Frogs of Marambaia: a naturally isolated Restinga and Atlantic Forest remnant of southeastern Brazil

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SILVA, H.R., CARVALHO, A.L.G. & BITTENCOURT-SILVA, G.B. 2008. **Frogs of Marambaia: a naturally isolated Restinga and Atlantic Forest remnant of southeastern Brazil.** Biota Neotrop. 8(4): http://www.biotaneotropica.org.br/v8n4/en/abstract?inventory+bn01808042008.

Abstract: We report the results of a seven-year survey of the anurans of Marambaia, in the State of Rio de Janeiro, southeastern Brazil, where 24 species were recorded. The species represented nine families: Hylidae (10 species), Bufonidae (3), Leptodactylidae (3), Hylodidae (2), Microhylidae (2), Craugastoridae (1), Centrolenidae (1), Cycloramphidae (1), and Leiuperidae (1). We also present notes on the natural history and habitat usage by the anurans.
Keywords: *anura, insular community, species list.*

SILVA, H.R., CARVALHO, A.L.G. & BITTENCOURT-SILVA, G.B. 2008. **Anfíbios da Marambaia: um remanescente naturalmente isolado de Restinga e Floresta Atlântica do Sudeste do Brasil.** Biota Neotrop. 8(4): http://www.biotaneotropica.org.br/v8n4/pt/abstract?inventory+bn01808042008.

Resumo: Apresentamos os resultados de um estudo de sete anos sobre os anuros da Marambaia, Estado do Rio de Janeiro, sudeste do Brasil, onde 24 espécies representantes de nove famílias foram registradas: Hylidae (10 espécies), Bufonidae (3), Leptodactylidae (3), Hylodidae (2), Microhylidae (2), Craugastoridae (1), Centronelidae (1), Cycloramphidae (1) e Leiuperidae (1). Apresentamos também notas sobre a história natural e uso de habitat pelos anuros.
Palavras-chave: *anura, comunidade insular, lista de espécies.*

Introduction

One peculiar characteristic of the geography of the State of Rio de Janeiro is the Restinga da Marambaia, which forms an east-west peninsular-like extension of the continent into the Atlantic Ocean (Figure 1). The Marambaia formation is composed of an island that approaches the continent through a sand dune extension, the actual restinga. The geological events that resulted in the formation of the restinga involved changes in relative sea level that took place in the Holocene, about five thousand years before the present (Roncarati & Menezes 2005).

Like most coastal areas in the State of Rio de Janeiro, Marambaia has a long history of human occupation (Kneip & Oliveira 2005). Recent human uses have left marks of environmental degradation similar to those observed along the mainland coast of the state, which can be noticed by different degrees of logging – from clear cutting for agriculture, to selective timber removal. During the 18th and 19th centuries, Marambaia served as a stopping place for ships involved in the slave trade from Africa (Pereira et al. 1990). More recently, the Brazilian government has been using the area for military bases and training (Army, Air Force, and Navy). Through a cooperation program among different research centers, universities, and the military, efforts to understand some basic aspects of the local biodiversity has been possible on Marambaia. As an outcome of such efforts, a book edited by Menezes et al. (2005) presents the first comprehensive results of research on the aspects of the biodiversity and some physical characterization of the area. On Marambaia the flora has been more thoroughly investigated than the fauna (Menezes & Araujo 2005, Fraga et al. 2005, Conde et al. 2005), which has been limited to studies of the communities of bats (Costa & Perachii 2005) and dragonflies (Costa & Oldrini 2005).

The first specimens of amphibians collected from Marambaia were deposited in the Coleção Eugenio Izecksohn (EI), housed at the Universidade Federal Rural do Rio de Janeiro (Izeckshon 1976), however a more thorough herpetological survey has not been conducted there until our recent efforts at describing the lizard community of the area (Carvalho et al. 2007, Carvalho & Araújo 2007). The list of anurans presented herein summarizes the continuation of our efforts to investigate the herpetological communities on coastal islands of southeastern Brazil, and reports our contribution toward their conservation.

Materials and Methods

1. Study site

The present work was conducted on Marambaia, Municipality of Mangaratiba, in the west portion of the State of Rio de Janeiro, southeastern Brazil (between 23° 04' S, 44° 00' W and 23° 02' S, 44° 34' W). The region encloses the Sepetiba Bay, and is comprised of an island, known as Ilha da Marambaia, linked to the continent through a sand dune formation approximately 40 km long called Restinga da Marambaia (Figure 1). Marambaia is an assemblage of different habitats that support a marked gradient of vegetational cover from the costal lowlands to higher altitudes - 640 m (Conde et al. 2005, Menezes & Araujo 2005). There are at least three distinct macro-habitat: mangrove, restinga (sand dune shrub and forested areas), and Atlantic Forest (Conde et al. 2005). The macroclimate of the region is classified as tropical by Köppen's method, with rainy summers and dry winters (AW). In the coldest months (July-August) mean temperature is higher than 18 °C and of the hottest (January) is higher than 22 °C. Rain fall is abundant in the summer and scarce in

