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Patterns of geographic distribution and conservation of the open-habitat avifauna of southeastern Brazilian mountaintops (*campos rupestres* and *campos de altitude*)

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ABSTRACT

Montane open-habitats of southeastern Brazil are represented by the campos rupestres *(principally in the Espinhaço Range) and by the* campos de altitude *(in the Serra do Mar and Serra da Mantiqueira). In spite of the occurrence of endemic species in both vegetation types, an analysis and synthesis of their bird communities have never been conducted. In this paper, we present an avifaunal survey of these areas, describe patterns of geographic distribution, and comment on the conservation of those open-habitats and their avifauna. A total of 231 bird species was recorded in the open-habitats of southeastern Brazilian mountaintops. In the* campos rupestres, *205 species were recorded, while in the* campos de altitude, *the total was 123 species. Five patterns of distribution are recognizable among birds occurring in these habitats: non-endemic (191 species), Atlantic Forest endemics (26 species), Cerrado endemics (6 species), Caatinga endemic (1 species), and montane open-habitat endemics (7 species). In spite of the presence of several protected areas in those regions, the existing reserves do not guarantee the conservation of their important vegetation types and their avifaunas under current low levels of implementation. Since several endemic and threatened bird species live in the* campos rupestres *and* campos de altitude, *more efforts must be directed for their conservation.*

Keywords: Avifauna; *Campos rupestres; Campos de altitude;* Conservation; Distribution.

INTRODUCTION

Montane open-habitats in southeastern Brazil are recognized as important centres of endemism for Neotropical flora and fauna (Eiten, 1992; Silva, 1995, 1997, 1998; Giulietti *et al.,* 1997; Sick, 1997; Stattersfield *et al.,* 1998; Safford, 1999a; Silva & Bates, 2002; Gonçalves *et al.,* 2007). Those habitats generally occur at higher elevations than the Cerrado and the Caatinga in their northern and western distribution and above the tree line in the Atlantic Forest region to the south and east.

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Montane open-habitats include the *campos rupestres* scattered along the Espinhaço Range and the *campos de altitude* dotting the ridges of the eastern mountains of the Serra do Mar, Serra da Mantiqueira, and associated ranges (Martinelli & Orleans e Bragança, 1996; Giulietti *et al.,* 1997; Safford, 1999a; Menezes & Giulietti, 2000). Both habitats harbor a wide variety of physiognomies, ranging from open grasslands to habitats with a dense cover of scrub and small trees. Rock outcrops and marshy areas also occur in both formations, which have many typical and endemic plants, such as bromeliads (Bromeliaceae), "sempre-vivas" (Eriocaulaceae), "canelas-de-ema" (Velloziaceae), bamboos and grasses (Poaceae) (Andrade *et al.,* 1986; Eiten, 1992; Meguro *et al.,* 1994; Martinelli & Orleans e Bragança, 1996; Safford, 1999a; Menezes & Giulietti, 2000; Conceição & Giulietti, 2002; Benites *et al.,* 2003; Caiafa & Silva, 2005; Conceição & Pirani, 2005; Ribeiro *et al.,* 2007).

Although *campos rupestres* and *campos de altitude* can present similar landscapes and share some common plant genera and species, they show important differences in the biogeographic affinities of their floras (Menezes & Giulietti, 1986; Eiten, 1992; Harley, 1995; Martinelli & Orleans e Bragança, 1996; Giulietti *et al.,* 1997; Rizzini, 1997; Safford, 1999a, 2007). The *campos rupestres* flora has affinities with those of central Brazilian Plateau, the Guianas Shield, and the restingas along the Atlantic Ocean coast of South America (Steyermark, 1986; Giulietti & Pirani, 1988; Giulietti & Hensold, 1990; Harley, 1995; Menezes & Giulietti, 2000; Alves, R.J.V. *et al.,* 2007), but with a high number of endemic Bromeliaceae, Eriocaulaceae, Orchidaceae, and Velloziaceae (Eiten, 1992; Menezes & Giulietti, 2000; Versieux & Wendt, 2007).

On the other hand, *campos de altitude* show a remarkable affinity with the Andean region and also with southern Brazilian grasslands (Harley, 1995; Martinelli & Orleans e Bragança, 1996; Safford, 1999a, 2007). In fact, *campos de altitude* have been considered as 'Brazilian Páramos' because their floristic, physiognomic, climatic, and edaphic features are so similar to those of the Andes and the high Central American mountains (Harley, 1995; Safford, 1999a, b, 2007).

