

Taxonomic groups with lower movement capacity may present higher beta diversity

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ABSTRACT. Diversity analysis by partition is an approach employed in order to understand how communities spatially structure themselves and the factors that operate in the generation and maintenance of distribution patterns. We examined the spatial structure of species diversity of four taxonomic groups, with different dispersal abilities, in 16 forest fragments in the southern region of the state of Minas Gerais, Brazil. Specifically, we tested: i) if the similarity in species composition would be negatively related to geographical distance between the 16 fragments; and ii) if the beta diversity of the different groups could be negatively related to their dispersal abilities. Alpha diversity and the compositional similarity between localities were both low. Beta diversity was not correlated with distance for any of the groups. Primates, followed by birds, showed a higher tendency of forming similarity groupings, although in a manner that was independent from distance between fragments, as well as showed the lowest beta diversity relative values. Spermatophytes and amphibians did not define groupings and presented the highest values of beta diversity. We interpreted such results as indications that the groups with higher dispersal ability (primates and birds) tend to reach, on average, farther localities and, therefore, to define more similar groupings (low beta diversity). The groups with lower dispersal ability (spermatophytes and amphibians) showed the opposite tendency. Although most of the species were restricted to few localities, contributing to the low similarity, beta and gamma diversity values showed the extent which the localities are, respectively, different and complementary to each other in terms of species composition. Such features reinforce and justify future conservation initiatives, both in local and regional levels.

KEYWORDS. Complementarity, dispersal ability, vertebrates, spermatophytes, Atlantic Forest.

RESUMO. Grupos taxonômicos com menor capacidade de dispersão podem apresentar maior diversidade beta. A análise da diversidade por partição é uma abordagem empregada para tentar compreender como as comunidades se estruturam espacialmente e os fatores que operam na geração e manutenção dos padrões de distribuição das espécies. Nós examinamos a estrutura espacial da diversidade de espécies referente a quatro grupos taxonômicos com diferentes capacidades de dispersão, em 16 fragmentos florestais localizados no sul do Estado de Minas Gerais, Brasil. Especificamente, testamos: i) se a similaridade na composição de espécies estaria relacionada negativamente com a distância geográfica entre os fragmentos e ii) se a diversidade beta apresentada por cada grupo poderia ser negativamente relacionada com as respectivas capacidades de dispersão. Tanto a diversidade alfa quanto a similaridade composicional entre as localidades foram baixas. A diversidade beta não esteve correlacionada com a distância para nenhum dos grupos. Os primatas, seguidos das aves, apresentaram maior tendência em formar agrupamentos de similaridade, embora de maneira independente da distância entre os fragmentos, bem como os menores valores relativos de diversidade beta. Já espermatófitas e anfíbios não definiram agrupamentos e apresentaram relativamente os maiores valores de diversidade beta. Interpretamos tais resultados como indicações de que grupos com maior capacidade de dispersão (primatas e aves) tendem a alcançar, em média, localidades mais distantes e, portanto, a definir agrupamentos mais similares (i.e. baixa diversidade beta). Já os grupos com menor capacidade de dispersão (espermatófitas e anfíbios) apresentaram a tendência oposta. Apesar da maioria das espécies terem apresentado ocorrência restrita a poucas localidades, contribuindo para a baixa similaridade, as altas diversidades beta e gama demonstraram o quanto as localidades são distintas e complementares entre si em termos de composição de espécies. Tais características reforçam e justificam futuras iniciativas de conservação, tanto em âmbito local quanto regional.

PALAVRAS-CHAVE. Complementariedade, habilidade de dispersão, vertebrados, espermatófitas, Mata Atlântica.

Several factors contribute to the diversity structure in communities and such factors are usually scale-dependent and interact with ecological, evolutionary and biogeographical processes (RICKLEFS, 1987; PINEDA & HALFFTER, 2004; GARDNER *et al.*, 2009). Species diversity in an area can also be considered at different scales, and can be split into alpha, beta and gamma components (WHITTAKER, 1960, 1972). Alpha diversity corresponds to the species richness found in

a location or individual habitat (WHITTAKER, 1960), which constitutes the sampling unit that contains an assemblage or community. Beta diversity, on the other hand, describes how the species composition varies in time and/or space between habitats/units (WHITTAKER, 1960, 1972; KOLEFF *et al.*, 2003; ANDERSON *et al.*, 2010). Gamma diversity is the entire species diversity observed in an area, landscape or region that contains a certain set of sampling units (WHITTAKER,

1960; TUOMISTO, 2010).

Beta diversity thus relates the alpha to the gamma diversity (RICKLEFS, 1987; ANDERSON *et al.*, 2010), indicating how many species are shared between the habitats/units and, therefore, the degree of biotic heterogeneity of a region (WILSON & SHMIDA, 1984). Beta diversity may be positively associated with environmental heterogeneity (SOININEN *et al.*, 2007a) or be independent from it, varying only with space (HUBBEL, 2001).

Several factors may influence spatial variation in beta diversity, such as geographical, environmental, historical and evolutionary processes (SOININEN *et al.*, 2007a). Those processes normally produce an inverse relationship between similarity in species composition and geographical distance among sampling units (NEKOLA & WHITE, 1999; HUBBEL, 2001). Such relation is partially due to the spatial autocorrelation pattern of environmental variables, with closer locations tending to be more environmentally similar to each other (LEGENDRE, 1993), which, by itself, influences the composition of species communities (HARRISON *et al.*, 1992; JIMÉNEZ-VALVERDE *et al.*, 2010). Therefore, a decrease in the similarity of environmental conditions along space may result in a correspondent decrease of the similarity in species composition (STEINITZ *et al.*, 2006).

Among the biotic factors that may influence the pattern of beta diversity there are the life history of the species (SOININEN *et al.*, 2007a) and the organisms' dispersal ability (DOBROVOLSKI *et al.*, 2011). Also, taxonomic groups of organisms may be broadly categorized in a gradient according to their dispersal abilities. Thus, the decay of similarity with the increase of geographical distance would be relatively higher for taxonomic groups that show lower dispersal ability (SOININEN *et al.*, 2007b; QIAN 2009a; DOBROVOLSKI *et al.*, 2011). Spermatophytes usually have passive dispersal and depend on seed dispersal agents (e.g. TABARELLI & PERES, 2002; ALMEIDA-NETO *et al.*, 2008). Among terrestrial vertebrates, birds are the most vagile, followed by mammals, amphibians being the less mobile ones (BÖHNING-GAESE *et al.*, 1998; QIAN, 2009b; DOBROVOLSKI *et al.*, 2011; QIAN & RICKLEFS, 2012).

In disturbed landscapes, one of the factors that may influence changes in beta diversity in relation to conserved habitats also relates to different dispersal abilities. Since fragmentation generates barriers for movement, it may limit even more the dispersal ability of organisms and, thus, favor differentiation in composition among fragments (ARROYO-RODRÍGUEZ *et al.*, 2013). Following the pattern expected for undisturbed landscapes, groups with high dispersal ability would thus have bigger chances of (re)colonizing neighbor habitats, keeping viable populations and reducing, that way, the compositional differences between fragments, the opposite occurring in groups with lower movement capacities (SOININEN *et al.*, 2007a).

In this study we analyzed the beta diversity variation of four groups with different dispersal abilities (spermatophytes, amphibians, birds and primates) in a region of the Atlantic Forest hotspot (MYERS *et al.*, 2000), a highly fragmented

biome. Specifically, our aims were: 1- to evaluate the relative contributions of alpha and beta diversities to the gamma diversity; 2- to test if there is higher similarity between closer localities than between farther ones due to spatial autocorrelation (LEGENDRE, 1993; JIMÉNEZ-VALVERDE *et al.*, 2010), especially regarding groups with relatively higher dispersal ability (birds and primates) (BUCKLEY & JETZ, 2008; QIAN & RICKLEFS, 2012); and 3- to test whether beta diversity is higher in groups with lower dispersal capacity. A better understanding of these issues will allow taking more scientifically sound decisions for the management and conservation of these fragments, especially in a biome as threatened as the Atlantic Rainforest (PINTO *et al.*, 2006). For example, understanding the contribution of the complementarity (beta diversity) to the gamma diversity within a landscape is important to the SLOSS debate and to where we should aim our conservation efforts (MARGULES & PRESSEY, 2000). In addition, understanding the influence of the dispersal capacity on the beta diversity may help us to take management decisions fine-tuned to specific issues of the different groups.

MATERIAL AND METHODS

Study sites. We conducted rapid surveys of spermatophytes, birds, amphibians and primates in 16 forest fragments in the southern region of the state of Minas Gerais, Brazil (Fig. 1, Tab. I), covering an area of about 65,000 km², during the summers of 2010 and 2011. Most of the fragments are located in areas listed as priorities for conservation (*sensu* DRUMMOND *et al.*, 2005, see green areas on the map). We employed a rapid survey approach, sampling each fragment once during two consecutive days (e.g. HERZOG *et al.*, 2002; YOUNG *et al.*, 2003; PENTER *et al.*, 2008).

Sampling. We recorded the occurrence of species using complementary methods, which increases the chances of sampling a greater number of species in a short period of time (SILVEIRA *et al.*, 2010).

For spermatophytes, we used the quadrant point's method (COTTAM & CURTIS, 1956), sampling 20 points on each fragment. The points were placed roughly 20 m apart from each other along a 400m transect in the central region of the fragment. In each point, we recorded the closest four individuals with diameter at breast height (DBH) \geq 3 cm. We identified the plants through comparisons with herbarium specimens and consultations with specialists and the specialized literature. We deposited the exsiccates in the herbarium of the Universidade Federal de Alfenas (UALF). Species nomenclature followed APG III (ANGIOSPERM PHYLOGENY GROUP, 2009).

For amphibians, we employed visual and audio surveys (CRUMP & SCOTT JR., 1994) during a fixed time period (between 19h00 min and 00h00 min). The search for individuals was directed to breeding sites, especially water bodies (SCOTT JR. & WOODWARD, 1994), as well as leaf litter and vegetation along trails and transects made to access the breeding sites. The sampling effort was 20 hours-