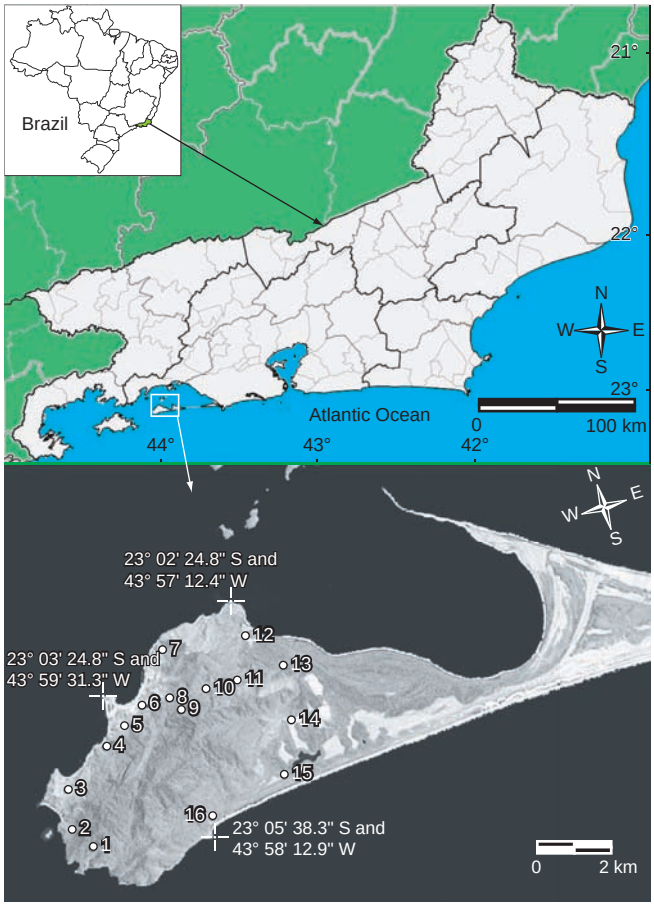

Figure 1. Map of the State of Rio de Janeiro, showing the location of Marambaia, which is enlarged and shown in more details. Numbers in the map of Marambaia represent collecting sites; a list of the species observed and or collected in each site is as follows: *Rhinella ornata* 5, 8 and 12, 13, 14; *Rhinella pygmaea* 14, *Dendrophryniscus brevipollicatus* 12 and 13; *Haddadus binotatus* 8 and 10, *Hyalinobatrachium eurygnathum* 8; *Thoropa miliaris* 2, 3, 8 and 10; *Aparasphenodon brunoi* 4, 8, 12, 13; *Aplastodiscus albofrenatus* 2, 8; *Hypsiboas albomarginatus* 4, 5, 6, 7, 11 and 12, *Dendropsophus decipiens* 5, *Dendropsophus cf. oliveirai* 5; *Scinax cf. alter* 3, 4, 5, 7, 8, 12, 13; *Scinax cf. perpusillus* 2, 12, 13; *Scinax trapicheiroi* 8, *Scinax cf. x-signatus* 5, 7, 12, 13, *Xenohyla truncata* 16; *Hylodes cf. phyllodes* 1, 9, 11; *Crossodactylus gaudichaudii* 1, 9, 11, *Physalaemus signifer* 8, 10, 11; *Leptodactylus marmoratus* 8 , 10, 11; *Leptodactylus marambaiae* 2, 3, 5, 6, 11, 12, 13, 14, *Leptodactylus ocellatus* 5, 6, 7, 8, 10, 11,12, 13, 14; *Chiasmocleis cf. carvalhoi* 8, 10, 11; *Myersiella microps* 8.

