
AMPHIBIANS OF AN OPEN CERRADO FRAGMENT IN SOUTHEASTERN BRAZIL

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Abstract

The Cerrado encompasses ca. 2 million km² in Brazil. Most Cerrado areas have been greatly disturbed in the past decades. Only 20% of this biome remain undisturbed, and only 1.2% is protected. Knowledge on the biology and diversity of Cerrado amphibian assemblages is still incipient. Here we present natural history information (habitat use and reproductive activity) of 28 species of frogs from the Estação Ecológica de Itirapina (EEI), and compare the composition of this assemblage with those of other Cerrado areas, other open areas, and a few forest areas throughout Brazil. We demonstrate that the Itirapina assemblage is more similar to those of other open areas than to those of forests, even when the latter are geographically closer. Six species occurred in the gallery forest at varying levels of dependence (three independent, two semi-dependent, and one totally dependent) while all other species occurred exclusively in open areas. For most species at EEI, reproduction was strongly synchronized with the onset of the rainy season, with the exception of *Hypsiboas lundii*, which called throughout the year, and *Proceratophrys* sp. which started calling prior to the beginning of the rainy season. The spatial and temporal patterns observed in this assemblage seem to reflect both ecological (e. g. hydroperiod of water bodies) and historical factors (e. g. early breeding in leptodactylids, late breeding in hylids, both phylogenetically constrained).

Key words: *Amphibians; Habitat use; Reproduction; Cerrado; Itirapina; São Paulo; Brazil*

Resumo

O Cerrado originalmente ocupava dois milhões km² no Brasil. Nas últimas décadas, as áreas naturais de Cerrado vêm sendo destruídas rapidamente. Somente 20% da região original permanece inalterada e apenas 1,2% encontram-se em unidades de conservação. O conhecimento sobre a biologia e a diversidade de espécies de Cerrado ainda são muito escassos. Neste trabalho, nós apresentamos informações sobre história natural (uso do ambiente e atividade reprodutiva) de 28 espécies de anfíbios da Estação Ecológica de Itirapina (EEI) e comparamos a composição das taxocenoses da EEI com aquelas de outras localidades de Cerrado, e também de áreas florestais e outras fisionomias abertas. Demonstramos que a taxocenose de Itirapina assemelha-se mais àquelas de outras formações vegetais abertas, estruturalmente mais semelhantes, do que as taxocenoses de formações florestais, mesmo que estas sejam geograficamente mais próximas. Seis espécies ocorreram nas matas de galeria em diferentes graus de dependência (três independentes, duas semi-dependentes e uma totalmente dependente) enquanto que as demais ocorreram exclusivamente nas fisionomias abertas. Para a maioria das espécies da EEI, a reprodução foi fortemente sincronizada com a estação chuvosa, com exceção de *H. lundii*, que vocalizou durante todo o ano e *Proceratophrys* sp. que iniciou as atividades de vocalização antes do início da estação chuvosa. Os padrões espacial e temporal observados nessa taxocenose parecem refletir tanto fatores ecológicos (e. g. hidroperíodo dos corpos d'água) e históricos (e. g. reprodução no início da estação reprodutiva para os leptodactídeos e tardia para os hílídeos, ambos filogeneticamente determinados).

Palavras-chave: *Anfíbios; Uso de ambiente; Reprodução; Cerrado; Itirapina; São Paulo; Brasil*

1. INTRODUCTION

The Cerrado is the second largest vegetational domain in Brazil, encompassing ca. 2 million km² in the northern, central, western, and southeastern regions of the country (Ratter et al. 1998). In the past decades, natural areas of Cerrado have been greatly disturbed, primarily due to extensive agriculture practice and cattle raising (Ratter et al. 1998). Presently, only 20% of this biome remains undisturbed, and only 1.2% is protected (Mittermeier et al. 2000). The Cerrado was recently ranked among the 25 most important terrestrial hotspots (Myers et al. 2000), and is possibly the most threatened tropical savanna in the world (Silva & Bates 2001). The typical landscape of the Cerrado consists of savanna-like vegetation in the well-drained interfluves and gallery forests along streams and rivers (Ratter et al. 1998). Cerrado vegetation varies in structure and composition (Furley & Ratter 1998, Ratter et al. 1998). Five main vegetation types of Cerrado are recognized (Eiten 1972, Ratter et al. 1998): *cerradão* (forest-like savanna), *cerrado sensu stricto* (woody savanna), *campo cerrado* (shrubby grassland with trees), *campo sujo* (shrubby grassland), and *campo limpo* (grassland).

