Anuran amphibians' diversity in a northwestern area of the Brazilian Pantanal

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Abstract: In the Pantanal, the largest continuous floodplain in the world, the diversity and distribution of anuran amphibians vary in and across distinct subregions and distinct habitats occurring along inundation gradients. Permanent and natural aquatic habitats are relatively scarce in the Pantanal, and occurrence of temporary aquatic habitats varies seasonally, depending on rains. We here present results of evaluations of anuran's species richness and abundance in a seasonally flooded area in the northwestern section of the Pantanal (*Fazenda Baía de Pedra*, Cáceres municipality, state of Mato Grosso, Brazil), comparing values obtained in 10 plots systematically distributed over 5 km^2 with those obtained in additional aquatic plots in the study area. Data were obtained in five field trips, from February 2008 to March 2009. In addition to the plots, 36 water bodies (20 permanent and 16 temporary) were also sampled for the presence of anurans. In total, 3,983 individuals from 34 anuran species distributed in five families were recorded: Hylidae (14 species), Leptodactylidae (8), Leiuperidae (6), Microhylidae (4), and Bufonidae (2). Local richness represents 77.3% of the anuran diversity already recorded for the Brazilian Pantanal. The number of species recorded exclusively in systematically distributed terrestrial plots and in water bodies was 28 and 32, respectively. Sampling methods used at *Fazenda Baía da Pedra* were efficient in determining anuran richness, abundance, composition and distribution. Evaluations of anuran richness and abundance by using permanent sampling plots in the Pantanal may benefit from additional sampling sites, particularly permanent and temporary water bodies.
Keywords: *anura, species rarefaction curve, wetlands, temporary ponds, permanent ponds.*

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Resumo: A distribuição e a diversidade das espécies de anfíbios anuros no Pantanal, maior planície inundável contínua do mundo, variam dentro e entre as distintas subregiões e os distintos hábitats ao longo do gradiente de inundação. Ambientes aquáticos naturais permanentes são relativamente escassos na planície e a presença de ambientes aquáticos temporários é sazonal, altamente dependente da precipitação. No presente trabalho, apresentamos informações sobre a riqueza e a abundância das espécies de anuros em uma localidade na porção noroeste do Pantanal (Fazenda Baía de Pedra, município de Cáceres, Mato Grosso, Brasil) e comparamos os valores obtidos em dez parcelas sistematicamente distribuídas em 5 km^2 com parcelas aquáticas adicionais na presente área de estudo. Os dados foram obtidos em cinco campanhas, entre fevereiro de 2008 e março de 2009. Além das parcelas sistematicamente distribuídas, 36 corpos d'água (20 permanentes e 16 temporários) foram também amostrados quanto à presença de anuros. Registramos 3.983 indivíduos pertencentes a 34 espécies de anuros distribuídas em cinco famílias: Hylidae (14), Leptodactylidae (8), Leiuperidae (6), Microhylidae (4) e Bufonidae (2). A riqueza local em espécies representa 77,3 % da riqueza de anuros já registrada para o Pantanal brasileiro. A riqueza detectada exclusivamente nas parcelas foi 28 espécies, enquanto nos corpos d'água, 32. Os métodos de amostragem utilizados na Fazenda Baía de Pedra mostraram-se eficientes na determinação da riqueza, abundância, composição e distribuição das espécies de anuros. Estudos dessa natureza, envolvendo o uso de parcelas sistematicamente distribuídas em áreas do Pantanal, podem ser beneficiados pelo emprego de parcelas adicionais de amostragem constituídas por corpos d'água permanentes e temporários.
Palavras-chave: *anura, curva de rarefação de espécies, áreas úmidas, poças temporárias, poças permanentes.*

Introduction

In the Neotropics, distribution patterns of anuran amphibians may be linked to topographic characteristics, climate, vegetation, as well as to historical factors (Duellman 1999). On a regional scale, anuran amphibians may exhibit distribution patterns dependent mostly on ecological factors, such as altitudinal gradient (Navas 2006), nutrient availability (McDiarmid 1994, Bastazini et al. 2007), and availability of water as rainfall (Duellman 1995), water bodies (Rodrigues et al. 2010), or rivers (Parris & McCarthy 1999).

Diversity patterns and ecological processes in Pantanal, the largest continuous floodplain in the world, are regulated by alternate and recurrent yearly cycles of floods and droughts (Junk et al. 1989, Hamilton et al. 1996, Junk & Wantzen 2004). Species distribution and diversity vary across and within distinct habitats comprising the inundation gradient. These habitats include permanently dry, seasonally flooded, and permanent aquatic areas (Cabido et al. 1996, Nunes da Cunha & Junk 2001, 2010, Silva et al. 2001).

Brazil harbors the highest anuran diversity in the world, with 847 species listed to date (Sociedade… 2011). At least 74 of these have been found in the Brazilian portion of the Upper Paraguay River Basin (UPRB), which includes the Pantanal (45 anuran species recorded) and surrounding plateaus (Strüssmann et al. 2007). Nevertheless, published information on taxonomic composition of anuran faunas inhabiting distinct Pantanal subregions is still scarce (e.g., Strüssmann 2000, 2001, Ávila & Ferreira 2004, Prado et al. 2005, Wang et al. 2005).