Furthermore, biogeographical affinities have been recognized between the flora and fauna of southeastern Brazilian mountains and the Andean-Patagonian region (Sick, 1970, 1985, 1997; Simpson-Vuilleumier, 1971; Simpson, 1979; Vielliard, 1990a, 1996; Safford, 1999a, 2007).

It is assumed that Brazilian mountains were colonized by Andean elements during Pleistocene glaciations, when climatic-vegetational connections between both regions were likely (Simpson-Vuilleumier, 1971; Simpson, 1979; Sick, 1970, 1985, 1997; Vielliard, 1990a). Those cooler periods would have led to the lowering of the tree line, increasing the latitudinal distribution of open-habitats in southeastern Brazil, similar to what is believed to have occurred in the Andean "páramos" (van der Hammen, 1974; Simpson-Vuilleumier, 1971; Simpson, 1979; Hooghiemstra & Cleef, 1995; Behling, 1998; Ledru *et al.,* 1998; Safford, 1999a). Also, during Late Glacial times, subtropical grasslands expanded from latitudes of about 28°/27°S to at least 20°S (Behling, 2002). During interglacial periods, those montane habitats would have retreated to cooler upland areas, explaining the isolated occurrence of some Andean-Patagonian taxa on southeastern Brazilian mountaintops (Simpson, 1979; Safford, 1999a). This model supports the notion that the high-altitude avifauna of southeastern Brazil has a biogeographical influence of Andean-Patagonian elements, with the putative dispersion of those taxa from the Andes and Patagonia to southeastern Brazil during Quaternary glacial periods (Sick, 1970, 1985, 1997; Vielliard, 1990a, 1996; Willis, 1992).

Despite the occurrence of some endemic birds in the montane open-habitats of southeastern Brazil (Sick, 1970, 1985, 1997; Silva, 1995; Melo-Júnior *et al.,* 1998; Stattersfield *et al.,* 1998; Vasconcelos *et al.,* 2003; Gonzaga *et al.,* 2007; Vasconcelos, 2008b), their biogeography is poorly known, with only sparse surveys and checklists (*e.g.* Miranda-Ribeiro, 1906, 1923; Lüderwaldt, 1909; Peixoto-Velho, 1923a, b; Holt, 1928; Pinto, 1951, 1954; Willis & Oniki, 1991; Parrini *et al.,* 1999; Simon *et al.,* 1999; Vasconcelos, 1999a, 2003, 2008a; Melo-Júnior *et al.,* 2001; Vasconcelos & Melo-Júnior, 2001). Bird communities from the *campos rupestres* and *campos de altitude* have never been subject to a thorough analysis and biogeographical synthesis. A good example of how poorly surveyed are these areas is the recent description of *Formicivora grantsaui* in the Chapada Diamantina (Gonzaga *et al.,* 2007), a relatively well-known region (Funch, 1999; Parrini *et al.,* 1999; Carvalhaes, 2001).

In his classic review of the physical environment and flora of the *campos de altitude,* Safford (1999a) recommended flora and fauna inventories as a first priority for research and conservation of this habitat. Following his lead, the goals of this paper are: 1) to review and present an ornithological synthesis of the *campos rupestres* and *campos de altitude;* 2) to describe patterns of geographic distribution of the montane open-habitat avifauna of southeastern Brazil; 3) to discuss the conservation of those habitats and their avifauna.

MATERIAL AND METHODS

We included in our survey those species that live in open natural habitats in the mountain areas of southeastern Brazil from Bahia south to São Paulo (Fig. 1). Those include marshes, grasslands, bamboo stands (*Chusquea* spp.), rocky outcrops covered with rupicolous herbs and shrubs, or with clumped shrubs and sparse low trees. Both *campos rupestres* and *campos de altitude* occur over a wide variety of rock substrates, such as granite, gneiss, quartzite, sandstone, and even iron ore. For physical and floristic characterizations of these habitats, *see* Andrade *et al.* (1986), Menezes & Giulietti (1986, 2000), Eiten (1992), Alves & Kolbek (1994), Meguro *et al.* (1994), Harley (1995), Martinelli & Orleans e Bragança (1996), Rizzini (1997), Safford (1999a), Conceição & Giulietti (2002), Dias *et al.* (2002), Benites *et al.* (2003, 2007), Vincent (2004), Caiafa & Silva (2005, 2007), Conceição & Pirani (2005), Conceição *et al.* (2007), Jacobi *et al.* (2007), and Ribeiro *et al.* (2007).