Figura 1. Mapa do Estado do Rio de Janeiro mostrando a localização da Marambaia, que esta destacada em tamanho maior e mostra mais detalhes. Os números no mapa da Marambaia representam os sítios de coleta; a lista das espécies observadas para cada sítio é a seguinte: *Rhinella ornata* 5, 8 and 12, 13, 14; *Rhinella pygmaea* 14, *Dendrophryniscus brevipollicatus* 12 and 13; *Haddadus binotatus* 8 and 10, *Hyalinobatrachium eurygnathum* 8; *Thoropa miliaris* 2, 3, 8 and 10; *Aparasphenodon brunoi* 4, 8, 12, 13; *Aplastodiscus albofrenatus* 2, 8; *Hypsiboas albomarginatus* 4, 5, 6, 7, 11 and 12, *Dendropsophus decipiens* 5, *Dendropsophus* cf. *oliveirai* 5; *Scinax* cf. alter 3, 4, 5, 7, 8, 12, 13; *Scinax* cf. *perpusillus* 2, 12, 13; *Scinax trapicheiroi* 8, *Scinax* cf. *x-signatus* 5, 7, 12, 13, *Xenohyla truncata* 16; *Hylodes* cf. *phyllodes* 1, 9, 11; *Crossodactylus gaudichaudii* 1, 9, 11, *Physalaemus signifer* 8, 10, 11; *Leptodactylus marmoratus* 8 , 10, 11; *Leptodactylus marambaiae* 2, 3, 5, 6, 11, 12, 13, 14, Leptodactylus ocellatus 5, 6, 7, 8, 10, 11,12, 13, 14; Chiasmocleis cf. carvalhoi 8, 10, 11; Myersiella microps 8.

the winter (no dry months). The annual mean precipitation is higher than 1200 mm (Mattos 2005).

2. Data collection

Anurans were collected or observed from April 2002 to April 2008, both in the rainy (summer) and dry (winter) seasons, with 86 days of field work. An estimate of collecting effort is presented as a species discovery curve in Figure 2. During expeditions, specimens were searched for at night and during the day in the restingas, lowland, and hillside forests. To evaluate the spatial distribution of amphibians, each habitat was subdivided into eight smaller microhabitat units: creek, forest litter, ground bromeliad, humid rock faces, shrubby vegetation, swamps (in flooded areas and river mouths), temporary ponds, and trees.

Most specimens were searched for when calling, detected visually, and hand captured. Bromeliads, which are abundant in the sand formations, were surveyed during the day. Five-hundred and forty bromeliads belonging to three species were surveyed in the search of frogs: *Neoregelia cruenta* (n = 400), *Vriesia neoglutionosa* (n = 90), and *Aecmaea pectinata* (n = 50). Terrestrial plants, growing on sand, from five different localities (Figure 1 - point 4, 5, 11, 12 and 13) were removed and carefully examined in search of frogs. In one of the hill-forest formations (Figure 1 - point 8), a 100 m long plastic fence with twenty 40-liter buckets, buried spaced every 5 m along the fence, was set and surveyed for four days, every month from April to December 2007 (the buckets were opened on the first day and closed on the last). With the exception of the two microhylids, *Dendrophryniscus brevipollicatus* Jiménez de la Espada, 1871 "1870", two *Dendropsophus*, and *Aparasphenodon brunoi* Miranda-Ribeiro, 1920, all reproductive notes presented herein were based on direct observations of the species in the field. Data for these taxa was obtained from the literature. All amphibians collected were identified, fixed in 10% formalin and stored in 70% ethanol. Specimens obtained by this research are housed in the Herpetological Collection of the Universidade Federal Rural do Rio de Janeiro (RU), Seropédica, Rio de Janeiro, Brazil, and a list of the vouchers is presented in the Appendix.

Results

We encountered 24 species, representing nine families, during our sampling of Marambaia (Table 1). The species discovery curve indicates a low probability of finding additional species with increasing effort. Additional records may be possible, however the effort to be applied must be tremenduous and has to take into account the dimensions of the area to be surveyed (Figure 1). Hylidae is the richest family, with 10 species, followed by Bufonidae (3), Leptodactylidae (3), Hylodidae (2), Microhylidae (2), Craugastoridae (1), Centrolenidae (1), Cycloramphidae (1), and Leiuperidae (1). These species are distributed unequally among habitats. Lowland and hillside forest areas include 12 and 15 species, respectively, while 12 species were found in restinga. Although the number of species may be similar in the three habitats, four species were found only in restinga, seven were found only in hillside forests, and just one species was found only in lowland forests.

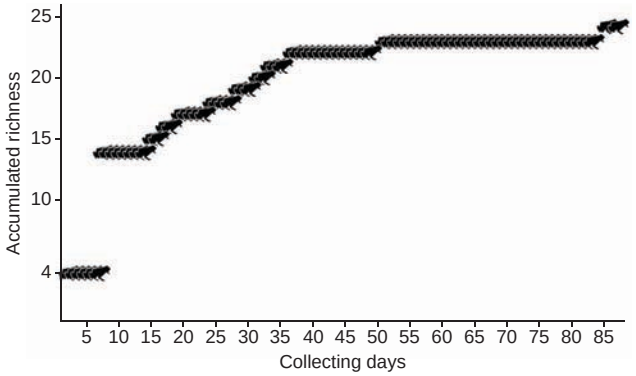

Figure 2. Cumulative curve of anuran species by collecting days for Marambaia, Rio de Janeiro, Brazil.

