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Anurans from a Cerrado-Atlantic Forest ecotone in Campos Gerais region, southern Brazil

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Abstract: Knowledge of the richness and distribution of anurans living in ecotone regions is still incipient, especially in transition zones between threatened phytogeographic areas like the Cerrado and the Atlantic Forest. This study presents a checklist of anuran amphibians in an ecotone (Cerrado-Atlantic Forest) in the Campos Gerais, Paraná State, Brazil. Samplings were conducted in 66 water bodies (ponds) between October 2012 and March 2013. We identified 42 anuran species, six of them in larval stage only and eight of them in adult stage only. The anurofauna accounted for 21.05% of the species registered for the Cerrado and 9.58% of the species found in the Atlantic Forest. Four species are endemic to the Cerrado and eight to the Atlantic Forest. Our results show that this region has a rich anurofauna with species characteristic of different biomes. This study contributes to the process of knowledge production to support further research in ecology, biogeography and conservation of anurans in the Campos Gerais.

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Introduction

The domains of the Cerrado and the Atlantic Forest are in the list of the world's biodiversity hotspots because they have a small representation of original areas as primary vegetation, high rates of endemism and a high degree of threat (Myers *et al*. 2000; Mittermeier *et al.* 2004). Cerrado is highly threatened by human activities, especially by agriculture and extensive livestock production (Ratter *et al.* 2003). Recent studies have estimated that about 55% of the 2 million km^2 of the original vegetation cover has been devastated (Machado *et al.* 2004). The Atlantic Forest, as well as the Cerrado, is threatened by human influence, and its original vegetation has been reduced, ranging from 11.4% to 16% of its original length, which was 1.5 million km^2 (Ribeiro *et al.* 2009).

The Campos Gerais suffer influence from the Atlantic Forest, but the southern limit of the Cerrado domain is also found in this region; therefore, there are some areas of savannah, which consist of a mixture of species that are characteristic of the Central Plateau of Brazil (Ritter *et al.* 2010). Ecotones are unique areas, with physical and biological characteristics of adjacent regions (Williams 1996). Therefore, they have a species composition derived from both areas and may have a diversity higher than that of a single biome alone (Remanamanjato *et al.* 2002). In this sense, disconnected remnants of different phytogeographical domains, such as of the Cerrado and the Atlantic Forest, may be important to support animal or plant species characteristic of these biomes, such as amphibians, for example. Amphibians are found in almost all types of terrestrial and freshwater habitats, and their distribution is strongly influenced by the presence of water (Duellman and Trueb 1986). Their dependence on water bodies or humid environments for reproduction explains the great diversity of species in the Neotropical region (Duellman and Trueb 1986; Wells 2007).

Anthropogenic factors such as habitat loss and fragmentation (Cushman 2006; Silva *et al.* 2011) are the major threats to amphibians, especially in Brazil (Silvano and Segalla 2005). In this sense, strategies to conserve biological diversity require studies with emphasis on surveys, biodiversity quantification and distribution, both in small and large scales. These elements should be recognised as important tools in the production of basic knowledge to support further research in the areas of systematics, ecology, biogeography and conservation (Heyer *et al.* 1994; Diniz-Filho *et al.* 2009).

Studies on amphibians from the Campos Gerais are recent and very little is known about the ecology and diversity of this group in this peculiar ecosystem. This work aimed to contribute to the knowledge of amphibians in disconnected remnants of the Cerrado and ecotone (Atlantic Forest) in the Campos Gerais, by presenting a survey of anuran species, both in larval and adult stages and discussing the species conservation status.

Materials and Methods

Study area

The Campos Gerais encompass a phytogeographic region located in southern Brazil, characterised by fields interspersed with gallery forests and scattered patches of forest (Maack 1981). They are found in the central-eastern portion of the Paraná State and have approximately 11,761.41 km^2 extension (Melo *et al.* 2007). In the region, the southern limit of the Cerrado meets with the northern boundary of the Campos Sulinos, beyond the presence of

the Atlantic Forest, with forest formations of Subtropical Ombrophilous Forest and Seasonal Semidecidual Forest forming mosaics of different vegetation types (Carmo *et al.* 2012; Moro 2012).

The region is under the influence of two climate types according to the Köeppen classification: Cfa, mesothermal subtropical climate with hot, rainy summers; and Cfb, mesothermal subtropical climate, humid, without a defined dry season and mild summers (Peel *et al.* 2007). The region exhibits a gently undulating relief, and altitude ranges from 800 to 1,200 m. The soil is a red-yellow oxisol and lithic neossolos, but cambisols and argisols can also occur (Melo *et al.* 2007).

