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## Extension of the geographical distribution of two anuran species for Rio Grande do Sul State, Brazil, with comments on natural history

Vinícius Matheus Caldart<sup>1,3</sup>, Samanta Iop<sup>1</sup>, Tiago Gomes dos Santos<sup>2</sup> & Sonia Zanini Cechin<sup>1</sup>

<sup>1</sup>Programa de Pós-graduação em Biodiversidade Animal, Laboratório de Herpetologia, Centro de Ciências Naturais e Exatas, Universidade Federal de Santa Maria – UFSM  
Av. Roraima, s/n, Camobi, CEP 97105-900, Santa Maria, RS, Brasil

<sup>2</sup>Universidade Federal do Pampa – UNIPAMPA, Campus São Gabriel  
Av. Antônio Trilha, 1847, CEP 97300-000, São Gabriel, RS, Brasil

<sup>3</sup>Corresponding author: Vinícius Matheus Caldart, e-mail [viniciuscaldart@yahoo.com.br](mailto:viniciuscaldart@yahoo.com.br)

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**Abstract:** We record for the first time *Crossodactylus schmidtii* (Anura: Hylodidae) and *Proceratophrys avelinoi* (Anura: Cycloramphidae) from Rio Grande do Sul State, Brazil, based on individuals captured in an area of Mesophytic Semideciduous Forest, the Parque Estadual do Turvo, located in the northwest region of the state. These records extend the geographical range for both species in about 60 km from the nearest known locality, the Municipality of San Vicente, Misiones, Argentina. We provide a characterization of the calling site used by males of *Crossodactylus schmidtii*, and we also determined the niche breadth of *P. avelinoi* regarding to the use of water bodies.

**Keywords:** range extension, calling site, breeding site, niche breadth, habitat use, Parque Estadual do Turvo, Mesophytic Semideciduous Forest.

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**Resumo:** Reportamos o primeiro registro de *Crossodactylus schmidtii* (Anura: Hylodidae) e *Proceratophrys avelinoi* (Anura: Cycloramphidae) para o Estado do Rio Grande do Sul, Brasil, com base em indivíduos coletados em área de Floresta Estacional Semidecidual, Parque Estadual do Turvo, região noroeste do estado. Estes registros ampliam a área de distribuição das duas espécies em aproximadamente 60 km a partir da localidade mais próxima conhecida, o Município de San Vicente, Misiones, Argentina. Fornecemos, ainda, uma caracterização do sítio de vocalização de *C. schmidtii* e determinamos a amplitude de nicho de *P. avelinoi* quanto ao uso de corpos d'água.

**Palavras-chave:** ampliação da distribuição, sítio de vocalização, sítio reprodutivo, amplitude de nicho, uso do habitat, Parque Estadual do Turvo, Floresta Estacional Semidecidual.

## Introduction

The State of Rio Grande do Sul, despite being located in a subtropical region, has a rich fauna of amphibians. A list of the species of anurans occurring in the state was published by Machado & Maltchik (2007), accounting for 84 anuran species with confirmed occurrence in this state. Later, new records were published, increasing the anuran richness of the state to 88 (Colombo et al. 2007; Zanella et al. 2007; Rosset 2008; Iop et al. 2009). Currently, the State of Rio Grande do Sul has confirmed the occurrence of 88 anuran species, which corresponds to approximately 10% of the fauna of anurans known to Brazil. In this paper we add more two species to the list of anurans from Rio Grande do Sul, belonging to the genera *Crossodactylus* and *Proceratophrys*.

The genus *Crossodactylus* is the second largest genus of the family Hylodidae, distributed from the Northeast to Southern Brazil, Southern Paraguay and Northern Argentina (Frost 2010). Species of *Crossodactylus* have small size, are diurnal and live in riparian habitats, where they show prolonged reproductive activity (Caramaschi & Sazima 1985, Almeida-Gomes et al. 2007). However, despite this information, data on taxonomy, natural history and geographical distribution of *Crossodactylus* species are still scarce (Pimenta et al. 2008). The 11 species of *Crossodactylus* currently recognized are grouped into three groups: *C. gaudichaudii*, *C. trachystomus*, and *C. schmidtii* (Caramaschi & Sazima 1985, Frost 2010). The group *C. schmidtii* is monospecific, consisting of the nominal species, whose description was made from a specimen collected in Misiones, Argentina (Gallardo 1961). Since then, few records were made to new locations (Segalla 2004; Brusquetti & Lavilla 2006; Lucas 2009).

