**ANURAN FAUNA OF THE HIGH-ELEVATION AREAS OF THE PARQUE NACIONAL DA SERRA DOS ÓRGÃOS (PARNASO), SOUTHEASTERN BRAZIL**

**ABSTRACT.** There is a lack of knowledge regarding the diversity of anuran in high-elevation areas. In order to improve the knowledge about the diversity of this group in this kind of environment, we present a list of anuran amphibians recorded in high-elevation areas (up to 1,200 m) of the Parque Nacional da Serra dos Órgãos (PARNASO). Twenty-eight species belonging to seven families were recorded: Brachycephalidae (6 species), Bufonidae (3), Cycloramphidae (4), Hemiphractidae (5), Hylidae (8), Hylodidae (1), and Odontophrynidae (1). According to the IUCN Red List eight of those species are classified as “Data Deficient” and two speciesare not assessed yet (i.e., *Dendrophryniscus organensis* and *Fritziana* sp. nov.). Ten speciesare classified as “Least Concern” with populations in decline, although four of them (*Bokermannohyla carvalhoi*, *B. circumdata*, *Proceratophrys appendiculata* and *Scinax albicans*)were frequently found during the fieldwork at PARNASO. The other eight species recorded herein classified as “Least Concern”, have stable populations. *Gastrotheca ernestoi* and *Ischnocnema holti* are probably restricted to high-elevations areas. *Proceratophrys appendiculata* is present along a wide altitudinal gradient in PARNASO*.* We add three species to the list of species endemic to the high-elevation areas of Serra dos Órgãos: *Cycloramphus organensis*, *Dendrophryniscus organensis*, and *Fritziana* sp. nov, raising to 14 the number of endemic taxa. *Brachycephalus ephippium*, *Ischnocnema* cf. *nasuta*, *Fritziana* sp*.* nov., *F. goeldii*, *F. ohausi*, *Scinax albicans*, *S. obtriangulatus*, *Phasmahyla guttata,* and *Proceratophrys appendiculata* were recorded only in the present study.

Key-words: Survey; Anura; Atlantic Forest;.

**INTRODUCTION**

The Brazilian anuran fauna is currently represented by 1,021 species, corresponding to 16% of the global diversity (Frost 2015). The Brazilian Atlantic Forest has been labeled as one of the 25 biodiversity hotspots in the world (Meyers *et al*. 2000), harboring an estimated 430 species of anurans, 80% endemic to this forest (Cruz & Feio 2007; Lemes *et al*. 2014). It also harbors 30 endemic genera, which represent 49% of the anuran genera in the Atlantic rainforest (Cruz & Feio 2007, Frost 2015). Nevertheless, due to several factors, mostly human action, the Atlantic Forest is nowadays composed only by an estimated 8% of its original area (SOS Mata Atlântica 2008), and most of the remnant patches are found in the highlands of the Serra do Mar and Serra da Mantiqueira in Southeastern Brazil (Eterovick *et al.* 2005). Only 1% of the current Atlantic Forest is legally known to occur within protected areas (Laurance 2009).

The Atlantic Forest biome encompasses the vegetation that occurs along the Brazilian coast (extending some distance inland), from the states of Rio Grande do Norte to Rio Grande do Sul (Delabie *et al.* 2000). The vegetation consists of dense ombrophilous forest, mixed ombrophilous forest and seasonal forest, including associated ecosystems, as mangroves and salt marshes (Veloso 1992, Joly *et al*. 1999). It also has high-elevation areas that reach more than 2,000 m.a.s.l. (Safford *et al*. 1999).

These high-elevation areas include brazilian highlands, such as “Campos de Altitude”, that are an open habitat present in Serra do Mar and Serra da Mantiqueira and that are poorly studied (Safford *et al*. 1999). “Campos de altitude” occurs on altitudes above 1,900 m and is concentrated predominantly in areas within the Parque Nacional da Serra dos Órgãos (Mallet-Rodrigues *et al*. 2010). There are few studies conducted in this ecosystem include flora (Safford *et al*. 1999), birds (Vasconcelos & Rodrigues 2010, Mallet-Rodrigues *et al*. 2010), and mammals (Geise *et al*. 2004). Inventories of the amphibian fauna for the highlands are nonexistent.

 Nevertheless, it is possible to find some studies about amphibians from high-elevation areas that are below to 1,900 m.a.s.l: Cruz & Feio (2007) reported the endemism of anuran species present in high-elevation areas in Serra do Mar and Serra da Mantiqueira, and Siqueira *et al.* (2011) reported the abundance of composition of anuran species represented in high altitude in Serra dos Órgãos, inserted in Serra do Mar. Most studies about the anuran fauna from high-elevation forest of the Brazilian Atlantic Forest consist in descriptions of species (e.g., Weber *et al.* 2011).

