

**Description of the advertisement call of
Cycloramphus bolitoglossus (Werner, 1897), with comments
on other species in the genus from Santa Catarina,
south Brazil (Amphibia, Cycloramphidae)**

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Abstract. Species of the genus *Cycloramphus* Tschudi 1838, occurring in the Atlantic Forest of Brazil are poorly known frogs which are generally under-represented in herpetological collections. For the first time, we provide the description of the advertisement call of *C. bolitoglossus*. The call consists of 16-18 harmonic notes emitted at intervals of 0.15-0.25 s. Call duration is from 3.95-4.48 s., and duration of the first note ranges from 0.21-0.28 s., whereas duration of each remaining note ranges from 0.07-0.12 s. Dominant frequency is 1.32-2.44 kHz. In the herpetological collections of the Natural History Museums in Berlin, Hamburg, München, and Stuttgart, we found valuable historical material of *Cycloramphus* collected by the German collector W. Ehrhardt in northeastern Santa Catarina state. This material included few specimens of *C. bolitoglossus* and *C. diringshofeni*, *C. izecksohni* which was also observed during our field work and *C. cf. asper*. Two syntypes of *Niedenia spinulifer* Ahl (a junior synonym of *C. asper* Werner) which were considered to be lost were rediscovered in the Berlin collection. We also report the first record of a species in this genus which is preliminary referred to *C. cf. catarinensis* from the Atlantic island Ilha de Santa Catarina.

Key words: *Cycloramphus*, Santa Catarina, vocalization, scientific collections, conservation

Introduction

Species of the genus *Cycloramphus* Tschudi 1838, are poorly known frogs which are restricted to the Atlantic Forest along eastern Brazil, from the state of Bahia to extreme north-eastern Rio Grande do Sul (Garcia and Vinciprova 1998, Garcia and Vinciprova 2003, Heyer 1983a, b, Heyer 1988, Heyer and Maxson 1983). The Atlantic Forest belongs to the leading global biodiversity hotspots in

terms of endemic plants and vertebrates, with only 7.5% of its primary vegetation remaining (Myers et al. 2000). Due to the lack of information, most species of *Cycloramphus* are currently considered "data deficient" (IUCN et al. 2006).

Twenty seven species are known in the genus *Cycloramphus* (Frost 2007, Brasileiro et al. 2007), eight of which occur in Santa Catarina state: *Cycloramphus asper* Werner, 1899, *C. bolitoglossus* (Werner, 1897), *C. catarinensis*

Heyer, 1983, *C. cedrensis* Heyer, 1983, *C. diringshofeni* Bokermann, 1957, *C. izecksohni* Heyer, 1983, *C. rhyakonastes* Heyer, 1983 and *C. valae* Heyer, 1983. For most of these taxa, data on distribution, ecology or bioacoustics are sparse and various species of *Cycloramphus* are known only from their type specimens (Pimenta et al. 2005).

Descriptions of vocalizations are important for taxonomical studies in anurans, since differences in some properties of advertisement calls could provide the first hint about the existence of cryptic species (e.g. Kwet et al. 2001, Kwet and Solé 2005, Lingnau et al. 2008). However, few species of *Cycloramphus* have their advertisement calls described. In this paper we provide the first description of the vocalization of *C. bolitoglossus* recorded from specimens near the type locality (Blumenau, Santa Catarina state, Brazil).

Due to the absence of biological data for most *Cycloramphus* species and the scarcity of preserved specimens in collections, any information about this poorly known genus is important. Therefore, we present herein new data on additional species of *Cycloramphus* from Santa Catarina. We report on historical material found in four herpetological collections in Germany, and we extend the distribution range of this genus on the Atlantic island of Ilha de Santa Catarina by two recently collected specimens.