The genus *Proceratophrys* comprises 18 species, occurring in eastern and Southern Brazil, Northeast Argentina, and Paraguay (Frost 2010). The *P. bigibbosa* group includes four species: *P. avelinoi* Mercadal de Barrio & Barrio 1993, *P. bigibbosa* (Peters 1872), *P. brauni* Kwet & Faivovich 2001, and *P. palustris* Giaretta & Sazima 1993. These species are characterized by postocular swellings and large marginal tubercles on the eyelids (Kwet & Faivovich 2001). The few studies regarding *P. avelinoi* include descriptions of the tadpole (De Sá & Langone 2002) and the advertisement call (Kwet & Baldo 2003), but in spite of the several and widely dispersed records, the geographical distribution of *P. avelinoi* is still poorly known.

Herein, besides reporting for the first time the occurrence of *C. schmidtii* and *P. avelinoi* in the State of Rio Grande do Sul, Brazil, we determined the niche breadth of *P. avelinoi* regarding the use of water bodies as breeding habitats, and we also provided a characterization of the calling site used by males of *C. schmidtii*.

## Material and Methods

The Parque Estadual do Turvo (PET) is located in the NorthWestern region of the State of Rio Grande do Sul, Municipality of Derrubadas (27° 14' 34.08" S and 53° 57' 13.74" W; altitude ranges from 100-400 m), and covers an area of 17,491.4 ha, belonging to the Atlantic Forest biome and characterized as Mesophytic Semideciduous Forest. This park is one of the last preserved remnants of this kind of forest in Southern Brazil (SEMA 2005). The local climate is characterized as subtropical subhumid with dry summer (ST SB v type of Maluf 2000). The average temperature of the warmest month (January) is above 22° C and the coldest month (July) ranges between -3 to 28 °C. The average annual rainfall is 1,665 mm and the rains are well distributed throughout the year (SEMA 2005).

From April 2009 to March 2010, ten days monthly, we carried out ecological studies with the anurofauna of PET (S. Iop, unpublished data), using complementary methods of inventory: pitfall traps with drift fences (Corn 1994; Cechin & Martins 2000) installed inside

and at the edges of the forest (four lines with four barrels of 100 L in each environment), as well as surveys at breeding sites. The sampling effort in the monitored breeding sites varied according to size and complexity (sensu Scott & Woodward 1994) along the edge of 27 water bodies in the PET (15 ponds, three swamps, eight streams, and the Uruguay River).

Moreover, from September 2009 to March 2010 we recorded the following descriptors in order to characterize the calling site of males of *C. schmidtii*:

- Substratum type: water, rocks, roots, ground or marginal vegetation;
- Edge distance (cm): the shortest distance from the calling male to the stream edge; and
- Height from water surface: on water level or above water level.

We also determined the niche breadth of *P. avelinoi* regarding to the use of water bodies available for breeding activities by Hurlbert's standardized niche breadth (Krebs 1999). This index allows analysis of the resource use considering a measure of the proportional abundance of each state of resource (Krebs 1999). The niche breadth varies from 0-1, considered minimal when all the individuals are recorded in only one resource state, and maximal when the individuals occur equally in all possible resource states (Krebs 1999). A species is considered to have a wide niche breadth when  $B'_A \geq 0.5$ .

For assessing the known distribution of *Crossodactylus schmidtii*, we also searched in Herpetological Collections (Museu de Zoologia – USP, and those available at the Rede Species Link: <http://splink.cria.org.br>). The collected specimens of *P. avelinoi* were deposited in the Herpetological Collection of the Universidade Federal de Santa Maria (ZUFMS 4375-77), and the collected specimens of *C. schmidtii* were deposited in the Herpetological Collection of the Museu Nacional do Rio de Janeiro (MNRJ 60785-89).

