Anurofauna de uma mata ciliar no município de São Carlos, estado de São Paulo, Brasil

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Abstract: We surveyed anuran amphibians in a riparian forest fragment of the Córrego do Espraiado, located at the Universidade Federal de São Carlos, Municipality of São Carlos, state of São Paulo, southeastern Brazil. During March 2009 and February 2010 we did weekly surveys in which we recorded 13 anuran species. The species showed a seasonal reproductive activity. In addition, we found a positive correlation between the number of reproductively active species and photoperiod. We also found that the studied community was more similar to those of transitional areas between the Atlantic Forest and Cerrado than those of the nearby Cerrado fragments.
Keywords: *amphibia, ecology, community, transition zone, cerrado, atlantic forest.*

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Resumo: No presente estudo foi realizado um inventário das espécies de anfíbios anuros que ocorrem em um fragmento de mata ciliar do Córrego do Espraiado, localizado na Universidade Federal de São Carlos, Município de São Carlos, estado de São Paulo, sudeste do Brasil. Durante os meses de março de 2009 a fevereiro de 2010 foram realizadas saídas de campo semanais nas quais foram registradas 13 espécies de anuros. A atividade reprodutiva das espécies de anuros componentes da comunidade estudada mostrou-se sazonal, sendo que houve correlação positiva e significativa entre o número de espécies em atividade reprodutiva e o fotoperíodo. Verificamos que a comunidade estudada mostrou-se mais semelhante a comunidades de anuros de florestas de transição entre Mata Atlântica e Cerrado do que a fragmentos de Cerrado próximos da região.
Palavras-chave: *amphibia, ecologia, comunidade, zona de transição, cerrado, mata atlântica.*

Introduction

The state of São Paulo has about 230 anuran species, and only about 10% of this fauna is considered to be endemic to the state (Araújo et al. 2009). The fauna and flora from coastal areas and along large rivers of Brazil are usually the most well studied ones (Brandão & Araujo 1998). The same applies to São Paulo state, where the number of studies on the ecology and biology of anuran species in inland areas begun to increase recently (e.g. Rossa-Feres & Jim 2001, Toledo et al. 2003, Brasileiro et al. 2005, Vasconcelos & Rossa-Feres 2005).

Transitional zones between biomes, despite showing unique geographical features, vegetation and wildlife (Odum 1988), are subsampled in the state of São Paulo. Some examples of studies that characterize anurans in these environments are those conducted by Jim (1980) and Rossa-Feres & Jim (1994) in the region of Botucatu, Haddad & Sazima (1992) in the Serra do Japi, Municipality of Jundiaí, Vasconcelos & Rossa-Feres (2005) in Nova Itapirema, and Araujo et al. (2009) in the Parque Ecológico das Furnas do Bom Jesus, Municipality of Pedregulho. One reason for the small number of studies in these areas lies in the fact that few are located in protected areas and most of them are already largely impacted by human activities. According to Silvano & Segalla (2005), conservation units provide easy access and good research infrastructure, therefore they are better studied in terms of the anuran community. Moreover, questions about transitional areas that pervade current studies on priority areas for conservation (i.e. are levels of endemism and species concentration higher in transitional areas?) remain unknown for many animal groups (Kark et al. 2007).

Species inventory is the first initiative to be taken for the assessment of potential priority areas for conservation. With these we can then develop management plans that are appropriate for each conservation unit, perform effective fauna and flora monitoring, and develop conservation strategies compatible with the policies, history and reality of each area. The scarcity of studies on community composition, diversity, species biogeography and ecology becomes, thus, a limiting factor for development, planning and decision-making (Garcia & Vinciprova 2003, Silvano & Segalla 2005).

The Cerrado fragment at the Universidade Federal de São Carlos is relatively well known in terms of flora (see Oliveira & Batalha 2005, Valenti et al. 2008) and fauna (see Roque et al. 2003, Motta-Júnior 2006, Silva et al. 2008). However, no study has surveyed the local anuran fauna. Thus, our aims in this study were: i) to determine the composition of anuran species present in a portion of the university's fragment and to estimate the species richness of the site; ii) to verify the occurrence of seasonality in the reproductive activity of the anuran community and the influence of climatic variables (rainfall, photoperiod and temperature) on species' reproductive activity; and iii) to compare the anuran fauna of the study area with other areas in the state of São Paulo.

Material and Methods

1. Study site

The region of São Carlos, state of São Paulo, is one of the several transition regions between the biomes of the Cerrado and Atlantic Forest in the state (Instituto... 2004). The region has soils of haplustox type (Instituto... 2001) and its climate is classified as Cwa-Awa, humid temperate (or subtropical), characterized by two well defined seasons: dry winter (April to September) and rainy summer (October to March) (Köppen 1900, Geiger 1961).

This study was conducted in a fragment with characteristics between Seasonal Semi-deciduous Forest (included in the Atlantic forest biome) and riparian forest, surrounded by Cerrado, located at the Universidade Federal de São Carlos, municipality of São Carlos, São Paulo state (21° 57' S and 47° 51' W, 900 m a.s.l., Figure 1), southeastern Brazil. This small fragment (about 55 ha) is surrounded by Cerrado and by areas altered by human activities (e.g., buildings and plantation, mainly sugar cane and *Eucalyptus* spp.). A second order stream, called Córrego do Espraiado, crosses the studied fragment, with a width of 0.70 to 2.5 m and depth ranging from 0.02 to 0.40 m. This water body ends in a permanent lake approximately 100 m long and 10-30 m wide.

2. Sampling and data analysis

Field work was carried out from March 2009 to February 2010. During this period, we undertook weekly nocturnal samples with an average duration of four hours, starting immediately after sunset and ending at the end of the route set for sampling, totaling up to 190 hours of field observations. We determined two sampling areas: the area within the fragment and the area around the permanent lake.

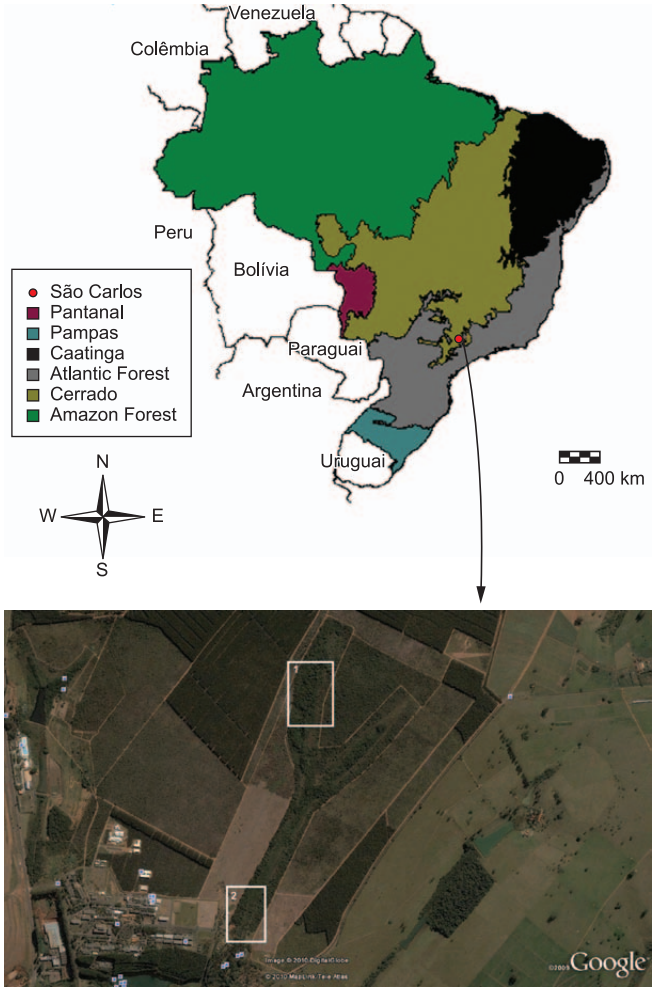

Figure 1. Map of the study site in the municipality of São Carlos, São Paulo state, southeastern Brazil, showing the two sampled areas: 1) riparian forest, on the left tributary of the stream and 2) pond at one side of the fragment.