Because biodiversity measures are strongly scale-dependent, data collected at different geographic scales cannot be compared. To conduct biodiversity surveys in a systematic and comparable basis among distinct ecological regions, a standardized sampling procedure had been designed and is now being implemented on a large scale in Brazil by the Biodiversity Research Program (PPBio; see Magnusson et al. 2005). The method consists of sampling 30 plots (250 m each, along the same elevational isocline), uniformly distributed in a grid covering 25 km^2. A less expensive approach is to sample smaller subunits (“modules”, according Magnusson et al. 2005), composed of only 10 plots uniformly distributed in two, paired, 5 km trails located 1 km apart.

When installed randomly in the landscape, grids or modules may occasionally neither cover adequately all habitat diversity, nor sample habitats used by a particular taxonomic group. This constraint can be overcome by the inclusion of additional plots in habitats of interest. By including riparian plots in PPBio grids in Brazilian Amazonia, Rojas-Ahumada & Menin (2010) and Condrati (2009) obtained better estimates of local anuran richness.

The goals of this study were to: 1) assess species richness and abundance of anuran amphibians in a seasonally flooded area in the northern Pantanal (*Fazenda Baía de Pedra*, Cáceres municipality, state of Mato Grosso, Brazil), and 2) compare anuran richness and abundance in 10 plots systematically distributed over 5 km^2 and in additional aquatic plots in the study area.

Material and Methods

1. Study area

A field study was conducted at *Fazenda Baía de Pedra* (16°27’59” S and 58°09’09” W, Figure 1), located in the northern Pantanal, in the municipality of Cáceres, Mato Grosso State, Brazil. Climate in the Pantanal floodplain is generally hot and wet (“Aw” in the classification proposed by Köppen 1931 apud Nimer 1979). There are two, well-marked seasons in the year: a dry season, from May to September, and a rainy season, from October to April (Nunes da Cunha & Junk 2004, Junk et al. 2006). Annual rainfalls range from 800 to 1,400 mm, with 80% concentrated from November to March. Mean temperature is 25.8 °C (Almeida 1998).

Annual hydrological changes in the Pantanal are characterized by four sequential phases: inundation, steady flood, receding, and drought (Prado et al. 1994). Apart from the annual flood cycle, multi-year periods of intense flood and/or severe drought may occur on an irregular basis (Nunes da Cunha & Junk 2001). In fact, our study was conducted during an abnormally dry year, during which floods were negligible due to the low rainfall from May 2008 to March 2009 (Instituto… 2009).

2. Data collection and analysis

Five field expeditions (15 to 20 days each) were made, in February, June, October and December 2008, and February/March 2009. Field data were gathered mainly in plots systematically distributed over 5 km^2, following a model developed by the Brazilian government through the Biodiversity Research Program (PPBio; see Magnusson et al. 2005).

In every expedition, 10 plots (250 × 1 m, along the same elevational isocline) were sampled. From the second expedition on, we additionally sampled 36 natural water bodies, located up to 2 km from the area of the permanent sampling module. Twenty of these bodies were permanent ponds, and 16 were temporary ones (“intermittent aquatic systems”, according Nunes da Cunha & Junk 2010). These latter bodies were sampled only in the last two field expeditions, after the onset of the rainy season.

Anuran fauna was sampled by using visual searches, bioacoustic records, and captures with pitfall and funnel traps combined with drift fences. Visual and acoustic searches were made from 6:00 PM to 1:00 AM by two observers walking simultaneously along each systematically distributed plot or around the margins of the additionally sampled water bodies.

At the end of each sampling plot, a set of pitfall traps and funnel traps combined with drift fences (see Cechin & Martins 2000) was installed. Originally employed to sample small gymnophthalmid lizards, our pitfalls traps consisted of four 4-l plastic buckets buried in the ground, 10 m apart in a straight line, and connected by a drift fence made of plastic mesh (75 cm of height). A pair of funnel traps was installed on the ground, on each side of the fence, between the first two buckets. Each funnel trap consisted of a cylinder of plastic mesh, 100 cm long, with a funnel (external diameter 96 cm, internal diameter 25 cm) on each extremity (Figure 2).

Traps were visited daily and all anurans trapped were caught and identified. Except for some voucher specimens (collected under permit IBAMA/SISBIO 16.723-1), all other animals were subsequently released nearly 40 m away from traps. Voucher specimens were euthanized, processed using standard procedures (Calleffo 2002), and subsequently incorporated in the *Coleção Zoológica de Vertebrados* from the *Universidade Federal de Mato Grosso* (UFMT, Appendix 1). The species list presented herein also includes taxa recorded during occasional encounters.

The sampling effort employed in active searches (both visual and acoustic) is herein expressed as observer-hours (sum of hours of sampling conducted by each observer). Capture effort for traps is given as the number of container-days (total number of sampling days × total number of containers [buckets + funnels traps]). Sampling effort totaled 409 observer-hours of active searches and 3,520 container-days, during 71 non-consecutive trapping days. Capture rates for each distinct method were obtained by dividing the total number of individuals recorded by the sampling effort.

