granules on cloacal region.

*Color in life.*—Dorsum uniformly red brown with irregular white spots mainly along flank and dorsal surface of thighs. Belly uniformly red brown with irregular white spots; light stripes at tip of fingers and toes in dorsal view. In preservative (70% alcohol), colors are similar to those in life.

*Measurements of holotype.*—SVL 42.9 mm; HL 16.4 mm; HW 17.7 mm; ED 3.5 mm; EN 3.3 mm; ID 4.3 mm; HAL 10.2 mm; FL

TABLE 1.—Descriptive analysis for adult males ( $n = 16$ ) and females ( $n = 4$ ) of *Cycloramphus acangatan*. The upper values are the means  $\pm$  standard deviation, and the lower values are the minimum and maximum, in millimeters.

Variable	Males	Females
SVL	37.5 $\pm$ 2.9 33.2–42.9	46.8 $\pm$ 1.6 44.7–48.1
HL	14.4 $\pm$ 1.3 11.7–16.4	18.1 $\pm$ 0.5 17.5–18.7
HW	15.9 $\pm$ 1.2 13.6–17.7	19.9 $\pm$ 0.6 19.1–20.5
ED	3.2 $\pm$ 0.4 2.5–4.0	3.9 $\pm$ 0.2 3.7–4.0
EN	2.8 $\pm$ 0.3 2.5–3.3	3.4 $\pm$ 0.3 3.2–3.7
ID	3.8 $\pm$ 0.4 2.8–4.3	4.7 $\pm$ 0.9 3.3–5.3
HAL	8.7 $\pm$ 0.7 7.41–10.2	10.9 $\pm$ 0.5 10.2–11.5
FL	13.6 $\pm$ 0.8 12.4–15.7	16.9 $\pm$ 0.9 15.5–17.7
TL	12.1 $\pm$ 0.7 10.7–13.7	14.8 $\pm$ 0.4 14.2–15.1
FOL	18.9 $\pm$ 0.9 17.3–20.7	23.0 $\pm$ 0.7 22.0–23.5
IMT	2.5 $\pm$ 0.3 1.9–3.0	2.6 $\pm$ 0.3 2.3–3.0

14.1 mm; TL 13.7 mm; FOL 16.6 mm; IMT 3.0 mm.

*Variation* ( $n = 68$ ).—Adult females of *C. acangatan* are larger than adult males (SVL 44–48 mm and 33–43 mm, respectively; Table 1). Only males have the inguinal gland; it is present in juvenile males, although it is more noticeable in adults. The inner metatarsal tubercles are also sexually dimorphic, being more noticeable and larger in adult males than in adult females. The fringes of the inner edge of the second and third fingers are so reduced that they are vestigial and might be overlooked in some individuals. Although almost all specimens studied had a uniformly red or dark brown dorsum, there was some variation in color pattern. In some individuals, the dorsal color pattern is lighter and a light bar between the eyelids is present. This lighter color pattern is most often present in juveniles. Some individuals present a series of light spots aligned from the posterior corner of the eyes to the angle of the jaw. The dorsal surface of the thighs is usually uniform with white spots. In some individuals, the light spots are aligned, although never in conspicuous strings. The color pattern of the belly is uniformly brown

with light spots. In some individuals, the gular region is darker than the belly. The jaw adductor muscles may be more or less noticeable, depending on preservation condition.

**Distribution.**—The species is known from the municipalities of Cotia, Ibiúna, Juquitiba, Piedade, Pilar do Sul (23° 48' S, 47° 45' W), Ribeirão Grande, and São Bernardo do Campo, and from Parque Estadual Intervales, all localities in the State of São Paulo, Brazil. It is probably present throughout the Serra de Paranapiacaba (Fig. 4).

**Etymology.**—From the Tupi language *acanga* (head) and *atan* (strong), in reference to the strong and massive jaw adductor muscles of these frogs.