Figura 1. Mapa geral do local estudado dentro do Município de São Carlos, São Paulo, sudeste do Brasil, com detalhe para as duas regiões amostradas: 1) interior da mata ciliar, no braço esquerdo do "Y" e 2) região da lagoa, na base do fragmento.

Inside the fragment we made five transects 50 m long each, 50 m distant from each other, which were parallel to the stream. Along the transects, we sampled anurans in temporary ponds formed during the rainy season, as well as on the stream banks. Additionally, we walked along the shores of the lake and along disturbed areas in its vicinity. Sampling methodology used was auditory search, visual encounter (of adults and tadpoles) and occasional surveys (Crump & Scott 1994). The species reproductive season and activity were determined by the presence of males in calling activity.

The species accumulation curve was constructed based on 1000 randomizations and these data and those obtained through the use of four nonparametric estimators (Jackknife1, Jackknife2, Chao1 and Bootstrap) were used to evaluate the effectiveness of the inventory (sensu Santos 2006).

To determine if the reproduction of anurans was seasonal, we used circular statistics (software Oriana®) with subsequent application of Rayleigh's Z-test of circular homogeneity to assess the significance of the average angle obtained from the analysis (Zar 1996, Prado et al. 2005).

We performed a parametric multiple linear regression analysis in the Past® software to determine which abiotic factor or set of factors would be related to number of active species in the area. Data on maximum and minimum temperatures and rainfall were obtained from the website of the Centro Integrado de Informações Agrometeorológicas (Centro... 2010) and photoperiod data from the website of the Observatório Nacional (2010) (Figure 2). Finally, to compare the species composition with other anuran communities in the state of São Paulo (Table 1, Figure 3), we performed a similarity analysis using Jaccard index coupled with a cluster analysis using the method of group-average clustering (Zar 1996) in the BioDiversity Profesional2® software. In all tests, results with $P < 0.05$ were considered as statistically significant (Zar 1996).

Voucher specimens were euthanized in xilocaine 5%, fixed in 10% formalin, preserved in 70% ethanol and housed at the Dr. Célio Fernando Baptista Haddad (CFBH) amphibian collection at the Universidade Estadual Paulista "Julio de Mesquita Filho", Rio Claro *campus*, São Paulo state, and in the collection of Dr. Maria Elina Bichuette at the Universidade Federal de São Carlos, São Paulo, Brazil.

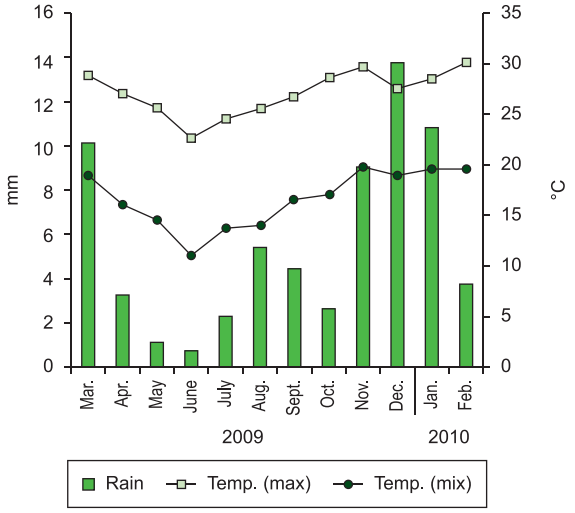

Figure 2. Mean monthly rainfall, maximum and minumum temperature in the study period, from March 2009 to February 2010 (Data from CIIAGRO and *Observatório Nacional*).

Figura 2. Valores médios mensais de chuvas, temperatura máxima e temperatura mínima no período estudado, de março de 2009 a fevereiro de 2010 (Dados: CIIAGRO e Observatório Nacional).

Table 1. Richness, biome, predominant forest type and reference source of assemblages compared with the present study.

Tabela 1. Número de espécies, Bioma em que está inserida, fitofisionomias predominantes e referências das taxocenoses comparadas com o local de estudo.

Areas in the map	Locality	Richness	Biome	Predominant forest type(s)	Reference
1	SF	13	Cerrado	FES/S	This study
2	PE das Furnas do Bom Jesus	24	Cerrado	FES/S	Araujo et al. (2009)
3	EE de Itirapina	27	Cerrado	S	Brasileiro et al. (2005)
4	FE Edmundo Navarro de Andrade	21	Atlantic Forest	FES	Toledo et al. (2003)
5	EE de Caetetus	24	Atlantic Forest	FES	Bertoluci et al. (2007)
6	Nova Itapirema	27	Cerrado	FES/S	Vasconcelos & Rossa-Feres (2005)
7	Mata São José	23	Atlantic Forest	FES	Zina et al. (2007)
8	Morro do Diabo	28	Atlantic Forest	FES	Santos et al. (2009)
9	EE de Assis	23	Cerrado	S	Ribeiro-Júnior & Bertoluci (2009)
10	Serra do Japi	19	Atlantic Forest	FES/FOD	Ribeiro et al. (2005)
11	REBIO da Serra da Paranapiacaba	31	Atlantic Forest	FOD	Pombal Júnior & Haddad (2005)
12	UC Jacupiranga	33	Atlantic Forest	FOD	Aguiar-De-Domenico (2008)
13	Icém	21	Atlantic Forest	FES/S/P	Silva & Rossa-Feres (2007)
14	EE Juréia-Itatins	20	Atlantic Forest	FOD/REST	Narvaes et al. (2009)
15	PE Ilha do Cardoso	16	Atlantic Forest	FOD/REST	Bertoluci et al. (2007)
16	EE Jataí	21	Atlantic Forest	FMS/S	Prado et al. (2009)
17	PE Carlos Botelho	28	Atlantic Forest	FOD	Bertoluci et al. (2007)
18	Santa Fé do Sul	20	Atlantic Forest	FES/P	Santos et al. (2007)
19	EB Boracéia	28	Atlantic Forest	FOD	Bertoluci & Rodrigues (2002a)

FES = semideciduous Atlantic Forest, S = savanna, FOD = dense rain forest, RES = sandbank, FMS = mesophytic semideciduous forest, P = pasture.

FES = floresta estacional semidecídua, S = savana, FOD = floresta ombrófila densa, REST = restinga, FMS = floresta mesofítica semidecídua, P = pastagem.

Results

1. Species richness and composition

We recorded 13 anuran species in the studied area, belonging to five families and nine genera (Table 2, Figure 4). The family Hylidae was the most speciose and the most common reproductive mode was mode 1 (sensu Haddad & Prado 2005) (Table 2).

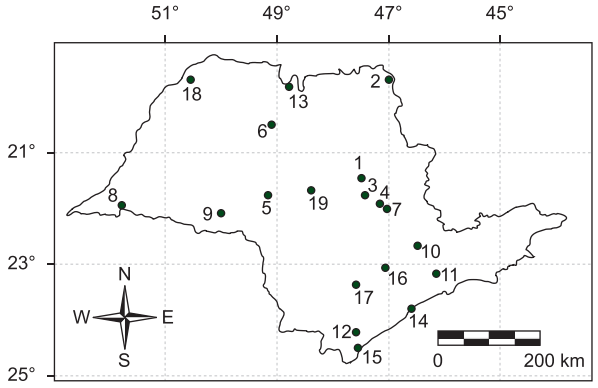

Figure 3. Map of the state of São Paulo, southeastern Brazil, showing the areas where the anurofauna was compared with the present study (see Table 1 for locality names).