Material and Methods

Field observations of *Cycloramphus* were made during two field trips in Santa Catarina in December 2004 and January 2006. Vocalizations were recorded with a Sony ECM-MS907

microphone coupled to a Marantz PMD-222 recorder. Calls were digitized with a sampling frequency of 22 kHz and 16 bits resolution. Audiospectrograms were made with the software Avisoft-SASLab Light with Fast Fourier Transformation of 256 points, 50% Overlap for an entire call, 75% Overlap for a sequence of the first six notes, and Window Hamming. Dominant frequencies, power spectrums and oscillograms were obtained with Cool Edit 96 with Fast Fourier Transformation of 1024 points.

Abbreviations used for museums are MCP (Museu de Ciências e Tecnologia da Pontifícia Universidade Católica do Rio Grande do Sul), SMNS (Staatliches Museum für Naturkunde Stuttgart), ZMB (Zoologisches Museum Berlin), ZMH (Zoologisches Museum der Universität Hamburg), and ZSM (Zoologische Staatssammlung München).

Results

Cycloramphus bolitoglossus (Fig. 1) was observed on 22 January 2006 in the Parque Nacional da Serra do Itajaí, 27°02'57"S, 49°09'00"W, at 640 m above sea level, during heavy rainfall (22 mm registered in less than one hour). At this locality we collected a single female (MCP 8725) walking above the leaf litter and heard sporadic calls of four males from the ground below the leaf litter. Due to the difficult access, we did not succeed to collect these males, but we recorded nine advertisement calls from one male. This call consisted of 16-18 harmonic notes emitted in a rapid sequence (Fig. 2). The intervals between notes were 0.15-0.25 s., and the call duration was from 3.95-4.48 s. The duration of the first note differed significantly from the remaining notes. Whereas the duration of the first note was 0.21-0.28 s., the duration of each remaining note was only 0.07-0.12 s. Dominant frequency ranged 1.32-2.44 kHz.



Figure 1. Female of *Cycloramphus bolitoglossus* in life, from Parque Nacional da Serra de Itajaí, Santa Catarina, Brazil (MCP 8725, 39.5mm). Photo: R. Lingnau.

Additional material of *C. bolitoglossus* was found recently in the herpetological collections of three natural history museums in Germany (Fig. 3). These historical specimens, which were in excellent conditions but partly misidentified and not yet inventoried, have been collected between 1918 and 1928 in the surroundings of Corupá (river basin of Rio Humboldt and Rio Novo) in northern Santa Catarina by the German collector Wilhelm Ehrhardt. This material comprised following specimens: ZMB 29997, 68240, 68184-186 (five specimens, see Gutsche et al. 2007a); ZMH A01745, A08793-95, A08796-8800, A08901 (ten specimens, see Gutsche et al. 2007b); and ZSM 103/1988 (two juvenile specimens). It is to remark that, in the ZSM collection,

we could not locate the type material of *Craspedoglossa Santae-Catharinae* Müller, 1922, a junior synonym of *C. bolitoglossus*, which was also collected by Ehrhardt confirming that these syntypes (originally under ZSM 658/1920, 10 specimens, and ZSM 662/1920, one specimen according to Glaw and Franzen 2006) are actually lost. It is also noteworthy to mention that the jars of six adult specimens in Hamburg, ZMH A08796-8800 and A08901, contained 11 lots with several large eggs presumably belonging to this species (or to the genus *Ischnocnema* – see discussion) collected in the ground by Ehrhardt (each lot containing between 1-9 eggs; see Fig. 4).

During our field trips, we observed various individuals of a second species in

this genus, *Cycloramphus izecksohni* (Fig. 5). Several vocalizing males, tadpoles and a gravid female could be collected at a small waterfall in the Serra Dona Francisca, municipality of Joinville, and at three rivulets in the municipality of Corupá. Due to the torrent water disturbing our call recordings, we cannot provide a description of the advertisement call consisting of weak, short clicks. *Cycloramphus izecksohni* seems to be more or less common in clear, fast running water in the mountainous surroundings of Corupá, living in syntopy with *Hylodes perplicatus* and a

species in the genus *Crossodactylus* which is not yet identified. This local abundance of *C. izecksohni* is confirmed by many historical specimens of this species collected near Corupá by Ehrhardt (Fig. 6). Following specimens were located in four herpetological collections: SMNS 8565, 11320 (eight specimens); ZMB 68496-98, 68771-75, 32019, 67225-27, 67935-36, 68081-87, 68119-20, 68192-95 (27 specimens, see Gutsche et al. 2007a); ZMH A08999-9002 (four specimens, see Gutsche et al. 2007b); ZSM 104/1988 (18 specimens).