In 1992, only 2% of the Cerrado areas in São Paulo State, southeastern Brazil, were represented by grasslands (Kronka et al. 1998). Presently, very few remnants of these open formations are protected. Thus, studies that provide information on the native fauna and flora of open Cerrado formations are of great importance for conservation management and implementation (see Silva & Bates 2001).

Knowledge on the Cerrado anuran fauna is extremely limited, and most studies were conducted in central and northern Brazil (Moreira & Barreto 1996, Martins 1998, Strüssmann 2000, Bastos et al. 2003; for a review see Colli et al. 2002). The anuran fauna of the southern regions of the Cerrado is virtually unknown, with the exception of two studies on the herpetofauna of high elevation (> 1500 m) Cerrado areas in central and southern Minas Gerais (Serra do Cipó, Eterovick & Sazima 2004; and Serra da Canastra, Haddad et al. 1988); furthermore, these areas also include *campos rupestres* (a shrubby vegetation that grows on rocky fields), which harbors several endemic species of plants and animals.

Here we present natural history information (habitat use and reproductive activity) on 28 species of frogs from the Estação Ecológica de Itirapina (EEI), one of the few remnants of protected grasslands in the State of São Paulo. We also compare the composition of this assemblage with those of other Cerrado sites, two Caatinga (dry, predominantly xerophitic open vegetation), and four forest areas throughout Brazil. We demonstrate that the Itirapina assemblage is more similar to those of other open areas than to those of forests, even when the latter are geographically closer to the EEI.

2. STUDY AREA

The Estação Ecológica de Itirapina (ca. 2300 ha) is located in the municipalities of Itirapina and Brotas (Fig. 1; 22°00' to 22°15' S; 47°45' to 48°00' W; elevation 720-750 m). The reserve is covered by well preserved, natural Cerrado vegetation, mainly *campo limpo* (grasslands), *campo sujo* (grasslands with scattered shrubs), *campo cerrado* (grasslands with scattered shrubs and trees), gallery forests, and marshes (Figs. 2 and 3). The soil of the drier interfluves (with grasslands) is primarily composed of sand (over 85%); soils in wetter areas contain 60-70% of clay or silt. There are two types of gallery forests in the reserve (Fig. 2): the gallery forest along Lobo stream floods on rare occasions and its soil contains more silt and coarse sand, whereas the gallery forest along Capão stream is flooded throughout the rainy season and the soil contains more clay and fine sand (hydromorphic). Amphibians breed in both permanent and temporary ponds in the EEI and also utilize puddles, streams, swamps, marshes, and large dams as breeding sites (Fig. 4).

The climate is mesothermic with a marked dry season (Fig. 5). In the period from 1998 to 2002, mean monthly rainfall in the dry season (April to September) was 44.2 mm (0 to 122 mm each month) and 191.2 mm during the wet season (October to March; 29 to 452 mm each month). From April 1998 to March 2002, the minimum temperature ranged from 0 to 11 °C during the dry season, and from 9 to 18 °C during the wet season; the maximum temperature ranged from 28 to 36 °C in the dry season, and from 33 to 39 °C during the wet season (Fig. 5). Occasional frosts occurred in winter, usually in June and July.

3. MATERIAL AND METHODS

We surveyed the anurans of EEI from September 1998 to March 2002 using three primary methods: pitfall traps with drift fences (*sensu* Greenberg et al. 1994, Cechin & Martins 1999), visual and audio surveys (Heyer et al. 1994), and incidental encounters. All bufonids, leptodactylids, and microhylids were captured or observed using all sampling methods, and hylids were captured using all methods but pitfall traps. Voucher specimens were deposited in the Museu de História Natural da Universidade Estadual de Campinas (ZUEC) and Coleção de Anfíbios da Universidade Estadual Paulista, Rio Claro (CFBH).