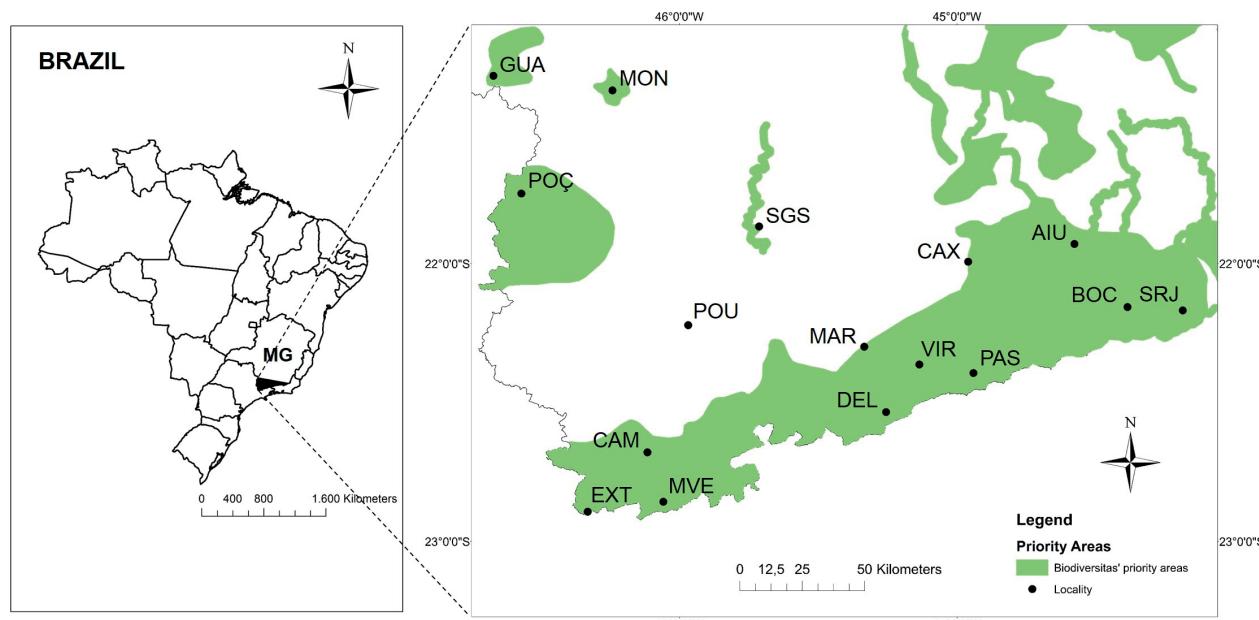


Fig. 1. Location of the 16 fragments sampled in Minas Gerais, Brazil (LOCALITY, municipality): AIU, Aiuruoca; BOC, Bocaina de Minas; CAM, Camanducaia; CAX, Caxambu; DEL, Delfim Moreira; EXT, Extrema; GUA, Guaxupé; MAR, Maria da Fé; MON, Monte Belo; MVE, Monte Verde; PAS, Passa Quatro; POC, Poços de Caldas; POU, Pouso Alegre; SGS, São Gonçalo do Sapucaí; SRJ, Santa Rita de Jacutinga and VIR, Virgínia.

Tab. I. Main characteristics of the 16 fragments sampled in Minas Gerais, Brazil (biome; geographic coordinates; area; altitude) and respective sampling period (month and year) (AIU, Aiuruoca; BOC, Bocaina de Minas; CAM, Camanducaia; CAX, Caxambu; DEL, Delfim Moreira; EXT, Extrema; GUA, Guaxupé; MAR, Maria da Fé; MON, Monte Belo; MVE, Monte Verde; PAS, Passa Quatro; POC, Poços de Caldas; POU, Pouso Alegre; SGS, São Gonçalo do Sapucaí; SRJ, Santa Rita de Jacutinga; VIR, Virgínia).

Locality	Biome	Coordinates	Area (ha)	Altitude (m)	Month/Year
AIU	SSF	21°55'46"S, 44°34'54"W	225	1056	Feb./2011
BOC	OF	22°09'22"S, 44°22'57"W	41	1263	Feb./2011
CAM	SSF	22°40'50"S, 46°06'55"W	72	1132	Dec./2010
CAX	SSF	21°59'39"S, 44°57'46"W	176	1037	Jan./2011
DEL	OF	22°31'32"S, 45°14'07"W	1591	1372	Dec./2010
EXT	OF	22°53'41"S, 46°19'25"W	4112	1539	Dec./2010
GUA	SSF	21°20'06"S, 46°39'54"W	763	1012	Feb./2010
MAR	SSF	22°16'28"S, 45°22'25"W	192	1566	Jan./2011
MVE	OF	22°52'08"S, 45°58'13"W	7143	1585	Dec./2010
MON	SSF	21°22'07"S, 46°16'44"W	525	865	Feb./2010
PAS	OF	22°23'30"S, 44°56'28"W	459	1114	Jan./2011
POC	SSF	21°54'17"S, 46°32'15"W	36	1427	Feb./2010
POU	SSF	22°13'21"S, 45°58'02"W	358	907	Dec./2010
SGS	SSF	21°52'40"S, 45°36'40"W	25	1016	Feb./2010
SRJ	OF	22°10'02"S, 44°10'59"W	438	719	Feb./2011
VIR	OF	22°19'16"S, 45°09'45"W	2083	1650	Jan./2011

man per locality. Some voucher specimens (AURICCHIO & SALOMÃO, 2002) were deposited in the Coleção Herpetológica Alfred Russel Wallace (CHARW) of Universidade Federal de Alfenas (IBAMA license #10704-1).

For birds, we employed the capture of understory species with mist nets (12 m x 2.5 m x 31 mm mesh) (DEVELEY, 2003). We installed ten nets in a row along a 150 m transect inside the forest, at least 50 m distant from the edge. The nets remained opened between 07h00 min and 17h00 min, totaling 200 net-hours effort per location. Each captured individual was identified and subsequently released (IBAMA license #22020-1).

For the primate surveys, we employed a couple of different approaches. To attempt detecting the buffy-tufted-

ear marmosets, *Callithrix aurita* (E. Geoffroy in Humboldt, 1812), the black-fronted titi monkeys, *Callicebus nigrifrons* (Spix, 1823), and the brown tufted capuchin monkeys, *Sapajus nigritus* Goldfuss, 1809, we used playbacks. We selected long-range, high amplitude calls, which are proposed to function either in inter-group communication (marmoset long calls and titi monkey duets) or to maintain contact between group members (capuchin monkey whistles). We reproduced the same calls throughout the study, both within the forest and/or at the borders. Inside the fragments we played the calls up to four times at different directions in each sampling point, so as to attempt covering a 360° radius around it. In contrast, we reproduced calls in two directions at the forest borders (each 45° from the edge line). Playbacks

for a given species were ended as soon as a response was obtained. Some occurrences were also recorded through direct visual and auditory contact (ROSALES-MEDA, 2007). In addition, we interviewed landowners and residents near the fragments about the occurrence of species (WATERS & ULLOA, 2007). This procedure was necessary to verify the occurrence of *Alouatta guariba clamitans* Cabrera, 1940, which usually do not respond well to playbacks. Also, marmosets and capuchins are less responsive to playbacks than titi monkeys, and are more likely not to respond, even if present. If the respondent mentioned the occurrence of marmosets, we only included these data if we could locate and identify the species, given the occurrence of an exotic species of the genus, *Callithrix penicillata* (E. Geoffroy, 1812), in the region. The fragment was excluded from further analysis if we could not correctly identify the species. In Pouso Alegre and Passa Quatro localities, we also obtained information regarding the presence of primates through management plans of the protected areas we surveyed. Given the lower richness of this group, we did not restrict ourselves to the two-day sampling scheme. When we had indications that a species might occur in a locality (e.g. through interviews), but were unsure about it (for example of which marmoset species it were, or due to conflicting or apparently inaccurate reports), we returned to the fragments in other occasions in a further attempt to confirm the findings. Whenever in doubt, we did not consider a species as occurring in a fragment.

Data analysis. Herein we considered gamma diversity (γ) as the total number of registered species in the 16 fragments sampled (regional richness, but see TUOMISTO, 2010). We considered alpha diversity (α) to be the number of species in each fragment (local richness). Last, we defined beta diversity (β) as the non-directional variation on species composition between the fragments (*sensu* ANDERSON *et al.*, 2010). We calculated beta diversity in two ways, using three different measures (β_w ; β_{add} ; β_c):

(1) Variation on the number of species among the localities: here we used both multiplicative beta diversity (β_w) (WHITTAKER, 1960) and additive beta diversity (β_{add}) (LANDE, 1996; CRIST & VEECH, 2006) measures. The multiplicative beta diversity is given by the formula [$\beta_w = \gamma / \alpha_{mean}$], where γ is the total number of species for the region and α_{mean} is the average number of species of the 16 fragments. β_w thus indicates “the number of times by which the richness in a region is greater than the average richness in the smaller-scale units” (ANDERSON *et al.*, 2010). On the other hand, the additive beta diversity is given by the formula [$\beta_{add} = \gamma - \alpha_{mean}$] and it informs the average number of species that are not shared among all the sampling units (ANDERSON *et al.*, 2010).

(2) Variation on the species composition between localities: beta diversity as a measure of complementarity (β_c). Through paired comparison of species between localities, the proportion of species that occur in only one of those localities is evaluated in relation to the total number species of both localities (COLWELL & CODDINGTON, 1994). The beta diversity values, in this case, are represented by the

inverse of the similarity indexes of species’ values (see next paragraph), that is, [$\beta_c = 1 - C_j$], where C_j is the similarity index value (KREBS, 1999). Thereby, pairs of locations with low similarity in species composition show high beta diversity, and vice versa. Complementarity values vary from zero (identical species composition between two localities) to 1 (completely different species composition between two localities) (COLWELL & CODDINGTON, 1994). We considered the values of average complementarity as significant if β_c was ≥ 0.5 (50%) (VASCONCELOS *et al.*, 2011).

Similarity in species composition was quantified both for each taxonomic group and for the four groups combined through grouping or cluster analysis (UPGMA) and computation of the Jaccard’s similarity index (C_j) (MAGURRAN, 1988), which determines the proportion of species shared between each pair of localities. We considered as a grouping every pair or group of localities showing $C_j \geq 0.5$. To verify if there was any correlation between species composition similarity and geodesic geographical distance between the localities, we applied the Mantel test (LEGENDRE & LEGENDRE, 2012), whose r values may vary from -1 (strong negative correlation) to +1 (strong positive correlation), zero meaning absence of correlation. The tests were carried out in the program R, version 3.0.1. (R DEVELOPMENT CORE TEAM, 2013).

Last, to classify the species according to the frequency of occurrence in the 16 localities, we used the following categories (adapted from DAJOZ, 1983): “frequent” (species with registered presence in at least nine locations); “common” (occurrence in five to eight locations); and “rare” (occurrence in four locations or less). Both the exotic species and the ones recorded by chance (i.e. outside the standardized sampling methods) were not computed on the data analysis. However, we included them in the general relation of species described in the supplementary material (Appendices 1 to 4).

RESULTS

We found 259 species of spermatophytes (Appendix 1), 45 of amphibians (Appendix 2), 66 of birds (Appendix 3) and four of primates (Appendix 4). However, local richness was usually much smaller than that (Tab. II). We also registered one exotic anuran species *Lithobates catesbeianus* (Shaw, 1802) in Delfim Moreira and one introduced primate species *Callithrix penicillata* in Guaxupé, Caxambu, Aiuruoca, Passa Quatro and Bocaina de Minas. The list of all species we recorded, as well as their distributions along the 16 fragments and respective frequency of occurrence (FO) can be found in the supplementary material (Appendices 1 to 4).

Through the multiplicative beta diversity measure (β_w), we verified that there were 8.3 times more species of spermatophytes, 5.3 times more amphibians, 3.2 times more birds’ species and 1.7 times more primate species on the regional scale (γ) than in each locality (α). Through the additive beta diversity measure (β_{add}), we verified that the proportion of species that are not shared among all localities was of 228 spermatophytes, 36 amphibians, 46 birds and two

Tab. II. Local species richness (alpha diversity) of spermatophytes, amphibians, birds, primates and all the groups found in the 16 fragments sampled in Minas Gerais, Brazil (AIU, Aiuruoca; BOC, Bocaina de Minas; CAM, Camanducaia; CAX, Caxambu; DEL, Delfim Moreira; EXT, Extrema; GUA, Guaxupé; MAR, Maria da Fé; MON, Monte Belo; MVE, Monte Verde; PAS, Passa Quatro; POÇ, Poços de Caldas; POU, Pouso Alegre; SGS, São Gonçalo do Sapucaí; SRJ, Santa Rita de Jacutinga; VIR, Virgínia).