 The Parque Nacional da Serra dos Órgãos (PARNASO) it is inserted in the Atlantic Forest, and contains some of the highest peaks of the Serra dos Órgãos mountain range, often exceed 2,000 m.a.s.l., such as Pedra do Açu (2,245 m.a.s.l.) and Pedra do Sino (2,275 m.a.s.l.; ICMBIO 2008)*.* Relatively little is known about the ecology, biogeography, or developmental history of these “sky island” formations (Safford 1999). PARNASO has a great diversity of habitats provided by climatic variation, a variety of soil types, geological formations and varying composition of vegetation, promoting a high diversity of species (ICMBIO 2008). It harbors a great part of the diversity of endemism of the Atlantic rainforest, including 100 species of anurans amphibians (ICMBIO 2008). It also represents the type locality of at least 20 species of anurans, which seven are endemic (Carvalho-e-Silva *et al.* in prep.). The PARNASO protects an important part of the Atlantic Forest. The Serra dos Órgãos was identified in assessment coordinated by the ministry of the environment as an area of extreme biological importance for all groups (Cronemberg & Viveiros de Castro 2007).

 Worldwide amphibian declines have been reported and several factors are suggested to be responsible, such as habitat loss and fragmentation, contamination of water and soil by chemical pollutants, climate change, and introductions of exotic species (Blaustein *et al.* 1994; Alford & Richards 1999; Lips *et al.* 2005; Hamer & McDonnel 2008; Laurance 2008). In the Atlantic Forest, some populations that were abundant have decreased dramatically, mainly in Serra do Mar and Serra da Mantiqueira (Heyer *et al.* 1988; Weygoldt 1989).

Experimental studies, monitoring and inventories are useful in reporting declines (Biek *et al.* 2002). It is also important to conduct studies that provide support for amphibian conservation, especially in areas without previous knowledge of the local anuran fauna (Rocha *et al.* 2003; Diniz-Filho *et al.* 2004), such as the high-elevation areas. Therefore, we present a list of anuran species recorded in the high-elevation areas (up to 1,200 m.a.s.l.) within Parque Nacional da Serra dos Órgãos, inserted in Serra dos Órgãos mountain range, that often exceed 2,000 m.a.s.l. (ICMBIO 2008).

**MATERIAL AND METHODS**

*STUDY AREA*

Serra do Mar mountain range complex encompasses the Atlantic forest, including the coast of Santa Catarina, Paraná, São Paulo and Rio de Janeiro states (Cruz & Feio 2007). The Parque Nacional da Serra dos Órgãos (PARNASO) is a national park located in the mountains of the Serra dos Órgãos range in the central part of the Serra do Mar, in the state of Rio de Janeiro. The Parque Nacional da Serra dos Órgãos (22°52' and 22°54' S; 42°09' and 45°06' W) encompasses part of the municipalities of Teresópolis, Petrópolis, Magé and Guapimirim, in an area of 20,024 hectares of dense ombrophilous forest. High-elevation areas (above 1,200 m.a.s.l.) are present only in Teresópolis and Petrópolis (Cruz & Feio 2007, ICMBIO 2008, Siqueira *et al.* 2011; Figure 1), representing around 60% of the park area (Cronemberg & Viveiros de Castro 2007).

PARNASO is located within the Atlantic Forest morphoclimatic domain (Ab’Saber 1977), with an average annual temperature of 19 °C. Rainfall fluctuates between 1,500 mm to 3,000 mm per year (ICMBIO 2008).

 The fieldwork was conducted in high-elevation areas in Pedra do Sino trail at PARNASO, municipality of Teresópolis. The altitudinal range chosen in the present work (1,200 – 2,250 m.a.s.l.) was based on the altitudinal range of Pedra do Sino trail, which starts on 1,200 m.a.s.l. and go until the highest peak at 2,250 m.a.s.l. (Cronemberg & Viveiros de Castro 2007).

**Figure 1.** Locality where the majority of the fieldwork were conducted (Pedra do Sino trail, Teresopólis, state of Rio de Janeiro, Brazil).

The vegetation in the area is mostly composed of well-preserved dense ombrophilous forest, presenting abundant palm trees, epiphytes and large-sized trees (ICMBIO 2008). Additionally, the sampling area presents variation of the vegetation and soil characteristics, which are classified according to Mallet-Rodrigues *et al*. (2010), as follows:

Montane Forest(“Floresta Montana”) – From 500 m to 1,500 m.a.s.l. Formation with extensive vegetation stratification. Its structure varies according to the specific conditions of each area. The tree layer is dominated by large trees reaching up to 40 m high and deep soils of composite crystalline rocks. Specimens of this vegetation were collected up 1,200 m.a.s.l.