In this survey, we did not include species living strictly in forested habitats associated with the *campos rupestres* or the *campos de altitude,* such as gallery, cloud, and montane forests. Nevertheless, some typical forest birds do use dense clumps of shrubs or bamboos in those montane open-habitats (*e.g. Mackenziaena leachii, Drymophila genei, Hemitriccus obsoletus, Phylloscartes difficilis,* and *Haplospiza unicolor*), and they were included in this revision. We also excluded bird species that live only in the different physiognomies of the Cerrado, such as cerradão, cerrado "sensu stricto", parque de cerrado, and campo sujo (*see* Ribeiro & Walter, 1998 for a detailed description of these habitat types).

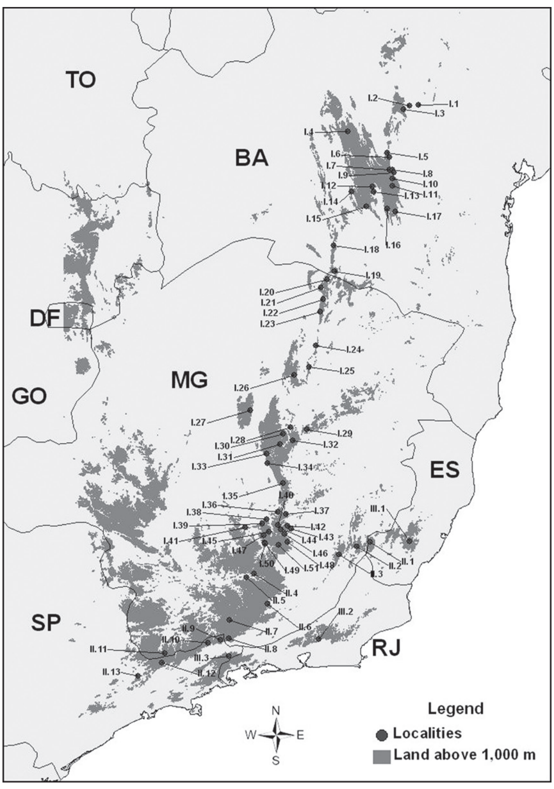

FIGURE 1: Map showing mountaintop regions of *campos rupestres* and *campos de altitude* considered in this review. Localities codes are presented in Table 1.

We selected different areas of *campos rupestres* and *campos de altitude* for our analysis (Fig. 1); the Chapada Diamantina region (Dias Coelho) was considered our northernmost site and Serra da Mantiqueira (Atibaia) the southern limit of the study area (Fig. 1). Localities surveyed in this study are summarized in Table 1. They were separated by mountain range (Espinhaço Range, Serra da Mantiqueira, and Serra do Mar) and type of habitat (*campo rupestre* or *campo de altitude*). All localities in the Espinhaço Range are covered by *campos rupestres,* and all localities in the Serra do Mar are represented by *campos de altitude.* The majority of the localities in the Serra da Mantiqueira are covered by *campos de altitude,* except Serra de São José and Serra do Lenheiro, which are covered by *campos rupestres* (*see* Alves & Kolbelk, 1994, 2009).

Due to the scarcity of data on birds of Brazilian montane open-habitats, we used all information gathered during fieldwork between 1993 and 2008. Voucher specimens were collected with mist-nets and shotguns, and deposited in the Coleção Ornitológica do Departamento de Zoologia da Universidade Federal de Minas Gerais, Belo Horizonte (DZUFMG). We also checked published bird records and data from specimens deposited in the following museums and collections: American Museum of Natural History, New York (AMNH); Museu de Biologia Mello Leitão, Santa Teresa (MBML); Museu de Ciências Naturais da Pontifícia Universidade Católica de Minas Gerais, Belo Horizonte (MCN); Museu de Ciências e Tecnologia da Pontifícia Universidade Católica do Rio Grande do Sul, Porto Alegre (MCP); Museu de História Natural de Taubaté, Taubaté (MHNT); Museu Paraense Emílio Goeldi, Belém (MPEG); Museu de Zoologia da Universidade de São Paulo, São Paulo (MZUSP); and Coleção Rolf Grantsau, São Bernardo do Campo (SG). In addition, we considered specimens deposited in the Museu Nacional, Rio de Janeiro (MNRJ), mentioned in the literature. We did not use published records

TABLE 1: Mountaintop regions of *campos rupestres* and *campos de altitude* considered in this review. Localities are listed from north to south and are grouped by Roman-Arabic number codes following the mountain ranges of each one: I = Espinhaço Range; II = Serra da Mantiqueira; III = Serra do Mar. Numerical codes for sources are presented in Appendix 1.