## Results and Discussion

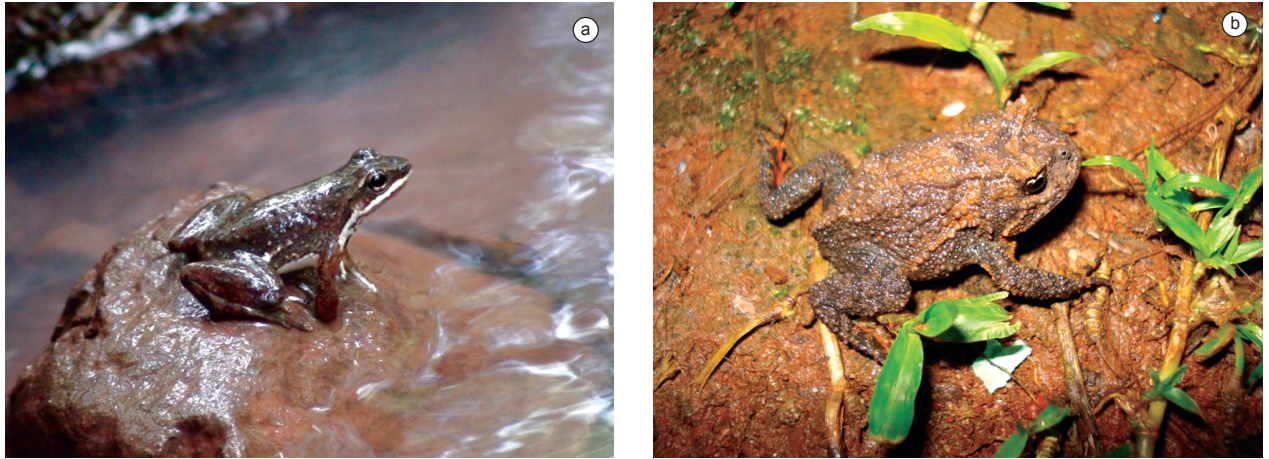
### 1. Species distribution

We record *C. schmidtii* and *P. avelinoi* (Figure 1) for Rio Grande do Sul based on individuals captured in the Parque Estadual do Turvo, Municipality of Derrubadas. Herein, we extend the known distribution of *C. schmidtii* and *P. avelinoi* in about 60 km to Southeastern in relation to the nearest records, the Municipality of San Vicente, Misiones Province, Argentina (Figure 2) (Kwet & Faivovich 2001).

In addition to our record, based on literature the current geographical distribution of *C. schmidtii* covers the type locality in Misiones, Northern Argentina (Gallardo 1961, Cei 1980), one locality in Itapúa, Southern Paraguay (Brusquetti & Lavilla 2006); two localities in Western Santa Catarina State (Lucas 2009) and one locality in Paraná State, Brazil (Segalla 2004, Frost 2010). However, searches in the herpetological collections showed additional records of *C. schmidtii* for one more locality in Misiones, Argentina (San Vicente, Depto Guarany, CFBH 9495-98), and for two other localities in Paraná, Brazil (Porto Camargo, MZUSP 15855- 63; Maringá, CFBH 17174-78 and CFBH 17265).