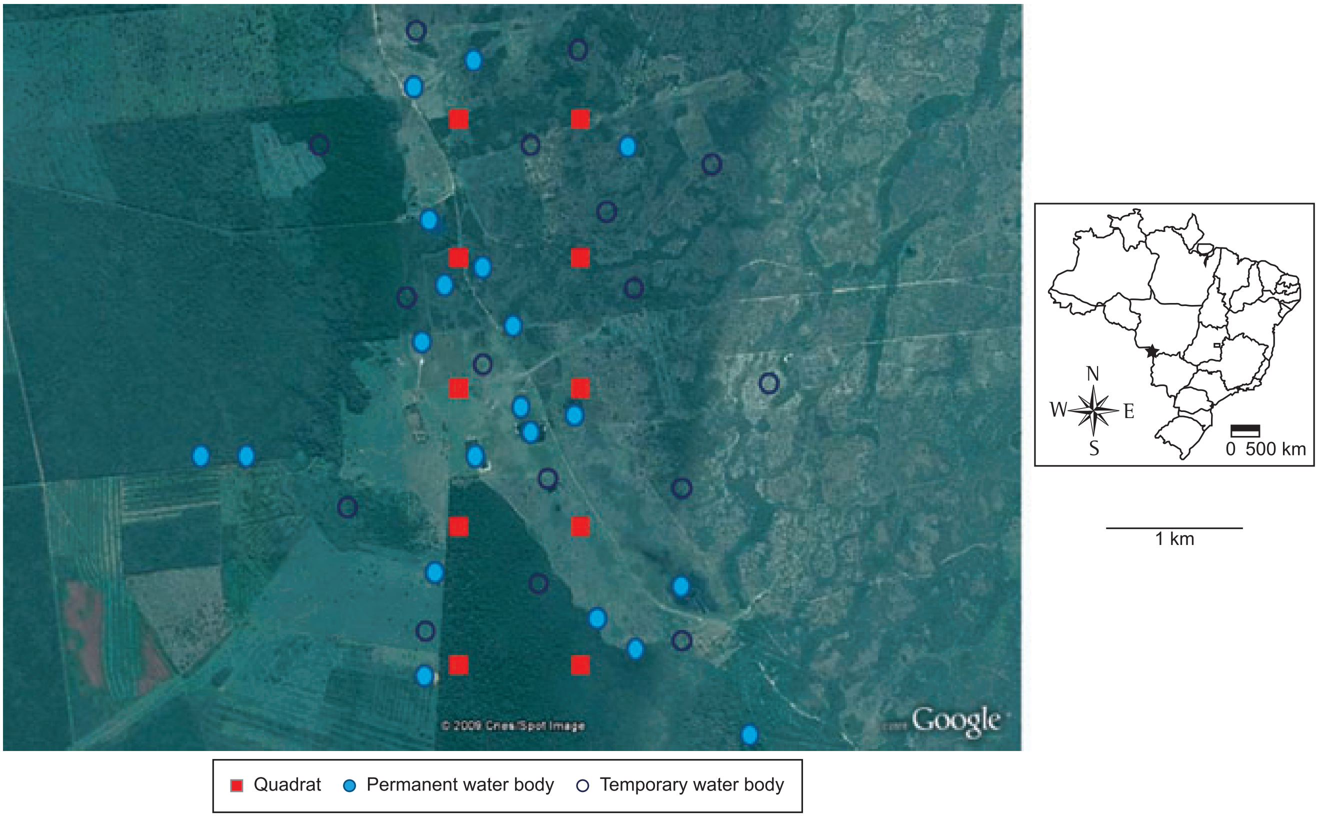

Figure 1. Study area at *Fazenda Baía da Pedra*, Cáceres municipality, Mato Grosso, Brazil, showing the location of anuran sampling points.

Figura 1. Área de estudo na Fazenda Baía de Pedra, município de Cáceres, Mato Grosso, Brasil, com a localização dos pontos de amostragem de anuros.

Figure 2. Detail of a set of pitfall traps with drift fences and of funnel traps employed to sample anuran amphibians in systematically distributed plots at *Fazenda Baía de Pedra*, Cáceres municpality, Mato Grosso, Brazil.

Figura 2. Detalhe de um conjunto de armadilhas de intercepção e queda (*pitfall traps with drift fences*) e armadilhas do tipo funil (*funnel traps*) utilizadas para amostragem de anfíbios anuros em parcelas sistematicamente distribuídas na Fazenda Baía de Pedra, município de Cáceres, Mato Grosso, Brasil.

To estimate local richness based on the number of sampling points (plots plus water bodies), and on the number of sampling days, species rarefaction curves were generated by using first-order Jackknife and Mao (Tau Sobs) estimators, both with 1,000 randomizations. These analyses were conducted using the software EstimateS 7.5.2 (Colwell 2005).