High Montane Rain Forest (“Floresta Pluvial Alto-Montana”) (Figure 2A) – From 1,500 m to 1,900 m.a.s.l. It is a typical humid forest, often enveloped in mist. The vegetation is dominated by shrubs and small species between 5 m and 10 m in height. Trees typically have crooked trunks covered by moss and epiphytes.

Highlands(“Campos de Altitude”) (Figure 2B) –. Above 1,900 m.a.s.l. Dominated by shrubby and herbaceous vegetation that grows on rocky outcrops. There is low input of organic matter and vegetation with a drier appearance. The soil is shallow and solar radiation is intense. In areas with large slope and exposure to wind and rain, the rock is bare with almost no vegetation coverage.

**Figure 2.** Sampling sites: (A) High Montane Rain Forest; (B) Highland; (C) *Pitfall* trap set in highlands site*.*

*SAMPLING*

 We made six excursions from 2009 to 2013 (one or two per year) in the area during both the rainy and dry seasons, totaling 15 sampling days. We used three complementary methods for sampling adult anurans: active search, acoustic search and pitfall traps (see Calleffo 2002), and one to sample tadpoles: active search.

We performed the active and acoustic searches randomly along the Pedra do Sino trail. In addition, four pitfall traps (60 L, with drift fence) were set in the highlands: the first three located in different sites of the “*Pedra da Baleia”* (22° 27' 37.0" S / 43° 01' 40.0" W, 2,131 m.a.s.l) with five, seven and eight buckets, respectively. The last one, with four buckets, was located in the “*Vale das Orquídeas*” (22° 27' 26.5" S / 43° 01' 10.4" W, 1,975 m.a.s.l), all in the Pedra do Sino trail (Figure 2C). The pitfall traps remained open 24 hours during each survey (from two to four days). We checked each pitfall trap every day. We also searched for tadpoles in bromeliads and streams along the trail. For the capture of tadpoles in the streams we used sieves and in the bromeliads we used an entomologic aspirator.

Adults and tadpoles were collected, photographed, and then anesthetized and killed with lidocaine injection (with insulin syringe needles), according to the Brazilian law (Diretriz Brasileira Para o Cuidado e a Utilização de Animais Para Fins Científicos e Didáticos – Concea). Specimens were deposited at the Amphibian Collection in the Departamento de Zoologia, Universidade Federal do Rio de Janeiro (ZUFRJ).

We also obtained data from the zoological collections of the Universidade Federal do Estado do Rio de Janeiro (Coleção de Anfíbios da Universidade Federal do Estado do Rio de Janeiro – UNIRIO), Universidade Federal Rural do Rio de Janeiro (Coleção Eugênio Izecksohn – EI), and Coleção da Universidade Federal do Rio de Janeiro (ZUFRJ), which encompass more than 20 years of fieldwork in the area. We only included specimens from PARNASO that have been sampled in the altitudinal range used in the present work (1,200 – 2,250 m.a.s.l.). The list of examined specimens are in Appendix 1.

Taxonomic nomenclature follows Frost (2015).

**RESULTS AND DISCUSSION**

We report twenty-eight anuran species, belonging to seven families (Table 1 and Figure 3): Brachycephalidae (6 species), Bufonidae (3), Cycloramphidae (4), Hemiphractidae (5), Hylidae (8), Hylodidae (1), and Odontophrynidae (1). Compared with all the anuran fauna of the PARNASO, the community of high-elevation areas presents 27.18% of the fauna of the park.

**Figure 3.** Specimens of high-elevations areas from PARNASO, RJ, Brazil; A) *Ischnocnema holti*; B) *Brachycephalus ephippium*; C) *Zachaenus parvulus*; D) *Proceratophrys appendiculata*; E) *Cycloramphus* *eleutherodactylus*; F) *C. organensis*; G) *Dendrophryniscus organensis*; H) *Fritziana* sp. nov.; I) *Gastrotheca ernestoi*; J) *G. ernestoi*; K) *Aplastodiscus musicus*; L) *A. flumineus*; M) *A*. *arildae*; N) *Bokermannohyla circumdata*; O) *B*. *carvalhoi*. Photo A and H by Felipe Quintarelli Machado; Photo C by Daniel de Góes; Photo G by Cyro de Luna-Dias; Other photos by Sergio Potsch de Carvalho-e-Silva.