Figura 3. Mapa do Estado de São Paulo, sudeste do Brasil, com os pontos correspondentes (para legenda ver Tabela 1) aos municípios cuja anurofauna foi comparada.

The most abundant species recorded in calling activity was *Hypsiboas lundii*, being also the species with the most prolonged breeding season (Table 2). We captured 25 individuals of this species, mostly males in calling activity (N = 18) and only two females, both near a calling male. All individuals were found within the riparian forest on the stream banks.

The species accumulation curve reached the asymptote after the 45th field trip (Figure 5). Richness estimators performed similarly and produced values close to the observed richness (Figure 5).

2. Seasonality in reproductive activity

Most species reproduced during a few months (mainly in the rainy season, in March and from September to Februrary), whereas others, especially those found in the interior of the fragment, were prolonged breeders (Table 2).

The value of vector *r* was 0.37 (Table 3, Figure 6). This parameter varies from 0 (indicating a high dispersion of data in the circumference, i.e., no seasonality) to 1 (highest degree of data concentration, i.e., high seasonality) (Zar 1996). The value of *r* obtained here can be taken as a measure of the degree of seasonality in the reproductive activity at the studied site, since the value of the Rayleigh's Z-test was significant (Table 3).

The year studied can be considered as an abnormal year because of the absence of a typical dry season. The multiple regression analysis indicated that the photoperiod was the only variable positively and significantly correlated with the number of calling species, explaining 59.7% of the reproductive activity of the species ($P < 0.001$).

Table 2. Species found in the fragment studied, São Carlos, state of São Paulo, showing the reproductive modes (RM), following Haddad & Prado (2005), months in which species were found, and recorded site (RS) (L = lake, F = within the fragment).

Tabela 2. Espécies encontradas no fragmento estudado, município de São Carlos, estado de São Paulo, com os respectivos modos reprodutivos (RM), segundo Haddad & Prado (2005), meses em que foram encontradas e locais de registro (RS) (L = lagoa e F = interior do fragmento).

Species	RM	2009										2010		RS
		Mar.	Apr.	May	Juny	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	
BUFONIDAE														
Rhinella ornata	1	-	-	-	-	-	-	-	♦	♦	-	♦	-	L
Rhinella schneideri	1	-	-	-	-	-	-	-	-	-	-	♦	-	F
CRAUGASTORIDAE														
Haddadus binotatus	23	-	-	-	-	-	-	-	-	-	♦	-	-	F
HYLIDAE														
Aplastodiscus perviridis	5	■	■	-	-	-	-	-	■	■♦	■	■	■	F
Bokermannohyla luctuosa	4	♦	♦	-	-	-	♦	♦	-	-	●	■●♦	●♦	F
Dendropsophus minutus	1	■		-	-	-	-	-	-	-	-	-	-	L
Hypsiboas albopunctatus	1	■	■	-	-	-	-	■♦	■	■♦	■	■♦	■	L
Hypsiboas faber	4	-	-	-	-	-	-	-	-	-	♦	-	-	L
Hypsiboas lundii	4	■	■	■♦	-	■	■	■♦	■	■	■♦	■●	■●	F
Scinax berthae		-	-	-	-	■	-	■	-	■	■	-	-	L
Scinax fuscovarius	1	♦	-	-	-	-	-	-	♦	-	-	■	-	F
LEIUPERIDAE														
Physalaemus cuvieri	11	-	-	-	-	-	-	-	-	■●	■●	■●	■	L
LEPTODACTYLIDAE														
Leptodactylus fuscus	30	-	-	-	-	-	-	-	-	-	-	■●	-	L
Season		R			D						R			
Total number of species		6	4	1	0	2	2	4	5	6	8	9	5	

■ reproductive activity, ● presence of species tadpoles, ♦ foraging activity, R = rainy season and D = dry season.

■ representa as espécies encontradas em atividade reprodutiva, ● representa o registro de girinos das espécies, ♦ representa as espécies encontradas forrageando, R = estação chuvosa e D = estação seca.

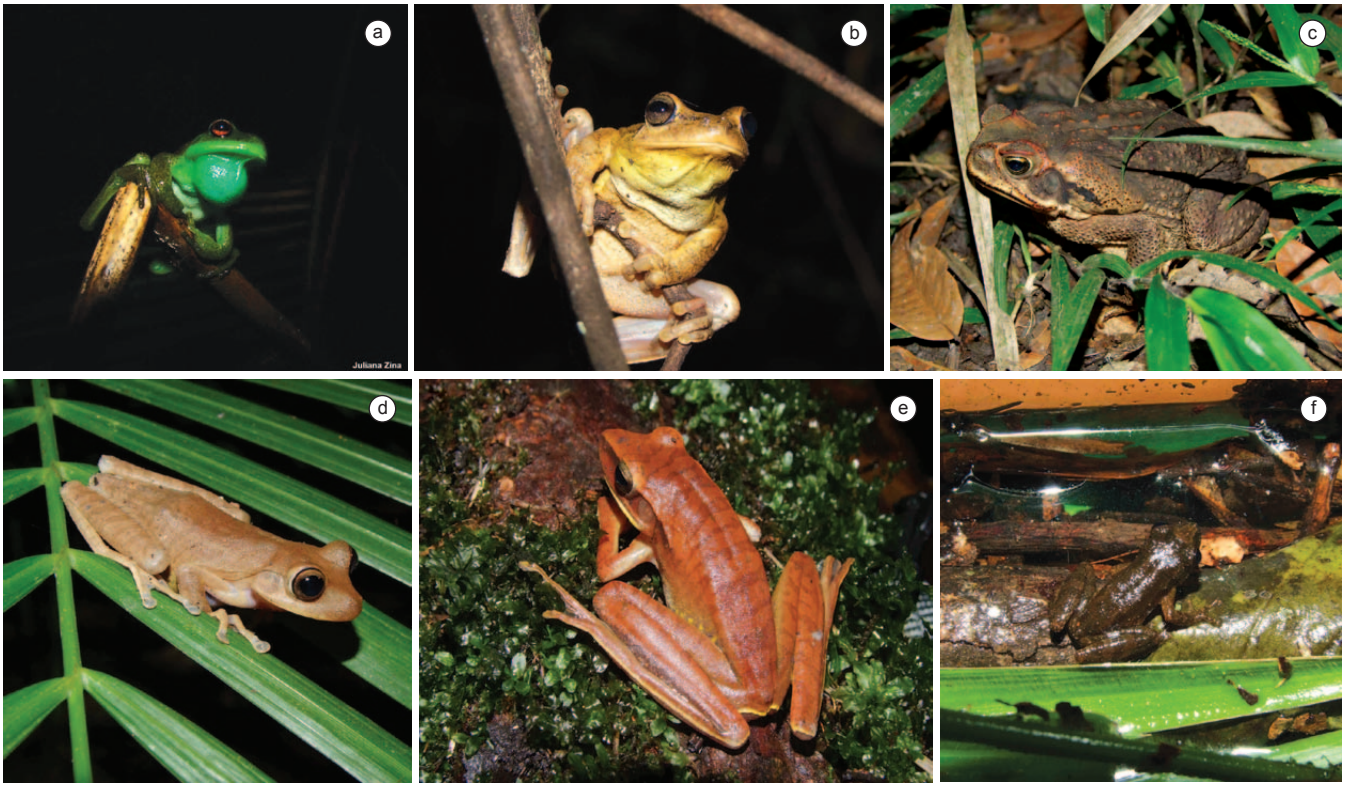

Figure 4. Photographs of some of the recorded species. a) *Aplastodiscus perviridis;* b) *Hypsiboas lundii;* c) *Rhinella schneideri;* d) *Bokermannohyla luctuosa;* e) *Hypsiboas albopunctatus;* f) *Scinax berthae*.