Data collection

Fieldwork was conducted between October 2012 and March 2013 during six field trips, each lasting for six days, amounting to 36 sampling days in the region. Samplings were performed in 66 water bodies (conisting of ponds only) located in fragments of the Cerrado and ecotone regions (Atlantic Forest) with Subtropical Ombrophilous Forest and Seasonal Semidecidual Forest in Campos Gerais. The typical vegetation formations of the region may be divided into: dry fields, wetlands fields, gallery forests, mixed forests of araucaria, Cerrado relicts, seasonal semidecidual forest (Klein and Hatschbach 1971; Pillar 2000; Rodrigues 2000; Di Bitetti *et al.* 2003; Melo et al. 2007), pine plantations and anthropogenic grasslands. The water bodies are located in the municipalities of Sengés, Jaguariaíva, Piraí do Sul, Tibagi, Carambeí and Ponta Grossa (Figure 1, Table 1).

Tadpoles were sampled during daytime with a steel dip net with 40 cm diameter and 3 mm^2 mesh, dragged by the margin and inside of each water body, with sampling effort of one hour (Heyer *et al.* 1994). The tadpoles collected were anesthetised with 5% benzocaine, fixed and preserved in 5% formalin. Individuals were identified according to Rossa-Feres and Nomura (2006), Machado and Maltchik (2007) and Conte *et al.* (2007) and also by comparison with individuals deposited in other collections, using a Zeiss stereomicroscope.

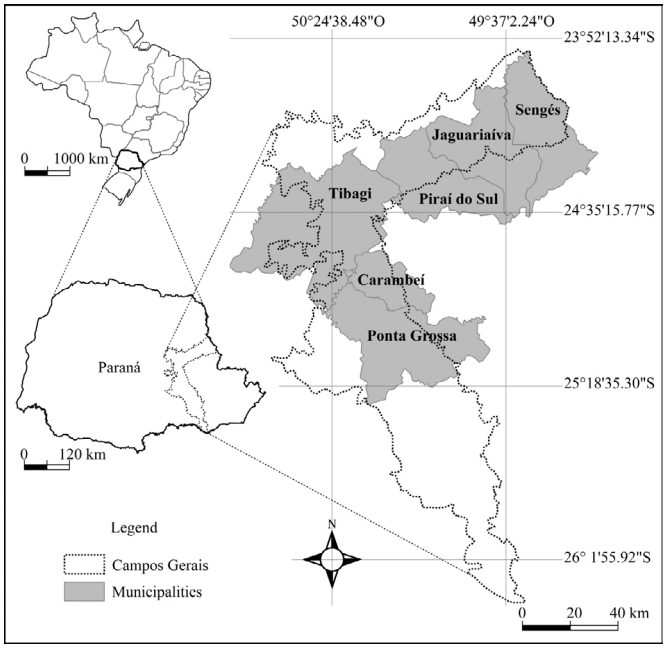

Figure 1. Map showing the sampled municipalities in Campos Gerais.

Adult anurans were sampled at night, using the methods of visual and auditory search, for an hour at each sampling site (Heyer *et al.* 1994). All vocalising males were counted, estimating the abundance for each sampling site. Voucher individuals were collected, anesthetized with 5% lidocaine, fixed in 10% formalin and preserved in 70% alcohol. Nomenclature follows Frost (2014). All tadpoles and voucher adults collected were deposited at the Coleção Zoológica da Universidade Federal de Goiás (ZUFG), Goiânia, Goiás State, Brazil (Collection permit IAP 439.12 and ICMBIO 35767-1) (Appendix 1).

The conservation status of each species was defined based on the data available on the IUCN Red List of Threatened Species (IUCN 2013). Information about the degree of association between the species and the Cerrado and Atlantic Forest and their distribution patterns were obtained through information available in Valdujo *et al.* (2012) and Haddad *et al.* (2013).

Results

A total of 42 amphibian species were identified, distributed into five families and 13 genera (Figure 2 and 3, Table 2). The most species-rich family was Hylidae (25 species), followed by Leptodactylidae (11 species), Bufonidae (tree species), Odontophrynidae (two species) and Microhylidae (one species). The sampling of tadpoles registered 14,802 specimens, distributed into 34 species, six registered only at larval stage (*Leptodactylus mystacinus*, *Physalaemus marmoratus*, *P. nattereri*, *Scinax aromothyella, S.* cf. *granulatus* and *S.* cf. *similis*). The sampling of adults encompassed a total of 1,782 specimens, distributed into 36 species, eight of which were verified only at this stage (*Aplastodiscus perviridis*, *Dendropsophus nanus*, *Dendropsophus elianae*, *Leptodactylus labyrinthicus, Leptodactylus podicipinus, Rhinella abei*, *Rhinella icterica* and *Scinax rizibilis*).