#### REMARKS

Species of the genus *Cycloramphus* occur along eastern Brazil from Bahia to Santa Catarina (Heyer, 1983a,b; 1988; Heyer and Maxson, 1983) in the Atlantic Forest domain (Ab'Saber, 1977). The general pattern of distribution of the genus is that of a species restricted to areas of sharp relief found mainly in the southern part of the Atlantic Forest domain (Heyer, 1983a; Heyer and Maxson, 1983). This pattern is to be expected for those species associated with streams, especially considering the reproductive restrictions imposed by their specialized larvae that live on splashed rocks. However, species of *Cycloramphus* associated with the forest floor also follow this general distribution pattern, despite the absence of obvious restrictions imposed by their habit or biology (Heyer, 1983a; Heyer and Maxson, 1983). Their terrestrial larvae, which might characterize the group, have been found on the forest floor in moist conditions (Heyer and Crombie, 1979). As an explanation of this distribution pattern, it has been suggested that the conditions adequate to complete the development of the terrestrial eggs and larvae seem to be found in humid forests, occurring primarily at hilly areas along the range of the Atlantic Forest domain (Heyer and Maxson, 1983).

The four species of the *C. bolitoglossus* group have small distributional areas mainly associated with major mountainous regions of the Atlantic Forest domain in southern Brazil (Heyer, 1988). *Cycloramphus bolitoglossus* occurs at the Serra do Mar in the States of

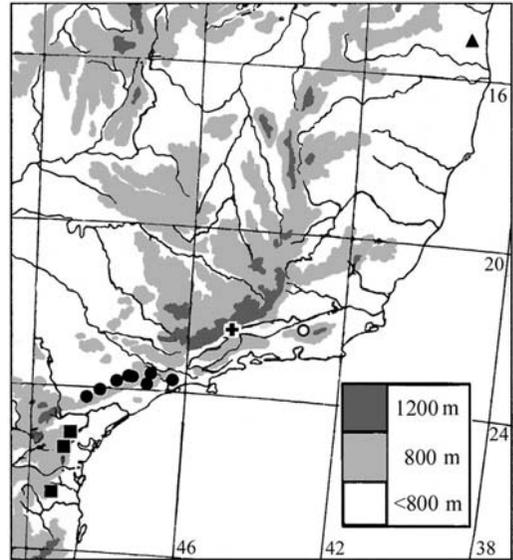


FIG. 4.—Distribution of *Cycloramphus acangatan* and the presumed closely related species of the *C. bolitoglossus* group. *Cycloramphus acangatan* (circles); *C. bolitoglossus* (squares); *C. carvalhoi* (cross); *C. migueli* (triangle); *C. stejneri* (open circle).

Paraná and Santa Catarina; *C. carvalhoi* occurs in the Serra da Mantiqueira in the State of Rio de Janeiro; *C. migueli* is known only from Fazenda Unacau, municipality of São José da Vitória, in the southern part of the State of Bahia; and *C. stejneri* occurs in the Organ Mountains in the State of Rio de Janeiro. As far as we know, *C. acangatan* seems to be restricted to the vicinities of the Serra de Paranapiacaba in the State of São Paulo following the same pattern presented by the other species of the *C. bolitoglossus* group (Fig. 4).

Species of the *Cycloramphus bolitoglossus* group have been considered rare in zoological collections (Heyer, 1983a). Our recent collections of *C. acangatan* suggest that these animals are more common than previously believed and can be easily captured by pitfall traps, a successful method for capturing animals with terrestrial and fossorial habits. Except for the five specimens of *C. acangatan* obtained at Ribeirão Grande, the other specimens were collected in pitfall traps after rainy days. The use of pitfall traps in other areas in the Atlantic Forest domain will improve our distributional data for species associated with

the forest floor, especially *Cycloramphus* of the *bolitoglossus* group. Our successful experience with this method in areas previously surveyed for *Cycloramphus* (and where it was supposed to be absent) suggests that distribution data for this group of frogs are far from complete.