Figura 2. Curva cumulativa das espécies de anuros por dias de coleta na Marambaia, Rio de Janeiro Brasil.

Regarding microhabitat usage, *Rhinella ornata* (Spix 1824) and *Leptodactylus ocellatus* (Linnaeus 1758) were present in all sampling sites. These frogs were more frequently found during the rainy season, at the peak of their reproduction in swamps, creeks, and temporary ponds, but individuals were also found during other periods of the year in or near swampy areas or in the forest litter. On one occasion we found both of these species in bromeliads during the day. In the restinga, the hylids *Aparasphenodon brunoi*, *Scinax*. cf. *alter* (B. Lutz 1973), *S.* cf. *perpusillus* (A. Lutz & B. Lutz 1939), *S.* cf. *x-signatus* (Spix 1824), and the bufonid *Dendrophryniscus brevipollicatus* were found more frequently in bromeliads during the day. In the hillside forest, only *Aplastodiscus albofrenatus* (A. Lutz 1924) (calling males) and *Scinax* cf. *perpusillus* were associated with bromeliads. The centrolenid *Hyalinobatrachium eurygnathum* (A. Lutz 1925) may be considered amongst the rarest species, with only a single individual being collected on a tree near a creek. Another rare species in the sample is the microhylid, *Myersiella microps* (Duméril & Bibron 1841), with only two specimens being recorded from the forest leaf litter.

Leptodactylus marambaiae Izecksohn 1976 was found calling in lowland costal swamps and temporary ponds. Males were heard calling before dusk and at night during the rainy season. *Hylodes* cf. *phyllodes* Heyer & Cocroft 1986 and *Crossodactylus gaudichaudii* Duméril & Bibron 1841 are the two diurnal frog species of Marambaia. These frogs were found during the day perching and calling from rocks along creeks, and sometimes they were found co-occurring in the same sites. These species were observed in three different creeks on opposite sides of the island.

The frogs of Marambaia represent several reproductive modes. *Dendrophryniscus brevipollicatus* and *Scinax* cf. *perpusillus* reproduce exclusively in bromeliads; *Dendropsophus decipiens* (A. Lutz, 1925) lay eggs on leaves hanging over water; *Thoropa miliaris* (Spix, 1824) calls, lay eggs, and has tadpoles over films of water on rock faces; *Hylodes* cf. *phyllodes* and *Crossodactylus gaudichaudii* are diurnal frogs and reproduce in creeks; *Aplastodiscus albofrenatus* also uses the creeks for reproduction, but calling and part of the courtship takes place in bromeliads near the rivers; *Physalaemus signifer* (Girard 1853) and *Chiasmocleis* cf. *carvalhoi* Cruz, Caramaschi & Izecksohn 1997 reproduce in temporary ponds inside the forest; and *Haddadus binotatus* (Spix 1824), *Leptodactylus marmoratus* (Steindachner 1867), and *Myersiella microps* reproduce in the forest leaf litter; *Rhinella pygmaea* (Myers & Carvalho 1952) and *R. ornata* reproduce in flooded areas near the mouth of creeks and rivers, the former being found only in the restinga. The remaining species reproduce explosively in temporary ponds or swamps.

Discussion

Although the State of Rio de Janeiro has been the point of entrance for several important expeditions since the 19th Century, and a list of amphibians exists for the state (Rocha et al. 2004a), regional inven-

Table 1. List of families and species of anurans of Marambaia with indication of the number of specimens collected, habitat, microhabitat and reproduction site usage. Habitats: R = restinga, L = low land forest, H = hillside forest; Microhabitats: T = tree, S = swamp, B = ground bromeliad, F = forest litter, P = temporary ponds, C = creek, U = humid rock, V = shrubby vegetation. *Rare encounters. **Data from the collection housed in Museu Nacional (MNRJ). Data on reproduction was compiled from field observations and from Izecksohn & Carvalho-e-Silva (2001) e Carvalho-e-Silva et al. (2008).

Tabela 1. Lista de famílias e espécies de anuros da Marambaia com indicação do número de espécimes coletados, habitat, microhabitat e sítio reprodutivo utilizado. Habitats: R = restinga, L = floresta de baixada, H = floresta de encosta; Microhabitats: T = árvore, S = brejo, B = tanque de bromélia, F = serapilheira, P = poça temporária, C = riacho, U = rocha úmida, V = vegetação arbustiva. *Encontros raros. **Dados coletados a partir da coleção herpetológica do Museu Nacional (MNRJ). Os dados sobre reprodução foram compilados a partir de observações de campo e a partir de Izecksohn, Carvalho-e-Silva (2001) e Carvalho-e-Silva et al. (2008).