Locality	Spermatophytes	Amphibians	Birds	Primates	All
AIU	38	7	23	2	70
BOC	29	9	13	2	54
CAM	34	6	13	1	54
CAX	34	10	14	3	61
DEL	35	15	22	3	75
EXT	39	9	22	3	73
GUA	27	6	26	2	61
MON	23	8	21	2	54
MAR	22	9	21	2	54
MVE	31	9	19	2	61
PAS	26	10	23	3	62
POÇ	37	8	23	2	70
POU	28	5	29	4	66
SGS	27	3	20	1	51
SRJ	31	11	19	3	64
VIR	36	9	16	2	63
mean±sd	31.1±5.3	8.4±2.7	20.3±4.5	2.3±0.8	62.1±7.4

primate species. The distinction between species composition (β_c) between pairs of locations was, on average, significant for spermatophytes (0.92; range: 0.75-1), amphibians (0.83; range: 0.47-1), birds (0.68; range: 0.42-0.91) and all the groups together (0.83; range: 0.69-0.93), but not for primates (0.47; range: 0-0.75).

As for the frequency of occurrence within the set of fragments, most of the species (84.4%) were “rare” when we consider the four groups combined, occurring in only one, two, three or four localities. The same pattern was observed for spermatophytes (93.8%), amphibians (77.3%) and birds (57.6%), but not for primates (0%) (Fig. 2).

When we analyzed the species composition similarity, there was no grouping between localities regarding spermatophytes (Fig. 3). As for the amphibians (Fig. 4), there was only the MAR-DEL grouping, with both localities

showing the same type of phytobiognomy (ombrophilous forest), but located 117 km apart from each other (Fig. 1). In birds, four groupings of similarity were formed (Fig. 5). The localities from the groupings POU-MAR and MON-GUA showed the same phytobiognomy (seasonal semideciduous forest) and are relatively close to each other (61 and 40 km, respectively). However, the localities of the groupings EXT-SRJ and MVE-DEL, though presenting the same phytobiognomy of ombrophilous forest, are distant from each other 235 and 90 km, respectively. The primates grouping (Fig. 6) was the only one with high composition similarity, forming six locality groupings, with all of them showing the same phytobiognomy between the fragments

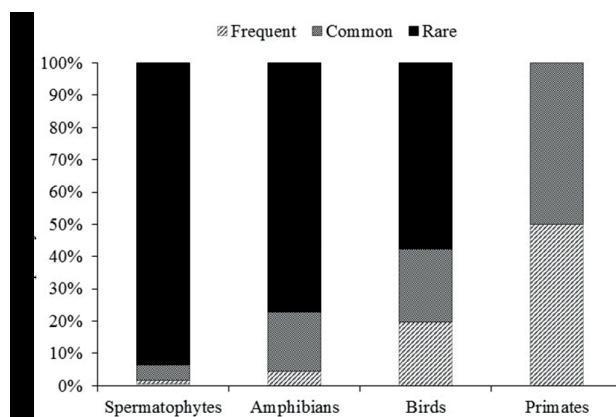


Fig. 2. Frequency of occurrence of spermatophytes (n=259), amphibians (n=44), birds (n=66) and primates (n=4) species in the 16 localities sampled in Minas Gerais, Brazil. Frequent (species with registered presence between nine and 16 locations); common (between five and eight localities); and rare (between one and four localities).

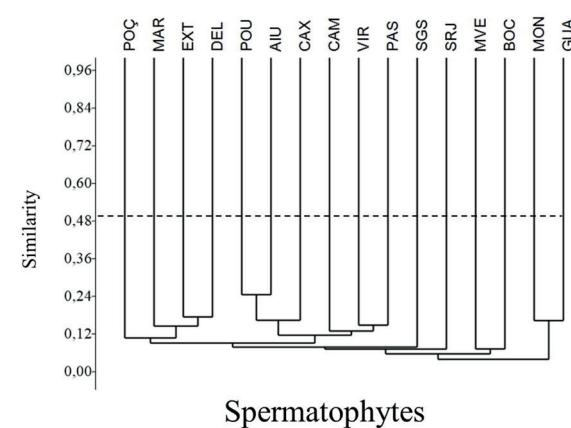
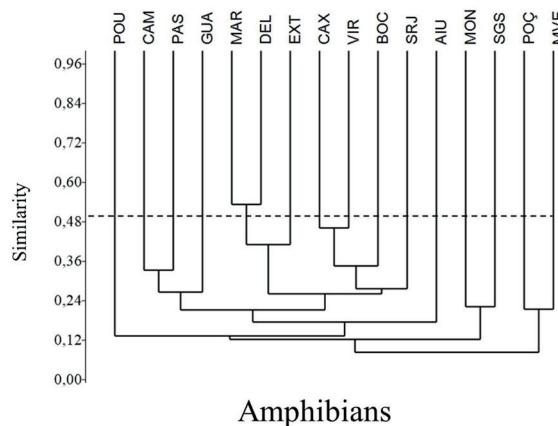


Fig. 3. Similarity in species composition of spermatophytes among the 16 localities sampled in Minas Gerais, Brazil, based on the Jaccard coefficient of similarity and subsequent cluster analysis (UPGMA). Obs.: dashed line (significance level: 0.5 or 50%) (AIU, Aiuruoca; BOC, Bocaina de Minas; CAM, Camanducaia; CAX, Caxambu; DEL, Delfim Moreira; EXT, Extrema; GUA, Guaxupé; MAR, Maria da Fé; MON, Monte Belo; MVE, Monte Verde; PAS, Passa Quatro; POÇ, Poços de Caldas; POU, Pouso Alegre; SGS, São Gonçalo do Sapucaí; SRJ, Santa Rita de Jacutinga; VIR, Virgínia).

of each grouping, independently from geographical distance. The only grouping common to birds and primates was MON-GUA. We did not find any grouping when we analyzed the four groups simultaneously (Fig. 7). Finally, we did not find any relation between species composition and geographical distance between localities for any of the groups through the Mantel test: spermatophytes ($r = 0.03$, $p = 0.35$), amphibians ($r = -0.01$, $p = 0.5$), birds ($r = -0.006$, $p = 0.49$), primates ($r = 0.14$, $p = 0.072$), and all the four groups together ($r = 0.01$, $p = 0.45$).

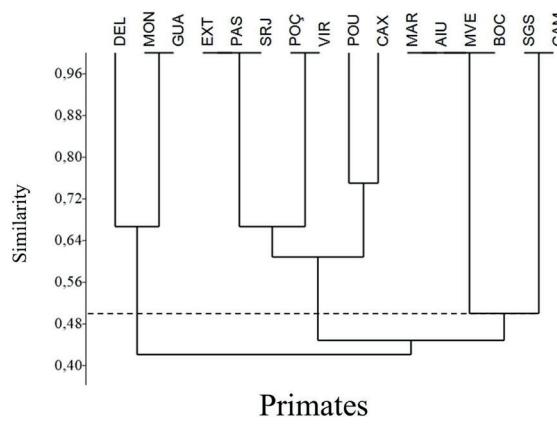
DISCUSSION

Beta diversity showed no correlation with geographic distance. Primates, followed by birds, presented a greater tendency to form location groups with species compositions more alike between themselves, though in a way that was independent from geographic distance, as well as showed the lower beta diversity values. On the other hand, spermatophytes and amphibians did not define such groupings and showed the highest values of beta diversity. We interpreted those



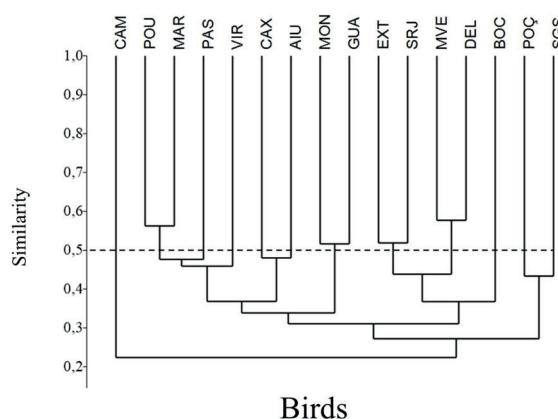
Amphibians

Fig. 4. Similarity in species composition of amphibians among the 16 localities sampled in Minas Gerais, Brazil, based on the Jaccard coefficient of similarity and subsequent cluster analysis (UPGMA). Obs.: dashed line (significance level: 0.5 or 50%) (AIU, Aiuruoca; BOC, Bocaina de Minas; CAM, Camanducaia; CAX, Caxambu; DEL, Delfim Moreira; EXT, Extrema; GUA, Guaxupé; MAR, Maria da Fé; MON, Monte Belo; MVE, Monte Verde; PAS, Passa Quatro; POÇ, Poços de Caldas; POU, Pouso Alegre; SGS, São Gonçalo do Sapucaí; SRJ, Santa Rita de Jacutinga; VIR, Virgínia).



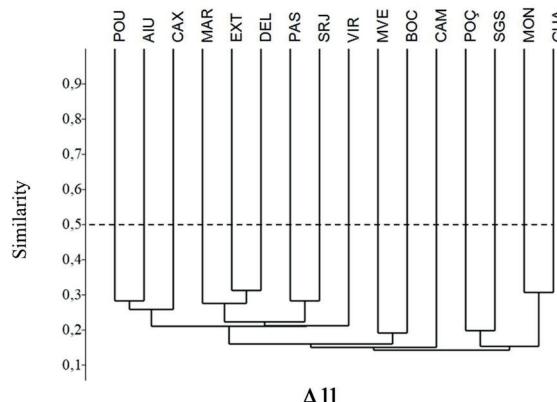
Primates

Fig. 6. Similarity in species composition of primates among the 16 localities sampled in Minas Gerais, Brazil, based on the Jaccard coefficient of similarity and subsequent cluster analysis (UPGMA). Obs.: dashed line (significance level: 0.5 or 50%) (AIU, Aiuruoca; BOC, Bocaina de Minas; CAM, Camanducaia; CAX, Caxambu; DEL, Delfim Moreira; EXT, Extrema; GUA, Guaxupé; MAR, Maria da Fé; MON, Monte Belo; MVE, Monte Verde; PAS, Passa Quatro; POÇ, Poços de Caldas; POU, Pouso Alegre; SGS, São Gonçalo do Sapucaí; SRJ, Santa Rita de Jacutinga; VIR, Virgínia).



Birds

Fig. 5. Similarity in species composition of birds among the 16 localities sampled in Minas Gerais, Brazil, based on the Jaccard coefficient of similarity and subsequent cluster analysis (UPGMA). Obs.: dashed line (significance level: 0.5 or 50%) (AIU, Aiuruoca; BOC, Bocaina de Minas; CAM, Camanducaia; CAX, Caxambu; DEL, Delfim Moreira; EXT, Extrema; GUA, Guaxupé; MAR, Maria da Fé; MON, Monte Belo; MVE, Monte Verde; PAS, Passa Quatro; POÇ, Poços de Caldas; POU, Pouso Alegre; SGS, São Gonçalo do Sapucaí; SRJ, Santa Rita de Jacutinga; VIR, Virgínia).