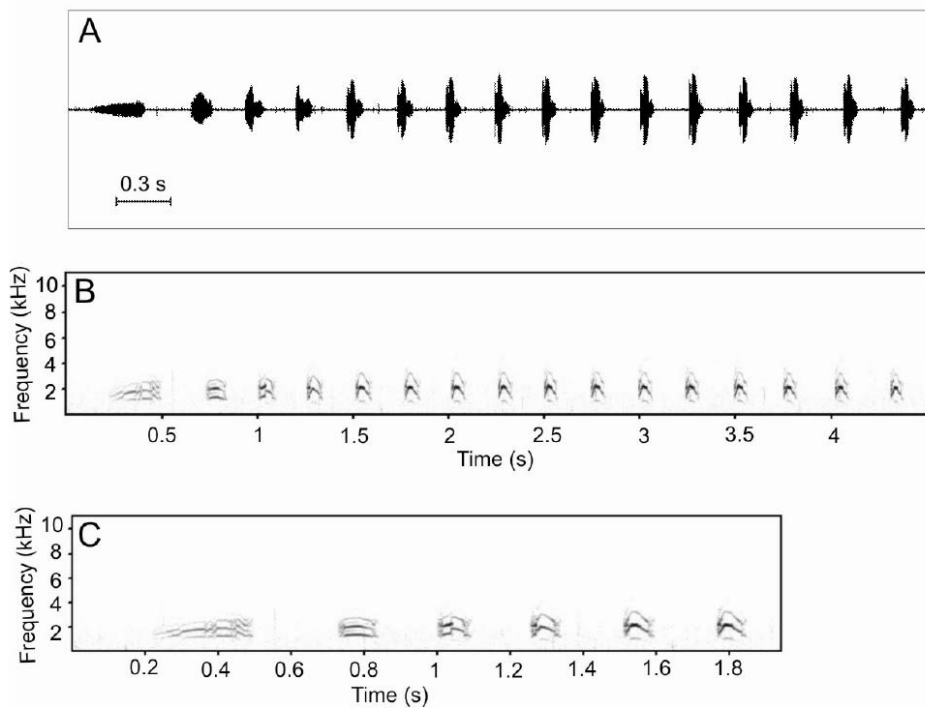


Figure 2. Advertisement call of *C. bolitoglossus*. Oscillogram (A) and audiospectrogram (B) of an entire call composed of 16 notes. (C) Audiospectrogram of the first six notes in detail. Recorded at Parque Nacional da Serra do Itajaí (Santa Catarina, Brazil) by R. Lingnau, 23°C air temperature.



Figure 3. Historical material of *C. bolitoglossus* in the ZMB collection, collected near Corupá (Rio Novo, Santa Catarina, Brazil) by Wilhelm Ehrhardt. Photo: A. Kwet.