Species	n	Habitat			Microhabitat								Reproduction
		R	L	H	T	S	B	F	P	C	U	V	
BUFONIDAE													
Rhinella ornata	79	●	●	●		▲	*	▲	▲				Swamp and temporary ponds
Rhinella pygmaea	04	●							▲				Temporary ponds
Dendrophryniscus brevipollicatus	02	●	●				▲	▲					Bromeliad
CRAUGASTORIDAE													
Haddadus binotatus	42		●	●				▲					Forest litter
CENTRONELIDAE													
Hyalinobatrachium eurygnathum	01			●	▲					▲			Creeks by the forest
CYCLORAMPHIDAE													
Thoropa miliaris	40			●						▲	▲		Water films over rocks
HYLIDAE													
Aparasphenodon brunoi	07	●	●				▲						Temporary ponds
Aplastodiscus albofrenatus	06			●			▲		▲				Creek
Hypsiboas albomarginatus	31	●	●	●			*		▲			▲	Temporary ponds
Dendropsophus decipiens	02		●						▲				Temporary ponds
Dendropsophus cf. *oliveirai*	03	●	●			▲			▲			▲	Temporary ponds
Scinax cf. *alter*	44	●				▲	▲		▲				Temporary ponds
Scinax cf. *perpusillus*	10	●		●			▲						Bromeliad
Scinax trapicheiroi	36			●						▲			Creek
Scinax cf. *x-signatus*	11	●					▲						Temporary ponds
Xenohyla truncata	**	●					▲						Temporary ponds
HYLODIDAE													
Hylodes cf. *phyllodes*	10			●						▲			Creek
Crossodactylus gaudichaudii	05			●						▲			Creek (1, 9, 10)
LEIUPERIDAE													
Physalaemus signifer	13		●	●				▲					Forest temporary ponds
LEPTODACTYLIDAE													
Leptodactylus marmoratus	08		●	●				▲					Forest litter
Leptodactylus marambaiae	07	●	●			▲			▲				Temporary ponds
Leptodactylus ocellatus	31	●	●	●		▲	*	▲	▲				Swamp and temporary ponds
MICROHYLIDAE													
Chiasmocleis cf. *carvalhoi*	27		●	●				▲					Forest temporary ponds
Myersiella microps	02			●				▲					Forest litter

tories, describing the anurofauna of municipalities are scant. For the continental region near Marambaia, a list of amphibian communities has been published recently (Carvalho-e-Silva et al. 2008), being our only source for comparison with the continental fauna. Data is also available for a larger, nearby Island, Ilha Grande (Figure 1) and has been made available through publication of partial lists (Rocha et al. 2001) and personal communication (C.F.D. Rocha).

For the Municipality of Mangaratiba, which is located on the continent near Marambaia, Carvalho-e-Silva et al. (2008) found 41 species distributed in ten families, two of which (Amphignatodontidae and Phyllomedusidae) have not been found on Marambaia. Due to the process of insulation and the reduction of area (Roncarati & Meneses 2005), the community of frogs of Marambaia may have been depressed, and nowadays includes only a subset of that of the continent. On the other hand, the richness of 24 amphibian species recorded for Marambaia can be considered high when compared to that of the only other island surveyed in the coast of the State of Rio de Janeiro (Ilha Grande, with 20 species: Rocha et al. 2001, C.F.D.

Rocha, personal communication). We are conducting a survey of 3 other islands in the area, which we already know have amphibians (Ilha da Gipóia, Ilha de Itacuruçá, and Ilha de Jaguanum). With this data we will be able to discuss the combined effects of island area, geography, and distance from the continent on the anuran communities and apply island biogeography models to understand this insular scenario.

According to the species discovery curve, we may be near reaching the total richness for Marambaia. We may have missed a few species that are either cryptic, habitat specialists of resctricted local occurrence, or that are only active during a short period of time when special climatic conditions are observed. Among these we suspect that *Brachycephalus didactylus* (Izecksohn 1971), *Flectonotus goeldii* (Boulenger 1895), *F. ohausii* (Wandolleck 1907), and *Stereocyclops parkeri* (Wettstein 1934) could possibly be present on Marambaia. On the other hand, the absence of species that are common and easily detected by their advertisement call on the mainland, is not likely a result of insufficient sampling effort. The absence in Marambia of toads and frogs that reproduce at river mouths and flooded lowland areas on the continent, such as *Arcovomer passarellii* Carvalho 1954*; Bokermannohyla circumdata* (Cope 1871), *Rhinella icterica* (Spix 1824), *R. schneideri* (Werner 1894), *Hypsiboas faber* (Wied-Neuwied 1821), *H. semilineatus* (Spix 1824), *Itapotihyla langsdorffii* (Duméril & Bibron 1841), *Scinax hayii* (Barbour 1909), *Trachycephalus mesophaeus* (Hensel 1867), *T. nigromaculatus* Tschudi 1838, plus several leaf litter users, like *Ischnocnema guentheri* (Steindachner 1864), *I. octavioi* (Bokermann 1965), *I. parva* (Girard 1853), *Proceratophrys appendiculata* (Günther 1873), *P. boiei* (Wied-Neuwied 1865), and *Zachaenus parvulus* (Girard 1853), all present on the continent (Carvalho-e-Silva et al. 2008, and unpublished data) and on some of the neighboring larger islands (Ilha Grande, Rocha et al. 2001), may indicate the possibility that the reduction of area and loss of habitats from for reproduction due to the process of insulation are important factors that are contributed to amphibian extinctions in the area.