*Cycloramphus organensis* is endemic to the high-elevation areas of PARNASO (Weber *et al.* 2011). In addition, a new species, *Fritziana* sp. nov., is being described from the high-elevation areas of the park (Folly *et al*. in prep.) and may be restricted to such habitat. *Gastrotheca ernestoi* and *Ischnocnema holti* are also probably restricted to high-elevations areas in PARNASO, despite not being endemic of the Serra dos Órgãos region (Costa *et al.* 2008; Izecksohn & Carvalho-e-Silva 2008; Siqueira *et al.* 2011).

The highest species richness was observed at 1,200 m – 1,500 m with 26 species, of which 13 were exclusive to that altitudinal range. Between 1,501 – 1,900 m we observed 14 species, of which none were exclusive. Up 1,900 m we observed seven species of which one were exclusive to that elevation (Fig. 4). Species richness decreased with elevation above 1,500 m.a.s.l. This pattern, known as a “diversity bulge” has been described by Grytnes & Vetaas (2002). The species richness found was inversely proportional to the altitude increase. This result may be due to the kind of vegetation found in the lower altitude (montane forest). Tree canopy would not only provide shelter to different species of treefrogs but also help keeping the leaf-litter layer humid and deep along the forest floor, where the anuran fauna is abundant (Rocha *et al.* 2004). On the other hand, the difficulty in accessing higher elavation sites, such as Campos de Altitudes, and the little knowledge about the fauna found in this ecosystem, may have influenced the sample size, showing the necessecity of continue to do field work in these high-elevation areas.

We recorded six endemic species previously reported from the high-elevation (1,200 – 2,250 m) areas of Serra dos Órgãos Mountains (Cruz & Feio 2007): *Aplastodiscus flumineus*, *A. musicus*, *Bokermannohyla carvalhoi*, *Cycloramphus stejnegeri*, *Hylodes charadranaetes* and *Ischnocnema gualteri*. We also sampled 14 species that have been reported for occurring in high-elevation areas (1,100 – 1,900 m.a.s.l.) within the Parque Estadual dos Três Picos (PEPT) (Siqueira *et al.* 2011): *Aplastodiscus arildae*, *Bokermannohyla carvalhoi*, *B. circumdata*, *Dendrophryniscus* cf. *brevipollicatus*, *Fritziana fissilis*, *Gastrotheca ernestoi*, *Hylodes charadranaetes*, *Ischnocnema* aff. *guentheri*, *I. holti*, *I. parva*, *Rhinella icterica*, *Scinax albicans*, *S. obtriangulatus* and *Zachaenus parvulus*.

The similarity of the anuran fauna assemblages at PARNASO and PETP, both located within the Serra dos Órgãos mountain range, may be due to them being located within the Serra dos Órgãos mountain range, both connected by a continuous habitat corridor and having similar environmental influences. Despite the similarities found in the high-elevation areas of both sites, several species are unique to one locality: PETP (21 species) and PARNASO (14 species).

As a result of one study conducted in Serra dos Órgãos, Siqueira *et al.* (2011) removed two species (*Gastrotheca albolineata* (Lutz & Lutz, 1939) and *Hylodes charadranaetes*) from the previous list of amphibians endemic to the high-elevation areas of the Serra dos Órgãos compiled by Cruz & Feio (2007), and added two species (*Holoaden pholeter* Pombal, Siqueira, Dorigo, Vrcibradic & Rocha, 2008 and *Brachycephalus garbeanus* Miranda-Ribeiro, 1920), maintaining the list with 11 species known to be endemic to the high-elevation areas of the Serra dos Órgãos. We add three more species to the list: *Cycloramphus organensis*, *Dendrophryniscus organensis* and *Fritziana* sp. nov., raising to 14 the number of amphibians species endemic of high-elevation areas in the Serra dos Órgãos region.

Lemes *et al.* (2014) predict a great number of anuran species that will have declined within protected areas in the Atlantic Forest under changing of climate conditions in the year 2050. Additionally, the range of some of these species is predicted to shift toward higher elevations, where a large number of endemic Atlantic Forest species already occur. Based on these predictions, Lemes *et al.* (2014) suggested that new protected areas in highlands would be more effective in alleviating the effect of climate change on this endangered fauna. The risk associated with a changing climate in a mountainous region with high levels of endemism at high elevations highlights the importance of preserving these habitats.

From the nine species considered to have declining populations (IUCN 2015), the species *Bokermanohyla carvalhoi*, *B. circumdata*, *I. parva*, *P. appendiculata*, *S. albicans* and *Z. parvulus* are found in relatively high abundance at PARNASO. Also, we sampled six species classified as Data Deficient (IUCN 2015). These two facts in addition to the diversity and endemism found in the high-elevation areas of the park highlight the importance of PARNASO for the conservation of the Atlantic Forest anuran fauna.