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#### LITERATURE CITED

- AB'SABER, A. N. 1977. Os domínios morfoclimáticos na América do Sul. Primeira aproximação. Geomorfologia, Instituto de Geografia, Universidade de São Paulo 53:1-23.
- BOKERMANN, W. C. A. 1951. Sinopse das espécies brasileiras do gênero *Cycloramphus* Tschudi, 1838 (Amphibia, Salientia, Leptodactylidae). Arquivos do Museu Nacional, Rio de Janeiro 42:77-106.
- HADDAD, C. F. B. 1998. Biodiversidade dos anfíbios no estado de São Paulo. Pp. 17-26. In R. Castro (Ed.), Biodiversidade do estado de São Paulo, Brasil. Síntese do conhecimento ao final do século XX. vol. 6: Vertebrados. Fundação de Amparo à Pesquisa do Estado de São Paulo, São Paulo, Brasil.
- HADDAD, C. F. B., AND I. SAZIMA. 1989. A new species of *Cycloramphus* from southeastern Brazil (Amphibia, Leptodactylidae). Herpetologica 45:425-429.
- HEYER, W. R. 1983a. Variation and systematics of frogs of the genus *Cycloramphus* (Amphibia, Leptodactylidae). Arquivos de Zoologia, São Paulo 30:235-339.
- . 1983b. Notes on the frog genus *Cycloramphus* (Amphibia: Leptodactylidae), with descriptions of two new species. Proceedings of the Biological Society of Washington 96:548-559.
- . 1988. A notable collection of *Cycloramphus* (Amphibia, Leptodactylidae) from Bahia, Brazil, with a description of a new species (*Cycloramphus migueli*). Proceedings of the Biological Society of Washington 101:151-154.
- HEYER, W. R., AND R. I. CROMBIE. 1979. Natural history notes on *Craspedoglossa stejnegeri* and *Thoropa petropolitana* (Amphibia: Salientia, Leptodactylidae). Journal of the Washington Academy of Sciences 69:17-20.
- HEYER, W. R., AND L. R. MAXSON. 1983. Relationships, zoogeography, and speciation mechanisms of frogs of the genus *Cycloramphus* (Amphibia, Leptodactylidae). Arquivos de Zoologia, São Paulo 30:341-373.
- LEONEL, C. (Ed.). 2001. Intervalos, fundação para a conservação e a produção florestal do estado de São Paulo. Fundação Florestal, São Paulo, São Paulo, Brasil.
- LUTZ, A. 1929. Taxonomia e biologia do gênero *Cycloramphus*. Memórias do Instituto Oswaldo Cruz 22:5-25.
- LUTZ, B. 1947. Trends towards non-aquatic and direct development in frogs. Copeia 1947:242-252.
- MYERS, N., R. A. MITTERMEIER, C. MITTERMEIER, G. A. B. FONSECA, AND J. KENT. 2000. Biodiversity hotspots for conservation priorities. Nature 403:853-858.
- PAVAN, D., P. NARVAES, AND M. T. RODRIGUES. 2001. A new species of leptodactylid frog from the Atlantic forests of southeastern Brazil with notes on the status and on the speciation of the *Hylodes* species groups. Papéis Avulsos de Zoologia, São Paulo 41:407-425.
- POMBAL, J. P., AND C. F. B. HADDAD. 1999. Frogs of the genus *Paratelmatobius* (Anura: Leptodactylidae) with descriptions of two new species. Copeia 1999:1014-1026.

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#### APPENDIX I

##### Specimens Examined

*Cycloramphus bolitoglossus* MZUSP 94805; *C. carvalhoi* MNRJ 132 (holotype); *C. catarinensis* MZUSP 57771 (paratype); *C. diringshofeni* MZUSP 73691 (holotype); *C. eleutherodactylus* MZUSP 20 (paralectotype), 24 (lectotype), 23830-36, 23839-41, 57801; *C. granulatus* MZUSP 57802-04; *C. migueli* MZUSP 63450 (holotype), *C. stejnegeri* MZUSP 53397-409, 58582, 94866-79 and *C. valae* MZUSP 57860 (holotype).