In the species accounts, we provided the approximate snout-vent length (SVL, mm) of adult males and females together, unless stated otherwise. We considered rare those species for which we found less than 50 individuals throughout the study, and abundant those for which we found 50 or more individuals during the same period.

We compared the composition of the EEI assemblage with those of five Cerrado sites (Ilha de Maracá, northern Brazil, Martins 1998; Serra da Canastra, southern Brazil, Haddad



Figure 1 – Map of Brazil with Estação Ecológica de Itirapina (22° 00' and 22° 15' S and 47° 45' and 48° 00' W), municipalities of Itirapina and Brotas, São Paulo State.



Figure 2 – Aerial photography showing Estação Ecológica de Itirapina taken in 2002. White line = limits of Estação. Physiognomies: CSt = cerrado senso stricto; CCE = campo cerrado (yellow line); CS = campo sujo; CL = campo limpo; AA = swamps; GFC = gallery forest along Capão stream; GFL = gallery forest along Lobo stream. GA, GB, GC = pitfall traps in gallery Forest; SA, SB, SC = pitfall traps in campo sujo; CA, CB, CC = pitfall traps in campo cerrado.

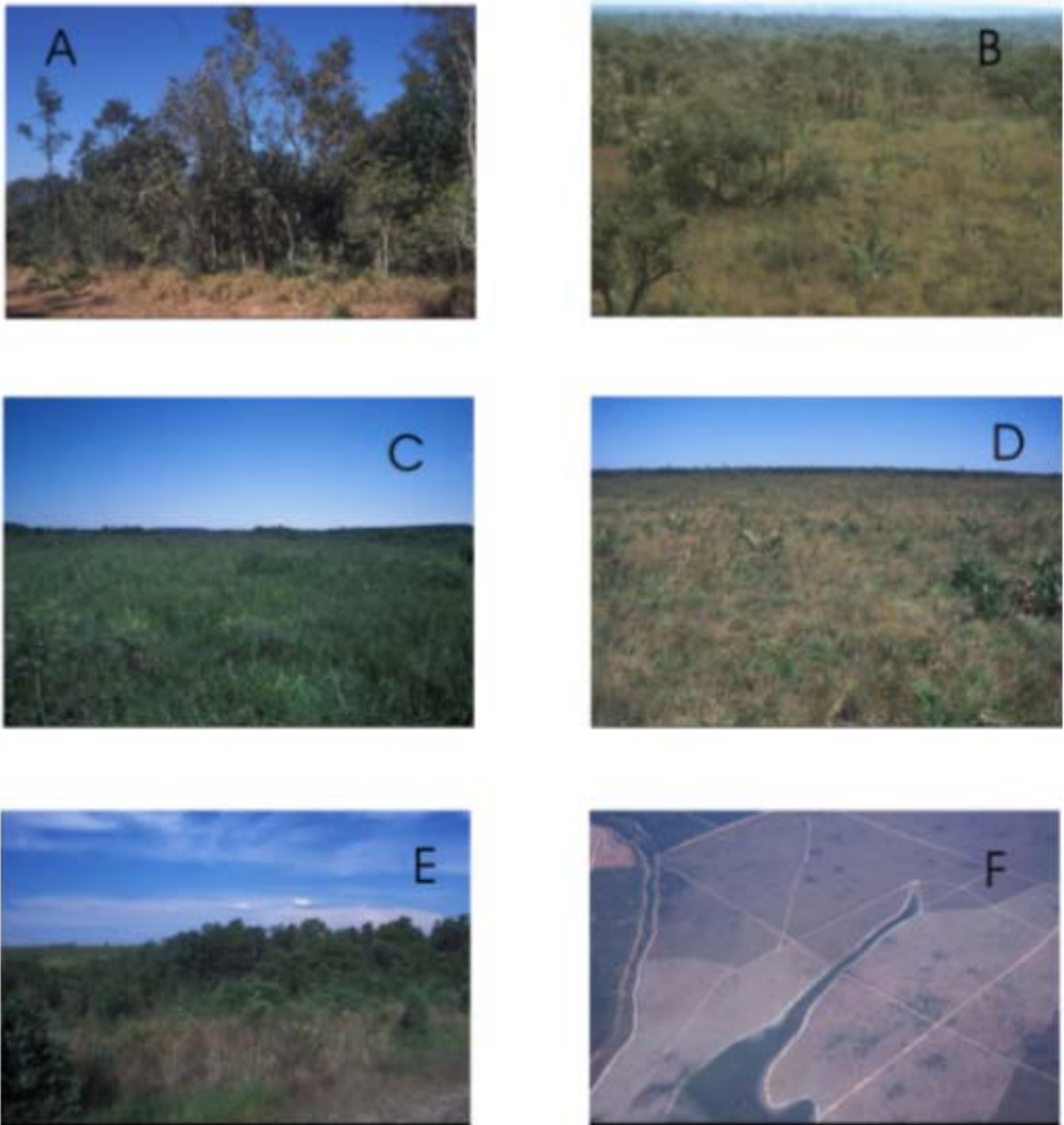


Figure 3 – Physiognomies of Estação Ecológica de Itirapina. **A** - Cerrado sensu stricto, **B** - Campo Cerrado, **C** - Campo Limpo; **D** - Campo Sujo, **E** - Swampy areas near gallery Forest; **F** - Gallery Forest.