Code	Locality	Coordinates	Elevation (m)	Sources
I.1	Dias Coelho	11°29'S, 40°49'W	950	21
I.2	Izabel Dias	11°30'S, 41°00'W	850	21
I.3	Morro do Chapéu	11°34'S, 41°07'W	930-1,000	21, 23, 24, 31, 36, 38, 41, 49, 50, 58, 63, 68, 70, 71, 104, 107, 109, 151
I.4	Paramirim	12°01'S, 42°15'W	1,050-1,280	21, 24, 68
I.5	Palmeiras-Lençóis	Between 12°26'S, 41°25'W and 12°29'S, 41°30'W	900-1,250	21, 22, 23, 24, 50, 68, 70, 71, 82, 85, 87, 101, 104, 106, 132, 167
I.6	Serra do Ribeirão	12°33'S, 41°25'W	950	132
I.7	Vale do Paty	12°48'S, 41°25'W	1,035	132
I.8	Serra de Andaraí	Between 12°46'S, 41°19'W and 12°51'S, 41°23'W	730-1,150	21, 22, 23, 24, 33, 50, 58, 68, 151, 157
I.9	Igatu	Between 12°52'S, 41°18'W and 12°53'S, 41°20'W	730-950	21, 22, 23, 24, 29, 30, 50, 68, 132, 159
I.10	Mucugê	Between 12°57'S, 41°20'W and 13°01'S, 41°23'W	870-1,320	21, 22, 23, 24, 33, 50, 51, 68, 70, 71, 82, 92, 96, 97, 98, 99, 100, 104, 106, 113, 126, 132, 134, 135, 152, 157, 158, 159, 167
I.11	Roncador	Between 13°08'S, 41°21'W and 13°08'S, 41°22'W	1,000-1,490	21
I.12	Piatã	Between 13°08'S, 41°44'W and 13°10'S, 41°46'W	1,220-1,640	21, 24, 50, 68
I.13	Serra do Cocal	Between 13°14'S, 41°44'W and 13°16'S, 41°45'W	900-1,170	21
I.14	Morro do Ouro	Between 13°15'S, 42°11'W and 13°16'S, 42°11'W	900-1,120	21
I.15	Serra das Almas	Between 13°31'S, 41°49'W and 13°35'S, 41°58'W	980-1,950	68, 70, 71, 82, 104, 157, 167
I.16	Espigão do Taquari	13°36'S, 41°27'W	1,130-1,235	21
I.17	Barra da Estiva	Between 13°40'S, 41°16'W and 13°41'S, 41°18'W	1,000-1,500	21, 23, 24, 50, 58, 68, 107
I.18	Brejinho das Ametistas	14°21'S, 42°32'W	1,050	152, 167
I.19	Jacaraci	14°53'S, 42°31'W	1,330	167
I.20	Serra do Pau D'Arco	Between 15°03'S, 42°40'W and 15°04'S, 42°41'W	1,150-1,600	104, 140, 152, 167
I.21	Serra da Formosa	Between 15°12'S, 42°47'W and 15°15'S, 42°50'W	1,000-1,780	144, 152, 167
I.22	Campos Geraes	15°27'S, 42°45'W	1,200	2, 151
I.23	Gerais de Santana	Between 15°41'S, 42°48'W and 15°44'S, 42°50'W	1,100-1,400	144, 167
I.24	Serra do Barão	Between 16°12'S, 42°52'W and 16°36'S, 42°56'W	800-1,250	21, 23, 24, 25, 27, 38, 50, 58, 63, 104, 107, 139, 153, 167
I.25	Campina do Bananal	Between 16°50'S, 43°01'W and 16°51'S, 43°03'W	1,100-1,360	94, 104, 107, 139, 140, 150, 152, 156, 167
I.26	Serra Resplandecente	Between 16°59'S, 43°19'W and 17°02'S, 43°21'W	1,020-1,320	36, 104, 139, 150, 152, 167
I.27	Serra do Cabral	Between 17°41'S, 44°10'W and 17°45'S, 44°17'W	950-1,250	127, 140, 152, 167
I.28	Serra dos Poções	18°04'S, 43°25'W	980	36, 38, 63, 104
I.29	Serra do Ambrósio	Between 18°06'S, 43°02'W and 18°08'S, 43°08'W	880-1,520	152
I.30	Diamantina	Between 18°08'S, 43°31'W and 18°16'S, 43°38'W	1,000-1,370	1, 6, 17, 18, 21, 23, 24, 25, 27, 36, 37, 38, 50, 58, 104, 107, 151, 152, 153, 157, 159, 167
I.31	Datas	Between 18°23'S, 43°36'W and 18°27'S, 43°39'W	1,020-1,370	36, 104
I.32	Serra do Gavião	Between 18°09'S, 43°17'W and 18°32'S, 43°27'W	1,000-2,000	38, 62, 63, 74, 93, 94, 104, 107, 108, 127, 129, 150, 152, 167

