

# *Chiasmocleis carvalhoi* Cruz, Caramaschi & Izecksohn, 1997 (Anura: Microhylidae): Distribution extension in São Paulo state, southeastern Brazil, and geographic distribution map

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**ABSTRACT:** Herein, we report new records for *Chiasmocleis carvalhoi* from southern regions of São Paulo state. We also provided an updated geographic range map and modelled the potential distribution of this species. New records extended the known species distribution about 150 km southwards of the São Paulo state coast. Moreover, the geographic range map of *C. carvalhoi* and its potential distribution evidenced that the distribution of this species is typical to lowlands forests habitats and reinforce its current endangered conservation status.

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*Chiasmocleis* is the most species-rich genera of Microhylidae with 29 assigned species, being widely distributed throughout the Neotropical region (Cruz *et al.* 1997; Frost 2014). In the South America, *Chiasmocleis* species are associated with the Amazon Forest, open areas of Brazilian savannas, the Chaco region, including Bolivia and Paraguay, and throughout the Atlantic Forest (Caramaschi and Cruz 1997; Frost 2014). Currently, eleven species of *Chiasmocleis* are assigned to the Atlantic Forest (Frost 2014), including the central humming frog *C. carvalhoi*.

*Chiasmocleis carvalhoi* (Figure 1) is a small sized species (SVL 15.0–22.0 mm) and is diagnosed by: hands and feet not webbed, finely marbled belly, and smaller size than other Atlantic Forest *Chiasmocleis* species (maximum SVL = 18.3 mm in males and 22.5 mm in females; see Cruz *et al.* 1997) described from municipality of Seropédica, Rio de Janeiro state (Cruz *et al.* 1997). *Chiasmocleis carvalhoi* lives on the leaf-litter of lowland Atlantic Forest (up to 40 m above sea level (a.s.l.)), breeding after heavy rains as an explosive breeder (Cruz *et al.* 1997). Males can be found calling on the edges or floating in the early-formed temporary ponds inside the forest (Izecksohn and Carvalho-e-Silva 2001; Pimenta and Peixoto 2004; Wogel *et al.* 2004). Pimenta *et al.* (2002) provided the first record from Bahia state, northeastern Brazil. Recently, records from Espírito Santo state were provided (Almeida *et al.* 2011), filling a gap between seemingly disjoint populations of this species (Pimenta and Peixoto 2004). The known southward limit of its distribution is the Ubatuba municipality on the northern coast of São Paulo State (Hartmann *et al.* 2002).

Herein, we report new records for *Chiasmocleis carvalhoi* from southern regions of São Paulo state.



**FIGURE 1.** Adult male of *Chiasmocleis carvalhoi* (SVL= 18.38 mm) from Itanhaém municipality, São Paulo state, Brazil. Photo by: Amom M. Luiz

Moreover, we provided an update geographic range map and modelled the potential distribution of this species based on the new records, literature, and museum-based data from “Coleção de Anfíbios Célio F. B. Haddad (CFBH)”, and “Museu de Zoologia Adão José Cardoso”, Universidade Estadual de Campinas (ZUEC). We choose these scientific collections due to their well-organized database with an excellent rate of sampling in the studied area, and due to our logistical constraints to sample other scientific collections. However, we are aware of the records equally relevant from other scientific collections (*e.g.*, MNRJ) and which are absent of our data.

On 16 December 2011, around 22:00 h during a fieldwork in a private ownership, at municipality of Itanhaém, southern coast of São Paulo state (24°11'1.9" S, 46°51'44.2" W; 20 m a.s.l.), we found three males (mean