All

Fig. 7. Similarity in species composition of all the groups combined among the 16 localities sampled in Minas Gerais, Brazil, based on the Jaccard coefficient of similarity and subsequent cluster analysis (UPGMA). Obs.: dashed line (significance level: 0.5 or 50%) (AIU, Aiuruoca; BOC, Bocaina de Minas; CAM, Camanducaia; CAX, Caxambu; DEL, Delfim Moreira; EXT, Extrema; GUA, Guaxupé; MAR, Maria da Fé; MON, Monte Belo; MVE, Monte Verde; PAS, Passa Quatro; POÇ, Poços de Caldas; POU, Pouso Alegre; SGS, São Gonçalo do Sapucaí; SRJ, Santa Rita de Jacutinga; VIR, Virgínia).

results as indications that the groups with higher dispersal ability (primates and birds) reached, in average, more distant locations and tend, therefore, to define locality groups with more similar compositions (i.e. low beta diversity). In less vagile groups (spermatophytes and amphibians), the low dispersal ability does not favor them in occupying nearest locations, even if the ecological conditions allow; such groups, thus, present the reverse tendency of not forming locality groups with similar compositions (i.e. high beta diversity).

Primates, moreover, were the only group in which there were no species with “rare” frequency of occurrence, probably due to the low regional richness of only four species. This may have increased the probability of generating locality groupings with similar compositions by chance alone. By excluding this group, because of its exceedingly low species number, it is possible to conclude that beta diversity, be it of spermatophytes, amphibians, birds or all these groups together, exerted a greater influence on regional diversity (gamma) than local species richness (alpha) (PINEDA & HALFFTER, 2004).

The absence of correlation between the similarity in species composition and the geographical distance and groupings of localities with similar compositions, independent from geographical distance, in birds and primates, suggests that other factors might be necessary to explain the variation on the species composition of each group along the space. Accordingly, several studies have demonstrated a host of different factors that may influence variation of species composition through space: (1) spatial and environmental gradients (e.g. CLARK *et al.*, 1999; NEKOLA & WHITE, 1999; OLIVEIRA-FILHO & FONTES, 2000; CARNEIRO & VALERIANO, 2003; STEINITZ *et al.*, 2006, 2007b; LEGENDRE *et al.*, 2009); (2) differences in the physiology, in the degree of biological interactions and in the dispersal ability of the species (NEKOLA & WHITE, 1999; TUOMISTO *et al.*, 2003; GILBERT & LECHOWICZ, 2004); (3) barriers imposed by the configuration of the landscape and the influence of weather on species’ dispersion (NEKOLA & WHITE, 1999; HUBBEL, 2001); (4) stochastic processes generated randomly and independently of environmental dissimilarities (Neutral Theory *sensu* HUBBEL, 2001; SOININEN *et al.*, 2007b; STEINBAUER *et al.*, 2012); (5) species’ tolerance to fragmentation (ARROYO-RODRÍGUEZ *et al.*, 2013); (6) spatial scale (extension, resolution; NEKOLA & WHITE, 1999; STEINITZ *et al.*, 2006; SOININEN *et al.*, 2007b; ARROYO-RODRÍGUEZ *et al.*, 2013). Therefore, more accurate analysis involving other variables could yield further explanations regarding the spatial distribution observed in this study.

Although our results support the relationship between dispersal ability and beta diversity, there are some controversial results in the literature (MCKNIGHT *et al.*, 2007). SOININEN *et al.* (2007a), for example, when comparing different trophic levels, showed that autotrophs have smaller beta diversity than omnivores and carnivores. This particular result was very different from ours, since the spermatophytes from our study showed a higher average

beta diversity value than all other groups, constituted by animals. A possible explanation for these differences can be found in the suggestions by the same authors (SOININEN *et al.*, 2007a): beta diversity is something very complex and influenced by extrinsic (e.g. landscape structure and environmental variations) and intrinsic factors (e.g. peculiar features of the organisms).

On the other hand, QIAN (2009a) and ARROYO-RODRÍGUEZ *et al.* (2013), both working with plants, showed results that were similar to those we found here, that is, high negative correlation between the dispersal ability and the beta diversity. According to ARROYO-RODRÍGUEZ *et al.* (2013), increasing the distance between forest fragments leads to communities with very specific compositions (i.e. high beta diversity), given seed dispersal is limited. Such parallel may indicate a potential problem for the landscapes in southern Minas Gerais, given its high degree of fragmentation, which may lead in the future to local extinctions.

Amphibians showed a very similar result to the spermatophytes, only with slightly lower beta diversity values and much smaller gamma diversity (regional). The high beta diversity of the group can be explained by two factors. First we have amphibians strict environmental requirements (DUELLMAN & TRUEB, 1994; WERNER *et al.*, 2007; BUCKLEY & JETZ, 2008), especially their need for both water (for reproduction), and higher temperatures, due to ectothermy (BUCKLEY & JETZ, 2008; QIAN, 2009b). Since the studied fragments vary in terms of water availability and altitude (thus temperature), the environmental requirements for amphibians vary accordingly. Besides, amphibians are usually considered as animals with low dispersal ability (QIAN, 2009b; DOBROVOLSKI *et al.*, 2011; QIAN & RICKLEFS, 2012). When compared to mammals and birds, amphibians always show higher beta diversity (see BUCKLEY & JETZ, 2008; QIAN, 2009b; DOBROVOLSKI *et al.*, 2011; QIAN & RICKLEFS, 2012). The same was observed for reptiles, an equally ectothermic and little vagile group (see QIAN, 2009b; QIAN & RICKLEFS, 2012). Amphibians may even show turnover values four times higher than birds (BUCKLEY & JETZ, 2008). The opposite happens to the median size of the geographic distributions of these two groups. In general, birds have occurrence areas four times bigger than amphibians, a clear sign of the greater dispersal ability made possible by flight. The relationship between these patterns is so outstanding that the amphibians’ turnover has been proved to be a better predictor for the birds’ turnover than the environmental variables (BUCKLEY & JETZ, 2008).

The high percentage of spermatophytes, amphibians and birds species with “rare” occurrence in this study is a sign of the low number of species shared between the local communities, especially on the first two groups. Some of these rarities actually represent less abundant species under some degree of threat (see INTERNATIONAL UNION FOR CONSERVATION OF NATURE, 2013), and the register of their occurrence is important for conservation purposes on the respective sampled municipalities. The registers of geographical distribution expansions are equally important,

as, for example, in the case of the amphibian *Ischnocnema holti* (Cochran, 1948) in the locality of Extrema, which extended its range to about 160 km southwest of its typical locality (see DA COSTA *et al.*, 2008; TARGINO & CARVALHO-E-SILVA, 2008).

The exotic species we found deserve mention due to the negative impacts they cause. The anuran *Lithobates catesbeianus*, originally from North America, is commercially farmed as a food source. Due to negligence in their containment, they commonly end up escaping captivity and settling up populations in natural environments, where they may cause problems to the native communities (BOTH *et al.*, 2011; SILVA *et al.*, 2011). The locality in which this species was collected constitutes a new register for the state of Minas Gerais. The primate *Callithrix penicillata*, a typical species of the Cerrado biome (MIRANDA & FARIA, 2001), was deliberately introduced in Atlantic Forest environments. Worse, it is a species with high adaptability and dispersion power, causing several impacts and possibly even hybridizing with native species of this biome (STEVENSON & RYLANDS, 1988; AURICCHIO, 1995).

A potential criticism to our results relates to the rapid survey sampling scheme we have adopted here. Such sampling scheme may be regarded insufficient (LAWTON *et al.*, 1998; STEINBAUER *et al.*, 2012), a problem compounded by the different levels of detectability of each species (BOULINIER *et al.*, 1998), given that the surveys were relatively fast. However, the overall conclusion would not be affected by a longer sampling on each location. Although alpha diversity values might increase on each fragment with higher sampling efforts, beta diversity would remain high. The reason is that longer sampling allows registering species that are rarer, which, however, naturally show a patchy distribution in the landscape, particularly in a fragmented one. Therefore, our sampling scheme was sufficient to gather the data necessary to provide the basis for our conclusions.

In summary, although alpha diversity within fragments was low, we found low similarity in species composition between localities (i.e. high beta diversity values), thus resulting in a high gamma diversity. Primates were the only group with average complementarity below 50%. In addition, they presented a greater tendency (followed by birds) to form location groups with species compositions more alike between themselves, though in a way that was independent from geographic distance. Thus, the decreasing gradient of beta diversity observed [spermatophytes (92%) > amphibians (83%) > birds (68%) > primates (48%)] coupled with the results of the groupings, indicate that the taxa with higher dispersal ability (primates and birds) may have reached, in average, more distant locations and tend, therefore, to define locality groups with more similar compositions (i.e. low beta diversity).

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Appendix 1. Species of spermatophytes recorded in the 16 localities sampled in Minas Gerais, Brazil, and their respective frequency of occurrence (FO): R (Rare); C (Common); and F (Frequent) (AIU, Aiuruoca; BOC, Bocaina de Minas; CAM, Camanducaia; CAX, Caxambu; DEL, Delfim Moreira; EXT, Extrema; GUA, Guaxupé; MAR, Maria da Fé; MON, Monte Belo; MVE, Monte Verde; PAS, Passa Quatro; POÇ, Poços de Caldas; POU, Pouso Alegre; SGS, São Gonçalo do Sapucaí; SRJ, Santa Rita de Jacutinga; VIR, Virgínia).

Spermatophytes FAMILY Species	Localities														Total	FO	
	AIU	BOC	CAM	CAX	DEL	EXT	GUA	MAR	MON	MVE	PAS	POÇ	POU	SGS	SRJ	VIR	
ANARCADIACEAE																	
<i>Astronium fraxinifolium</i> Schott ex Spreng.		x					x		x							3	R
<i>Schinus terebinthifolius</i> Raddi												x				1	R
<i>Tapirira guianensis</i> Aubl.	x		x									x	x			4	R
<i>Tapirira obtusa</i> (Benth.) J.D. Mitch.	x	x	x									x				4	R
ANNONACEAE																	
<i>Annona cacans</i> (R.E. Fr.) H. Rainer		x			x											2	R
<i>Annona sericea</i> Dunal				x	x											2	R
<i>Annona</i> sp.	x		x										x			3	R
<i>Annona sylvatica</i> A. St.-Hil.	x				x		x					x				3	R
<i>Duguetia lanceolata</i> A. St.-Hil.			x													1	R
<i>Guatteria</i> sp.	x															1	R
<i>Guatteria australis</i> A. St.-Hil.				x					x		x	x	x			4	R
<i>Guatteria nigrescens</i> Mart.	x															1	R
<i>Xylopia brasiliensis</i> Spreng.			x									x				2	R
<i>Xylopia sericea</i> A. St.-Hil.												x				1	R
APOCYNACEAE																	
<i>Aspidosperma australe</i> Müll. Arg.								x				x				1	R
<i>Aspidosperma parvifolium</i> A. DC.	x	x		x		x										3	R
<i>Aspidosperma spruceanum</i> Benth. ex Müll. Arg							x					x				1	R
<i>Aspidosperma subincanum</i> Mart. ex A. DC.								x								1	R
<i>Tabernaemontana</i> sp.	x								x							1	R
AQUIFOLIACEAE																	
<i>Ilex cerasifolia</i> Loes.	x									x		x				2	R
<i>Ilex conocarpa</i> Reissek		x														1	R
<i>Ilex paraguariensis</i> A. St.-Hil.	x									x			x			2	R
<i>Ilex sapotifolia</i> Reissek	x		x													2	R
<i>Ilex theezans</i> Mart. ex Reissek	x															1	R
ARALIACEAE																	
<i>Aralia excelsa</i> (Griseb.) J. Wen					x			x								1	R
<i>Schefflera calva</i> (Cham.) Frodin & Fiaschi									x		x					1	R
<i>Schefflera</i> sp.	x															1	R
ARAUCARIACEAE																	
<i>Araucaria angustifolia</i> (Bert.) O. Kuntze						x				x						1	R
ARECACEAE																	
<i>Geonoma schottiana</i> Mart.							x				x					1	R
<i>Syagrus romanzoffiana</i> (Cham.) Glassman								x								1	R
ASTERACEAE																	
<i>Baccharis serrulata</i> (Lam.) Pers.					x			x								1	R
<i>Eremanthus erythropappus</i> (DC.) MacLeish				x								x				1	R
<i>Eremanthus</i> sp.	x															1	R
<i>Piptadenia gonoacantha</i> (Mart.) J.F. Macbr.	x										x	x				3	R
<i>Piptocarpha axillaris</i> (Less.) Baker		x														1	R
<i>Piptocarpha macropoda</i> (DC.) Baker											x					1	R
BIGNONIACEAE																	
<i>Handroanthus catarinenses</i> (A.H. Gentry) S. O. Grose					x											1	R
<i>Jacaranda puberula</i> Cham.							x				x		x			2	R

Appendix 1. Cont.