The lack of research on the biology and demography of tropical anuran faunas complicates the design of appropriate strategies for the conservation of amphibians (Silvano & Segalla 2005). This deficiency is more evident regarding the fauna of high-elevation areas, where, historically, the rugged, mountainous terrain has hampered access (Kattan & Franco 2004). Also, the anurans of those regions tend to have their reproductive activity limited to a few short periods each year due to the severe cold weather, making it harder to sample individuals during the dry season. Moreover, some trapping methods, such as pitfall traps, might be less efficient in the highlands as a consequence of the rocky soil, which hampers their implementation on the grounds, making it necessary a high sampling effort and usage of more than one capture method. Nonetheless, it is hard to conclude if the low rate of anurans captured in the pitfall traps is due to the frog ecology, which could be arboreal for most species, or if it is due to the sample effort. Yet, it is crucial to conduct more studies in the high-elevation areas to improve the knowledge about this important ecosystem.

**Table 1.** List of anurans from high-elevation areas of the Parque Nacional da Serra dos Órgãos (PARNASO), their status of conservation according to the International Union for Conservation of Nature and Natural Resources (IUCN), and altitudinal ranges (meters above sea level – m.a.s.l.) within the study area. The altitudinal ranges of each species are categorized according to our records from field work, zoological collections and literature data (Duellman & Gray 1983, Frost *et al.* 2015, Weber *et al*. 2011). IUCN status categories are: Least Concern (LC); Data Deficient (DD); Stable population (St); Decreasing population (Dc); Unknown status (Un); \* Additional data collected in the fieldwork.

|  |  |  |
| --- | --- | --- |
| Taxa | Status in IUCN | Altitudinal range (m.a.s.l.) |
| 1200–1500 | 1501–1900 | Up 1,900 |
|  |  |  |  |  |
|  |  |  |  |  |
| **BRACHYCEPHALIDAE** |  |  |  |  |
| *Brachycephalus ephippium* (Spix, 1824)  | LC – St | X | X |  |
| *Ischnocnema* aff. *guentheri* \* | LC – St | X | X |  |
| *Ischnocnema gualteri* (Lutz, 1974)  | LC – Dc | X | X |  |
| *Ischnocnema holti* (Cochran, 1948) \* | DD – Un | X | X | X |
| *Ischnocnema* cf. *nasuta* (Lutz, 1925)  | LC – Dc |  | X | X |
| *Ischnocnema parva* (Girard, 1853) \* | LC – Dc | X | X | X |
| **BUFONIDAE** |  |  |  |  |
| *Dendrophryniscus* cf*. brevipollicatus* Jiménez de la Espada, 1870  | LC – St | X | X |  |
| *Dendrophryniscus organensis* Carvalho-e-Silva, Mongin, Izecksohn & Carvalho-e-Silva, 2010  | ------------- | X |  |  |
| *Rhinella icterica* (Spix, 1824) \* | LC – St | X | X | X |
| **CYCLORAMPHIDAE** |  |  |  |  |
| *Cycloramphus eleutherodactylus* (Miranda-Ribeiro, 1920)  | DD – Un | X |  |  |
| *Cycloramphus organensis* Weber, Verdade, Salles, Fouquet, & Carvalho-e-Silva, 2011  | DD – Un  |  |  | X |
| *Cycloramphus stejnegeri* (Noble, 1924)  | DD – Dc | X |  |  |
| *Zachaenus parvulus* (Girard, 1853) \* | LC – Dc | X |  |  |
| **HEMIPHRACTIDAE** |  |  |  |  |
| *Fritziana fissilis* (Miranda-Ribeiro, 1920) \* | LC – St | X | X |  |
| *Fritziana goeldii* (Boulenger, 1895) \* | LC – St | X | X |  |
| *Fritziana ohausi* (Wandolleck, 1907) \* | LC – St | X |  |  |
| *Fritziana* sp. nov. \* | ------------- | X | X | X |
| *Gastrotheca ernestoi* Miranda-Ribeiro, 1920 \* | DD – Un | X | X | X |
| **HYLIDAE** |  |  |  |  |
| *Aplastodiscus arildae* (Cruz & Peixoto, 1987) \* | LC – St | X |  |  |
| *Aplastodiscus flumineus* (Cruz & Peixoto, 1985) \* | DD – Dc | X |  |  |
| *Aplastodiscus musicus* (Lutz, 1949)  | DD – Dc | X |  |  |
| *Bokermannohyla carvalhoi* (Peixoto, 1981) \* | LC – Dc | X |  |  |
| *Bokermannohyla circumdata* (Cope, 1871) \* | LC – Dc | X |  |  |
| *Phasmahyla guttata* (Lutz, 1924)  | LC – Dc | X |  |  |
| *Scinax albicans* (Bokermann, 1967)  | LC – Dc | X | X |  |
| *Scinax obtriangulatus* (Lutz, 1973)  | LC – Dc | X | X |  |
| **HYLODIDAE** |  |  |  |  |
| *Hylodes charadranaetes* Heyer & Cocroft, 1986  | DD – Un | X |  |  |
| **ODONTOPHRYNIDAE** |  |  |  |  |
| *Proceratophrys appendiculata* (Günther, 1873) \* | LC – Dc | X |  |  |