Figura 4. Fotografias de algumas espécies registradas no local de estudo. a) *Aplastodiscus perviridis;* b) *Hypsiboas lundii;* c) *Rhinella schneideri;* d) *Bokermannohyla luctuosa;* e) *Hypsiboas albopunctatus;* f) *Scinax berthae*.

Table 3. Results of the circular statistics to test for seasonality in reproduction of anurans recorded in the studied area, São Carlos, state of São Paulo, between March 2008 and February 2009.

Tabela 3. Valores gerados pela estatística circular para verificação de ocorrência de sazonalidade reprodutiva das espécies de anuros registradas no local estudado, município de São Carlos, estado de São Paulo, durante os meses de março de 2008 a fevereiro de 2009.

Summary	Value
Number of observations	38
Mean angle (a)	315.997°
Mean vector (r)	0.396
Circular variance	0.604
Circular standard deviation	78.006°
Rayleigh test (Z)	5.954
p-value of Rayleigh test	0.002

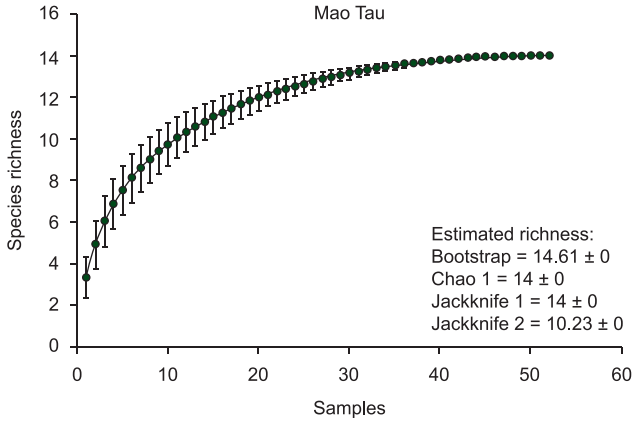

Figure 5. Observed species richness (Mao Tau) in the fragment studied, estimated richness calculated using Bootstrap and Chao1, the two best species richness estimators for the study site.

Figura 5. Curva da riqueza observada (Mao Tau) do Y, curva da riqueza calculada pela estimativa de Bootstrap e curva da riqueza calculada pela estimativa de Chao1, as duas melhores estimativas de riqueza para o local estudado.

3. Comparison with other anuran communities

The similarity analysis performed among the studied anuran community and other assemblages of the state (Figure 7) separated all the communities into two mean groups. The first group was formed by Parque Estadual da Ilha do Cardoso (PEIC), Estação Ecológica Juréia-Itatins (EEJI), Unidades de Conservação de Jacupiranga (UCJ), Parque Estadual Carlos Botelho (PECB), Serra do Japi (SP), Estação Biológica de Boracéia (EBB) and the Serra de Paranapiacaba (SP). The second group was formed by the Municipality of Icém (ICÉM), Municipality of Santa Fé do Sul (SFS), Estação Ecológica de Jataí (EEJ), Municipality of Nova Itapirema (NI), Estação Ecológica de Caetetus (EEC), Morro do Diabo (MD), Estação Ecológica de Assis (EEA), Mata São José (MSJ), Floresta Estadual Edmundo Navarro de Andrade (FEENA), Estação Ecológica de Itirapina (EEI), Parque

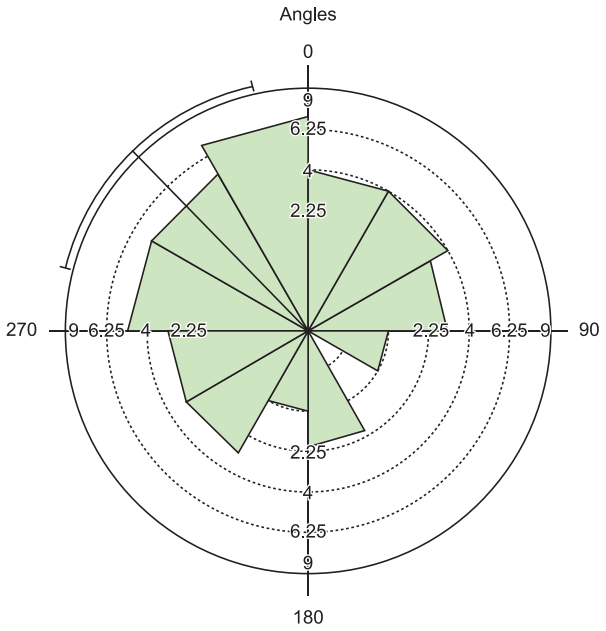

Figure 6. Results of the circular statistics. The arrow indicates the r vector obtained. The angle 0 represents the beginning of the samplings, in March 2009, and each 30° represents one month. Each month is in green, which represents the number of species found calling.

Figura 6. Gráfico da estatística circular. A seta simboliza o vetor r obtido. O ângulo 0 representa o início das coletas, em março de 2009, e cada 30° representa um mês. Cada mês (representado por intervalo de 30°) está preenchido em verde, que representa o número de espécies em atividade de vocalização.

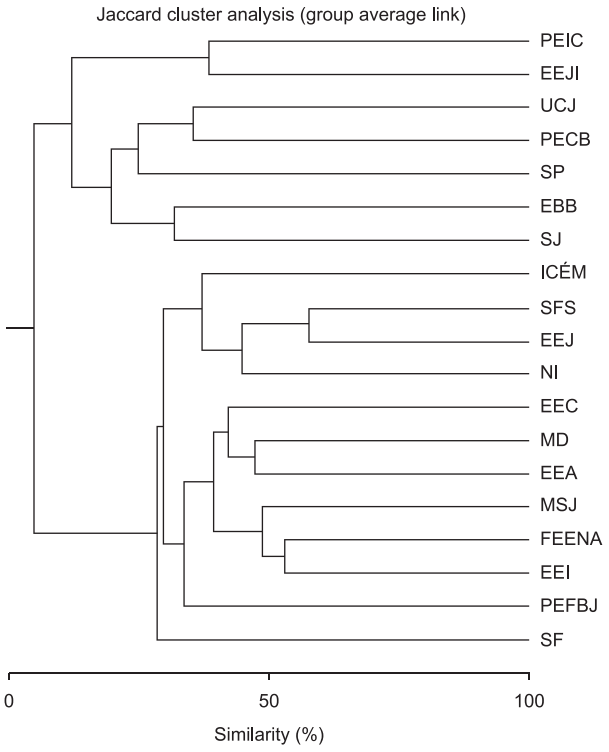

Figure 7. Similarity dendrogram of species composition between 19 localities from São Paulo State. Legend: SF = studied fragment, Córrego do Espraiado, São Carlos; PEFBJ = PE das Furnas do Bom Jesus; EEI = Estação Ecológica de Itirapina; FEENA = FE Edmundo Navarro de Andrade; EEC = Estação Ecológica de Caetetus; NI = Nova Itapirema; MSJ = Mata São José; MD = Morro do Diabo; EEA = Estação Ecológica de Assis; SJ = Serra do Japi; SP = Reserva Biológica da Serra da Paranapiacaba; UCJ = Unidades de Conservação de Jacupiranga; ICÉM = Icem; EEJI = Estação Ecológica de Juréia-Itatins; EEIC = Estação Ecológica da Ilha do Cardoso; EEJ = Estação Ecológica de Jataí; EECB = Estação Ecológica de Carlos Botelho; SFS = Santa Fé do Sul; EBB = Estação Biológica de Boracéia.