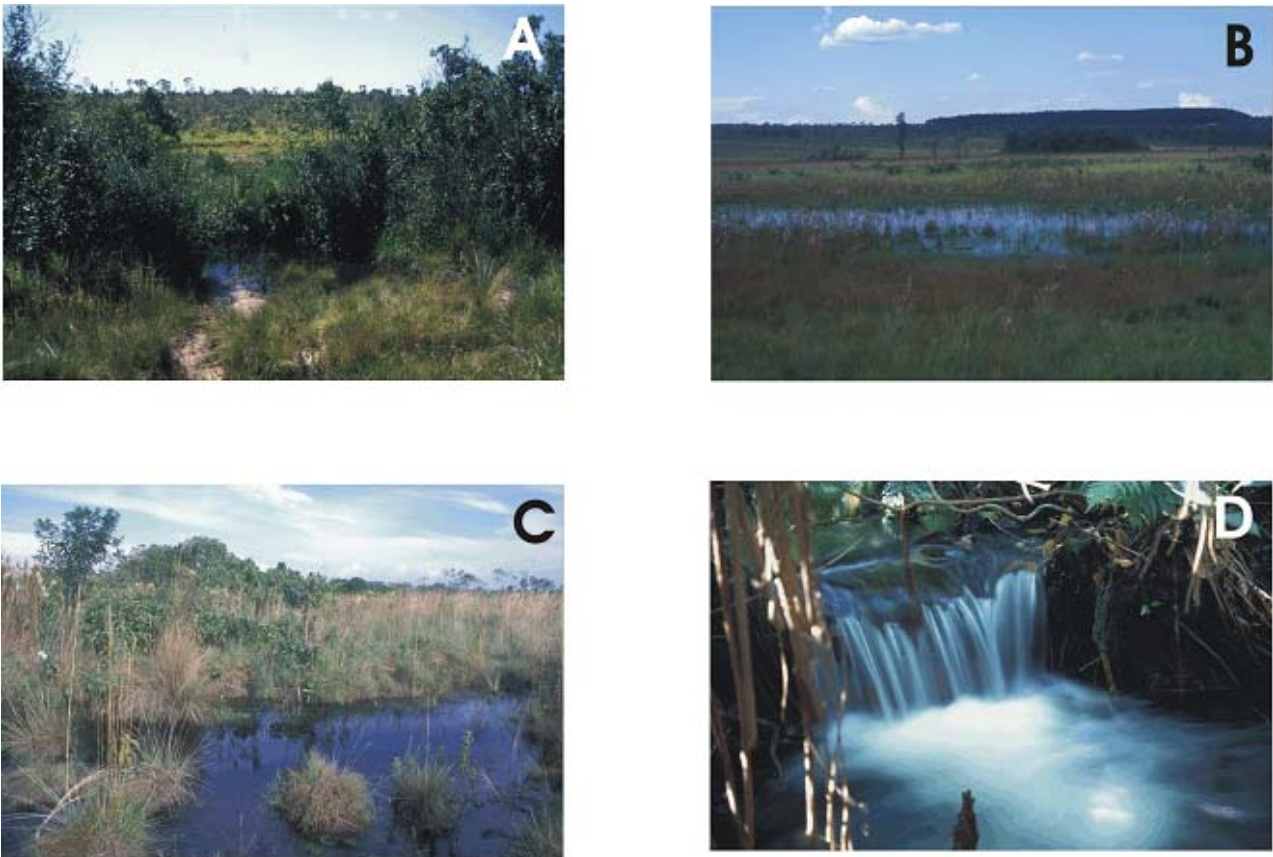


Figure 4 – Some sampled habitats in Estação Ecológica de Itirapina. A- Permanent pond; B - Temporary pond, Photo: Marcio Martins; C- Temporary pond ; D- Permanent stream, Photos: (Pictures by Marcio Martins (A and B), Alexandro Tozetti (C), and Ivan Sazima (D).

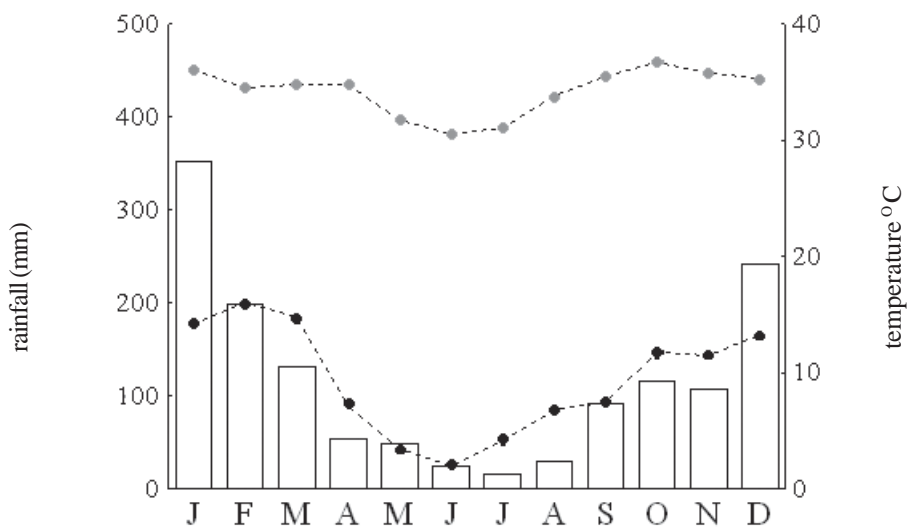


Figure 5 - Mean monthly rainfall (mm; bars), and mean minimum and maximum monthly temperatures (°C; lines) from April 1998 to March 2002 at Estação Ecológica de Itirapina.

Family/Species	Physiognomy	Breeding Site	Breeding period
Bufo			
<i>Bufo ornatus</i>	GF,SA	-	-
<i>B. schneideri</i>	CS,CL,SA	PP,TP	-
Hylidae			
<i>Dendropsophus jimi</i>	SA	SW,PP,TP	Sep - Jan
<i>Dendropsophus minutus</i>		SW,PP,TP	Oct - Jan
<i>Dendropsophus nanus</i>	SA	SW,PP	Sep - Jan
<i>Dendropsophus sanborni</i>	SA	SW,PP	Sep - Jan
<i>Hypsiboas albopunctatus</i>	GF *	PP,SW	Sep - Mar
<i>Hypsiboas lundii</i>	GF	S	Sep - May **
<i>Hypsiboas faber</i>	-	PP	-
<i>Osteocephalus langsdorffi</i>	GF	S	-