Results and Discussion

We recorded a total of 3,983 individual anuran amphibians representing 34 species, 15 genera, and five families (Table 1). Hylidae and Leptodactylidae were the most abundant families (40 and 23% of the specimens recorded, respectively), following the

Table 1. Absolute and relative abundance of anuran amphibians recorded, by all methods, at *Fazenda Baía de Pedra*, northern Pantanal, Cáceres municipality, state of Mato Grosso, Brazil. **Family/Species:** number of species in each family is in parenthesis. **Plots**: uniformly distributed permanent sampling point, with 250 m along the same isocline; **N**: number of individuals recorded; **%**: relative abundance of the species. **Water bodies**: additional sampling point (permanent or temporary pond); **OE**: occasional encounters; **Total**: total abundance of the species recorded; **Reproductive pattern**: reproductive activity pattern of the species in the sampled area (according to Wells 1977) - **explosive:** the species breeds for a few days during the rainy season; **prolonged:** the species breeds for more than three consecutive months; **Habitats**: environments (according to Nunes da Cunha & Junk 2010) where representatives of the species occur in the sampled area.

Tabela 1. Abundância absoluta e relativa de anfíbios anuros registrados, por todos os métodos, na Fazenda Baía de Pedra, Pantanal norte, Cáceres, Mato Grosso, Brasil. **Família/Espécie:** entre parênteses, o número de espécies em cada família; **Parcela**: ponto de amostragem permanente uniformemente distribuído; **N**: número de indivíduos registrados; **%**: abundância relativa das espécies. **Corpo d'água**: ponto adicional de amostragem (poça/lagoa permanente ou temporária); **EO**: encontro ocasional; **Padrão de Atividade Reprodutiva**: atividade reprodutiva das espécies na área amostrada (segundo Wells 1977); **Ambiente**: locais de ocorrência das espécies na área amostrada (segundo Nunes da Cunha & Junk 2010). **Total**: abundância total das espécies registradas.

Family/Species	Plots		Water bodies				OE		Total		Reproductive pattern	Habitats
			Permanent		Temporary							
	N	%	N	%	N	%	N	%	N	%		
Bufonidae (2)												
Rhinella major Muller & Helmich, 1936	1	0.07	3	0.33	48	3.00	-	-	52	1.31	Explosive	Perianthropic; natural depression
Rhinella schneideri (Werner, 1894)	5	0.36	1	0.11	5	0.31	-	-	11	0.28	Explosive	Perianthropic; natural grasslands
Hylidae (14)												
Dendropsophus cf. *elianeae* (Napoli & Caramaschi, 2000)	6	0.43	-	-	36	2.25	3	3.61	45	1.13	Prolonged	Artificial grasslands; artificial systems reservoirs
Dendropsophus aff. *elianeae* (Napoli & Caramaschi, 2000)	-	-	1	0.11	-	-	-	-	1	0.03	Prolonged	Natural depression; artificial systems reservoirs
Dendropsophus melanargyreus (Cope, 1887)	-	-	13	1.43	67	4.19	5	6.02	85	2.13	Prolonged	Natural depression; artificial systems reservoirs
Dendropsophus minutus (Peters, 1872)	-	-	8	0.88	32	2.00	-	-	40	1	Prolonged	Natural depression
Dendropsophus nanus (Boulenger, 1889)	69	4.96	72	7.90	154	9.63	9	10.8	304	7.63	Prolonged	Natural grasslands; natural depression
Hypsiboas raniceps Cope, 1862	14	1.01	73	8.01	137	8.57	1	1.2	225	5.65	Prolonged	Forested area; natural grasslands
Phyllomedusa azurea Cope, 1862	4	0.29	62	6.81	33	2.06	2	2.41	101	2.54	Prolonged	Natural grasslands; natural depression
Pseudis limellum (Cope, 1862)	35	2.52	108	11.86	37	2.31	1	1.2	181	4.54	Prolonged	Natural depression; bay; artificial systems reservoirs
Pseudis paradoxa (Linnaeus, 1758)	-	-	5	0.55	3	0.19	-	-	8	0.2	Prolonged	Natural depression; bay; artificial systems reservoirs
Scinax acuminatus (Cope, 1862)	-	-	4	0.44	9	0.56	-	-	13	0.33	Explosive	Perianthropic; natural depression
Scinax fuscomarginatus (A. Lutz, 1925)	21	1.51	11	1.21	88	5.50	3	3.61	123	3.09	Prolonged	Natural grasslands/artificial
Scinax fuscovarius (A. Lutz, 1925)	24	1.73	17	1.87	53	3.31	-	-	94	2.36	Explosive	Natural depression; artificial systems reservoirs
Scinax nasicus (Cope, 1862)	18	1.29	4	0.44	60	3.75	1	1.2	83	2.08	Explosive	Forested area; natural depression; Perianthropic
Trachycephalus venulosus (Laurenti, 1768)	24	1.73	2	0.22	29	1.81	1	1.2	56	1.41	Explosive	Forested area; natural depression; perianthropic
Leiuperidae (6)												
Eupemphix nattereri Steindachner, 1863	7	0.50	68	7.46	69	4.32	2	2.41	146	3.67	Explosive	Forested area; natural depression; Artificial systems reservoirs

Table 1. Continued...