The most abundant species as tadpoles were *Dendropsophus minutus*, *Leptodactylus latrans*, *Physalaemus cuvieri* and *Rhinella schneideri* which together represented 40.88% of the total specimens collected. The most abundant species as adults were *D. minutus*, *D. sanborni*, *Hypsiboas albopunctatus*, *Scinax* sp. (gr. *ruber*) and *P. cuvieri*, together representing 59.26% of the observed specimens. The species of the families Bufonidae and Odontophrynidae were recorded only occasionally in few sampling sites.

Two species were not formally assessed for the IUCN conservation status (*Hypsiboas jaguariaivensis* and *Physalaemus lateristriga*). None of the other species recorded are considered endangered. Four species are endemic to the Cerrado (*Dendropsophus elianae*, *Hypsiboas jaguariaivensis*, *Physalaemus marmoratus* and *Physalaemus nattereri*) according to Valdujo *et al.* (2012), and eight species are endemic to the Atlantic Forest (*Hypsiboas bischoffi*, *Aplastodiscus albosignatus*, *Sphaenorhynchus surdus*, *Scinax perereca*, *Scinax aromothyella*, *Scinax rizibilis*, *Scinax* cf. *catharinae* and *Physalaemus lateristriga*) (Haddad *et al.* 2013).

Table 1. Location of habitats sampled in remnants of Cerrado and ecotone (Atlantic Forest) on Campos Gerais of the Paraná. Abbreviations: CR = Cerrado relict (forest edge), DF = dried fields (natural), G = grassland (anthropic), GF = gallery forest (forest edge), MFA = mixed forests of Araucaria (forest edge), PP = pine plantation (forest edge), SSF = seasonal semidecidual forest (forest edge), WF = wetland fields (natural).