<i>Scinax cf. berthae</i>	CS,CL,SA,GF	TP,PP,SW	Oct - Jan
<i>Scinax fuscomarginatus</i>	CC,CS,CL	SW,PP,TP	Jan - Apr
<i>Scinax fuscovarius</i>	CC,CS,CL	SW,TP,PP,P	Oct - Mar
<i>Scinax squalirostris</i>	CS,CL,SA	TP,PP	Oct - Jan
<i>Scinax cf. similis</i>	CS,CL,SA	TP,PP,P	Sep - Mar
Leptodactylidae			
<i>Leptodactylus furnarius</i>	CC,CS,SA	TP	Dec - Mar
<i>Leptodactylus fuscus</i>	SG,CS,CC	TP,SW	Sep - Feb
<i>Leptodactylus jolyi</i>	CL,CS	SW	-
<i>Leptodactylus labyrinthicus</i>	CC,CS,CL	PP,LT,SW	Oct - Mar
<i>Leptodactylus mystacinus</i>	CS,CC,CL,SA	TP,PP,SW	Oct - Jan
<i>Leptodactylus cf. ocellatus</i>	CS,CL,SA	TP,PP	Oct - Mar
<i>Physalaemus centralis</i>	CS,CL	TP,P	Oct - Jan
<i>Physalaemus cuvieri</i>	CC,CS,CL,AS,GF	TP,PP	Sep - Mar
<i>Physalaemus fuscomaculatus</i>	CC,CS,CL	TP,P	Sep - Jan
<i>Physalaemus nattereri</i>	CS,CL, CC	TP,P	Sep - Jan
<i>Proceratophrys</i> sp.	CS,GF	S	Oct - Mar
Microhylidae			
<i>Chiasmocleis albopunctata</i>	CC,CS,CL	TP,P	Nov - Feb
<i>Elachistocleis ovalis</i>	CC,CS,CL,SA	TP,PP,SW,P	Dec - Apr