At Marambaia, restinga and hillside forest are essential habitats for many of the frog species. Together, these habitats support 23 of the 24 species of amphibians of the area, with 17 and 29% of the species, respectively, occurring nowhere else. In the restinga, a large number of anurans could be found exclusively in bromeliads. The high density and diversity of bromeliad species seem to contribute to the high species richness of frogs, which use these plants as shelters throughout the year, and some also using them for reproduction (Rocha et al. 2000, 2004b). The small water bodies held between the leaves of these plants, known as phytotelmata (Varga 1928), have been recognized as important sources of water and shelter for different groups of animals (Richardson 1999, Greeney 2001, Lopes & Rios 2001, Lehtinen 2004).

In the hillside forest, most of the anurans use streams, creeks, or the leaf litter. Several species are riparian or, in some degree, dependent on the streams that occur on the island of Marambaia and are absent in the restinga. Some of the rivers that drain the forest run to parts of the restinga, either forming a lake or passing through the sand banks directly to the sea. *Hylodes* cf. *phyllodes*, *Crossodactylus gaudichaudii*, *Thoropa miliaris*, *Hyalinobatrachium eurygnathum*, *Scinax trapicheiroi* (B. Lutz 1954), and *Aplastodiscus albofrenatus* are restricted to the areas along hillside forest streams, confirming a high degree of association of these species to these habitats (Izecksohn & Carvalho-e-Silva 2001, Hatano et al. 2002, Carvalho-e-Silva & Carvalho-e-Silva 2005). On Marambaia, *T. miliaris* was not found on coastal rock faces feeding on marine organisms, as has been reported for other localities (Sazima 1970), but it is dependent on films of water for its reproduction (Rocha et al. 2002).

The majority of the frogs present in the lowlands are species commonly found in this habitat elsewhere in the State of Rio de Janeiro (Izecksohn & Carvalho-e-Silva 2001), also use restinga or hillside forest, and have their reproductive behavior associated with the mouths of rivers and creeks, flooded areas, or temporary ponds (Carvalho-e-Silva et al. 2008). In this category we have species including *Rhinella ornata*, *Dendropsophus* cf. *oliveirai* (Bokermann 1963), *Hypsiboas albomarginatus* (Spix 1824), *S.* cf. *alter*, *S.* cf. *x-signatus*, and *Leptodactylus ocellatus*. Therefore, although lowland areas have just one exclusive species, many depend on particular microhabitats present there for reproduction (Izecksohn & Carvalho-e-Silva 2001, Carvalho-e-Silva et al. 2008).

Marambaia includes one endemic species, *Leptodactylus marambaiae* (Izecksohn & Carvalho-e-Silva 2001). This species, a member of the *L. fuscus* group (Heyer 1978), represents an intriguing biogeographic question, similar to that of *Bothrops insularis* (Serpentes), *Cycloramphus faustoi* Brasileiro, Haddad, Sawaya, & Sazima 2007, *Scinax peixotoi* Brasileiro, Haddad, Sawaya & Martins 2007, *S. faivovichi* Brasileiro, Oyamaguchi & Haddad 2007, *Proceratophrys tupinamba* Prado & Pombal 2008, and possibly *Hylodes fredi* Canedo & Pombal 2007 (Anura), all endemic to coastal islands either in the State of São Paulo (Marques et al. 2002, Brasileiro et al. 2007a, Brasileiro et al. 2007b), or Rio de Janeiro (Canedo & Pombal 2007, Prado & Pombal 2008). These coastal islands were all formed as a result of fluctuations in sea level, which started about 17,500 y.b.p (Suguio & Martin 1978, Martin et al. 1993), isolating some coastal mountains. Although there are endemic species on the islands, it is uncertain if they originated as a result of this event of insulation or of an older event. It is also puzzling that while on the continent *L. fuscus* is found in almost all lowland areas in the State of Rio de Janeiro, including coastal areas, it is not present on Marambaia which was once connected to the continent when sea level was lower (Andrade et al. 2003, Roncarati & Menezes 2005). Investigations of different aspects of the natural and evolutionary history of *L. marambaiae* are necessary so that we may understand this biogeographic conundrum.