HABITAT	MUNICIPALITY	COORDINATES		ALTITUDE	HABITAT TYPE
		LATITUDE	LONGITUDE		
1	Sengés	24°7′5.80″ S	49°29′5.32′′ W	742	G
2	Sengés	24°7′27.60″ S	49°31′30.84′′ W	756	GF
3	Sengés	24°6′59.99″ S	49°30′15.77′′ W	736	GF
4	Sengés	24°5′20.93″ S	49°32′18.75′′ W	850	G
5	Sengés	24°10′09.2″ S	49°33′55.8′′ W	961	PP
6	Sengés	24°10′33.19″ S	49°33′31.11′′ W	876	MFA
7	Sengés	24°10′41.02″ S	49°34′3.10′′ W	863	MFA
8	Sengés	24°7′21.9″ S	49°31′30.8′′ W	761	G
9	Sengés	24°17′54.2″ S	49°31′55.4′′ W	1151	WF
10	Sengés	24°16′46.43″ S	49°31′31.25′′ W	1124	G
11**	Sengés	24°12′55.72″ S	49°31′43.18′′ W	893	G
12	Sengés	24°9′23.24″ S	49°30′59.24′′ W	690	G
13	Sengés	24°13′12.94″ S	49°29′22.20′′ W	864	CR
14	Sengés	24°6′53.23″ S	49°25′2.23′′ W	634	G
15	Jaguariaíva	24°10′59.8′′ S	49º39′36.1′′ W	822	CR
16	Jaguariaíva	24°9′56.99″ S	49°40′0.41′′ W	764	GF
17**	Jaguariaíva	24°9′51.91″ S	49°39′58.81′′ W	747	GF
18**	Jaguariaíva	24°9′50.25″ S	49°39′59.32′′ W	719	GF
19	Jaguariaíva	24°10′50.30″ S	49°41′36.27′′ W	853	G
20	Jaguariaíva	24°10′56.9′′ S	49°41′31.4′′ W	850	G
21	Jaguariaíva	24°12′3.80″ S	49°40′58.59′′ W	870	G
22**	Jaguariaíva	24°11′24.10″ S	49°41′48.55′′ W	885	SSF
23**	Jaguariaíva	24°8′30.31″ S	49°41′1.44′′ W	811	GF
24**	Jaguariaíva	24°7′46.17″ S	49°40′38.99′′ W	731	GF
25**	Jaguariaíva	24°13′44.06″ S	49°41′50.33′′ W	847	G
26**	Jaguariaíva	24°8′49.65″ S	49°46′28.35′′ W	843	SSF
27	Piraí do Sul	24°30′8.13″ S	49°59′57.75′′ W	1055	CR
28	Piraí do Sul	24°31′52.51″ S	49°57′51.38′′ W	1034	SSF
29	Piraí do Sul	24°31′50.45″ S	49°57′52.21′′ W	1010	G
30	Piraí do Sul	24°34′52.97″ S	49°59′32.77′′ W	1025	G
31	Piraí do Sul	24°36′54.3′′ S	50°1′42.5′′ W	1094	MFA
32	Piraí do Sul	24°32′16.24″ S	49°54′40.97′′ W	1101	SSF
33	Piraí do Sul	24°32′14.95″ S	49°54′17.50′′ W	1084	SSF
34	Piraí do Sul	24°31′34.86″ S	49°54′55.14′′ W	1054	SSF
35	Piraí do Sul	24°27′47.6′′ S	50°0′30.4′′ W	1244	DF
36	Piraí do Sul	24°28′45.53″ S	50°1′2.63′′ W	1219	WF
37	Tibagí	24°33′53.26″ S	50°15′34.56′′ W	975	MFA
38	Tibagí	24°34′1.64″ S	50°15′54.78′′ W	1063	WF
39	Tibagí	24°33′53.9′′ S	50°16′21.6′′ W	1044	WF
40*	Tibagí	24°33′38.97″ S	50°16′57.86′′ W	1025	G
41	Tibagí	24°41′14.92″ S	50°12′37.14′′ W	1216	DF
42	Tibagí	24°39′49.54″ S	50°13′10.85′′ W	1231	WF
43	Tibagí	24°36′4.25″ S	50°15′22.13′′ W	1145	G
44	Tibagí	24°40′1.10″ S	50°13′0.83′′ W	1242	WF
45	Tibagí	24°42′30.77″ S	50°14′45.28′′ W	1150	WF
46	Tibagí	24°42′34.86″ S	50°14′40.37′′ W	1161	WF
47	Tibagí	24°45′59.2′′ S	50°9′49.2′′ W	1183	G
48	Tibagí	24°36′0.74″ S	50°14′18.65′′ W	1165	WF
49	Tibagí	24°38′21.71″ S	50°13′50.54′′ W	1200	WF
50	Carambeí	24°57′54.24″ S	50°3′11.70′′ W	1027	G
51**	Carambeí	24°57′49.04″ S	50°3′13.55′′ W	1022	MFA
52	Carambeí	24°58′46.34″ S	50°0′14.13′′ W	981	SSF
53*	Ponta Grossa	25°13′41′′ S	50°2′07.1′′ W	817	MFA
54	Ponta Grossa	25°13′12.48″ S	50°0′44.96′′ W	828	WF
55	Ponta Grossa	25°14′43.36″ S	50°2′25.65′′ W	798	MFA
56	Ponta Grossa	25°13′9.62″ S	49°53′2.81′′ W	1099	WF
57**	Ponta Grossa	25°11′5.71″ S	49°55′46.82′′ W	1067	G
58**	Ponta Grossa	25°9′35.61″ S	49°55′29.73′′ W	1051	G
59	Ponta Grossa	25°9′41.42″ S	49°54′17.55′′ W	968	WF
60**	Ponta Grossa	25°12′32.01″ S	49°56′13.93′′ W	1001	G
61**	Ponta Grossa	25°15′44.85″ S	49°56′47.24′′ W	874	G
62**	Ponta Grossa	25°10′36.64″ S	49°58′44.35′′ W	924	G
63**	Ponta Grossa	25° 9′0.37″ S	49°57′24.40′′ W	1035	G
64**	Ponta Grossa	25°6′13.1′′ S	49°54′25.1′′ W	831	MFA
65	Ponta Grossa	25°9′46.4′′ S	49°54′44.3′′ W	961	G
66**	Ponta Grossa	25°10′29.14″ S	49°53′56.62′′ W	1091	MFA

* Habitats sampled only for the adult stage. ** Habitats sampled only for the larval stage.

Table 2. List of species of anurans sampled in disjoint remnants of Cerrado and ecotone (Atlantic Forest) on Campos Gerais of the Paraná, Brazil. Abbreviations: Association = association level of the Cerrado, Distribution = distribution pattern, T = typical species, M = marginal species, E = endemic to the Cerrado, W = widely distributed, S = species with southern distribution occurring in the Cerrado, AT = species occurring in the Atlantic Forest and the Cerrado. Asterisks indicate species endemic to the Atlantic Forest.