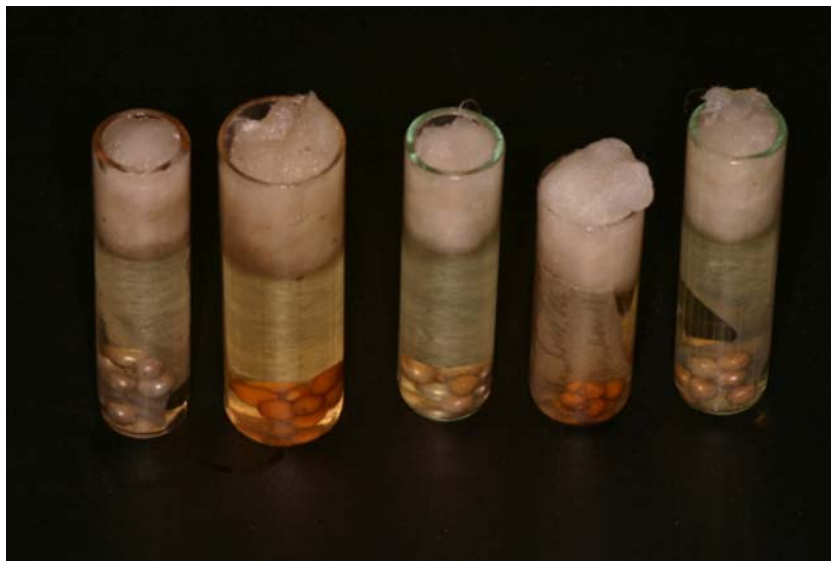


Figure 4. Five lots containing large eggs attributed to *C. bolitoglossus* by W. Ehrhardt, but possibly belonging to the genus *Ischnocnema* (lots are within the jars of specimens ZMH A08796–8800 and A08901). Photo: A. Kwet.



Figure 5. Male of *C. izecksohni* in life from the surroundings of Corupá (Santa Catarina, Brazil). Photo: A. Kwet.



Figure 6. Historical material of *C. izecksohni* in the ZMB collection, collected near Corupá (Rio Novo, Santa Catarina, Brazil) by W. Ehrhardt. Photo: A. Kwet.

In two collections we found material of a third species, *C. diringshofeni*, also collected near Corupá by Ehrhardt (Fig. 7): ZMB 68191 (1 specimen, see Gutsche et al. 2007a) and ZSM 95/1952 (2 specimens along with a third specimen without collection number). There are no recordings of *C. diringshofeni* in the SMNS and ZMH collections, and we did not find traces of this presumably very rare species in nature.

In the Berlin collection we also located 18 specimens of a small *Cycloramphus* from Corupá (ZMB 32014, 67942, 68226, 68499, 68776-89) which were tentatively referred to *C. cf. asper* by Gutsche et al. (2007a). However, this material might belong to another species, due to

differences to specimens of *C. asper* we examined. During our studies in the ZMB collection we rediscovered two type specimens of *C. asper* which were considered “probably destroyed” according to Heyer (1983a) or “possibly lost” according to Frost (2007). These syntypes (two specimens without numbers according to Heyer 1983a) of *Niedenia spinulifer* Ahl, 1924 (a synonym of *C. asper*) are inventoried under ZMB 26867 and 63129 (Fig. 8). According to the label the locality is given as “?Ndjiri-Sümpfe? ?Schillings?” (meaning Ndjiri swamps, Schillings?), but the type locality of this species was regarded “surely southern Brazil” by Bokermann (1966).



Figure 7. Two specimens of *C. diringshofeni* (labeled as *Leptodactylus* aff. *podicipinus*) in the ZSM collection, collected near Corupá (Rio Novo, Santa Catarina, Brazil) by W. Ehrhardt. Photo: A. Kwet.



Figure 8. Two rediscovered syntypes (ZMB 26867 and 63129) of *Niedenia spinulifer* (= *C. asper*) in the ZMB collection (locality restricted to “surely southern Brazil” by Bokermann (1966)). Photo: A. Kwet.



Figure 9. One of two recently collected specimens in pitfalls from Ilha de Santa Catarina, Santa Catarina, Brazil (MCP 8277-8278), preliminary identified as *C. cf. catarinensis*. A) dorsolateral, B) ventral views. Photos: A. Kwet.

Finally, two specimens of *Cycloramphus* (Fig. 9) collected in November 2004 in insect pitfalls on the island of Ilha de Santa Catarina (UCAD Reserve near Florianópolis) extend the

known distribution range of this genus in Santa Catarina state further to the east. The subadult specimens (MCP 8277-8278) are morphologically similar to *C. catarinensis* which is known to date only

from its type locality, Queçaba, Aguas Mornas, about 50 km from Florianópolis being separated from the continent by the Atlantic Ocean (about 400-1000 m wide). Pending further studies and including the collection of adult specimens we preliminary refer to this species as *C. cf. catarinensis*.