Family/Species	Plots		Water bodies				OE		Total		Reproductive pattern	Habitats
			Permanent		Temporary							
	N	%	N	%	N	%	N	%	N	%		
Physalaemus albonotatus (Steindachner, 1864)	214	15.40	57	6.26	152	9.51	5	6.02	428	10.7	Prolonged	Natural grasslands; forested area; Natural depression; artificial systems reservoirs
Physalaemus centralis Bokermann, 1962	2	0.14	-	-	9	0.56	1	1.2	12	0.3	Prolonged	Forested area; temporary reservoirs
Pleurodema fuscomaculatum (Steindachner, 1864)	30	2.16	-	-	90	5.63	7	8.43	127	3.19	Prolonged	Forested area; natural grasslands
Pseudopaludicola cf. *mystacalis* (Cope, 1887)	382	27.48	62	6.81	152	9.51	19	22.9	615	15.4	Explosive	Natural grasslands
Pseudopaludicola sp.	-	-	-	-	10	0.63	7	8.43	17	0.43	Explosive	Water puddle on forest border
Leptodactylidae (8)												
Leptodactylus bufonius Boulenger, 1894	1	0.07	52	5.71	22	1.38	11	13.3	86	2.16	Prolonged	Natural depression; artificial systems reservoirs
Leptodactylus chaquensis Cei, 1950	71	5.11	118	12.95	8	0.50	-	-	197	4.95	Explosive	Natural grasslands; natural depression
Leptodactylus cf. *diptyx* Boettger, 1885	6	0.43	-	-	-	-	-	-	6	0.15	Prolonged	Forested area
Leptodactylus elenae Heyer, 1978	78	5.61	1	0.11	14	0.88	1	1.2	94	2.36	Prolonged	Forested area, natural depression
Leptodactylus fuscus (Schneider, 1799)	162	11.65	84	9.22	133	8.32	-	-	379	9.52	Prolonged	Natural grasslands; natural depression; flood field
Leptodactylus labyrinthicus (Spix, 1824)	2	0.14	8	0.88	6	0.38	-	-	16	0.4	Prolonged	Forested area; natural depression
Leptodactylus mystacinus (Burmeister, 1861)	1	0.07	12	1.32	16	1.00	2	2.41	31	0.78	Prolonged	Natural grasslands
Leptodactylus podicipinus (Cope, 1862)	91	6.55	48	5.27	57	3.56	-	-	196	4.92	Prolonged	Natural grasslands; natural depression
Microhylidae (4)												
..*Chiasmocleis albopunctata* (Boettger, 1885)	1	0.07	-	-	-	-	-	-	1	0.03	Explosive	Natural grasslands
Dermatonotus muelleri (Boettger, 1885)	53	3.81	3	0.329	20	1.251	1	1.2	77	1.93	Explosive	Forested area; artificial systems reservoirs
Elachistocleis cf. *magnus* Toledo, 2010.	8	0.58	-	-	6	0.375	-	-	14	0.35	Explosive	Natural grasslands; natural depression
Elachistocleis matogrosso (Caramaschi, 2010)	60	4.32	11	1.54	44	2.75	1	1.2	119	2.99	Explosive	Natural grasslands; natural depression
Total number of individuals recorded	1,390	-	911	-	1,599	-	83	-	3,983	-		
Total number of species recorded	28		27		31		20		34			

general pattern observed in other Neotropical sites (e.g., Duellman 1999, Navas 2006) including the Pantanal floodplain and surrounding elevated plateaus (Gordo & Campos 2003, Strüssmann 2000, 2001, Ávila & Ferreira 2004, Prado et al. 2005, Wang et al. 2005, Valério-Brun & Strüssmann 2010). Five species individually represented more than 5% of the total number of specimens recorded throughout the study, and together summed almost 50% of the total abundance: *Pseudopaludicola* cf. *mystacalis*, *Physalaemus albonotatus*, *Leptodactylus fuscus*, *Dendropsophus nanus*, and *Hypsiboas raniceps*. The 29 remaining species individually showed relative abundances of less than 5% (Table 1).

The rarefaction curve based on the number of sampling points estimated a mean number (± standard deviation) of 37.93 ± 2.17 anuran species in the sampling area, and reached an asymptote after 19 sampling points (Figure 3a). When the curve was generated using sampling days, the asymptote was reached after 33 days (Figure 3b).

The observed richness of anurans in the systematically distributed plots alone (28 species) is 11.3% lower than that recorded for the water bodies (32 species), and 17.7% lower than the total richness (34 species) recorded in this study for the whole region of *Fazenda Baía da Pedra*. Species recorded exclusively in the plots include the cryptozoic