Spermatophytes FAMILY Species	Localities													Total	FO	
	AIU	BOC	CAM	CAX	DEL	EXT	GUA	MAR	MON	MVE	PAS	POC	POU	SGS	SRJ	
BORAGINACEAE																
<i>Cordia sellowiana</i> Cham.												x	1	R		
<i>Cordia</i> sp.	x											1		R		
BURSERACEAE																
<i>Protium heptaphyllum</i> (Aubl.) Marchand												x	1	R		
<i>Protium spruceanum</i> (Benth.) Engl.	x													1	R	
<i>Protium widgrenii</i> Engl.				x								x		2	R	
CARICACEAE																
<i>Jacararia spinosa</i> (Aubl.) A. DC.							x								1	R
CELASTRACEAE																
<i>Maytenus ilicifolia</i> Mart. ex Reissek										x			x		1	R
<i>Maytenus robusta</i> Reissek					x										1	R
<i>Maytenus salicifolia</i> Reissek						x									1	R
<i>Maytenus</i> sp.	x	x													2	R
CLETHRACEAE																
<i>Clethra scabra</i> Pers.										x	x				2	R
CONNARACEAE																
<i>Connarus regnelli</i> G. Schellenb.	x						x					x			3	R
DICKSONIACEAE																
<i>Dicksonia sellowiana</i> Sodiro										x					1	R
ELAEOCARPACEAE																
<i>Sloanea hirsuta</i> (Schott) Planch. ex Benth.	x			x			x				x				4	R
EUPHORBIACEAE																
<i>Alchornea castaneifolia</i> (Humb. & Bonpl. ex Willd.) A. Juss.										x					1	R
<i>Alchornea cf. triplinervia</i>	x							x		x					2	R
<i>Alchornea glandulosa</i> Poepp.		x			x					x	x				4	R
<i>Alchornea sidifolia</i> Müll. Arg.			x									x	1	R		
<i>Alchornea triplinervia</i> (Spreng.) M. Arg.	x											x	2	R		
<i>Aparisthium cordatum</i> (A.Juss.) Baill										x		x	1	R		
<i>Croton floribundus</i> Spreng.	x	x			x		x			x		x		5	C	
<i>Croton organensis</i> Baill.				x							x		x	2	R	
<i>Maprounea guianensis</i> Aubl.										x		x	1	R		
<i>Pera glabrata</i> (Schott) Poepp. ex Baill.										x		x	2	R		
<i>Sapium glandulosum</i> (L.) Morong									x			x	2	R		
<i>Sebastiania commersoniana</i> (Baill.) L.B. Sm. & Downs	x	x			x		x	x						4	R	
<i>Sebastiania serrata</i> (Baill. ex Müll. Arg.) Müll. Arg.			x											1	R	
FABACEAE																
<i>Anadenanthera</i> sp.	x													1	R	
<i>Apuleia leiocarpa</i> (Vogel) J.F. Macbr.	x	x									x		x	3	R	
<i>Bauhinia forficata</i> Link			x											1	R	
<i>Bauhinia rufa</i> (Bong.) Steud.	x													1	R	
<i>Bauhinia</i> sp.		x												1	R	
<i>Copaifera langsdorffii</i> Desf.	x		x						x		x		x	4	R	
<i>Copaifera</i> sp.										x		x	1	R		
<i>Dalbergia frutescens</i> (Vell.) Britton									x		x			1	R	
<i>Dalbergia villosa</i> (Benth.) Benth.	x	x	x	x	x	x		x	x		x	x	9	F		
<i>Dipteropis ferruginea</i> Benth.										x		x	1	R		
<i>Holocalyx balansae</i> Micheli					x		x							2	R	
<i>Hymenaea courbaril</i> L.							x							1	R	
<i>Inga vera</i> Willd.										x		x	1	R		
<i>Machaerium brasiliense</i> Vogel											x		x	1	R	
<i>Machaerium hirtum</i> (Vell.) Stellfeld										x	x			2	R	
<i>Machaerium villosum</i> Vogel	x		x	x		x			x	x		x		6	C	
<i>Myroxylon peruferum</i> L. f.								x						1	R	
<i>Ormosia fastigiata</i> Tul.					x									1	R	
<i>Platycyamus regnellii</i> Benth.	x						x		x	x	x	x		5	C	
<i>Podocarpus sellowii</i> Klotzsch ex Endl.							x		x					1	R	
<i>Pseudopiptadenia</i> sp.											x		x	1	R	
<i>Pterocarpus rohri</i> Vahl					x									1	R	
<i>Senegalia polyphylla</i> (DC.) Britton							x			x			x	1	R	

Appendix 1. Cont.

Spermatophytes FAMILY Species	Localities														Total	FO	
	AIU	BOC	CAM	CAX	DEL	EXT	GUA	MAR	MON	MVE	PAS	POÇ	POU	SGS	SRJ	VIR	
<i>Senna macranthera</i> (DC. ex Collad.) H.S. Irwin & Barneby	x															1	R
<i>Stryphnodendron polypyllum</i> Mart.												x				1	R
<i>Swartzia flaemingii</i> Raddi												x				1	R
<i>Swartzia myrtifolia</i> Sm.			x													1	R
<i>Tachigali rugosa</i> (Mart. ex Benth.) Zarucchi & Pipoly				x												1	R
<i>Vernonanthura divaricata</i> (Spreng.) H. Rob.				x												1	R
<i>Vernonanthura</i> sp.	x							x			x					3	R
HUMIRIACEAE																	
<i>Vantanea compacta</i> (Schnizl.) Cuatrec.												x				1	R
HYPERICACEAE																	
<i>Vismia guianensis</i> (Aubl.) Pers.		x														1	R
<i>Vismia magnoliifolia</i> Schltld. & Cham.												x				1	R
<i>Vismia</i> sp.										x						1	R
<i>Vitex megapotamica</i> (Spreng.) Moldenke	x									x						2	R
LACISTEMATACEAE																	
<i>Lacistema hasslerianum</i> Chodat												x				1	R
LAMIACEAE																	
<i>Vitex polygama</i> Cham.	x										x			x		3	R
LAURACEAE																	
<i>Aniba firmula</i> (Nees & Mart. ex Nees) Mez			x													1	R
<i>Aniba</i> sp.			x													1	R
<i>Cinnamomum glaziovii</i> (Mez) Kosterm.								x				x				1	R
<i>Cinnamomum triplinerve</i> (Ruiz & Pav.) Kosterm.			x													1	R
<i>Cryptocarya aschersoniana</i> Mez		x	x	x	x	x		x		x			x		7	C	
<i>Endlicheria paniculata</i> (Spreng.) J.F. Macbr.		x		x					x	x					3	R	
<i>Endlicheria verticillata</i> Mez	x															1	R
Lauraceae sp. 1							x			x						1	R
<i>Nectandra oppositifolia</i> Nees & Mart.	x			x		x		x	x	x	x	x	x		7	C	
<i>Ocotea aciphylla</i> (Nees & Mart.) Mez		x												x		1	R
<i>Ocotea brachybotrya</i> (Meisn.) Mez				x												1	R
<i>Ocotea corymbosa</i> (Meisn.) Mez	x	x	x	x								x			4	R	
<i>Ocotea diospyrifolia</i> (Meisn.) Mez					x	x										2	R
<i>Ocotea divaricata</i> (Nees) Mez		x		x						x		x			x	3	R
<i>Ocotea minarum</i> (Nees & Mart.) Mez				x					x		x					2	R
<i>Ocotea odorifera</i> Rohwer			x							x		x				2	R
<i>Ocotea</i> sp.	x															1	R
<i>Persea rufotomentosa</i> Nees & C. Mart.												x				1	R
MALVACEAE																	
<i>Ceiba speciosa</i> (A. St.-Hil.) Ravenna								x			x				x	1	R
<i>Luehea candidans</i> Mart.							x									1	R
<i>Luehea grandiflora</i> Mart.											x				x	1	R
MELASTOMATACEAE																	
<i>Leandra scabra</i> DC.	x					x		x								2	R
<i>Leandra</i> sp.		x			x		x	x			x				x	3	R
<i>Miconia castaneifolia</i> Naudin			x	x												2	R
<i>Miconia cf. petropolitana</i> Cogn.									x							1	R
<i>Miconia chartacea</i> Triana	x		x	x	x	x	x									4	R
<i>Miconia cinerascens</i> Miq.								x								1	R
<i>Miconia cinnamomifolia</i> (DC.) Naudin	x	x								x	x	x	x	x		5	C
<i>Miconia latecrenata</i> (DC.) Naudin									x							1	R
<i>Miconia pusilliflora</i> (DC.) Naudin				x					x							2	R
<i>Miconia sellowiana</i> Naudin					x		x	x				x			x	3	R
<i>Miconia</i> sp	x		x	x	x	x	x	x		x				x		6	C
<i>Miconia tristes</i> Spring		x														1	R
<i>Miconia urophylla</i> DC.		x										x			x	2	R
<i>Miconia willdenowii</i> Klotzsch ex Naudin				x												1	R
<i>Tibouchina estrellensis</i> (Raddi) Cogn.					x				x		x				x	2	R
<i>Tibouchina fissinervia</i> Cogn.												x			x	1	R
<i>Tibouchina fothergillae</i> (DC.) Cogn.				x												1	R
<i>Tibouchina granulosa</i> (Desr.) Cogn.			x													1	R

Appendix 1. Cont.