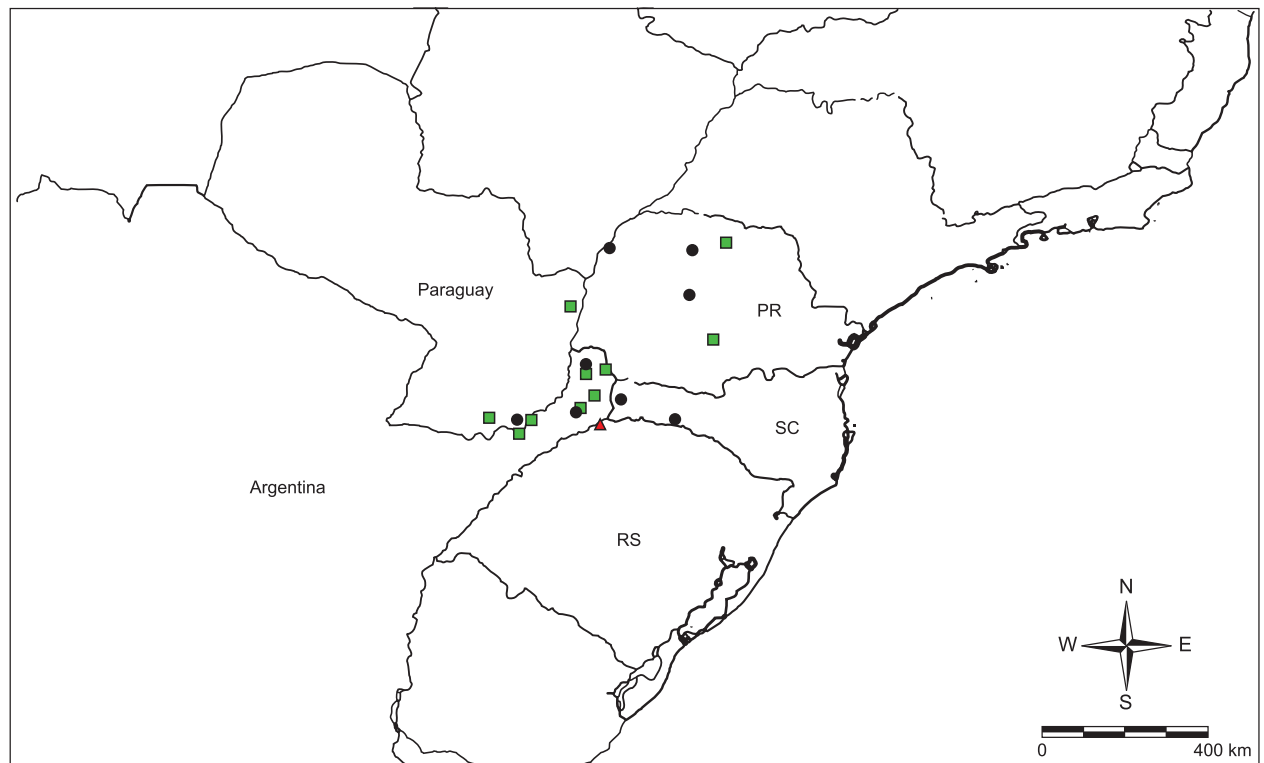
The geographical distribution of *P. avelinoi* includes ten localities, in addition to our record: one in department of Itapúa and one in department of Alto Paraná, Paraguay (Brusquetti & Lavilla 2006, Carosini et al. 2010); six in Misiones, Argentina (Kwet & Faivovich 2001); and two in the State of Paraná, Brazil (Machado et al. 1999, De Sá & Langone 2001). There are also records for Ipuacu Municipality, State of Santa Catarina, Brazil (Giasson et al. 2001, Hartmann et al. 2008), but according to Lucas (2008) the specimens refer to *P. bigibbosa*.

## Distribution extension of two anuran species for Rio Grande do Sul



**Figure 1.** Adult males of a) *Crossodactylus schmidtii* and b) *Proceratophrys avelinoi* from Parque Estadual do Turvo, State of Rio Grande do Sul, Brazil. Photos by a) Vinícius M. Caldart and b) Samanta Iop.

**Figura 1.** Machos adultos de a) *Crossodactylus schmidtii* e b) *Proceratophrys avelinoi* do Parque Estadual do Turvo, Estado do Rio Grande do Sul, Brasil. Fotos de a) Vinícius M. Caldart e b) Samanta Iop.



**Figure 2.** Geographical distribution of *Crossodactylus schmidtii* and *Proceratophrys avelinoi*. Black dots: localities of occurrence of *C. schmidtii*; Green squares: localities of occurrence of *P. avelinoi*; Red triangle: new state record for both *C. schmidtii* and *P. avelinoi*, Municipality of Derrubadas, Rio Grande do Sul, Brazil.

**Figura 2.** Distribuição geográfica de *Crossodactylus schmidtii* e *Proceratophrys avelinoi*. Pontos pretos: localidades de ocorrência de *C. schmidtii*; Quadrados verdes: localidades de ocorrência de *P. avelinoi*. Triângulo vermelho: novo registro para *C. schmidtii* e *P. avelinoi*, município de Derrubadas, Rio Grande do Sul, Brasil.