TAXON	TADPOLES	ADULTS	ASSOCIATION	DISTRIBUTION
Anura				
Bufonidae				
Rhinella schneideri (Werner, 1894)	X	X	T	W
Rhinella icterica (Spix, 1824)		X	M	AT
Rhinella abei (Baldissera, Caramaschi, & Haddad, 2004)*		X	M	S
Odontophrynidae				
Proceratophrys boiei (Wied-Neuwied, 1824)	X	X	M	AT
Odontophrynus americanus (Duméril & Bibron, 1841)	X	X	M	S
Hylidae				
Dendropsophus nanus (Boulenger, 1889)		X	T	W
Dendropsophus sanborni (Schmidt, 1944)	X	X	M	S
Dendropsophus minutus (Peters, 1872)	X	X	T	W
Dendropsophus elianeae (Napoli & Caramaschi, 2000)		X	T	E
Hypsiboas faber (Wied-Neuwied, 1821)	X	X	M	AT
Hypsiboas albopunctatus (Spix, 1824)	X	X	T	W
Hypsiboas bischoffi (Boulenger, 1887)*	X	X	M	S
Hypsiboas prasinus (Burmeister, 1856)	X	X	M	AT
Hypsiboas caingua (Carrizo, 1991)	X	X	M	AT
Hypsiboas jaguariaivensis Caramaschi, Cruz, & Segalla, 2010	X	X	T	E
Phyllomedusa tetraploidea Pombal & Haddad, 1992	X	X	M	S
Aplastodiscus perviridis Lutz, 1950		X	T	AT
Aplastodiscus albosignatus (Lutz & Lutz, 1938)*	X	X	M	S
Sphaenorhynchus surdus (Cochran, 1953)*	X	X	M	S
Scinax fuscovarius (Lutz, 1925)	X	X	T	W
Scinax perereca Pombal, Haddad, & Kasahara, 1995*	X	X	M	S
Scinax cf. *similis* (Cochran, 1952)	X		M	S
Sxinax cf. *granulatus* (Peters, 1871)	X		M	S
Scinax uruguayus (Schmidt, 1944)	X	X	M	S
Scinax squalirostris (Lutz, 1925)	X	X	T	S
Scinax fuscomarginatus (Lutz, 1925)	X	X	T	W
Scinax aromothyella Faivovich, 2005*	X		M	S
Scinax rizibilis (Bokermann, 1964)*		X	M	S
Scinax cf. *catharinae**	X	X	M	S
Scinax sp. (gr. *ruber*)	X	X	M	S
Leptodactylidae				
Physalaemus aff. *gracilis* (Boulenger, 1883)	X	X	M	S
Physalaemus cuvieri Fitzinger, 1826	X	X	T	W
Physalaemus lateristriga (Steindachner, 1864)*	X	X	M	S
Physalaemus marmoratus (Reinhardt & Lütken, 1862)	X		T	E
Physalaemus nattereri Steindachner, 1863	X		T	E
Leptodactylus labyrinthicus (Spix, 1824)		X	T	W
Leptodactylus aff. *latrans* (Steffen, 1815)	X	X	T	W
Leptodactylus gracilis (Duméril & Bibron, 1840)	X	X	M	S
Leptodactylus fuscus (Schneider, 1799)	X	X	T	W
Leptodactylus mystacinus (Burmeister, 1861)	X		T	AT
Leptodactylus podicipinus (Cope, 1862)		X	T	W
Microhylidae				
Elachistocleis bicolor (Guérin-Méneville, 1838)	X	X	T	S

Discussion

The species richness found herein is high compared to other areas of Cerrado (Ribeiro-Junior and Bertoluci 2009; Morais *et al*. 2012; Melo et al. 2013) and Atlantic Forest (Serafim *et al*. 2008; Cunha *et al*. 2010, Armstrong and Conte 2010), and other areas of ecotone (Araujo *et al.* 2009; Bertoluci *et al*. 2009; Vasconcelos *et al*. 2011), although this study covered a larger area. According to Valdujo *et al.* (2011), differences in species composition between localities may stem from historical factors that contribute to the distribution of each species. The finding of a large number of species of the families Hylidae and Leptodactylidae was similar to the results of other studies and follows the pattern found in Neotropical environments (Duellman 1999; Ribeiro-Junior and Bertoluci 2009).