Spermatophytes FAMILY Species	Localities														Total	FO		
	AIU	BOC	CAM	CAX	DEL	EXT	GUA	MAR	MON	MVE	PAS	POC	POU	SGS	SRJ	VIR		
<i>Tibouchina</i> sp.						x											1	R
MELIACEAE																		
<i>Cabralea canjerana</i> (Vell.) Mart.	x	x		x							x	x					5	C
<i>Guarea kunthiana</i> A. Juss.											x						1	R
<i>Trichilia catiguá</i> A. Juss.	x						x	x									3	R
<i>Trichilia clausenii</i> C. DC.							x	x									2	R
<i>Trichilia elegans</i> A. Juss.							x	x									2	R
<i>Trichilia pallida</i> Sw.							x				x						2	R
MONIMINIACEAE																		
<i>Macropelus dentatus</i> (Perkins) I. Santos & Peixoto	x																1	R
<i>Mollinedia argyrogyna</i> Perkins								x			x						2	R
<i>Mollinedia</i> sp.	x																1	R
<i>Mollinedia widgrenii</i> A. DC.											x						1	R
MORACEAE																		
<i>Ficus enormis</i> (Mart. ex Miq.) Mart.								x									1	R
<i>Machura tinctoria</i> (L.) D. Don ex Steud.								x			x		x				2	R
<i>Sorocea bonplandii</i> (Baill.) W.C. Burg., Lanj. & Wess. Boer			x	x	x	x					x					5	C	
MYRTACEAE																		
<i>Blepharocalyx salicifolius</i> (Kunth) O. Berg			x								x		x				2	R
<i>Calyptanthes brasiliensis</i> Spreng.										x							1	R
<i>Calyptanthes clusiifolia</i> (Miq.) O. Berg	x		x							x	x	x	x				4	R
<i>Calyptanthes</i> sp.							x	x		x							2	R
<i>Calyptanthes widgreniana</i> O. Berg									x		x			x			2	R
<i>Campomanesia guazumifolia</i> (Cambess.) O. Berg										x							1	R
<i>Campomanesia sessiliflora</i> (O. Berg) Mattos									x								1	R
<i>Campomanesia</i> sp.	x						x						x				2	R
<i>Eugenia acutata</i> Miq.							x	x	x								3	R
<i>Eugenia blastantha</i> (O. Berg) D. Legrand	x																1	R
<i>Eugenia florida</i> DC.											x						1	R
<i>Eugenia handroana</i> D. Legrand			x														1	R
<i>Eugenia sonderiana</i> O. Berg		x							x		x		x	x	x		4	R
<i>Eugenia</i> sp.	x		x							x							3	R
<i>Marlierea laevigata</i> (DC.) Kjaersk.		x															1	R
<i>Marlierea racemosa</i> (Vell.) Kjaersk.									x								1	R
<i>Myrciaria miersiana</i> (Gardner) D. Legrand & Kausel									x								1	R
<i>Myrciaria myrcioides</i> (Cambess.) O. Berg								x			x						1	R
<i>Myrciaria</i> sp.								x		x							1	R
<i>Myrcia guianensis</i> (Aubl.) DC.			x				x			x							2	R
<i>Myrcia hebepepetala</i> DC.						x											1	R
<i>Myrcia multiflora</i> (Lam.) DC.									x		x		x				1	R
<i>Myrcia obovata</i> (O. Berg) Nied.														x			1	R
<i>Myrcia perforata</i> O. Berg				x													1	R
<i>Myrcia retorta</i> Cambess.								x		x							1	R
<i>Myrcia</i> sp.								x	x	x	x	x	x	x	x		3	R
<i>Myrcia splendens</i> (Sw.) DC.	x	x	x	x		x	x	x	x	x	x	x	x	x	x	10	F	
<i>Pimenta pseudocaryophyllus</i> (Gomes) Landrum	x											x	x				2	R
<i>Pisidium</i> sp.												x					1	R
<i>Pisidium rufum</i> DC.										x							1	R
<i>Pisidium</i> sp.		x												x			2	R
<i>Siphoneugena densiflora</i> O. Berg					x	x						x					3	R
<i>Siphoneugena reitzii</i> D. Legrand					x	x				x							3	R
<i>Siphoneugena widgreniana</i> O. Berg			x														1	R
NYCTAGINACEAE																		
<i>Guapira opposita</i> (Vell.) Reitz				x	x							x			x		3	R
<i>Guapira</i> sp.				x													1	R
OCHNACEAE																		
<i>Ouratea semiserrata</i> (Mart. & Nees) Engl.												x			x		1	R
OLEACEAE																		
<i>Chionanthus filiformis</i> (Vell.) P.S. Green				x													1	R
<i>Chionanthus</i> sp.			x														1	R

Appendix 1. Cont.

Spermatophytes FAMILY Species	Localities														Total	FO		
	AIU	BOC	CAM	CAX	DEL	EXT	GUA	MAR	MON	MVE	PAS	POC	POU	SGS	SRJ	VIR		
OPILIACEAE							x										1	R
<i>Agonandra excelsa</i> Griseb.																	1	R
PENTAPHYLACACEAE						x											1	R
<i>Ternstroemia brasiliensis</i> Cambess.																	1	R
PHYLLANTHACEAE																		
<i>Heronima alchornoioides</i> Allemão														x	1		R	
PHYTOLACCACEAE																		
<i>Gallesia integrifolia</i> (Spreng.) Harms								x					x	2		R		
PRIMULACEAE																		
<i>Myrsine coriacea</i> (Sw.) R. Br. ex Roem. & Schult.							x									1	R	
<i>Myrsine lineata</i> (Mez) Imkhan.	x											x	x	3		R		
<i>Myrsine</i> sp.							x					x	x	2		R		
<i>Myrsine umbellata</i> Mart.	x		x	x	x	x					x				6	C		
PROTEACEAE																		
<i>Euplassa rufa</i> (Loes.) Sleumer								x								1	R	
<i>Roupala meisneri</i> Sleumer		x														1	R	
<i>Roupala montana</i> Aubl.							x									1	R	
RHAMNACEAE																		
<i>Rhamnidium elaeocarpum</i> Reissek							x									1	R	
ROSACEAE																		
<i>Prunus myrtifolia</i> (L.) Urb.	x	x	x				x	x	x			x				7	C	
RUBIACEAE																		
<i>Alseis</i> sp.							x	x	x							2	R	
<i>Amaioua guianensis</i> Aubl.	x		x	x				x	x			x	x	x	7	C		
<i>Chomelia sericea</i> Müll. Arg.						x										1	R	
<i>Cordiera concolor</i> (Cham.) Kuntze	x							x				x				3	R	
<i>Cordiera</i> sp.										x						1	R	
<i>Coussarea contracta</i> (Walp.) Müll. Arg.						x										1	R	
<i>Coussarea</i> sp.												x				1	R	
<i>Coutarea hexandra</i> (Jacq.) K. Schum.								x				x	x			2	R	
<i>Ixora brevifolia</i> Benth.	x					x										2	R	
<i>Ixora</i> sp.	x															1	R	
<i>Psychotria myriantha</i> Müll. Arg.			x													1	R	
<i>Psychotria</i> sp.						x		x								1	R	
<i>Psychotria vellosiana</i> Benth.	x	x	x	x	x	x		x	x	x	x	x	x		10	F		
<i>Rudgea jasminoides</i> (Cham.) Müll. Arg.						x		x	x	x	x				2	R		
<i>Rudgea</i> sp.						x										1	R	
RUTACEAE																		
<i>Metrodorea nigra</i> A. St.-Hil.							x	x	x							2	R	
<i>Metrodorea stipularis</i> Mart.							x									1	R	
<i>Zanthoxylum fagara</i> (L.) Sarg.						x			x				x	3		R		
SABIACEAE																		
<i>Meliosma sinuata</i> Urb.		x														1	R	
SALICACEAE																		
<i>Casearia decandra</i> Jacq.						x		x	x		x	x	x	5		C		
<i>Casearia lasiophylla</i> Eichler								x				x	x	2		R		
<i>Casearia obliqua</i> Spreng.						x				x	x	x	x		4		R	
<i>Casearia sylvestris</i> Sw.						x			x	x	x	x	x		4		R	
<i>Prockia crucis</i> P. Browne ex L.										x						1	R	
SAPINDACEAE																		
<i>Cupania paniculata</i> Cambess.						x				x		x				2	R	
<i>Cupania vernalis</i> Cambess.							x			x		x				2	R	
<i>Cupania zanthoxyloides</i> Cambess.	x										x					2	R	
<i>Matayba</i> cf. <i>robusta</i> Radlk.	x											x				1	R	
<i>Matayba guianensis</i> Aubl.			x								x					2	R	
<i>Matayba juglandifolia</i> Radlk.	x									x		x	x	3		R		
<i>Toulia subsquamulata</i> Radlk.										x		x	x	1		R		
SAPOTACEAE																		
<i>Chrysophyllum gonocarpum</i> (Mart. & Eichler ex Miq.) Engl.								x								1	R	
SIPARUNACEAE																		
<i>Siparuna brasiliensis</i> (Spreng.) A. DC.		x							x							1	R	
<i>Siparuna guianensis</i> Aubl.								x			x		x	2		R		

Appendix 1. Cont.

Spermatophytes FAMILY Species	Localities														Total	FO	
	AIU	BOC	CAM	CAX	DEL	EXT	GUA	MAR	MON	MVE	PAS	POÇ	POU	SGS	SRJ		
SOLANACEAE																	
<i>Aureliana velutina</i> Sendtn.											x					1	R
<i>Solanum pseudoquina</i> A. St.-Hil.						x							x			2	R
<i>Solanum</i> sp.						x							x			2	R
STYRACACEAE																	
<i>Styrax latifolius</i> Pohl													x			1	R
SYMPLOCACEAE																	
<i>Symplocos celastrina</i> Mart. ex Miq.	x	x														2	R
<i>Symplocos insignis</i> Brade,A.									x							1	R
<i>Symplocos pubescens</i> Klotzsch ex Benth.			x													1	R
THEACEAE																	
<i>Laplacea fruticosa</i> (Schrad.) Kobuski		x														1	R
THYMELAEACEAE																	
<i>Daphnopsis fasciculata</i> (Meisn.) Nevling									x			x				1	R
<i>Daphnopsis utilis</i> Warm.										x			x			1	R
URTICACEAE																	
<i>Cecropia glaziovii</i> Smetl.											x					1	R
<i>Cecropia</i> sp.											x					1	R
<i>Urera bacifera</i> (L.) Gaudich.					x	x										2	R
VOCHysiACEAE																	
<i>Qualea cryptantha</i> (Spreng.) Warm.									x			x				1	R
<i>Qualea dichotoma</i> (Mart.) Warm.										x			x			1	R
<i>Vochysia grandis</i> Mart.							x									1	R
<i>Vochysia magnifica</i> Warm.	x				x			x				x			x	4	R
WINTERACEAE																	
<i>Drimys brasiliensis</i> Miers		x						x		x						2	R
Total	38	29	34	34	35	39	27	22	23	31	26	37	28	27	31	36	

Appendix 2. Species of amphibians recorded in the 16 localities sampled in Minas Gerais, Brazil, and their respective frequency of occurrence (FO): R (Rare); C (Common); and F (Frequent) (AIU, Aiuruoca; BOC, Bocaina de Minas; CAM, Camanducaia; CAX, Caxambu; DEL, Delfim Moreira; EXT, Extrema; GUA, Guaxupé; MAR, Maria da Fé; MON, Monte Belo; MVE, Monte Verde; PAS, Passa Quatro; POÇ, Poços de Caldas; POU, Pouso Alegre; SGS, São Gonçalo do Sapucaí; SRJ, Santa Rita de Jacutinga; VIR, Virginia).