TABLE 1: Continued.

Code	Locality	Coordinates	Elevation (m)	Sources
I.33	Serra do Barro Preto	Between 18°35'S, 43°53'W and 18°39'S, 43°55'W	1,170-1,300	150, 152, 167
I.34	Serra Talhada	18°48'S, 43°53'W	1,000-1,035	62, 94
I.35	Serra do Cipó	Between 19°02'S, 43°25'W and 19°25'S, 43°43'W	1,150-1,690	21, 23, 24, 29, 30, 34, 36, 37, 38, 41, 42, 44, 46, 47, 48, 49, 50, 57, 58, 61, 62, 63, 74, 84, 87, 89, 91, 94, 104, 107, 110, 111, 112, 114, 115, 116, 117, 118, 119, 125, 131, 140, 142, 144, 145, 146, 147, 149, 150, 151, 152, 153, 157, 159, 160, 167
I.36	Serra da Piedade	Between 19°48'S, 43°40'W and 19°49'S, 43°41'W	1,400-1,740	18, 21, 24, 37, 50, 58, 63, 74, 77, 89, 95, 102, 104, 107, 140, 152, 153, 167
I.37	Serra da Água Limpa	Between 19°49'S, 43°30'W and 19°54'S, 43°31'W	1,000-1,400	161, 167
I.38	Serra do Curral	Between 19°57'S, 43°54'W and 19°58'S, 43°55'W	1,250-1,330	53, 59, 63, 66, 67, 74, 75, 76, 77, 87, 89, 104, 138, 167
I.39	Serra do Rola-Moça	Between 20°00'S, 43°58'W and 20°05'S, 44°00'W	1,300-1,450	77, 87, 104, 105, 120, 121, 122, 123, 128, 133, 152, 154, 167
I.40	Serra da Gandarela	Between 20°03'S, 43°39'W and 20°06'S, 43°42'W	1,470-1,640	38, 58, 63, 104, 152, 164, 167
I.41	Serra de Itatiaiuçu	Between 20°07'S, 44°19'W and 20°07'S, 44°21'W	1,230-1,340	51, 159
I.42	Serra do Caraça	Between 20°03'S, 43°26'W and 20°08'S, 43°31'W	1,200-2,070	6, 17, 21, 24, 29, 30, 35, 36, 37, 38, 40, 50, 51, 58, 63, 64, 74, 81, 86, 87, 88, 89, 90, 102, 103, 104, 107, 108, 129, 141, 149, 151, 152, 153, 155, 157, 158, 159, 160, 167
I.43	Alegria	Between 20°07'S, 43°25'W and 20°12'S, 43°23'W	900-1,000	24, 50, 107, 151, 152, 153, 167
I.44	Serra do Capanema	Between 20°10'S, 43°36'W and 20°11'S, 43°37'W	1,400-1,700	104, 152, 163, 167
I.45	Serra Santa	Between 20°11'S, 43°50'W and 20°14'S, 43°52'W	1,110-1,350	18, 24, 29, 30, 104, 107, 158, 159, 160
I.46	Serra do Batatal	Between 20°13'S, 43°30'W and 20°18'S, 43°34'W	1,240-1,810	38, 102, 104, 152, 157, 167
I.47	Serra da Moeda	Between 20°13'S, 43°56'W and 20°22'S, 43°58'W	1,270-1,480	38, 58, 63, 74, 77, 89, 104, 107, 167
I.48	Pico do Itacolomi	Between 20°24'S, 43°30'W and 20°26'S, 43°26'W	1,200-1,720	6, 17, 18, 21, 23, 24, 37, 38, 60, 77, 87, 89, 102, 104, 167
I.49	Serra de Belo Vale	Between 20°26'S, 43°56'W and 20°27'S, 43°56'W	1,260-1,520	77, 152
I.50	Serra do Mascate	Between 20°27'S, 43°55'W and 20°28'S, 43°56'W	1,350-1,620	152, 167
I.51	Serra de Ouro Branco	Between 20°28'S, 43°35'W and 20°30'S, 43°44'W	1,150-1,540	38, 63, 104, 107, 157, 167
II.1	Serra do Caparaó	Between 20°22'S, 41°47'W and 20°29'S, 41°50'W	1,900-2,890	10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 26, 28, 32, 45, 50, 58, 64, 65, 69, 78, 83, 102, 104, 130, 151, 167
II.2	Serra da Vargem Grande	20°30'S, 42°04'W	1,500-1,750	140, 152, 167
II.3	Serra do Brigadeiro	Between 20°33'S, 42°25'W and 20°47'S, 42°28'W	1,300-1,980	72
II.4	Serra de São José	Between 21°02'S, 44°06'W and 21°06'S, 44°13'W	1,000-1,320	63, 87, 104
II.5	Serra do Lenheiro	Between 21°08'S, 44°17'W and 21°09'S, 44°19'W	1,050-1,200	63, 104, 140, 167
II.6	Serra do Ibitipoca	Between 21°40'S, 43°52'W and 21°42'S, 43°54'W	1,400-1,780	54, 55, 104, 148, 152, 167
II.7	Serra do Papagaio	Between 22°00'S, 44°38'W and 22°03'S, 44°41'W	1,500-2,150	73, 104, 140, 143, 167
II.8	Serra do Itatiaia	Between 22°21'S, 44°38'W and 22°25'S, 44°43'W	2,000-2,787	3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 16, 17, 18, 19, 20, 26, 32, 38, 39, 43, 51, 52, 58, 64, 102, 104, 151, 157, 159, 167