Discussion

Heyer (1983a) suggested five species groups in the genus *Cycloramphus*: the *C. bolitoglossus* group, the *C. eleutherodactylus* group, the *C. fuliginosus* group, the *C. granulatus* group and the *C. ohausi* group. All these species could be splitted in two ecomorphological groups: aquatic and terrestrial (Verdade 2005). The aquatic group is composed of the *fuliginosus*, *granulosus* and *ohausi* groups, characterized by flattened bodies and well-developed interdigital membranes in the feet; habitats in rocky streams in the forest (with the exception of *C. bandeirensis*, which dwells in open highland areas, Heyer 1983a), placement of eggs in layers on rocks in streams or waterfalls, and tadpoles that hatch early and feed on rocky stream banks (Verdade 2005). The terrestrial group is composed of the *bolitoglossus* and *eleutherodactylus* groups, characterized by short limbs, no interdigital membranes, terrestrial or semi-fossorial habitats, found on or under the leaf litter in forests, large eggs deposited in chambers or under logs on the leaf litter, and endotrophic tadpoles that hatch in advanced stages already with posterior limbs (Verdade 2005).

Field observations and general information on the natural history of most species in this genus are very

scarce. Out of 27 recognized taxa, only 12 had their advertisement calls described (Heyer 1983a, b, Heyer and Mello 1979, Giaretta and Cardoso 1995, Haddad and Sazima 1989, Brasileiro et al. 2007; see Table 1): two species in the *C. eleutherodactylus* group, eight species in the *C. fuliginosus* group, and only one in the *C. granulatus* and in the *C. ohausi* groups. The advertisement call of *C. bolitoglossus* presented in this paper is the first call described for a member of the *bolitoglossus* group. It is completely different from the advertisement calls of all other *Cycloramphus* species with available call descriptions, mainly by a distinct note pattern and longer call duration. All other calls in this genus have a typical pulse structure, composed of one to three short pulsed notes emitted sporadically, or up to 26 pulsed notes in *C. valae* and 37 pulsed notes in *C. ohausi*. In *C. bolitoglossus*, this typical pulse structure for *Cycloramphus* calls does not occur.

In *C. stejnegeri*, the only member of the *bolitoglossus* group with known reproductive mode, the eggs are deposited in a bead-like string and larvae in stages 30 and 31 (Gosner 1960) were found on the dorsum of females completing their metamorphosis by using the nutrients from large yolk stores (Heyer and Crombie 1979). However, notes on the reproduction of *C. bolitoglossus* are controversial. Müller (1922) wrote about the direct development of larvae in *Craspedoglossa Santae-Catharinae* (= *Cycloramphus bolitoglossus*): "the eggs are deposited in a clump on the leaf litter, and larvae grow inside leaving the egg almost as a completely developed frog". Later, Miranda-Ribeiro (1926) published a

figure of direct development in *Craspedoglossus sanctae-catharinae* (= *Cycloramphus bolitoglossus*), which became the subject of hard discussions between Adolfo Lutz and Miranda-Ribeiro (see Lutz 1929 and Miranda-Ribeiro 1929). All these observations by Müller, Lutz and Miranda-Ribeiro were only based on labels inside the jars with specimens of *C. bolitoglossus* collected by Wilhelm Ehrhardt, a German collector, who supplied various museums with important zoological items (brief biography in Gutsche et al. 2007a). However, most probably these observations are incorrect and the figured developmental eggs belong to the genus *Ischnocnema* (Heyer, 1983a). This means the reproductive mode of *C. bolitoglossus* needs to be confirmed

directly in the field. Although the reproduction of *C. bolitoglossus* is probably similar to *C. stejnegeri* instead for the direct development presumed by the formerly mentioned authors, this hypothesis could also be surprisingly correct. However, the very distinct advertisement call along with the distinct reproductive mode (known from *C. stejnegeri*) might indicate a distinct clade for the terrestrial members of this *Cycloramphus* species group. Species of the *bolitoglossus* group have been previously placed in the genus *Craspedoglossa* Müller, 1922, but more detailed studies are needed to confirm this hypothesis including other species of the *bolitoglossus* group and of the genus *Zachaeus* with similar morphology and larval development (Lutz 1944).