**ACKNOWLEDGMENTS:** We thank all employees of Parque Nacional da Serra dos Órgãos who contributed to the field trip logistics for collections of specimens and data collections. We thank Dr. Oswaldo Luiz Peixoto for allowing access to the Coleção Eugênio Izecksohn. We thank Felipe Quintarelli Machado and Daniel de Góes for the photos and Kerry Cobb for reviewing the manuscript. Sergio Potsch de Carvalho-e-Silva thanks CNPq for granting him a research. The project received grant from Fundação de Amparo à Pesquisa do Estado do Rio de Janeiro (FAPERJ) (process E-26/112.137/2008).

**REFERENCES**

AB’SABER, A.N. 1977. Os domínios morfoclimáticos na América do Sul. Primeira aproximação. *Geomorfologia*, 52: 1–22.

ALFORD, R.A. & RICHARDS, S.J. 1999. Global amphibian declines: a problem in applied ecology. *Annual Review of Ecology and Systematics*, 30: 133–165.

BIEK, R.; FUNK, W.C.; MAXELL, B.A. & MILLS, L.S. 2002. What is missing in amphibian decline research: insights from ecological sensitivity analysis. *Conservation Biology*, 16(3):728–734.

BLAUSTEIN, A.R.; WAKE, D.B. & SOUSA, W.P. 1994. Amphibian declines: judging stability, persistence, and susceptibility of populations to local and global extinctions. *Conservation Biology*, 8(1): 60–71.

CALLEFFO, M.E.V. 2002. Anfíbios. *In* Auricchio, P. & Salomão, M.G. Técnicas de coleta e preparação de vertebrados para fins científicos e didáticos. Instituto Pau Brasil de História Natural, São Paulo, 43–74 pp.

COSTA, P.N.C.; CARVALHO-E-SILVA, S.P.; CARVALHO-E-SILVA, A.M.P.T. & WEBER, L.N. 2008. Amphibia, Anura, Brachycephalidae, *Ischnocnema holti*: Distribution extension. *Check List*, 4 (3): 232–233.

CRONEMBERGER, C. & VIVEIROS DE CASTRO, E.B. (orgs.) 2007. Ciência e conservação na Serra dos Órgãos. Ibama. 298 p.

CRUZ, C.A.G. & FEIO, R.N. 2007. Endemismos em anfíbios em áreas de altitude na Mata Atlântica no sudeste do Brasil. Pp. 117-126. *In*: L.B. Nascimento & M.E. Oliveira (eds.). *Herpetologia no Brasil II*. Belo Horizonte, Sociedade Brasileira de Herpetologia, Belo Horizonte, MG. 354 p.

DELABIE, J.H.C.; AGOSTINI, D. & NASCIMENTO, I.C.. 2000. Litter ant communities of the Brazilian Atlantic rain forest region, Pp.1-17. *In*: D. Agosti, J.D. Majer, L. Alonso & T. Schultz (eds.). Sampling Ground-dwelling Ants: Case Studies from the World‘s Rain Forests. Curtin University School of Environmental Biology Bulletin N° 18, Perth, Australia.

DINIZ-FILHO, J.A.F.; BINI, L.M.; VIEIRA, C.M.; SOUZA, M.C.; BASTOS, R.P.; BRANDÃO, D. & OLIVEIRA, L.G. 2004. Spatial patterns in species richness and priority areas for conservation of anurans in the Cerrado region, Central Brazil. *Amphibia-Reptilia*, 25(1): 63–75.

DUELLMAN, W.E. & GRAY, P. 1983. Developmental Biology and Systematics of the Egg-Brooding Hylid Frogs, Genera *Flectonotus* and *Fritziana*. *Herpetologica*, 39(4): 333–359.

ETEROVICK, P.C.; CARNAVAL, A.C.O.Q.;  BORGES-NOJOSA, D.M.; SILVANO, D.L.; SEGALLA M.V.; SAZIMA I. 2005. Amphibian Declines in Brazil: An Overview. *Biotropica*, 27(2): 166–179**.**

FROST, D.R. 2015. Amphibian Species of the World: an Online Reference. Version 6.0 (08.26.2015). Electronic Database accessible at http://research.amnh.org/herpetology/amphibia/index.html. American Museum of Natural History, New York, USA.