Others special cases are *Rhinella pygmaea* and *Xenohyla truncata* (Izecksohn 1959), which are species apparently restricted to restingas of Rio de Janeiro (Carvalho-e-Silva et al. 2000). Marambaia is the southernmost limit of distribution of both of these species (Carvalho-e-Silva et al. 2000, IUCN, Conservation International, and NatureServe 2006) and because of its relatively good conservation condition, may represent the best option for the maintenance of these species along the coast.

If confirmed by the study of additional islands in the area, the relationship between area reduction — with consequent loss of some habitats, and impoverishment of the community —, of this archipelago may shed light on the understanding of the consequences of habitat fragmentation caused by human activities on the mainland and the subsequent loss of anuran species. The relationship between the process of insulation and the conservation of Atlantic Forest anurans seems obvious; selection of areas for conservation of anurans should take into consideration not only the size of the area, but also the diversity of microhabitats used as sites for anurans reproduction it contains.

Acknowledgements

Our activities on Marambaia are part of a cooperative accord between our University and the military base in the Island. Dr. Roberto de Xerez serves a liaison between the University and the Navy base. We are thankful to him for assigning our field trips with the military base Commander. We are also in debt to the Bra-

zilian Navy, especially the commanding officer of CADIM (Centro de Adestramento da Ilha da Marambaia) for the logistic support during field work; to the students and colleagues of the Laboratory of Herpetology of the Universidade Federal Rural do Rio de Janeiro for their help in the field and laboratory. The MCT-CNPq (National Council for Scientific and Technological Development) provided support for this research through the grant process CNPq 471081/04-3.

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Data Received 15/06/08
Revised 16/11/08
Accepted 24/11/08

Appendix

List of anurans collected on Marambaia, Mangaratiba, Rio de Janeiro, Brazil. The specimens are housed in the Herpetological Collection of the Universidade Federal Rural do Rio de Janeiro (RU). The only specimen of *Xenohyla truncata* from Marambaia is deposited in the herpetological collection housed in the Museu Nacional (MNRJ)