Amphibians FAMILY Species	Localities														Total	FO	
	AIU	BOC	CAM	CAX	DEL	EXT	GUA	MAR	MON	MVE	PAS	POÇ	POU	SGS	SRJ	VIR	
BRACHYCEPHALIDAE																	
<i>Ischnocnema guentheri</i> (Steindachner, 1864)	x			x	x		x	x	x				x			7	C
<i>Ischnocnema holti</i> (Cochran, 1948)				x												1	R
<i>Ischnocnema parva</i> (Girard, 1853)								x								1	R
BUFONIDAE																	
<i>Rhinella icterica</i> (Spix, 1824)	x		x	x	x		x		x	x	x	x	x	x	x	11	F
<i>Rhinella ornata</i> (Spix, 1824)			x	x	x			x				x		x		2	R
<i>Rhinella rubescens</i> (Lutz, 1925)	x									x		x				2	R
<i>Rhinella schneideri</i> (Werner, 1894)								x				x				1	R
CRAUGASTORIDAE																	
<i>Haddadus binotatus</i> (Spix, 1824)							x						x			2	R
CYCLORAMPHIDAE																	
<i>Odontophrynus americanus</i> (Duméril & Bibron, 1841)						x										1	R
<i>Proceratophrys boiei</i> (Wied-Neuwied, 1824)					x	x		x								3	R
<i>Proceratophrys appendiculata</i> (Günther, 1873)	x															1	R
HYLIDAE																	
<i>Aplastodiscus arildae</i> (Cruz & Peixoto, 1985)	x															1	R
<i>Aplastodiscus leucopygius</i> (Cruz & Peixoto, 1985)					x	x	x									3	R
"1984"																	
<i>Aplastodiscus perviridis</i> A. Lutz in B. Lutz, 1950									x	x	x	x	x			2	R
<i>Bokermannohyla circumdata</i> (Cope, 1871)	x	x							x			x				3	R
<i>Bokermannohyla luctuosa</i> (Pombal & Haddad, 1993)	x						x	x	x		x					4	R

Appendix 2. Cont.

Amphibians FAMILY Species	Localities														Total	FO	
	AIU	BOC	CAM	CAX	DEL	EXT	GUA	MAR	MON	MVE	PAS	POC	POU	SGS	SRJ	VIR	
<i>Bokermannohyla vulcaniae</i> De Vasconcelos & Giareta, 2005											x					1	R
<i>Dendropsophus elegans</i> (Wied-Neuwied, 1824)														x	x	2	R
<i>Dendropsophus microps</i> (Peters, 1872)				x					x	x						2	R
<i>Dendropsophus minutus</i> (Peters, 1872)	x	x	x	x			x	x	x		x			x	8	C	
<i>Dendropsophus rubicundulus</i> (Reinhardt and Lütken, 1862)			x			x					x		x	x	4	R	
<i>Dendropsophus sanborni</i> (Schmidt, 1944)	x									x						2	R
<i>Hypsiboas albopunctatus</i> (Spix, 1824)	x	x	x			x	x	x		x			x	x	8	C	
<i>Hypsiboas faber</i> (Wied-Neuwied, 1821)	x		x		x	x	x	x		x		x	x	x	7	C	
<i>Hypsiboas semilineatus</i> (Spix, 1824)													x		1	R	
<i>Hypsiboas lundii</i> (Burmeister, 1856)			x													1	R
<i>Hypsiboas pardalis</i> (Spix, 1824)											x					1	R
<i>Hypsiboas polytaenius</i> (Cope, 1870*1869*)	x	x		x	x	x	x	x	x	x			x		10	F	
<i>Hypsiboas prasinus</i> (Burmeister, 1856)									x						1	R	
<i>Phasmahyla cochranae</i> (Bokermann, 1966)										x					1	R	
<i>Scinax crospedopilus</i> (A. Lutz, 1925)									x			x		x	2	R	
<i>Scinax flavoguttatus</i> (A. Lutz and B. Lutz, 1939)									x			x			1	R	
<i>Scinax fuscovarius</i> (Lutz, 1925)	x			x	x		x						x		5	C	
<i>Scinax hayii</i> (Barbour, 1909)							x		x	x					1	R	
<i>Scinax longilineus</i> (B. Lutz, 1968)						x			x		x				3	R	
<i>Scinax ranki</i> (Andrade & Cardoso, 1987)									x			x			1	R	
LEIUPERIDAE																	
<i>Eupemphix nattereri</i> Steindachner, 1863							x								1	R	
<i>Physalaemus centralis</i> Bokermann, 1962												x	x		1	R	
<i>Physalaemus cuvieri</i> Fitzinger, 1826	x	x		x	x					x	x		x	x	7	C	
<i>Physalaemus olfersii</i> (Lichtenstein and Martens, 1856)					x		x								1	R	
LEPTODACTYLIDAE																	
<i>Leptodactylus fuscus</i> (Schneider, 1799)	x	x		x								x	x	x	5	C	
<i>Leptodactylus labyrinthicus</i> (Spix, 1824)										x		x	x		2	R	
<i>Leptodactylus latrans</i> (Steffen, 1815)	x	x	x	x	x			x				x	x	x	7	C	
<i>Leptodactylus mystacinus</i> (Burmeister, 1861)	x						x		x						2	R	
RANIDAE																	
<i>Lithobates catesbeianus</i> (Shaw, 1802)**					x										1	R	
Total	7	9	6	10	15	9	6	9	8	9	10	8	5	3	11	9	

Appendix 3. Species of birds recorded in the 16 localities sampled in Minas Gerais, Brazil, and their respective frequency of occurrence (FO): R (Rare); C (Common); and F (Frequent) (AIU, Aiuruoca; BOC, Bocaina de Minas; CAM, Camanducaia; CAX, Caxambu; DEL, Delfim Moreira; EXT, Extrema; GUA, Guaxupé; MAR, Maria da Fé; MON, Monte Belo; MVE, Monte Verde; PAS, Passa Quatro; POC, Poços de Caldas; POU, Pouso Alegre; SGS, São Gonçalo do Sapucaí; SRJ, Santa Rita de Jacutinga; VIR, Virgínia).

Birds FAMILY Species	Localities														Total	FO	
	AIU	BOC	CAM	CAX	DEL	EXT	GUA	MAR	MON	MVE	PAS	POC	POU	SGS	SRJ	VIR	
ACCIPITRIDAE																	
<i>Buteo nitidus</i> (Latham, 1790)*					x											1	R
<i>Heterospizias meridionalis</i> (Latham, 1790)*							x									1	R
<i>Rupornis magnirostris</i> (Gmelin, 1788)*					x		x	x				x		x		4	R
ALCEDINIDAE																	
<i>Chloroceryle americana</i> (Gmelin, 1788)						x										1	R
<i>Megaceryle torquata</i> (Linnaeus, 1766)*					x											1	R
ARDEIDAE																	
<i>Bubulcus ibis</i> (Linnaeus, 1758)*							x									1	R
BUCCONIDAE																	
<i>Malacoptila striata</i> (Spix, 1824)														x	1	R	
CARDINALIDAE																	
<i>Herpsilochmus rubica</i> (Vieillot, 1817)	x	x			x			x	x	x	x	x		x	6	C	
<i>Piranga flava</i> (Vieillot, 1822)*							x								1	R	
<i>Saltator fuliginosus</i> (Daudin, 1800)*					x										1	R	

Appendix 3. Cont.

Birds FAMILY Species	Localities														Total	FO	
	AIU	BOC	CAM	CAX	DEL	EXT	GUA	MAR	MON	MVE	PAS	POC	POU	SGS	SRJ	VIR	
<i>Saltator similis</i> d'Orbigny & Lafresnaye, 1837					x		x				x	x	x	x		5	C
CARIAMIDAE																	
<i>Cariama cristata</i> (Linnaeus, 1766)*		x					x				x		x			4	R
COEREBIDAE																	
<i>Coereba flaveola</i> (Linnaeus, 1758)	x						x					x				3	R
COLUMBIDAE																	
<i>Columbina squammata</i> (Lesson, 1831)*								x								1	R
<i>Columbina talpacoti</i> (Temminck, 1809)*							x	x	x	x		x	x	x		5	C
<i>Leptotila rufaxilla</i> (Richard & Bernard, 1792)												x				1	R
<i>Patagioenas plumbea</i> Vieillot, 1818	x	x							x							3	R
<i>Zenaida auriculata</i> (Des Murs, 1847)*			x								x					2	R
CONOPOPHAGIDAE																	
<i>Conopophaga lineata</i> (Wied, 1831)	x		x	x			x				x	x	x	x		8	C
CORVIDAE																	
<i>Cyanocorax cristatellus</i> Temminck, 1823*									x							1	R
COTINGIDAE																	
<i>Pachyramphus validus</i> (Lichtenstein, 1823)*											x					1	R
<i>Schiffornis virescens</i> (Lafresnaye, 1838)											x					1	R
CRACIDAE																	
<i>Penelope obscura</i> Temminck, 1815*					x					x						2	R
CUCULIDAE																	
<i>Crotophaga ani</i> Linnaeus, 1758*							x									1	R
<i>Guira guira</i> (Gmelin, 1788)*							x					x				2	R
<i>Piaya cayana</i> (Linnaeus, 1766)*				x	x			x	x	x	x	x	x		5	C	
<i>Tapera naevia</i> (Linnaeus, 1766)*					x											1	R
DENDROCOLAPTIDAE																	
<i>Lepidocolaptes angustirostris</i> (Vieillot, 1818)	x						x			x		x		x	x	5	C
<i>Sittasomus griseicapillus</i> (Vieillot, 1818)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	14	F	
<i>Xiphorhynchus fuscus</i> (Vieillot, 1818)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	12	F	
EMBERIZIDAE																	
<i>Haplospiza unicolor</i> Cabanis, 1851*											x			x		1	R
<i>Sicalis flaveola</i> (Linnaeus, 1766)*								x				x		x		2	R
<i>Sporophila caerulescens</i> (Vieillot, 1823)*								x								1	R
<i>Sporophila lineola</i> (Linnaeus, 1758)				x				x		x						1	R
<i>Volatinia jacarina</i> (Linnaeus, 1766)*					x						x		x			2	R
<i>Zonotrichia capensis</i> (Müller, 1776)*					x			x		x	x	x	x			4	R
FALCONIDAE																	
<i>Caracara plancus</i> (Miller, 1777)*	x		x					x					x		x	4	R
FORMICARIIDAE																	
<i>Chamaezza ruficauda</i> (Cabanis & Heine, 1859)*									x							1	R
FURNARIIDAE																	
<i>Automolus leucophthalmus</i> (Wied, 1821)	x		x	x	x	x	x		x	x		x		x	x	10	F
<i>Cranioleuca pallida</i> (Wied, 1831)*											x			x		1	R
<i>Furnarius rufus</i> (Gmelin, 1788)*								x								1	R
<i>Heliobletus contaminatus</i> Berlepsch, 1885*									x			x		x		1	R
<i>Lochmias nematura</i> (Lichtenstein, 1823)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	12	F
<i>Philydor rufum</i> (Vieillot, 1818)	x	x		x					x							4	R
<i>Sclerurus scansor</i> (Ménétries, 1835)							x									1	R
<i>Synallaxis albescens</i> Temminck, 1823*									x			x				1	R
<i>Synallaxis frontalis</i> Pelzeln, 1859 *								x	x	x			x			1	R
<i>Synallaxis ruficapilla</i> Vieillot, 1819	x						x	x	x		x	x	x	x		7	C
<i>Synallaxis spixi</i> Sclater, 1856							x	x	x		x	x	x	x		5	C
<i>Xenops rutilans</i> Temminck, 1821	x		x	x	x			x	x	x	x	x	x	x	x	10	F
ICTERIDAE																	
<i>Cacicus chrysopterus</i> (Vigors, 1825)									x							1	R

Appendix 3. Cont.