Figure 2. Species recorded in the study area: 1- *Rhinella schneideri*, 2- *R. abei*, 3- *R. ictérica*, 4- *Proceratophrys boiei*, 5- *Dendropsophus nanus*, 6- *D. sanborni*, 7- *D. minutus*, 8- *Hypsiboas faber*, 9- *H. albopunctatus*, 10- *H. bischoffi*, 11- *H. prasinus*, 12- *H. caingua*, 13- *H. jaguariaivensis*, 14- *Phyllomedusa tetraploidea*, 15- *Aplastodiscus perviridis*, 16- *A. albosignatus*, 17- *Sphaenorhynchus surdus*, 18- *Scinax fuscovarius*.

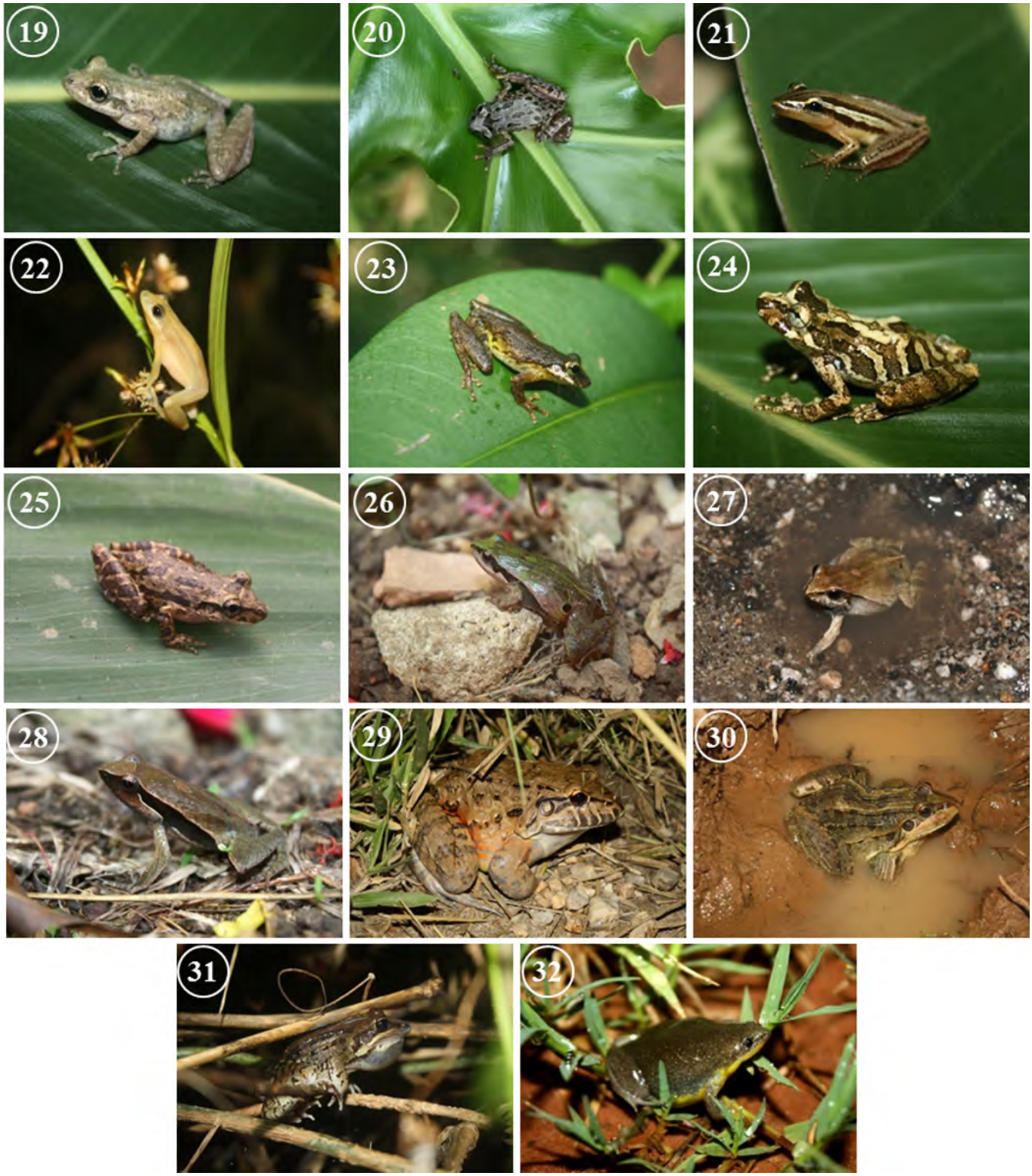

Figure 3. Species recorded in the study area: 19- *Scinax perereca*, 20- *S. uruguayus*, 21- *S. squalirostris*, 22- *S. fuscomarginatus*, 23- *S. rizibilis*, 24- *S.* cf. *catharinae*, 25- *Scinax* sp. (gr. ruber), 26- *Physalaemus gracilis*, 27- *P. cuvieri*, 28- *P. lateristriga*, 29- *Leptodactylus labyrinthicus*, 30- *L. latrans*, 31- *L. mystacinus*, 32- *Elachistocleis bicolor*.