* Mainly in edge gallery forest. - ** In June, July and August, individuals sporadically call.

Table 1 – Physiognomies of occurrence, breeding site and calling period for each species recorded in Estação Ecológica de Itirapina, from September 1998 to March 2002. Physiognomies: SA, swamp areas CC, campo cerrado; CL, campo limpo; CS, campo sujo; and G, Gallery Forest. Breeding Sites: SW, swamps; TP, temporary pond; PP, permanent pond; P, puddles; and S, stream.

et al. 1988; Rio Manso, Strüssman 2001; Silvânia, Bastos et al. 2003; and Água Emendadas, Brandão & Araújo 1998, all three located in central Brazil), two Caatinga sites (Maturéia and São José do Bonfim, northeastern Brazil, Arzabe 1999), and four forest sites (Manaus, Amazonian forest, northern Brazil, M. Martins unpublished data; Guaraqueçaba, L. M. Castanho unpublished data, Atlantic forest, southeastern Brazil; Intervaes, Bertolucci 2001, Atlantic forest, southeastern Brazil; and Ubatuba, C. F. B. Haddad and M. Hartmann, unpublished data, Atlantic forest, southeastern Brazil). For this comparison we used the Sorensen similarity index (Wolda 1981) and the clustering method WPGMA (Sneath & Sokal 1973), with the software MVSP (Kovach 1999). We use World Wildlife Fund's ecoregions (e. g., Dinerstein et al. 2000) to refer to Brazilian ecosystems.

4. RESULTS AND DISCUSSION

4.1 SPECIES ACCOUNTS

We recorded 28 species in ten genera and four families at Estação Ecológica de Itirapina (Table 1). The information on each species is detailed below.

We recorded 28 species in ten genera and four families at Estação Ecológica de Itirapina (Table 1). The information on each species is detailed below.

Bufonidae

Bufo ornatus

This moderate-sized toad (SVL males \bar{x} = 54.4, SD = 15.7 mm, N = 21; Fig. 6) was a rare species at EEI. No calls were heard at the station, although adults and juveniles were observed and captured in pitfall traps close to the Lobo stream gallery forest during the rainy season. Voucher specimens: ZUEC 12009-10.

Bufo schneideri

This large toad (SVL males = 136.2, SD = 11.1 mm; N = 6; SVL females = 168.7, SD = 3.8 mm, N = 4; Fig. 7) was a rare species at EEI. It is an explosive breeder, frequently encountered at the end of the dry season, and early in the rainy season. It was captured mostly in pitfall traps near gallery forests (mainly along Lobo stream), but occasionally observed in *campo sujo*. It called for a few nights along the margins of large dam along the borders of the reserve during the onset of the rainy season. Additional information on the biology of *B. schneideri* was provided by Moreira & Barreto (1997), Brandão & Araújo (1998), and Toledo et al. (2003). Voucher specimen: ZUEC 12012.