## 2. Calling sites of *Crossodactylus schmidt*

We recorded males in calling activity and found tadpoles of the species swimming at the stream bottom in all field samples. Males of *C. schmidt* were active mainly during the day, but also showed calling activity at night. Individuals called mainly on rocks, at the water level (77.41%;  $n = 24$ ). Only two individuals who were recorded calling on rocks were above the water level (6.45%;  $n = 2$ ). Few males were found calling perched on vegetation (Cyperaceae, Poaceae, and Pteridophyta), near the stream edge (16.13%;  $n = 5$ ), a type of substrate commonly used by inactive individuals during the night. *Crossodactylus schmidt* showed a large plasticity in relation to the distance from the stream edge at the site of vocalization, (range = 0-190 cm;  $X = 58 \pm 50$  cm;  $n = 31$ ), which is possibly related to the availability of rocks along the streams, since in some places this type of substrate is available closer to the edges, and other, more distant.

On the other hand, *C. schmidt* showed a narrow fidelity in relation to the types of substrate, since from the five substrates considered, only rocks (mainly) and marginal vegetation were used as calling sites. The use of rocks as calling sites seems to be more advantageous in several aspects for *C. schmidt*, because it provides quick access to water at potential risk of predation and access to underwater chambers, as well as provides wide visibility for the development of visual repertoires related to the breeding activities of this species. The use of rocks as calling sites is well reported for species of the genus *Hylodes*, which also live in streams and perform visual communication (Wogel et al. 2004; Hartmann et al. 2005; Narvaes & Rodrigues 2005).

## 3. Habitat use in *Proceratophrys avelinoi*

We recorded calling males of *P. avelinoi* in three of 27 water bodies sampled at PET, from September to November 2009: a permanent swamp near a stream source (27° 14' 41.55" S and 53° 57' 13.21" W); a temporary pond located inside PET (27° 12' 34.68" S and 53° 51' 17.76" W); and a permanent swamp located between the forest and an open area used for cattle grazing (27° 14' 45.65" S and 53° 57' 0.01" W). Additionally, we found two males of *P. avelinoi* in June 2009 in the forest edge (27° 14.570' 35.49" S and 53° 57' 1.00" W), by trapping. All collected specimens had a dirty, muddy dorsum, such as reported by Kwet & Faivovich (2001). We did not find *P. avelinoi* in the streams sampled inside the park. Species of the *P. bigibbosa* group are cryptic and of difficult identification, but *P. avelinoi* can be recognized by its small size, since it is the smallest species of the group (Kwet & Faivovich 2001).

*Proceratophrys avelinoi* was considered as specialist regarding to the use of water bodies as breeding habitats ( $B'_A = 0.229$ ; 95% confidence = -0.009 to 0.467), since only three of the 27 water bodies sampled in the PET were used by calling males. Water bodies used by *P. avelinoi* in the study area were closely similar in several structural characteristics: water surface covered by dense vegetation (usually clumps of Poaceae and Cyperaceae), shallow water (mean depth of 10 cm), and swamps with slow water flow. Similar structural characteristics were reported for the breeding habitats used by *P. avelinoi* in the Municipality of San Vicente, Misiones Province (Kwet & Faivovich 2001), indicating that this species has narrow breeding habitat requirements, represented mainly by lentic water bodies covered by vegetation.

We recorded males of *P. avelinoi* calling during both night and day, a behavior not observed before in this species, but reported for other species of the *P. bigibbosa* group (Kwet & Faivovich 2001). The occurrence of *P. avelinoi* in the Northwest part of the State of Rio Grande do Sul was expected, since the geographical distribution

of this species is associated with Mesophytic Semideciduous Forest (Kwet & Faivovich 2001) of the Misiones Nucleus (*sensu* Pennington et al. 2000). Thus, the geographical distribution of *P. avelinoi* may be larger than currently known, which could be confirmed with future surveys in remnants of Mesophytic Semideciduous Forest in Southern Brazil.

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