The anurofauna corresponded to 21.05% of the recorded species for the Cerrado (Valdujo *et al.* 2012) and 9.58% of the species found in the Atlantic Forest (Haddad *et al.* 2013). There are at least 18 (42.85%) species shared with Cerrado and Atlantic Forest (e.g. *Rhinella schneideri*, *Hypsiboas albopunctatus*, *Scinax fuscovarius* and *Leptodactylus fuscus*), which reinforces the transitional nature of the sampled area. This richness also represents 30.98% of anurans registered for the Paraná State (Conte *et al.* 2010), which is higher than that observed for other areas of the state (Conte and Rossa-Feres 2006, 34 species; Armstrong and Conte 2010, 32 species; Cunha *et al*. 2010, 32 species). Moreover, this study adds nine new species for the region (*D. elianae*, *Hypsiboas caingua*, *Physalaemus marmoratus*, *P. nattereri*, *Scinax aromothyella*, *S. fuscomarginatus*, *S. uruguayus*, *S.* cf. *similis* and *S.* cf. *granulatus*), extending their distribution to the Paraná State.

In general, the species sampled in this study occur in more than one biome (*e.g.* Cerrado, Atlantic Forest *sensu*

lato and Pampa), or even in neighbouring countries (Frost 2014). Among the recorded species, 54.8% (n = 23) are considered marginal, occurring in environments of transition between the Cerrado and other biomes, and 45.2% (n=19) are considered typical of the Cerrado (Valdujo *et al.* 2012). *Hypsiboas jaguariaivensis* is the only species endemic to the region, with restricted distribution to remnant of ''cerrado'' vegetation in Campos Gerais (Caramaschi *et al.* 2010). Six species (14.28%) presented taxonomic difficulties. The taxonomic problem is mainly due to difficulty in identifying the tadpoles, since many species have not yet had their larval stages described (Provete *et al.* 2012). Furthermore, larvae exhibit great morphological variation, and their body shape may change according to the environment they occupy (Michel 2011).

Most of the recorded species breed in open areas (*e.g. Hypsiboas albopunctatus*, *Leptodactylus fuscus*, *Physalaemus cuvieri*, *Rhinella schneideri* and *Scinax fuscovarius*), successfully colonising disturbed environments. These species do not have great specificity of breeding sites, and may be considered habitat-generalists (Brasileiro *et al.* 2005; Silva and Rossa-Feres 2007). Nevertheless, species such as *Aplastodiscus albosignatus*, *Scinax rizibilis*, *Scinax* cf. *catharinae* and *Physalaemus lateristriga* may demonstrate specificity of habitats, occurring only in forest areas (or forest edge), as previously reported in other studies (Bernarde and Machado 2001; Conte and Rossa-Feres 2007; Moraes *et al*. 2007). The occurrence of species in open areas in forests and forest edges reinforces the idea that the forest edge is a transition zone, where habitat generalists or specialists may eventually be found (Silva and Rossa-Feres 2007).

Although it was not tested, the high diversity of anurans recorded can be explained by the high environmental heterogeneity that has arisen from the mosaic of environments in the region (Silva *et al*. 2012; Melo *et al*. 2013), which is formed by different Cerrado physiognomies, Campos Sulinos, Subtropical Ombrophilous Forest and Seasonal Semidecidual Forest (Carmo *et al*. 2012; Moro 2012). Considering the large number of threatened species among amphibians in the Cerrado and the Atlantic Forest, it is imperative to create strategies and mechanisms that maximise conservation efforts, especially in regions where few data on the diversity, abundance and distribution of the species are available (Young *et al*. 2001; Diniz-Filho *et al.* 2009). In agreement to the report of Diniz-Filho *et al.* (2005), there are still many poorly sampled regions, mainly in the Cerrado, which suggests an underestimated number of frog species recorded to date.