Birds FAMILY Species	Localities													Total	FO		
	AIU	BOC	CAM	CAX	DEL	EXT	GUA	MAR	MON	MVE	PAS	POC	POU	SGS	SRJ	VIR	
<i>Molothrus bonariensis</i> (Gmelin, 1789)*										x						1	R
<i>Psarocolius decumanus</i> (Pallas, 1769)*					x						x					2	R
MIMIDAE																	
<i>Mimus saturninus</i> (Lichtenstein, 1823)*										x						1	R
PARULIDAE																	
<i>Basileuterus culicivorus</i> (Deppe, 1830)	x			x	x	x	x	x	x	x	x	x	x	x	x	11	F
<i>Basileuterus flaveolus</i> (Baird, 1865)		x								x			x			3	R
<i>Basileuterus hypoleucus</i> Bonaparte, 1850		x					x	x			x		x			5	C
<i>Basileuterus leucoblepharus</i> (Vieillot, 1817)	x	x		x	x	x	x	x	x	x	x	x	x	x	x	13	F
PHALACROCORACIDAE																	
<i>Phalacrocorax brasiliensis</i> (Gmelin, 1789)*							x									1	R
PICIDAE																	
<i>Campephilus robustus</i> (Lichtenstein, 1819)*							x									1	R
<i>Celeus flavescens</i> (Gmelin, 1788)*							x									1	R
<i>Colaptes melanochloros</i> (Gmelin, 1788)*												x				1	R
<i>Dryocopus lineatus</i> (Linnaeus, 1766)*							x	x	x							3	R
<i>Piculus aurulentus</i> (Temminck, 1823)*								x								1	R
<i>Picumnus cirratus</i> Temminck, 1825							x	x	x		x	x	x	x	x	7	C
<i>Veniliornis passerinus</i> (Linnaeus, 1766)*									x							1	R
PIPRIDAE																	
<i>Chiroxiphia caudata</i> (Shaw & Nodder, 1793)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	13	F
<i>Manacus manacus</i> (Linnaeus, 1766)								x								1	R
PSITTACIDAE																	
<i>Aratinga auricapillus</i> (Kuhl, 1820)*							x									1	R
<i>Aratinga leucophthalma</i> (Müller, 1776)*					x											1	R
<i>Brotogeris tirica</i> (Gmelin, 1788)*								x								1	R
RAMPHASTIDAE																	
<i>Ramphastos dicolorus</i> Linnaeus, 1766*										x						1	R
<i>Ramphastos toco</i> Müller, 1776*							x	x		x	x	x	x	x	x	4	R
STRIGIDAE																	
<i>Pulsatrix koeniswaldiana</i> (Bertoni & Bertoni, 1901)*							x									1	R
<i>Pulsatrix perspicillata</i> (Latham, 1790)*								x								1	R
THAMNOPHILIDAE																	
<i>Drymophila ferruginea</i> (Temminck, 1822)*						x		x		x	x	x	x	x	x	4	R
<i>Dysithamnus mentalis</i> (Temminck, 1823)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	15	F
<i>Dysithamnus plumbeus</i> (Wied, 1831)	x															1	R
<i>Pyriglenia leucoptera</i> (Vieillot, 1818)	x		x	x		x	x	x	x	x	x	x	x	x	x	12	F
<i>Thamnophilus caerulescens</i> Vieillot, 1816						x				x	x	x	x	x		4	R
<i>Thamnophilus torquatus</i> Swainson, 1825*						x										1	R
THRAUPIDAE																	
<i>Conirostrum speciosum</i> (Temminck, 1824)*										x						1	R
<i>Dacnis cayana</i> (Linnaeus, 1766)*						x										1	R
<i>Euphonia chlorotica</i> (Linnaeus, 1766)*						x				x						2	R
<i>Hemithraupis ruficapilla</i> (Vieillot, 1818)*										x	x	x	x	x	x	3	R
<i>Lanio melanops</i> (Vieillot, 1818)	x	x	x	x	x		x		x	x	x	x	x	x	x	9	F
<i>Pipraeidea melanonota</i> (Vieillot, 1819)			x			x			x							2	R
<i>Pyrrhocoma ruficeps</i> (Strickland, 1844)			x													1	R
<i>Stephanophorus diadematus</i> (Temminck, 1823)*					x											1	R
<i>Tachyphonus coronatus</i> (Vieillot, 1822)						x						x			x	1	R
<i>Tangara cayana</i> (Linnaeus, 1766)	x					x						x			x	3	R
<i>Tangara cyanocephala</i> (Müller, 1776)*						x										1	R
<i>Tangara desmaresti</i> (Vieillot, 1819)*	x				x						x	x	x	x	x	4	R
<i>Tangara ornata</i> (Sparrman, 1789)*	x			x						x	x	x	x	x	x	1	R
<i>Tangara sayaca</i> (Linnaeus, 1766)*			x	x			x	x	x	x	x	x	x	x	x	6	C

Appendix 3. Cont.

Birds FAMILY Species	Localities														Total	FO	
	AIU	BOC	CAM	CAX	DEL	EXT	GUA	MAR	MON	MVE	PAS	POC	POU	SGS	SRJ	VIR	
TINAMIDAE																	
<i>Crypturellus obsoletus</i> (Temminck, 1815)*												x				1	R
TROCHILIDAE																	
<i>Amazilia láctea</i> (Lesson, 1829)	x			x			x			x						4	R
<i>Amazilia versicolor</i> (Vieillot, 1818)										x						1	R
<i>Clytolaema rubricauda</i> (Boddaert, 1783)	x			x					x							3	R
<i>Eupetomena macroura</i> (Gmelin, 1788)*							x					x				2	R
<i>Florisuga fusca</i> (Vieillot, 1817)*						x										1	R
<i>Leucochloris albicollis</i> (Vieillot, 1818)				x	x		x	x		x	x					4	R
<i>Phaethornis eurynome</i> (Lesson, 1832)	x	x		x	x					x		x	x			7	C
<i>Phaethornis pretrei</i> (Lesson & DeLattre, 1839)						x						x	x			3	R
<i>Thalurania glaucopis</i> (Gmelin, 1788)	x					x	x		x				x			5	C
TROGONIDAE																	
<i>Trogon surrucura</i> Vieillot, 1817*				x								x				2	R
TURDIDAE																	
<i>Turdus albicollis</i> Vieillot, 1818	x		x	x				x	x	x	x		x			8	C
<i>Turdus amaurochalinus</i> Cabanis, 1850					x					x						2	R
<i>Turdus leucomelas</i> Vieillot, 1818	x				x	x	x									3	R
<i>Turdus leucops</i> (Taczanowski, 1877)						x		x				x				2	R
<i>Turdus rufiventris</i> Vieillot, 1818		x	x		x		x	x	x	x	x	x	x			8	C
TYRANNIDAE																	
<i>Attila rufus</i> (Vieillot, 1819)			x			x										2	R
<i>Camptostoma obsoletum</i> (Temminck, 1824)*					x	x	x	x	x	x	x		x		4	R	
<i>Colonia colonus</i> (Vieillot, 1818)*				x	x			x				x				3	R
<i>Contopus cinereus</i> (Spix, 1825)											x			x		1	R
<i>Corythopis delalandi</i> (Lesson, 1831)	x	x														2	R
<i>Elaenia flavogaster</i> (Thunberg, 1822)*	x									x		x	x			3	R
<i>Elaenia obscura</i> (D'Orbigny & Lafresnaye, 1837)			x													1	R
<i>Fluvicola nengeta</i> (Linnaeus, 1766)*						x			x							1	R
<i>Hemitriccus diops</i> (Temminck, 1822)		x			x		x	x				x				4	R
<i>Hemitriccus orbitatus</i> (Wied, 1831)*					x		x		x			x				2	R
<i>Knipolegus cyanirostris</i> (Vieillot, 1818)						x			x							1	R
<i>Lathrotriccus euleri</i> (Cabanis, 1868)	x					x	x		x		x	x	x	x		5	C
<i>Leptopogon amurocephalus</i> Tschudi, 1846	x		x	x			x		x		x	x				6	C
<i>Megarynchus pitanguá</i> (Linnaeus, 1766)*						x			x				x			2	R
<i>Mionectes rufiventris</i> Cabanis, 1846	x	x		x	x		x			x	x	x	x	x		10	F
<i>Myiarchus tyrannulus</i> (Müller, 1776)							x					x				1	R
<i>Myiobius barbatus</i> (Gmelin, 1789)						x										1	R
<i>Myiodynastes maculatus</i> (Müller, 1776)*							x					x				1	R
<i>Myiopagis viridicata</i> (Vieillot, 1817)	x												x			2	R
<i>Myiophobus fasciatus</i> (Müller, 1776)										x						1	R
<i>Phyllomyias griseocapilla</i> Sclater, 1861	x															1	R
<i>Pitangus sulphuratus</i> (Linnaeus, 1766)*			x		x	x	x	x	x	x						4	R
<i>Platyrinchus mystaceus</i> Vieillot, 1818	x		x	x	x	x	x	x	x	x	x	x	x	x		13	F
<i>Todirostrum poliocephalum</i> (Wied, 1831)*					x				x			x				2	R
<i>Tolmomyias sulphurescens</i> (Spix, 1825)	x							x		x	x	x	x			4	R
TYTONIDAE																	
<i>Tyto alba</i> (Scopoli, 1769)*										x			x			1	R
VIREONIDAE																	
<i>Cyclolepis gujanensis</i> (Gmelin, 1789)						x	x	x		x	x	x		x		7	C
<i>Vireo olivaceus</i> (Linnaeus, 1766)*						x							x	x		2	R
Total	24	16	15	16	25	31	44	28	45	26	33	38	40	34	23	20	

Appendix 4. Species of primates recorded in the 16 localities sampled in Minas Gerais, Brazil, and their respective frequency of occurrence (FO): R (Rare); C (Common); and F (Frequent) (AIU, Aiuruoca; BOC, Bocaina de Minas; CAM, Camanducaia; CAX, Caxambu; DEL, Delfim Moreira; EXT, Extrema; GUA, Guaxupé; MAR, Maria da Fé; MON, Monte Belo; MVE, Monte Verde; PAS, Passa Quatro; POÇ, Poços de Caldas; POU, Pouso Alegre; SGS, São Gonçalo do Sapucaí; SRJ, Santa Rita de Jacutinga; VIR, Virgínia).

Primates FAMILY Species	Localities														Total	FO		
	AIU	BOC	CAM	CAX	DEL	EXT	GUA	MAR	MON	MVE	PAS	POÇ	POU	SGS	SRJ	VIR		
ATELIDAE																		
<i>Alouatta guariba clamitans</i> (Humboldt, 1812)	x	x			x	x	x		x	x	x	x	x	x	x	9	F	
CALLITRICHIDAE																		
<i>Callithrix aurita</i> (E. Geoffroy in Humboldt, 1812)			x		x					x	x	x	x	x	x	7	C	
<i>Callithrix penicillata</i> (E. Geoffroy, 1812) **	x	x	x			x		x		x						5	C	
CEBIDAE																		
<i>Sapajus nigritus</i> (Goldfuss, 1809)			x	x		x	x	x	x		x	x	x	x	x	5	C	
PITHECIIDAE																		
<i>Callicebus nigrifrons</i> (Spix, 1823)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	16	F	
Total	3	3	1	4	3	3	3	2	2	2	4	2	4	1	3	2		