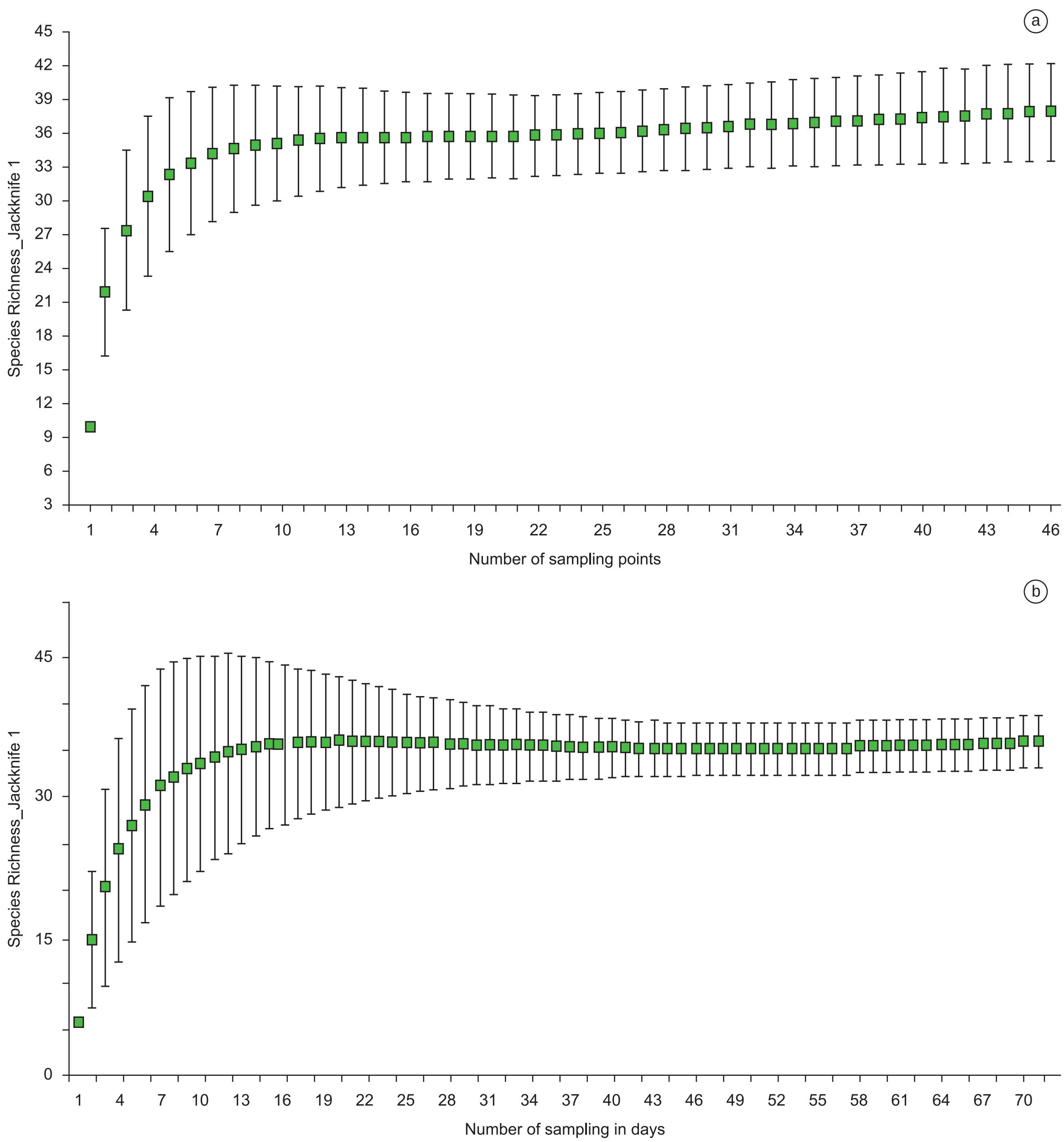

Figure 3. Rarefaction curves of estimated species richness (circles) and rarefaction curves of observed species richness (triangles) of anuran amphibians collected at *Fazenda Baía da Pedra*, Cáceres municipality, Mato Grosso, Brazil, based on the number of sampling points (46 points; a) and on the number of sampling days (71 days; b) throughout the five field excursions (between February 2008 and March 2009).

Figura 3. Curvas de rarefação estimada (círculos) e observada (triângulos) de espécies de anfíbios anuros na região da Fazenda Baía de Pedra, município de Cáceres, Mato Grosso, Brasil, com base no número de pontos amostrais (46 pontos; a) e no número de dias despendidos nas amostragens (71 dias; b), ao longo de cinco campanhas (entre fevereiro/2008 e março/2009).

Figure 4. Some of the anuran amphibians recorded at *Fazenda Baía da Pedra*, northern Pantanal, Cáceres municipality, Mato Grosso state, Brasil. a) *Rhinella major*; b) *Rhinella schneideri*; c) *Dendropsophus* cf. *elianeae*; d) *Phyllomedusa azurea*; e) *Dendropsophus melanargyreus*; f) *Dendropsophus minutus*; g) *Scinax fuscovarius*; h) *Scinax acuminatus*; i) *Scinax nasicus*; j) *Trachycephalus venulosus*; l) *Pseudis limellum*; m) *Eupemphix nattereri*; n) *Pseudopaludicola* sp.; o) *Leptodactylus elenae*; p) *Leptodactylus bufonius*; q) *Leptodactylus mystacinus*; r) *Dermatonotus muelleri*; s) *Elachistocleis* cf. *magnus* (Photos: A. Pansonato & C. Strüssmann).