Aparasphenodon brunoi RU 0062, RU 0104, RU 0143, RU 0144, RU 3531, RU 4862, RU 4867; *Aplastodiscus albofrenatus* RU 0078, RU 0159, RU 0253, RU 3502, RU 3758, RU 4297; *Chiasmocleis* cf. *carvalhoi* RU 0201, RU 0202, RU 3501, RU 3608, RU 3652, RU 3653, RU 3741, RU 3764, RU 4298, RU 4885, RU 4886, RU 4887, RU 4888, RU 4889, RU 4890, RU 4987, RU 4988, RU 4989, RU 5021, RU 5022, RU 5023, RU 5024, RU 5025, RU 5026, RU 5027, RU 5028, RU 5029; *Crossodactylus gaudichaudii* RU 0204, RU 0205, RU 0873, RU 1862, RU 1863; *Dendrophryniscus brevipollicatus* RU 0094, RU 0096; *Dendropsophus decipiens* RU 1327, RU 4872; *Dendropsophus* cf. *oliveirai* RU 0048, RU 0059, RU 0267; *Haddadus binotatus* RU 0026, RU 0037, RU 0058, RU 0061, RU 0071, RU 0076, RU 0077, RU 0123, RU 0184, RU 0263, RU 0264, RU 0265, RU 0868, RU 0869, RU 0870, RU 0871, RU 1318, RU 1753, RU 2698, RU 3503, RU 3504, RU 3607, RU 3620, RU 3649, RU 3651, RU 3671, RU 3682, RU 3767, RU 3768, RU 3769, RU 3770, RU 3875, RU 3894, RU 4293, RU 4294, RU 4876, RU 4877, RU 4878, RU 4895, RU 4896, RU 5217, RU 5218; *Hyalinobatrachium eurygnatum* RU 0046; *Hylodes* cf. *phyllodes* RU 0095, RU 0206, RU 0207, RU 0208, RU 0209, RU 0210, RU 0211, RU 1750, RU 1751, RU 2454; *Hypsiboas albomarginatus* RU 0068, RU 0101, RU 0115, RU 0116, RU 0117, RU 0118, RU 0170, RU 0171, RU 0172, RU 0173, RU 0174, RU 0175, RU 0176, RU 0177, RU 0178, RU 0179, RU 0180, RU 0181, RU 0182, RU 0187, RU 0188, RU 0189, RU 0190, RU 0472, RU 1326, RU 1368, RU 3759, RU 4863, RU 4883, RU 5286, RU 5287; *Leptodactylus marambaiae* RU 0069, RU 0119, RU 0120, RU 0121, RU 0122, RU 3535, RU 3569; *Leptodactylus marmoratus* RU 0097, RU 0099, RU 0102, RU 0255, RU 0259, RU 0384, RU 0385, RU 5019; *Leptodactylus ocellatus* RU 0131, RU 0132, RU 0133, RU 0134, RU 0135, RU 0136, RU 0137, RU 0138, RU 0139, RU 0140, RU 0141, RU 0155, RU 0156, RU 0157, RU 0158, RU 0192, RU 0193, RU 0194, RU 0195, RU 0196, RU 0197, RU 0198, RU 0199, RU 0200, RU 0251, RU 0350, RU 0471, RU 1322, RU 3763, RU 3881, RU 4864; *Myersiella microps* RU 3681, RU 5292; *Physalaeumus signifer* RU 0033, RU 0050, RU 0098, RU 0383, RU 0872, RU 1323, RU 1861, RU 3876, RU 4884, RU 4897, RU 5020, RU 5216, RU 5289; *Rhinella ornata* RU 0072, RU, 0081, RU 0100, RU 0145, RU 0160, RU 0161, RU 0162, RU 0163, RU 0164, RU 0165, RU 0166, RU 0167, RU 0168, RU 0169, RU0183, RU 0191, RU 0467, RU 0468, RU 0469, RU 0470, RU 1736, RU 3644, RU 3645, RU 3646, RU 3737, RU 3738, RU 3739, RU 3760, RU 3761, RU 3762, RU 3874, RU 3882, RU 4837, RU 4838, RU 4839, RU 4840, RU 4841, RU 4842, RU 4843, RU 4844, RU 4845, RU 4846, RU 4847, RU 4848, RU 4849, RU 4850, RU 4851, RU 4852, RU 4853, RU 4854, RU 4855, RU 4856, RU 4857, RU 4858, RU 4859, RU 4860, RU 4861, RU 4880, RU 4881, RU 4882, 4891, RU 4892, RU 4893, RU 4894, RU 5030, RU 5212, RU 5213, RU 5214, RU 5215, RU 5267, RU 5268, RU 5269, RU 5270, RU 5271, RU 5272, RU 5273, RU 5274, RU 5275, RU 5276; *Rhinella pygmaea* RU 0070, RU 0751, RU 0752, RU 1839; *Scinax* cf. *x-signatus* RU 0029, RU 0030, RU 0034, RU 0042, RU 0043, RU 0045, RU 0142, RU 0252, RU 0355, RU 2466, RU 3766; *Scinax* cf. *alter* RU 0027, RU 0031, RU 0032, RU 0044, RU 0060, RU 0082, RU 0083, RU 0084, RU 0085, RU 0086, RU 0103, RU 0105, RU 0106, RU 0107, RU 0108, RU 0109, RU 0110, RU 0111, RU 0112, RU 0113, RU 0114, RU 0146, RU 0147, RU 0148, RU 0254, RU 0257, RU 0258, RU 0351, RU 0352, RU 0353, RU 0354, RU 0913, RU 1077, RU 1078, RU 1079, RU 1080, RU 1081, RU 1082, RU 1083, RU 1752, RU 3676, RU 3765, RU 4870, RU 4871; *Scinax* cf. *perpusillus* RU 0028, RU 0035, RU 1746, RU 1747, RU 1748, RU 1749, RU 1757, RU 1758, RU 1854 (two tadpole); *Scinax trapicheiroi* RU 0047, RU 0049, RU 0051, RU 0052, RU 0053, RU 0054, RU 0055, RU 0056, RU 0057, RU 0066, RU 0075, RU 0124, RU 0125, RU 0126, RU 0127, RU 0129, RU 0149, RU 0150, RU 0151, RU 0185, RU 0186, RU 0203, RU 0266, RU 1324, RU 1720, RU 1721, RU 1722, RU 1723, RU 1724, RU 1725, RU 3650, RU 4295, RU 4835, RU 4879, RU 5277, RU 5278; *Thoropa miliaris* RU 0039, RU 0040, RU 0041, RU 0063, RU 0064, RU 0065, RU 0067, RU 0073, RU 0074, RU 0079, RU 0080, RU 0152, RU 0153, RU 0154, RU 0260, RU 0261, RU 0262, RU 1319, RU 1320, RU 1321, RU 1731, RU 1732, RU 1733, RU 1734, RU 1737, RU 1738, RU 1739, RU 1740, RU 1741, RU 1742, RU 1754, RU 1796, RU 1842, RU 3605, RU 3606, RU 3883, RU 3884, RU 3895, RU 4296, RU 4899; *Xenohyla truncata* MNRJ 20031.