GEISE, L., PEREIRA, LG, BOSSI, DEP and BERGALLO, HG. 2004. Pattern of elevational distribution and richness of non volant mammals in itatiaia national park and its surroundings, in southeastern brazil. *Brazilian Journal of Biology*, 64(3): 599–612.

GRYTNES, J.A. & VETAAS, O.R. 2002. Species richness and altitude: a comparison between null models and interpolated plant species richness along the Himalayan altitudinal gradient, Nepal. *The American Naturalist*, 159(3): 294–304.

HAMER, A.J. & McDONNEL, M.J. 2008. Amphibian ecology and conservation in the urbanizing world: A review. *Biological Conservation*, 141(10): 2432–2449.

HEYER, W.R.; RAND, A.S.; CRUZ, C.A.G. & PEIXOTO, O.L. 1988. Decimations, extinctions, and colonizations of frog populations in southeast Brazil and their evolutionary implications. *Biotropica*, 20(3):230–235.

ICMBIO (Instituto Chico Mendes de Conservação da Biodiversidade). 2008. *Plano de manejo do Parque Nacional da Serra dos Órgãos*. 665 pp.

IUCN (International Union for Conservation of Nature). 2015. IUCN Red List of Threatened Species. Version 2015.1. <www.iucnredlist.org>. (Accessed in 08/26/2015).

IZECKSOHN, E. & CARVALHO-E-SILVA, S.P. 2008. As espécies de *Gastrotheca* Fitzinger na Serra dos Órgãos, Estado do Rio de Janeiro, Brasil (Amphibia: Anura: Amphignathodontidae). *Revista Brasileira de Zoologia*, 25(1): 100–110.

JOLY, C.A.; AIDAR, M.P.M.; KLINK, C.A.; MCGRATH, D.G.; MOREIRA, A.G.; MOUTINHO, P.; NEPSTAD, D.C.; OLIVEIRA, A.A.; POTT, A.; RODAL, M.J.N. & SAMPAIO, E.V.S.B. 1999. Evolution of the Brazilian phytogeography classification systems: implications for biodiversity conservation. *Ciência e Cultura*, 51(5/6): 331–348.

KATTAN, G.H. & FRANCO, P. 2004. Bird diversity along elevational gradients in the Andes of Colombia: Area and mass effects. Global Ecology and Biogeography 13: 451–458.

LAURANCE, W.F., 2008. Global warming and amphibian extinctions in eastern Australia. *Austral Ecology*, 33(1): 1–9.

LAURANCE, W.F. 2009. Conserving the hottest of the hotspots. *Biological Conservation*, 142: 1137, doi:10.1016/j.biocon.2008.10.011

LEMES, P.; Melo, A.S. & Loyola, R.D. 2014 Climate change threatens protected areas of the Atlantic Forest. *Biodiversity and Conservation*, 23(2):357-368, doi: 10.1007/s10531-013-0605-2.

LIPS, K.R.; BURROWES, P.A.; MENDELSON III, JR. & PARRA-OLEA, G. 2005. Amphibian declines in Latin America: widespread population declines, extinctions, and impacts. *Biotropica*, 37(2): 163–165.

MALLET-RODRIGUES, F.; PARRINI, R.; PIMENTEL, L.M.S. & BESSA, R. 2010. Altitudinal distribution of birds in a mountainous region in southeastern Brazil. *Zoologia*, 27(4): 503–522, doi: 10.1590/S1984-46702010000400003

MYERS, N.; MITTERMEIER, R.A.; MITTERMEIER, C.G.; DA FONSECA, G.A.B & KENT, J. 2000. Biodiversity hotspots for conservation priorities. *Nature*, 403: 853–858, doi:10.1038/35002501.

ROCHA, C.F.D.; BERGALLO, H.G.; VAN SLUYS, M. & ALVES, M.A.S. 2003. A biodiversidade nos grandes remanescentes florestais do Estado do Rio de Janeiro e nas restingas da Mata Atlântica. São Paulo: Rima. 160 p.

ROCHA, C.F.D.; VAN SLUYS, M.; HATANO, F.H.; BOQUIMPANI-FREITAS, L.; MARRA, R.V. & MARQUES, R.V. 2004. Relative efficiency of anuran methods in a (Jurubatiba, Rio de Janeiro, Brazil). *Brazilian Journal of Biology*, 64(4): 879–884.

SAFFORD, H.D. 1999. Brazilian páramos I. An introduction to the physical environment and vegetation of the campos de altitude. *Journal of Biogeography*, 26: 693–712.