Figura 4. Fotografias em vida de espécimes de anfíbios anuros registrados na Fazenda Baía de Pedra, Pantanal norte, município de Cáceres, Mato Grosso, Brasil. a) *Rhinella major*; b) *R. schneideri*; c) *Dendropsophus* cf. *elianeae*; d) *Phyllomedusa azurea*; e) *D. melanargyreus*; f) *D. minutus*; g) *Scinax fuscovarius*; h) *Scinax acuminatus*; i) *S. nasicus*; j) *Trachycephalus venulosus*; l) *Pseudis limellum*; m) *Eupemphix nattereri*; n) *Pseudopaludicola* sp.; o) *Leptodactylus elenae*; p) *L. bufonius*; q) *L. mystacinus*; r) *Dermatonotus muelleri*; s) *Elachistocleis* cf. *magnus* (Fotos: André Pansonato & Christine Strüssmann).

microhylid *Chiasmocleis albopunctata* and the leptodactylid *Leptodactylus* cf. *diptyx*. Species recorded only in the vicinities of water bodies included mostly hylids (*Dendropsophus melanargyreus*, *Dendropsophus minutus*, *Scinax acuminatus*, and *Pseudis paradoxa*), and the leiuperid *Pseudopaludicola* sp. (Figure 4). The total richness observed in this study corresponds to 77.3% of the known richness in the Pantanal floodplain (Strüssmann et al. 2007) and is similar to the expected richness (38 species) calculated by the Jackknife estimator.

Species richness in systematically distributed plots was greater in the present study than in another PPBio grid previously installed in an easternmost Pantanal subregion (22 species; Valério-Brun & Strüssmann 2010). In both studies, however, occasional encounters near the plots increased richness estimates, by about 17 and 31%, respectively. This pattern may be related to the differential availability of water bodies across Pantanal landscape. Permanent natural aquatic environments are scarce in the floodplain, man-made water bodies are located near human settlements, and temporary aquatic environments are seasonal and highly dependent on rainfalls. Specimens collected in water bodies at *Fazenda Baía da Pedra* represented 63% of the total amount of individuals and 94.1% of the species richness recorded in the present study. The sampling of additional plots near water bodies increased the estimates of anuran diversity obtained in systematically distributed plots in the present study, a result also observed in Amazonian sites (Rodrigues et al. 2010, Rojas-Ahumada & Menin 2010, Condrati 2009).

The abundance of individuals in the plots represented 35.7% of the total number of individuals recorded throughout the study. Species that individually represented at least 5% of the total number of individuals recorded in the plots (Table 1) were the leiuperids *Pseudopaludicola* cf. *mystacalis*, *Physalaemus albonotatus*, and the leptodactylids *Leptodactylus fuscus*, *Leptodactylus podicipinus*, *Leptodactylus elenae,* and *Leptodactylus chaquensis*. Together, they accounted for almost 71.8% of the total number of individuals in the plots.

Species of hylids were also abundant in the water bodies, where 64.3% of the total number of individuals were recorded. *Dendropsophus nanus*, *Leptodactylus fuscus*, *Pseudopaludicola* cf. *mystacalis*, *Hypsiboas raniceps*, *Physalaemus albonotatus*, *Pseudis limellum*, *Eupemphix nattereri,* and *Leptodactylus chaquensis* were the eight most abundant species in the water bodies, summing 58.8% of the total number of individuals. Each of them individually represented between 5-10% of the sample for the water bodies alone, as well as of the sample for the whole area (Table 1).

Distinct sampling methods yield different anuran species composition and relative abundances in the 10 plots surveyed at *Fazenda Baía da Pedra*. Visual and bioacoustic search efforts in these plots summed 200 observer-hours and returned 913 anurans (4.56 specimens/observer-hour) of 27 species, whereas the rarefaction curve estimated the occurrence of 34 ± 2.62 anuran species. Visual and bioacoustic search efforts in water bodies summed 409 observer-hours and returned 3,459 anurans (8.45 specimens/observer-hour) of 31 species. Species most frequently recorded during visual and bioacoustic searches were *Pseudopaludicola* cf. *mystacalis* (28.5%), *Physalaemus albonotatus* (18%), *Leptodactylus podicipinus* (9%), *Dendropsophus nanus* (7.5%), and *Leptodactylus fuscus* (7%).

Pitfalls and funnel traps, combined with drift fences, resulted in 477 captures belonging to 18 species, and produced an estimate of 25 ± 2.24 anuran species. The 40 buckets and 40 funnels kept open for 44 days totaled 3,520 container-days and returned a capture rate of 0.13 specimens/container-day. Species most frequently captured in traps were *Pseudopaludicola* cf. *mystacalis* (25%), and the two cryptozoic microhylids *Elachistocleis matogrosso* (9.8%) and *Dermatonotus muelleri* (9%). The four least-represented species in traps (a single specimen each) were the terrestrial bufonid toad *Rhinella schneideri*, and the arboreal hylid treefrogs *Hypsiboas raniceps*, *Phylomedusa azurea,* and *Scinax nasicus*.