Figura 7. Dendrograma de similaridade na composição de espécies entre 19 localidades no Estado de São Paulo. Legenda: SF = fragmento estudado, Córrego do Espraiado, São Carlos; PEFBJ = PE das Furnas do Bom Jesus; EEI = Estação Ecológica de Itirapina; FEENA = FE Edmundo Navarro de Andrade; EEC = Estação Ecológica de Caetetus; NI = Nova Itapirema; MSJ = Mata São José; MD = Morro do Diabo; EEA = Estação Ecológica de Assis; SJ = Serra do Japi; SP = Reserva Biológica da Serra da Paranapiacaba; UCJ = Unidades de Conservação de Jacupiranga; ICÉM = Icem; EEJI = Estação Ecológica de Juréia-Itatins; EEIC = Estação Ecológica da Ilha do Cardoso; EEJ = Estação Ecológica de Jataí; EECB = Estação Ecológica de Carlos Botelho; SFS = Santa Fé do Sul; EBB = Estação Biológica de Boracéia.

Estadual das Furnas do Bom Jesus (PEFBJ) and the studied fragment at São Carlos (SF). The study area was most similar to Estação Ecológica de Caetetus (37.04%), to Mata São José (33.33%) and to Morro do Diabo (32.26%), although they did not form a distinct group in the dendrogram.

Discussion

1. Species composition

The morphology of hylids allows a large exploitation of the available vegetation strata, from forested areas to the edges of disturbed sites with marginal vegetation. This may explain the large species richness of this family in many anuran communities in the Neotropics (e.g. Brasileiro et al. 2005, Canelas & Bertoluci 2007, Zina et al. 2007, São Pedro & Feio 2010). Moreover, Hylidae is one of the most speciose families among anurans (Frost 2010).

The prevalence of the reproductive mode 1 is common in many anuran communities (e.g. Machado & Bernarde 2002, Toledo et al. 2003, Prado et al. 2005, Zina et al. 2007). This reproductive mode is the most generalized among anurans (Haddad & Prado 2005), and is characterized by eggs in lentic water bodies, where exotrophic tadpoles develop (Haddad & Prado 2005). The large number of species with the reproductive mode 1 found in reproductive activity at the lake may be related to the presence of a permanent water body at our study site. The species recorded reproducing inside the fragment presented more specialized reproductive modes (modes 4 and 5, sensu Haddad & Prado 2005). The presence of specific resources, such as vegetation strata that provide calling sites and proper shading for the development of tadpoles, as well as the physical characteristics of microenvironments within the fragment (e.g. lotic water bodies and soil suitable for the building of underground chambers to lay eggs), may explain the presence of species with more specialized reproductive modes in this type of environment.

The species richness recorded for the studied area is low compared to other inventories performed in the Atlantic rainforest and in the Cerrado of São Paulo state (e.g. Brasileiro et al. 2005, Pombal Júnior & Haddad 2005, Araujo et al. 2009, Santos et al. 2009). However, the anuran composition at the fragment studied is similar to that recorded in Seasonal Semi-deciduous Forests (Zina et al. 2007, Santos et al. 2009) as discussed below. There is a strict dependence of amphibians upon humid areas due to their physiological and reproductive requirements, especially the prevention of desiccation, association with cutaneous gas exchange, and eggs that depend on

water bodies or moist environments for an adequate development (Duellman & Trueb 1994). As a consequence of these unique characteristics, rainfall is considered to be the main variable related to amphibian species richness (see Vasconcelos et al. 2010). Thus, areas with higher amounts of total annual rainfall, such as the Amazon Forest and the Atlantic Forest, usually have the highest species richness (Vasconcelos et al. 2010). Although this study evaluated only a single and atypical year, we can still infer that the low number of species at our site is more similar to that of Seasonal Semi-deciduous Forests than to the Atlantic Forest. This is probably related to low rainfall in these sites. Another important thing to consider is the observation of Vasconcelos et al. (2010) that only 23.5% of the total variance of data on species richness was explained by the altitude and the total annual rainfall, while the remaining percentage were unexplained.

Many of the recorded species are commonly found in permanent water bodies subjected to anthropogenic alterations, such as: *Hypsiboas albopunctatus*, *Hypsiboas faber*, *Scinax fuscovarius* and *Physalaemus curvieri* (Toledo et al. 2003). Exceptions are: *Hypsiboas lundii*, *Aplastodiscus perviridis*, *Haddadus binotatus* and *Bokermannohyla luctuosa*, which are typical forest inhabitants (Pombal Júnior & Haddad 1993, 2005, Zina et al. 2007). Bertoluci et al. (2007) consider *H. binotatus* an excellent bioindicator of environmental quality, as it depends on special microclimate and microhabitat conditions.

The high abundance of *Hypsiboas lundii* inside the fragment can be explained by the typical habitat of this species. *Hypsiboas lundii* is a species that occurs in gallery forests where males can be observed calling on the arboreal strata at the banks of permanent water bodies (Zina et al. 2007, Oda et al. 2009, Ribeiro-Júnior & Bertoluci 2009). Other species, such as *Physalaemus cuvieri*, *H. albopunctatus*, *H. faber* and *Scinax fuscovarius*, use open areas near lentic water bodies (ponds and temporary pools) for reproduction (Toledo et al. 2003), which may explain why these species were infrequent and only found when it rained enough for the formation of temporary ponds in open areas near the lake.

Although the species accumulation curve has reached an asymptote and the estimated richness was similar to the observed species richness, it is not possible to say that all species have been sampled. For instance, some species with explosive breeding, which reproduce during one or few days, may not have been recorded during the study period. We reached this conclusion since we found an abnormal temporal pattern for some species, such as *Dendropsophus minutus* and *Leptodatctylus fuscus* (see Toledo et al. 2003, Zina et al. 2007, De-Carvalho et al. 2008). These species are commonly regarded as prolonged breeders (sensu Wells 1977), but we recorded them on only one or two field trips. Abnormal rainfall and physical characteristics of the studied area (e.g. few temporary pools in open areas or lack of some resources not measured in the present study) may be responsible for the atypical temporal distributions of these species. Further studies and comparisons of the physical conditions of the sites studied in São Paulo state may provide relevant data regarding the differences in abundance and species composition of anuran communities, thus making it possible to determine whether these differences, if present, should be solely attributed to the biome in which the studies were conducted.

2. Seasonality in reproductive activity

The circular statistics indicated that the reproductive activity of the anurans was seasonal, though this seasonality was not very pronounced. Seasonal activity was also indicated by the small number of calling males in May, July and August 2009, and their absence in June 2009.

Rainfall and air temperatures are a cue for the availability of resources for reproduction, contributing to the positive correlation between anuran species in reproductive activity and these abiotic factors, as reported in several studies (e.g. Aichinger 1987, Bertoluci & Rodrigues 2002a, Toledo et al. 2003, Kopp & Eterovick 2006, Santos et al 2007, Canavero et al. 2009). A large number of authors claim that there is a combined effect of temperature and precipitation influencing the seasonality within anurans communities (e.g. Heyer et al. 1990, Rossa-Feres & Jim 1994; Pombal Júnior 1997). In coastal regions of the state, the relative air humidity is high year-round and the dry season is less pronounced, therefore, anuran calling activity seems to be more influenced by the air temperature (Bertoluci 1998, Bertoluci & Rodrigues 2002a, Giasson 2008, Zina 2010). In inland areas, however, rainfall is not well distributed throughout the year; the winter is often remarkably dry and rainfall tends to be the major determinant of seasonality in anuran reproduction (Bertoluci 1998, Bertoluci & Rodrigues 2002b, Toledo et al. 2003, Prado et al. 2005, Brasileiro et al. 2005, Zina et al. 2007). The presence of permanent water bodies for breeding, association of the reproductive mode of most species with permanent water bodies, and the high relative air humidity (also due to the presence of a permanent water body) are some of the possible reasons for the absence of correlation between rainfall and number of species in reproductive activity, similarly to the pattern observed for coastal areas of the state. Furthermore, the studied year was abnormal regarding the rainfall amount, which can explain the absence of correlation between rainfall and species reproductive activity and also the atypical activity of some prolonged breeders, such as *Leptodactylus fuscus*.