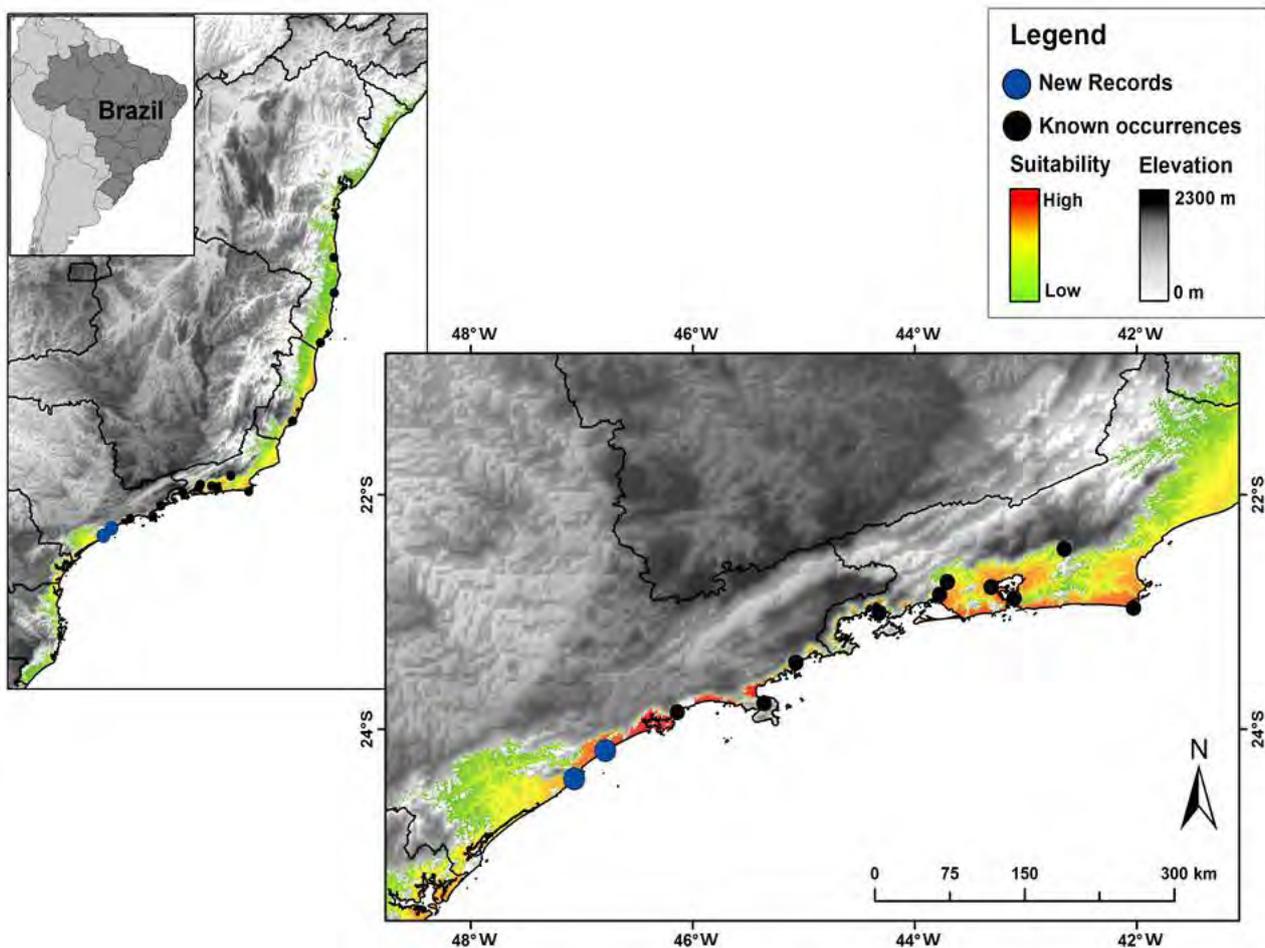
SVL = 18.04 mm) and one female (SVL = 21.14 mm) of *Chiasmocleis carvalhoi*. The specimens were on the leaf-litter of a lowland forest area. Specimens are housed at “Museu de Zoologia da Universidade de São Paulo” (MZUSP 153445–153449). We also recorded a specimen (CFBH 23711; collected by Ricardo Sawaya, Fausto Barbo, and Murilo Guimarães on 1 October 2011; Figure 2) at Ilha do Ameixal, Peruíbe municipality, southern coast of São Paulo state ( $24^{\circ}25'28.46''$  S,  $47^{\circ}4'52.84''$  W; 18 m a.s.l.). These records represent the southernmost known localities of geographic range of *C. carvalhoi*, and extend its known geographic range for about 230 km from the last published record (Ubatuba municipality; Hartmann *et al.* 2002). Figure 3 shows the known occurrence points, new records, and potential distribution based on species distribution modeling (SDM). The potential distribution was modeled using 114 records compiled from literature data, voucher specimens and new records.