Table 1. Members of the genus *Cycloramphus* with described advertisement call, and their taxonomic and ecomorphologic group (Table adapted from Verdade 2005).

Species	Taxonomic group	Ecomorphologic group	Reference
<i>Cycloramphus eleutherodactylus</i>	<i>C. eleutherodactylus</i>	Terrestrial	Brasileiro et al. 2007
<i>Cycloramphus faustoi</i>	<i>C. eleutherodactylus</i>	Terrestrial	Brasileiro et al. 2007
<i>Cycloramphus boraceiensis</i>	<i>C. fuliginosus</i>	Aquatic	Heyer and Mello 1979 (as <i>C. dubius</i>)
<i>Cycloramphus brasiliensis</i>	<i>C. fuliginosus</i>	Aquatic	Heyer 1983a
<i>Cycloramphus cedrensis</i>	<i>C. fuliginosus</i>	Aquatic	Heyer 1983b
<i>Cycloramphus dubius</i>	<i>C. fuliginosus</i>	Aquatic	Giaretta and Cardoso 1995
<i>Cycloramphus izecksolmi</i>	<i>C. fuliginosus</i>	Aquatic	Heyer 1983a (as <i>C. duseni</i>)
<i>Cycloramphus juimirim</i>	<i>C. fuliginosus</i>	Aquatic	Haddad and Sazima 1989
<i>Cycloramphus rhyakonastes</i>	<i>C. fuliginosus</i>	Aquatic	Heyer 1983a
<i>Cycloramphus semipalmatus</i>	<i>C. fuliginosus</i>	Aquatic	Heyer and Mello 1979 (as <i>C. asper</i>)
<i>Cycloramphus valae</i>	<i>C. granulatus</i>	Aquatic	Heyer 1983b
<i>Cycloramphus ohausi</i>	<i>C. ohausi</i>	Aquatic	Heyer 1983a
<i>Cycloramphus bolitoglossus</i>	<i>C. bolitoglossus</i>	Terrestrial	This study

Beside the general scarcity of natural history data of many *Cycloramphus* species, members of the *C. bolitoglossus* group have been considered especially rare in zoological collections (Heyer 1983a). However, Verdade and Rodrigues (2003) suggested that species of this group may be more common in nature than previously reported and that specimens can be easily captured in pitfall traps. We agree in that these species may be easily captured by the pitfall trap method, especially during heavy rains, as confirmed by our record of two specimens of *C. cf. catarinensis* from Ilha de Santa Catarina. However, during several months both sudadults were the only specimens collected in these pitfalls on the island, and under ideal reproductive conditions (warm, wet weather and several field trips within the presumed breeding season) we could not find any traces of additional specimens at this well studied locality. Similarly we could hear only four males vocalizing at the type locality of *C. bolitoglossus* during excellent conditions for reproduction. Conte and Machado (2005) also heard only five specimens, when observing vocalizing males of *C. bolitoglossus* during strong rainfall (Machado, pers. comm. 2008). Although members in the *C. bolitoglossus* group are explosive breeders with seasonal activity patterns, it should be considered that natural populations of these species might be often small.

During an evaluation of the endangered fauna of the adjacent state of Paraná, Segalla and Langone (2004) considered various species of *Cycloramphus* in the category "data deficient" according to IUCN et al. (2006). For *C. valae*, the only species occurring in

adjacent Rio Grande do Sul, Garcia and Vinciprova (2003) stated "vulnerable" for populations in this state. To date, there is no regional list of endangered species in Santa Catarina, and especially the conservation status of *Cycloramphus* species needs to be verified with new data as provided herein. Currently, all species mentioned in our paper are considered "data deficient" sensu IUCN et al. (2006).

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