However, the influence of photoperiod on the species calling activity observed here is similar to that found by Both et al. (2008) in southern Brazil, in which the photoperiod predicted 73% of the anurans´ reproductive activity. Photoperiod influences different physiological mechanisms in animal species, such as hormone production, the production of germ cells, foraging period, and hibernation season (Schmidt-Nielsen 2002). In some amphibian species, the duration of calling activity is positively correlated with photoperiod (Hatano et al. 2002), which may also show a positive correlation with the production of germ cells (Duellman & Trueb 1994). The photoperiod is the environmental variable that best describes the seasons: summer (warm and rainy in the region of São Carlos) with longer periods of light, and winter (dry and cold) with shorter periods of light. In this study, the photoperiod seems to have been the environmental cue for the availability of resources. Canavero et al. (2008) concluded that the annual pattern of males calling activity is mainly determined by all the components of seasonal variation or by a variable that synthesize the environmental seasonal trends rather than by a single and specific response to rainfall or temperature. Bradshaw & Holzapfel (2007) pointed that the photoperiod can be seen as the variable that synthesizes the environmental seasonal trends. Thus, the sensitivity of physiological processes in anuran species to photoperiod could explain the positive correlation between this variable and the number of species in calling activity (DeCoursey 2004, Nelson 2005).

3. Comparison with other anuran communities

The higher similarities of the study area with the three semideciduous forest areas - Estação Ecológica de Caetetus, Mata São José and Morro do Diabo - are possibly due to five species shared with these sites (*Hypsiboas albopunctatus*, *Dendropsophus minutus*, *Physalaemus cuvieri*, *Rhinella ornata*, *Rhinella schneideri*). The high similarity between our study site and the Estação Ecológica de Caetetus may be due to the presence of the species *Haddadus binotatus* in addition to those species aforementioned. Nevertheless, it can be

noted in the dendrogram that the studied area is separated from these areas, being located at an intermediate position between them and those of Atlantic Rainforest. This can be explained by the fact that we recorded typical species from different physiognomies of the coastal Atlantic Forest, such as *Scinax berthae* (also recorded in Rossa-Feres & Jim 1994), *Bokermannohyla luctuosa* (also recorded in Pombal Júnior & Haddad 1993), *Haddadus binotatus* (also recorded in Araújo et al. 2009) and *Aplastodiscus perviridis* (also recorded in Jim (1980), Bernarde & Anjos (1999), Bernarde & Machado (2000)). Although this type of analysis (cluster analysis) may be useful in providing an overview of the differences and similarities between anuran communities, caution must be taken when interpreting the results. We must take into account that each author uses a different sampling effort, has different taxonomic concepts, the areas are of different sizes, present different physical characteristics and conservation status (Bastos et al. 2003, Santos et al. 2009).

Albeit our study was more similar to areas of the inland Seasonal Semi-deciduous Forest regarding anuran species richness and composition, the presence of amphibian and plant species typical of the Coastal Atlantic Forest, such the palm tree *Euterpe edulis* and the tree fern *Dicksonia sellowiana*, reinforces its transitional position between the Cerrado and Atlantic Forest biomes. This corroborates the idea that transitional areas harbor rare species because of their unique features that may provide exclusive resources for some species (Kark et al. 2007).

Many amphibians use forest remnants as habitats or breeding sites, which makes these sites "gene banks" and a source of biological diversity. This emphasizes the importance of studies in these fragments, involving anuran community ecology and natural history of particular species. Thus, as pointed out by Santos et al. (2009), the low species richness and the absence of endemism in fragments of Seasonal Semi-deciduous Forest cannot be arguments to reduce the importance of conserving these regions.

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References

AGUIAR-DE-DOMENICO, E. 2008. Herpetofauna do Mosaico de Unidades de Conservação do Jacupiranga (SP). Dissertação de Mestrado, Universidade de São Paulo, São Paulo.

AICHINGER, M. 1987. Annual activity patterns of anurans in a seasonal neotropical environment. Oecol. 71:583-592. http://dx.doi.org/10.1007/BF00379302

ARAUJO, C.O., CONDEZ, T.H. & SAWAYA, R.J. 2009. Anfíbios anuros do Parque Estadual das Furnas do Bom Jesus. Biota Neotrop. 9(2): http://www.biotaneotropica.org.br/v9n2/en/abstract?article+bn01309022009 (último acesso em 21/09/2010).

ARAÚJO, O.G.S., TOLEDO, L.F., GARCIA, P.C.A. & HADDAD, C.F.B. 2009. The amphibians of São Paulo State. Biota Neotrop. 9(4): http://www.biotaneotropica.org.br/v9n4/en/abstract?inventory+bn03109042009 (último acesso em 21/09/2010).

BASTOS, R.P., MOTTA, J.A.O., LIMA, L.P. & GUIMARÃES, L.D. 2003. Anfíbios da Floresta Nacional de Silvânia, estado de Goiás. Stylo Gráfica e Editora, Goiânia.

BERNARDE, P.S. & ANJOS, L. 1999. Distribuição espacial e temporal da anurofauna no Parque Estadual Mata dos Godoy, Londrina, Paraná, Brasil (Amphibia: Anura). Comun. Mus. Ci. Tecnol. PUCRS, Sér. Zool. 12:127-140.

BERNARDE, P.S. & MACHADO, R.A. 2000. Riqueza de espécies, ambientes de reprodução e temporada de vocalização da anurofauna em Três Barras do Paraná, Brasil (Amphibia: Anura). Cuad. Herpetol. 14(2):93-104.

BERTOLUCI, J. 1998. Anuran patterns of breeding activity in Atlantic rainforest anurans. J. Herpetol. 32(4):607-611. http://dx.doi.org/10.2307/1565223

BERTOLUCI, J. & RODRIGUES, M.T. 2002a. Seasonal patterns of breeding activity of Atlantic Rainforest anurans at Boracéia, southeastern Brazil. Amphibia-Reptilia 23:161-167. http://dx.doi.org/10.1163/156853802760061804

BERTOLUCI, J. & RODRIGUES, M.T. 2002b. Utilização de habitats reprodutivos e micro-habitats de vocalização em uma taxocenose de anuros (AMPHIBIA) da Mata Atlântica do Sudeste do Brasil. Pap. Avulsos Zool. 42:287-297.

BERTOLUCI, J., BRASSALOTI, R.A., RIBEIRO Júnior, J.W., VILELA, V.M.F.N. & SAWAKUCHI, H.O. 2007. Species composition and similarities among anuran assemblages of Forest sites in southeastern Brazil. Sci. Agric. 64(4):364-374. http://dx.doi.org/10.1590/S0103-90162007000400007

BOTH, C., KAEFER, I.L., SANTOS, T.G. & CECHIN, S.T.Z. 2008. An austral anuran assemblage in the Neotropics: seasonal occurrence correlated with photoperiod. J. Nat. Hist. 42(3-4):205-222. http://dx.doi.org/10.1080/00222930701847923

BRADSHAW, W.E., HOLZAPFEL, C.M. 2007. Evolution of animal photoperiodism. Ann. Rev. Ecol. Evol. Syst. 38:1-25. http://dx.doi.org/10.1146/annurev.ecolsys.37.091305.110115

BRANDÃO, R.A. & ARAUJO, A.F.B. 1998. A herpetofauna da Estação Ecológica de Águas Emendadas. In Vertebrados da Estação Ecológica de Águas Emendadas: história natural e ecologia em um fragmento de Cerrado do Brasil Central (J. Marinho-Filho, F. Rodrigues & M. Guimarães, eds.). SEMATEC/IEMA, Brasília, p.9-21.