The potential distribution of *C. carvalhoi* modeled by Maxent (Phillips *et al.* 2006) based on occurrence records analyzed and the 19 bioclimatic variables (Hijmans *et al.* 2005) shows that this species is constrained to lowlands. In fact, its occurrence seems to be strongly associated to lowlands forest environments, such as “restinga” habitats, mainly in São Paulo and Rio de Janeiro states (Figure 3). “Restinga” habitats are described as the quaternary sediments deposited during oceanic transgressions



**FIGURE 2.** *Chiasmocleis carvalhoi* (CFBH 23711) from Ilha do Ameixal, Peruíbe municipality, São Paulo state, Brazil. Photo by: Ricardo J. Sawaya.

and regressions (Suguio and Tessler 1984). Moreover, this term can be used to designate a complex of vegetal physiognomic forms (*i.e.*, fields, scrubs, and forests), generating a gradient from the so called restinga fields to restinga forests, established on sandy soils along the Brazilian coast plains (Cerqueira 2000; but see Marques *et al.* 2011). However, as cited here, Pimenta and Peixoto (2004) recorded disjunct populations of *C. carvalhoi* in the southern part of the state of Bahia in eastern Brazil. In fact, these populations may possibly occur in the “mussunungas”



**FIGURE 3.** Geographic distribution map and potential distribution of *Chiasmocleis carvalhoi*. Circles represent points of occurrence. Black circles represent known records from literature and scientific collections, and blue circles represent new records. The SDM was computed in MaxEnt 3.3.3 (Phillips *et al.* 2006), using 19 bioclimatic variables at spatial resolution of  $30''$  (Hijmans *et al.* 2005) and 114 records. AUC value was 0.998 which indicated a model with better performance than expected by chance (see Elith *et al.* 2006).

habitats. As are the “restinga”, the “mussunungas” also are habitats associated with Atlantic rainforest biome, and occurs from southern Bahia and northern Espírito Santo states. This habitat can be defined as a physiognomy that ranges from grasslands to woodlands, which grows over sandy spodosol soils, originated from sandstones of the Barreiras Group from the Tertiary period (ca. 16 million years before present) (Saporetti-Junior *et al.* 2012). Thus, “mussunungas” habitats seem to be very similar to “restinga” habitats and the former can represent a potential occurrence distribution of *C. carvalhoi* based on our SDM for the species.

The International Union for Conservation of Nature (IUCN) listed *Chiasmocleis carvalhoi* as endangered, based on restricted area occupancy, distribution severely fragmented and probable declining of its habitat quality (Pimenta and Peixoto 2004). Therefore, although our records had extended the known distribution of this species, its endangered and restricted habitat, including São Paulo state, are concerns to take account in the conservation of *Chiasmocleis carvalhoi* and other typical species from restinga forests. This is the case for other anuran species inhabiting restinga forests in the São Paulo state (e.g., *Arcovomer passarelli*; Malagoli *et al.* 2012). Restinga habitats are one of the most endangered physiognomic forms of the Atlantic rainforest (Marques *et al.* 2011), and consequently, species restricted to and strongly associated with these habitats are prone to severe population declines, as evidenced by the conservation status of *Chiasmocleis carvalhoi*. Distributional data are primary to inform conservation planning and reinforce the concerns about necessity of creation of new conservation units in restinga habitats (Rocha *et al.* 2008).