SILVANO, D.L. & SEGALLA, M.V. 2005. Conservation of Brazilian amphibians. *Conservation Biology*, 19: 653–658. doi: 10.1111/j.1523-1739.2005.00681.x

SIQUEIRA C.C.; VRCIBRADIC D.; DORIGO. T.A. & ROCHA, C.F.D. 2011. Anurans from two high-elevation areas of Atlantic Forest in the state of Rio de Janeiro, Brazil. *Zoologia*, 28 (4): 457–464, doi: 10.1590/S1984-46702011000400007.

SOS MATA ATLÂNTICA. 2008. Atlas dos remanescentes florestais da mata Atlântica: período 2000 a 2005. São Paulo: Fundação SOS Mata Atlântica; São José dos Campos: Instituto Nacional de Pesquisas Espaciais, 2008. 157 p. Disponível em: <www.matatlantica.org.br>. (Accessed in 01/07/2014).

VASCONCELOS, M.F. & RODRIGUES, M. 2010. Avifauna of southeastern Brazilian mountaintops. *Papéis Avulsos de Zoologia*, 50(1): 1–29.

VELOSO, H.P. 1992. Sistema fitogeográfico. *Relatório Técnico.* Manual técnico da vegetação brasileira. Instituto Brasileiro de Geografia e Estatística (IBGE). 38 p.

WEBER, L.N.; VERDADE, V.K.; LULA-SALLES, R.O.; FOUQUET, A. & CARVALHO-E-SILVA, S.P. 2011. A new species of *Cycloramphus* Tschudi (Anura: Cycloramphidae) from the Parque Nacional da Serra dos Órgãos, Southeastern Brazil. *Zootaxa*, 2737: 19–33.

**APPENDIX**

**Material examined. Brachycephalidae**: *Brachycephalus ephippium* (ZUFRJ: 11270 –11274, 11482-11484; UNIRIO: 2537, 3750), *Ischnocnema parva* (ZUFRJ: 11097, 11098, 11281 –11283, 11720, 11721; UNIRIO: 10108, 3346), *Ischnocnema* aff. *guentheri* (ZUFRJ: 11279, 11280, 13977), *Ischnocnema gualteri* (ZUFRJ: 12402), *Ischnocnema holti* (ZUFRJ9664 – 9675, 11722-11725, 13975, 13976, 13979, 13992; UNIRIO: 4875), *Ischnocnema* cf. *nasuta* (ZUFRJ: 9661); **Bufonidae**: *Dendrophryniscus* cf. *brevipollicatus* (ZUFRJ: 11275 – 11276), *Dendrophryniscus organensis* (ZUFRJ: 9794; UNIRIO: 4946, 2406, 2183) *Rhinella icterica* (ZUFRJ: 11805), **Cycloramphidae**: *Cycloramphus stejnegeri* (ZUFRJ: 12113 – 12114), *Cycloramphus eleutherodactylus* (ZUFRJ: 12403), *Cycloramphus organensis* (ZUFRJ: 10348 – 10354, 10471 – 10474); *Zachaenus parvulus*(ZUFRJ: 14487-14488; UNIRIO: 4925, 4931 – 4933); **Hemiphractidae**: *Fritziana fissilis* (ZUFRJ: 9662-9663, 11717 – 11718), *Fritziana goeldii* (ZUFRJ: 8916)*,* *Fritziana ohausi* (ZUFRJ: 12154 – 12155)*, Fritziana* sp. nov. (ZUFRJ: 11680 – 11681, 11726, 13978), *Gastrotheca ernestoi* (ZUFRJ: 13974; UNIRIO: 2534); **Hylidae**: *Aplastodiscus arildae* (ZUFRJ: 11515; UNIRIO: 4944, 1581, 1590, 1630, 1755), *Aplastodiscus flumineus* (ZUFRJ: 6984 (tadpole); UNIRIO: 1589; EI: 7328), *Aplastodiscus musicus* (ZUFRJ: 6213, 6345, EI: 7532, 7533; MNRJ: 3213 lectotype, 3214 – 3219 paralectotype), *Bokermannohyla carvalhoi* (ZUFRJ: 10232, 11806, 11809 (tadpole), 11810; UNIRIO: 1105, 1106, 1136, 1503, 3363), *Bokermannohyla circumdata* (ZUFRJ: 11265, 11811), *Phasmahyla guttata* (ZUFRJ: 6340, 12425; UNIRIO: 2347), *Scinax albicans* (ZUFRJ: 11099 – 11102, 12175), *Scinax obtriangulatus* (ZUFRJ: 2033), **Hylodidae**: *Hylodes charadranaetes* (ZUFRJ: 12408, 12409); **Odontophrynidae:** *Proceratophrys appendiculata* (ZUFRJ: 11719, 12727 11807; UNIRIO: 4471, 4472, 4922).