BRASILEIRO, C.A., SAWAYA, R.J., KIEFER, M.C. & MARTINS, M. 2005. Amphibians of an open Cerrado fragment in southeastern Brazil. Biota Neotrop. 5(2): http://www.biotaneotropica.org.br/v5n2/pt/abstract?article+BN00405022005 (último acesso em 21/09/2010).

CANAVERO, A., ARIM, M. & BRAZEIRO, A. 2009. Geographic variations of seasonality and coexistence in communities: The role of diversity and climate. Austral Ecol. 34:741-750. http://dx.doi.org/10.1111/j.1442-9993.2009.01980.x

CANAVERO, A., ARIM, M., NAYA, D.E., CAMARGO, A., ROSA, I. & MANEYRO, R. 2008. Calling activity patterns in an anuran assemblage: the role of seasonal trends and weather determinants. Northwest. J. Zool. 4(1):29-41.

CANELAS, M.A.S. & BERTOLUCI, J. 2007. Anurans of the Serra do Caraça, southeastern Brazil: species composition and phenological patterns of calling activity. Iheringia, Zool. 97(1):21-26. http://dx.doi.org/10.1590/S0073-47212007000100004

CENTRO INTEGRADO DE INFORMAÇÕES AGROMETEOROLÓGICAS - CIIAGRO. http://www.ciiagro.sp.gov.br (último acesso 10/03/2010).

CRUMP, M.L. & SCOTT, N.J. 1994. Standard techniques for inventory and monitoring. In Measuring and monitoring biological diversity: standard methods for amphibians (W.R. Heyer, M.A. Donnelly, R.W. McDiarmid, L.C. Hayek & M.S. Foster, eds.). Smithsonian Institution Press, Washington, London, p.76-141.

DE-CARVALHO, C.B., FREITAS, E.B., FARIA, R.G., BATISTA, R.C., BATISTA, C.C., COELHO, W.A. & BOCCHIGLIERI, A. 2008. História natural de *Leptodactylus mystacinus* e *Leptodactylus fuscus* (Anura: Leptodactylidae) no Cerrado do Brasil Central. Biota Neotrop. 8(3): http://www.biotaneotropica.org.br/v8n3/en/abstract?article+bn01308032008 (ultimo acesso em 21/09/2010).

DeCOURSEY, P.J. 2004. The behavioral ecology and evolution of biological timing systems. In Chronobiology, biological timekeeping (J.C. Dunlap, J.J. Loros & P.J. DeCoursey, eds.). Sinauer Associates Inc Publishers, Sunderland, Massachusetts, p.27-65.

DUELLMAN, W.E. & TRUEB, L. 1994. Biology of Amphibians. McGraw-Hill, Baltimore.

FROST, D.R. 2010. Amphibian Species of the World 5.5, an Online Reference. The American Museum of Natural History. http://research.amnh.org/herpetology/amphibia/index.php (último acesso em 21/09/2010).

GARCIA, P.C.A. & VINCIPROVA, G. 2003. Anfíbios. In Livro vermelho da fauna ameaçada de extinção no Rio Grande do Sul (C.S. Fontana, G.A. Bencke & R.E. Reis, eds.). Porto Alegre, Edipucrs, p.147-164.

GEIGER, R. 1961. Überarbeitete Neuausgabe Von Geiger, R. Klima der Erde. Köppen-Geiger. Klett-Perthes, Gotha.

GIASSON, L.O.M. 2008. Atividade sazonal e uso do ambiente por anfíbios da Mata Atlântica no alto da Serra do Mar. Tese de doutorado, Universidade Estadual Paulista "Júlio de Mesquita Filho", Rio Claro.

HADDAD, C.F.B. & PRADO, C.P.A. 2005. Reproductive modes in frogs and their unexpected diversity in the Atlantic Forest of Brazil. BioScience 55(3):207-217. http://dx.doi.org/10.1641/0006-3568(2005)055[0207:RMIFAT]2.0.CO;2

HADDAD, C.F.B. & SAZIMA, I. 1992. Anfíbios anuros da Serra do Japi. In História natural da Serra do Japi. (L.C.P. Morellato, ed.). Editora da Unicamp, Campinas, p.188-211.

HATANO, F.H., ROCHA, C.F.D. & VAN SLUYS, M. 2002. Environmental factors affecting calling activity of a tropical diurnal frog (*Hylodes phyllodes*: Leptodactylidae). J. Herpetol. 36(2):314-318.

HEYER, R., RAND, A., CRUZ, C., PEIXOTO, L. & NELSON, C. 1990. Frogs of Boracéia. Arq. Zool. 31; 231-410.

INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA - IBGE. 2001. Mapa de solos do Brasil. IBGE. http://biblioteca.ibge.gov.br (último acesso em 21/09/2010).

INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA - IBGE. 2004. Mapa de vegetação do Brasil. IBGE. http://biblioteca.ibge.gov.br (último acesso em 21/09/2010).

JIM, J. 1980. Aspectos ecológicos dos anfíbios registrados na região de Botucatu, São Paulo (Amphibia, Anura). Tese de doutorado, Universidade de São Paulo, São Paulo.

KARK, S., ALLNUTT, T.F., LEVIN, N., MANNE, L.L. & WILLIAMS, P.H. 2007. The role of transitional areas as avian biodiversity centres. Global Ecol. Biogeogr. 16:187-196. http://dx.doi.org/10.1111/j.1466-8238.2006.00274.x

KOPP, K. & ETEROVICK, P.C. 2006. Factors influencing spatial and temporal structure of frog assemblages at ponds in southeastern Brazil. J. Nat. Hist. 40:29-31. http://dx.doi.org/10.1080/00222930601017403

KÖPPEN, W. 1900. Versuch einer Klassifikation der Klimate, vorzugsweise nach ihren Beziehungen zur Pflanzenwelt. Geogr. Z. 6:593-611.

MACHADO, R.A. & BERNARDE, P.S. 2002. Anurofauna da bacia do rio Tibagi. In A bacia do rio Tibagi (M. Medri, E. Bianchini, O. Shibatta, J. Pimenta, eds.). Universidade Estadual de Londrina, Londrina, Paraná, p.297-306.

MOTTA-Júnior, J.C. 2006. Relações tróficas entre cinco Strigiformes simpátricas na região central do Estado de São Paulo, Brasil. Rev. Bras. Ornitol. 14(4):359-377.

NARVAES, P., BERTOLUCI, J. & RODRIGUES, M.T. 2009. Composição, uso de hábitat e estações reprodutivas das espécies de anuros da floresta de restinga da Estação Ecológica Juréia-Itatins, sudeste do Brasil. Biota Neotrop. 9(2):http://www.biotaneotropica.org.br/v9n2/pt/abstract?article+bn02009022009 (último acesso em 06/03/2011).

NELSON, R.J. 2005. An introduction to behavioral endocrinology. Sinauer Associates Inc., Massachussets.

OBSERVATÓRIO NACIONAL - ON. Anuário Interativo do Observatório Nacional. ON, Rio de Janeiro. http://euler.on.br/ephemeris/index.php (último acesso em 21/09/2010).

ODA, F.H., BASTOS, R.P., LIMA, M.A.C.S. 2009. Anuran assemblage in Cerrado of Niquelândia, Goiás State, Brazil: diversity, local distribution and seasonality. Biota Neotrop. 9(4): http://www.biotaneotropica.org.br/v9n4/en/abstract?inventory+bn03609042009 (último acesso em 21/09/2010).

ODUM, E.P. 1988. Ecologia. Guanabara Koogan, Rio de Janeiro.