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#### LITERATURE CITED

- Almeida, A.P., J.L. Gasparini and P.L.V. Peloso. 2011. Frogs of the state of Espírito Santo, southeastern Brazil—The need for looking at the ‘coldspots’. *Check List* 7(4): 542–560 (<http://www.checklist.org.br/getpdf?SL021-11>).
- Caramaschi, U. and C.A.G. Cruz. 1997. Redescription of *Chiasmocleis albopunctata* (Boettger) and description of a new species of *Chiasmocleis* (Anura: Microhylidae). *Herpetologica* 53(2): 259–268 (<http://www.biotaneotropica.org.br/v11n3/pt/fullpaper?bn02411032011+en>).
- Cruz, C.A.G., U. Caramaschi and E. Izecksohn. 1997. The genus *Chiasmocleis* Méhely, 1904 (Anura, Microhylidae) in the Atlantic Rain Forest of Brazil, with description of three new species. *Alytes* 15(2): 48–71 (<http://www.bioone.org/doi/full/10.2994/1808-9798%282007%292%5B47%3AANSOCA%5D2.0.CO%3B2>).
- Elith, J., C.H. Graham, R.P. Anderson, M. Dudik, S. Ferrier, A. Guisan, R.J. Hijmans, F. Huettmann, J.R. Leathwick, A. Lehmann, J. Li, L.G. Lohmann, B.A. Loiselle, G. Manion, C. Moritz, M. Nakamura, Y. Nakazawa, J.M. Overton, A.T. Peterson, S.J. Phillips, K. Richardson, R. Scachetti-Pereira, R.E. Schapire, J. Soberon, S. Williams, M.S. Wisz and N.E. Zimmermann. 2006. Novel methods improve prediction of species’ distributions from occurrence data. *Ecography* 29: 129–151 (doi: 10.1111/j.2006.0906-7590.04596.x).
- Frost, D.R. 2014. *Amphibian Species of the World: An Online Reference. Version 5.6*. Accessible at <http://research.amnh.org/vz/herpetology/amphibia>. Captured on 14 April 2014.
- Hartmann, M.T., P.A. Hartmann and C.F.B. Haddad. 2002. Advertisement calls of *Chiasmocleis carvalhoi*, *Chiasmocleis mehelyi*, and *Myersiella microps* (Microhylidae). *Journal of Herpetology* 36(3): 509–511 (doi: 10.2307/1566200).
- Hijmans, R.J., S.E. Cameron, J.L. Parra, P.G. Jones and A. Jarvis. 2005. Very high resolution interpolated climate surfaces for global land areas. *International Journal of Climatology* 25: 1965–1978 (doi: 10.1002/joc.1276).
- Izecksohn, E. and S.P. Carvalho-e-Silva. 2001. *Anfíbios do Município do Rio de Janeiro*. Rio de Janeiro: Editora UFRJ. 149 pp.
- Malagoli, L.R., T.H. Condez and C.F.B. Haddad. 2012. *Arcovomer passarelli* Carvalho, 1954 (Amphibia: Anura: Microhylidae): Distribution extension in São Paulo state, Brazil and geographic distribution map. *Check List* 8(3): 505–506 (<http://www.checklist.org.br/getpdf?NGD158-11>).
- Marques M.C.M., M.D. Swaine, and D. Liebsch. 2011. Diversity distribution and floristic differentiation of the coastal lowland vegetation: implications for the conservation of the Brazilian Atlantic Forest. *Biodiversity and Conservation* 20: 153–168 (doi: 10.1007/s10531-010-9952-4).
- Pimenta, B., C.A.G. Cruz and M. Dixo. 2002. Geographic distribution. *Chiasmocleis carvalhoi* (Central Humming Frog). *Herpetological Review* 33: 219.
- Pimenta, B. and O.L. Peixoto. 2004. *Chiasmocleis carvalhoi*. *IUCN Red List of Threatened Species. Version 2012.2*. Accessible at <http://www.iucnredlist.org>. Captured on 15 October 2013.
- Phillips, S.J., R.P. Anderson and R.E. Schapire. 2006. Maximum entropy modeling of species geographic distributions. *Ecological Modelling* 190: 231–259 (doi: 10.1016/j.ecolmodel.2005.03.025).
- Rocha, C.F.D., F.H. Hatano, D. Vrcibradic and M. Van Sluys. 2008. Frogs species richness, composition and  $\beta$ -diversity in coastal Brazilian restinga habitats. *Brazilian Journal of Biology* 68(1): 101–107 (doi: 10.1590/S1519-69842008000100014).
- Saporetti-Junior, A.W. Schaefer, C.E.G.R. Souza, A.L. Soares, M.P. Soares, D.S.D. Araújo and J.A.A. Meira-Neto. 2012. Influence of soil physical properties on plants of the Mussununga ecosystem, Brazil. *Folia Geobotanica* 47(1): 29–39 (doi: 10.1007/s12224-011-9106-9).
- Wells, K.D. 2007. *The Ecology and Behavior of Amphibians*. Chicago: Chicago Press. 1117 pp.
- Wogel, H., P.A. Abrunhosa and G.M. Prado. 2004. The tadpole of *Chiasmocleis carvalhoi* and the advertisement calls of three species of *Chiasmocleis* (Anura, Microhylidae) from Atlantic Rain Forest of southeastern Brazil. *Phyllomedusa* 3(2): 133–140 (<http://www.phyllomedusa.esalq.usp.br/articles/volume3/number2/32133140.pdf>).

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