Due to its ecological uniqueness, especially regarding the mosaic formed when forest and field intertwine, along with the low representativeness of protected areas, anthropogenic pressures imposed by colonisation and agricultural activities, the Campos Gerais are one of the most threatened ecosystems in Brazil (Rocha 2006). Thus, the importance and immediacy in the development of studies on the fauna of this region are evident considering that the anurofauna of the Paraná State is still poorly known (Rossa-Feres and Conte 2006; Rossa-Feres and Conte 2007; Conte *et al.* 2010). Studies in different types of environments favour the expansion of distribution of some taxa and discovery of new species (Caramaschi *et al.* 2010; Pombal *et al.* 2011), as well as understanding regional patterns of species richness (Valdujo *et al.* 2011). This work increases our knowledge about the species that may occur in marginal regions or remnants of Cerrado and ecotone regions with the Atlantic Forest in the Campos Gerais.

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Appendix 1. Voucher adults: *Hypsiboas prasinus*: ZFUG-7293; ZUFG-7303; ZUFG-7313; ZUFG-7319. *Dendropsophus minutus*: ZUFG-7294; ZUFG-7297; ZUFG-7298; ZUFG-7304; ZUFG-7305. *Phyllomedusa tetraploidea*: ZUFG-7295; ZUFG-7296; ZUFG-7314; ZUFG-7315; ZUFG-7557. *Hypsiboas caingua*: ZUFG-7299; ZUFG-7300; ZUFG-7301; ZUFG-7302. *Hypsiboas bischoffi*: ZUFG-7306; ZUFG-7309; ZUFG-7310; ZUFG-7538; ZUFG-7561. *Hypsiboas faber*: ZUFG-7529. *Hypsiboas albopunctatus:* ZUFG-7555. *Shaenorhynchus cf. surdus*: ZUFG-7307; ZUFG-7308; ZUFG-7320; ZUFG-7535; ZUFG-7536. *Leptodactylus* cf. *latrans:* ZUFG-7312. *Leptodactylus labyrinthicus:* ZUFG-7531. *Scinax squalirostris*: ZUFG-7316; ZUFG-7513. *Scinax uruguayus*: ZUFG-7577; ZUFG-7579. *Physalaemus cuvieri*: ZUFG-7321; ZUFG-7510; ZUFG-7511; ZUFG-7512. *Physalaemus lateristriga:* ZUFG-7526. *Physalaemus gracilis:* ZUFG-7528; ZUFG-7541; ZUFG-7548; ZUFG-7549; ZUFG-7551. *Leptodactylus gracilis*: ZUFG-7514. *Odonthoprynus americanus*: ZUFG-7322. *Dendropsophus sanborni:* ZUFG-7323; ZUFG-7324; ZUFG-7325; ZUFG-7326; ZUFG-7546. *Hypsiboas jaguariaivensis*: ZUFG-7327; ZUFG-7328; ZUFG-7329; ZUFG-7330; ZUFG-7331. *Scinax sp. (gr. ruber):* ZUFG-7332; ZUFG-7333; ZUFG-7580; ZUFG-7581; ZUFG-7582. *Scinax* cf. *catharinae:* ZUFG-7587; ZUFG-7588. *Scinax fuscovarius*: ZUFG-7506. *Rhinella abei*: ZUFG-7509. *Rhinella icterica*: ZUFG-7563; ZUFG-7564. *Proceratophrys boiei:* ZUFG-7562; ZUFG-7569. *Aplastodiscus albosignatus*: ZUFG-7516; ZUFG-7517; ZUFG-7543; ZUFG-7544; ZUFG-7545. *Aplastodiscus perviridis*: ZUFG-7533; ZUFG-7539; ZUFG-7554; ZUFG-7556. *Scinax fuscomarginatus*: ZUFG-7521. *Elachistocleis bicolor:* ZUFG-7524; ZUFG-7525.

Voucher tadpoles: *Physalaemus cuvieri*: ZUFG-1843. *Dendropsophus sanborni*: ZUFG-1844. *Dendropsophus minutus*: ZUFG-1845. *Hypsiboas faber*: ZUFG-1846. *Shaenorhynchus* cf. *surdus*: ZUFG-1847. *Elachistocleis bicolor*: ZUFG-1848. *Rhinella shneideri*: ZUFG-1849. *Hypsiboas albopunctatus*: ZUFG-1850. *Phyllomedusa tetraploidea*: ZUFG-1851. *Leptodactylus gracilis*: ZUFG-1852. *Scinax aromothyella*: ZUFG-1853. *Scinax uruguaius*: ZUFG-1854.