OLIVEIRA, F.F. & BATALHA, M.A. 2005. Lognormal abundance distribution of woody species in a cerrado fragment (São Carlos, southeastern Brazil). Rev. Bras. Bot. 28(1):39-45. http://dx.doi.org/10.1590/S0100-84042005000100004

POMBAL Júnior, J.P. 1997. Distribução espacial e temporal de anuros (Amphibia) em uma poça permanente na Serra de Paranapiacaba, sudeste do Brasil. Rev. Bras. Biol. 57:583-94.

POMBAL Júnior, J.P. & HADDAD, C.F.B. 1993. *Hyla luctuosa,* a new treefrog from southeastern Brazil (Amphibia: Hylidae). Herpetologica 49(1):16-21.

POMBAL Júnior, J.P. & HADDAD, C.F.B. 2005. Estratégias e modos reprodutivos de anuros (Amphibia) em uma poça permanente da Serra de Paranapiacaba, Sudeste do Brasil. Pap. Avulsos Zool. 45(15):215-229.

PRADO, C.P.A., UETANABARO, M. & HADDAD, C.F.B. 2005. Breeding activity patterns, reproductive modes, and habitat use by anurans (Amphibia) in a seasonal environment in the Pantanal, Brazil. Amphibia-Reptilia 26:211-221. http://dx.doi.org/10.1163/1568538054253375

PRADO, V.H.M., SILVA, F.R., DIAS, N.Y.N., PIRES, J.S.R. & ROSSA-FERES, D.C. 2009. Anura, Estação Ecológica de Jataí, São Paul state, southeastern Brazil. CheckList 5(3):495-502.

RIBEIRO, R.S, EGITO, G.T.B.T. & HADDAD, C.F.B. 2005. Chave de identificação: anfíbios anuros da vertente de Jundiaí da Serra do Japi, Estado de São Paulo. Biota Neotrop. 5(2): http://www.biotaneotropica.org.br/v5n2/pt/abstract?identification-key+bn03005022005 (último acesso em 21/09/2010).

RIBEIRO-JÚNIOR, J.W. & BERTOLUCI, J. 2009. Anuros do cerrado da Estação Ecológica e da Floresta Estadual de Assis, sudeste do Brasil. Biota Neotrop. 9(1): http://www.biotaneotropica.org.br/v9n1/en/abstract?inventory+bn02709012009 (último acesso em 21/09/2010).

ROQUE, F.O., PEPINELLI, M., FRAGOSO, E.N., FERREIRA, W.A., BARILLARI, P.R., YOSHINAGA, M.Y., STRIXINO, S.T., VERANI, N.F. & LIMA, M.I.S. 2003. Ecologia de Macroinvertebrados, Peixes e Vegetação Ripária de um córrego de Primeira Ordem em Região de Cerrado do Estado de São Paulo (São Carlos, SP). In Ecótonos nas Interfaces dos Ecossistemas Aquáticos (R. Henry, org.). Rima, São Carlos, p.313-338.

ROSSA-FERES, D.C. & JIM, J. 1994. Distribuição sazonal em comunidades de anfíbios anuros na região de Botucatu, São Paulo. Rev. Bras. Biol. 54(2):323-334.

ROSSA-FERES, D.C. & JIM, J. 2001. Similaridade no sítio de vocalização em uma comunidade de anfíbios anuros na região noroeste do estado de São Paulo, Brasil. Rev. Bras. Zool. 18:439-454. http://dx.doi.org/10.1590/S0101-81752001000200015

SANTOS, A.J. 2006. Estimativas de riqueza em espécies. In Métodos de estudos em biologia da conservação e manejo da vida silvestre (L. Cullen Júnior, R. Rudran & C. Valladares-Pádua, orgs.). Editora UFPR, Curitiba, 652p.

SANTOS, T.G., ROSSA-FERES, D.C. & CASATTI, L. 2007. Diversidade e distribuição espaço-temporal de anuros em região com pronunciada estação seca no sudeste do Brasil. Iheringia Sér. Zool. 97(1):37-49.

SANTOS, T.G., VASCONCELOS, T.S., ROSSA-FERES, D.C. & HADDAD, C.F.B. 2009. Anurans of a seasonally dry tropical Forest: Morro do Diabo State Park, São Paulo state, Brazil. J. Nat. Hist. 43(15-16):973-993. http://dx.doi.org/10.1080/00222930802702498

SÃO PEDRO, V.A. & FEIO, R.N. 2010. Distribuição espacial e sazonal de anuros em três ambientes na Serra do Ouro Branco, extremo sul da Cadeia do Espinhaço, Minas Gerais, Brasil. Biotemas 23(1):143-154.

SCHMIDT-NIELSEN, K.S. 2002. Fisiologia Animal: adaptação e meio ambiente. Editora Santos, Santos.

SILVA, F.R & ROSSA-FERES, D.C. 2007. Uso de fragmentos florestais por anuros (Amphibia) de área aberta na região noroeste do Estado de São Paulo. Biota Neotrop. 7(2): http://www.biotaneotropica.org.br/v7n2/pt/abstract?article+bn03707022007 (último acesso em 06/03/2011).

SILVA, I.A., FIGUEIREDO, R.A. & MATOS, D.M.S. 2008. Feeding visit time of fruit-eating birds in Cerrado plants: revisiting the predation risk model. Rev. Bras. Zool. 25:682-688. http://dx.doi.org/10.1590/S0101-81752008000400013

SILVANO, D.L. & SEGALLA, M.V. 2005. Conservation of brazilian amphibians. Conserv. Biol. 19(3):653-658. http://dx.doi.org/10.1111/j.1523-1739.2005.00681.x

TOLEDO, L.F., ZINA, J. & HADDAD, C.F.B. 2003. Distribuição espacial e temporal de uma comunidade de Anfíbios Anuros do Município de Rio Claro, São Paulo, Brasil. Holos Environ. 3(2):136-149.

VALENTI, M.W., CIANCIARUSO, M.V. & BATALHA, M.A. 2008. Seasonality of litterfall and leaf decomposition in a cerrado site. Braz.J. Biol. 68:459-465. http://dx.doi.org/10.1590/S1519-69842008000300002

VASCONCELOS, T.S. & ROSSA-FERES, D.C. 2005. Diversidade, distribuição espacial e temporal de anfíbios anuros (Amphibia, Anura) na região noroeste do estado de São Paulo. Biota Neotrop. 5(2): http://www.biotaneotropica.org.br/v5n2/pt/abstract?article+BN01705022005 (último acesso em 21/09/2010).

VASCONCELOS, T.S., SANTOS, T.G., HADDAD, C.F.B. & ROSSA-FERES, D.C. 2010. Climatic variables and altitude as predictors of anuran species richness and number of reproductive modes in Brazil. J. Trop. Ecol. 26:423-432. http://dx.doi.org/10.1017/S0266467410000167

WELLS, K.D. 1977. The social behaviour of anuran amphibians. Anim. Behav. 25:666-693. http://dx.doi.org/10.1016/0003-3472(77)90118-X

ZAR, J.H. 1996. Biostatistical analysis. Prentice Hall, New Jersey.

ZINA, J. 2010. Estudo comparativo da taxocenose de anuros de quatro municípios do Lagamar Paulista. Tese de doutorado, Universidade Estadual Paulista, Rio Claro.

ZINA, J., ENNSER, J., PINHEIRO, S.C.P., HADDAD, C.F.B. & TOLEDO, L.F. 2007. Taxocenose de anuros de uma mata semidecídua do interior do estado de São Paulo e comparações com outras taxocenoses do estado, sudeste do Brasil. Biota Neotrop. 7(2): http://www.biotaneotropica.org.br/v7n2/pt/abstract?article+bn00607022007 (último acesso em 21/09/2010).

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