Richness and abundance of anurans recorded in the present study are roughly the same as those obtained by Valério-Brun & Strüssmann (2010). Although situated nearly at the same latitude of *Fazenda Baía de Pedra*, the grid area studied by those authors (30 plots; 25 km^2) is five times larger than the module studied here (10 plots; 5 km^2). In the present study, however, the sampling of water bodies in addition to the systematically distributed plots definitely enhanced estimates of anuran richness and abundance (see also Valério-Brun et al. 2010).

The two areas, both used for extensive cattle husbandry, harbor 28 species in common. Four species recorded in the *Pirizal* sampling grid have not been recorded in *Baía da Pedra*: *Hypsiboas* aff. *geographicus*, *Hypsiboas punctatus*, *Physalaemus cuvieri* and *Leptodactylus* sp. (=*Adenomera*). In contrast, six species recorded in *Fazenda Baía de Pedra* (*Dendropsophus* aff. *elianeae*, *Scinax fuscovarius*, *Leptodactylus bufonius*, *Leptodactylus mystacinus*, *Dermatonotus muelleri*, and *Elachistocleis matogrosso*) were not recorded in the *Pirizal* sampling grid. Of the six species unique to *Fazenda Baía*, only *L. bufonius*, a typical inhabitant of Chacoan areas (Souza et al. 2010), may not reach easternmost areas of the Pantanal, such as the *Pirizal* region.

Studies carried out in Amazonian sites suggested that sampling efforts conducted in small areas (1 to 5 km^2) may capture only a small portion of the local diversity, mainly due to spatial heterogeneity Menin et al. 2008). In the more homogeneous Pantanal floodplain, however, smaller modules (instead of complete PPBio grids), which are cheaper to install and check periodically, were found to be efficient in quantifying anuran richness and abundance. This procedure could certainly benefit from the inclusion of additional sampling points, especially permanent or temporary water bodies. Arboreal species such as *Dendropsophus melanargyreus* and *Trachycephalus venulosus*, and cryptozoic species such as *Dermatonotus muelleri* and *Chiasmocleis albopunctatus* may be detected only when they aggregate for reproduction in a few selected ponds, after heavy rains. Similarly, species highly dependent upon (or strongly associated with) aquatic habitats, such as *Pseudis limellum*, *Pseudis platensis* and *Hysiboas punctatus*, may be absent from permanent sampling plots in areas that periodically dry out.

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Appendix 1

Appendix 1. List of vouchers and respective accession numbers of anuran amphibians recorded in *Fazenda Baía de Pedra* (Northern Pantanal, Cáceres municipality, state of Mato Grosso, Brazil) and deposited in the *Coleção Zoológica de Vertebrados* from the *Universidade Federal de Mato Grosso*.

Apêndice 1. Lista de espécimes-testemunho (e respectivos número-tombo) das espécies de anfíbios anuros registradas na Fazenda Baía de Pedra (Pantanal norte, Cáceres, Mato Grosso, Brasil), depositados na Coleção de Vertebrados da Universidade Federal de Mato Grosso.

Voucher species	Accession numbers
Rhinella major	UFMT 10424-10431
Rhinella schneideri	UFMT 10422-10423
Dendropsophus cf. *elianeae*	UFMT 10277, 10279, 10280
Dendropsophus aff. *elianeae*	UFMT 10278
Dendropsophus melanargyreus	UFMT 10281-10285
Dendropsophus minutus	UFMT 10268-10273
Dendropsophus nanus	UFMT 10300-10315
Hypsiboas raniceps	UFMT 10254-10262
Phyllomedusa azurea	UFMT 10246-10253
Pseudis limellum	UFMT 10371-10383
Pseudis paradoxa	UFMT 10384
Scinax acuminatus	UFMT 10229-10230
Scinax fuscomarginatus	UFMT 10233-10236
Scinax fuscovarius	UFMT 10221, 10222, 10224
Scinax nasicus	UFMT 10223, 10225-10228
Trachycephalus venulosus	UFMT 10263-10267
Eupemphix nattereri	UFMT 10348-10353
Physalaemus albonotatus	UFMT 10364-10370
Physalaemus centralis	UFMT 10354-10355
Pleurodema fuscomaculata	UFMT 10356, 10363
Pseudopaludicola cf. *mystacalis*	UFMT 10481-10509
Pseudopaludicola sp.	UFMT 10419-10421
Leptodactylus bufonius	UFMT 10540-10546, 10556-10569
Leptodactylus chaquensis	UFMT 10439-10444
leptodactylus cf. *diptyx*	UFMT 10323, 10334, 10345
Leptodactylus elenae	UFMT 10324-10330
Leptodactylus fuscus	UFMT 10338-10346
Leptodactylus labyrinthicus	UFMT 10432-10433
Leptodactylus mistacinus	UFMT 10434-10438
Leptodactylus podicipinus	UFMT 10385-10397
Chiasmocleis albopunctata	UFMT 10398
Dermatonotus muelleri	UFMT 10209-10220
Elachistocleis cf. *magnus*	UFMT 10399-10406
Elachistocleis matogrosso	UFMT 10407-10418