Hylidae

Dendropsophus jimi

This small treefrog (SVL males = 19.1, SD = 0.4 mm; N = 6; Fig. 8) was very abundant in swampy areas and temporary ponds at EEI. Males called on grasses of these ponds throughout the rainy season; calling sites were 40 to 120 cm above the ground. Some males were observed using the same calling site over multiple nights. Tadpoles were found in temporary ponds. Voucher specimen: ZUEC 12047.

Dendropsophus minutus

This small treefrog (SVL males = 21.0, SD = 0.9 mm; N = 8; Fig. 9) was very common in swampy areas and temporary ponds throughout the reserve. Males called on the vegetation (usually grasses and shrubs) from 30 to 80 cm above ground, throughout the rainy season. Tadpoles were common in these ephemeral water bodies. Additional information on the biology of *D. minutus* was provided by Cardoso & Haddad (1984) and Eterovick & Sazima (2004). Voucher specimens: ZUEC 12042-43.

Dendropsophus nanus

This diminutive treefrog (SVL males = 20.4, SD = 0.8 mm; N = 10) was common in large flooded areas. Males called on grasses and shrubs from 10 to 40 cm above ground throughout the rainy season. Additional information on its biology was provided by Rossa-Feres & Jim (2001) and Toledo et al. (2003). Voucher specimen: ZUEC 12041.

Dendropsophus sanborni

A diminutive treefrog (SVL males = 17.3, SD = 1.4 mm; N = 6; Fig. 10) frequently encountered in swamps, large flooded areas, and ponds. Males called from the vegetation 30 to 60 cm above ground throughout the rainy season. Additional information on its biology was provided by Rossa-Feres & Jim (2001) and Toledo et al. (2003). Voucher specimens: ZUEC 12039-40.

Hypsiboas albopunctatus

This moderate-sized treefrog (SVL males = 53.1, SD = 7.2 mm; N = 6; Fig. 11) was very abundant in permanent or long lasting ponds and swampy areas around both gallery forests. It called from low branches of shrubs and low trees, and was found mostly from 30 to 100 cm above ground. Calling activity occurred throughout the rainy season, but peaked at the end of the season. Tadpoles were found in permanent ponds. Additional information on the biology of *H. albopunctatus* was provided by Moreira & Barreto (1997) and Toledo et al. (2003). Voucher specimens: ZUEC 12013-14.



Figure 6 - *Bufo ornatus*
Bufonidae. Photo: Ricardo J. Sawaya



Figure 7 - *Bufo schneideri*
Bufonidae. Photo: Ricardo J. Sawaya



Figure 8 - *Dendropsophus jimi*
Hylidae. Photo: Ricardo J. Sawaya



Figura 9 - *Dendropsophus minutus*
Hylidae. Photo: Alexandro Tozetti



Figura 10 - *Dendropsophus sanborni*
Hylidae. Photo: Ivan Sazima



Figure 11 - *Hypsiboas albopunctatus*
Hylidae. Photo: Alexandro Tozetti



Figure 12 - *Hypsiboas faber*
Hylidae. Photo Ricardo J. Sawaya



Figure 13 - *Hypsiboas lundii*
Hylidae. Photo: Alexandro Tozetti



Figure 14 - *Osteocephalus lagsdorfii*
Hylidae. Photo: Ricardo J. Sawaya



Figure 15 - *Scinax cf. berthae*
Hylidae. Photo: Marcio Martins



Figure 16 - *Scinax fuscomarginatus*
Hylidae. Photo: Luis Felipe Toledo



Figure 17 - *Scinax fuscovarius*
Hylidae. Photo: Marcio Martins



Figure 18 - *Scinax cf. similis*
Hylidae. Photo: Marcio Martins



Figure 19 - *Scinax squalirostris*
Hylidae. Photo: Marcio Martins



Figure 20- *Leptodactylus labyrinthicus*
Leptodactylidae. Photo: Ricardo J. Sawaya



Figure 21 - *Leptodactylus furnarius*
Leptodactylidae. Photo: Ricardo J. Sawaya

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