TABLE 1: Continued.

Code	Locality	Coordinates	Elevation (m)	Sources
II.9	Pedra da Mina	22°25'S, 44°50'W	2,797	79
II.10	Marins-Itaguaré	Between 22°29'S, 45°04'W and 22°29'S, 45°07'W	2,050-2,250	137, 156
II.11	Pedra de São Domingos	22°41'S, 45°57'W	2,000	140, 152, 167
II.12	Serra dos Poncianos	Between 22°53'S, 46°00'W and 22°53'S, 46°03'W	1,800-2,010	167
II.13	Atibaia	Between 23°08'S, 46°30'W and 23°10'S, 46°31'W	1,050-1,350	56
III.1	Pedra Azul	Between 20°24'S, 41°00'W and 20°24'S, 41°01'W	1,450-1,900	65, 80, 167
III.2	Serra dos Órgãos	Between 22°20'S, 42°34'W and 22°29'S, 43°06'W	1,400-2,263	8, 11, 20, 26, 32, 52, 58, 64, 124, 136, 151, 157, 162, 165, 166, 167
III.3	Serra da Bocaina	Between 22°42'S, 44°34'W and 22°49'S, 44°46'W	1,500-2,200	49, 52, 58, 104, 158, 159

by Ihering (1900) and Ruschi (1978, 1982b), since those authors did not mention the elevation and habitats where they recorded the species (*see* Remsen, 1994). Based on our field experience, we also did not include species only recorded in some published checklists not supported by physical evidence (specimens, photos or tape-recordings) since these records are possibly based on misidentifications. A list of all sources used in this revision is presented in Appendix 1.

Geographical distribution patterns for bird species were discussed based on: 1) our own fieldwork conducted in the following regions: Brazil (Pará, Maranhão, Ceará, Pernambuco, Tocantins, Bahia, Goiás, Mato Grosso, Mato Grosso do Sul, Minas Gerais, Espírito Santo, Rio de Janeiro, São Paulo, Paraná, Santa Catarina, Rio Grande do Sul), Peru (Ancash), Bolivia (Santa Cruz), and Argentina (Misiones); 2) specimens housed in the above mentioned institutions; and 3) literature review (*see* Appendix 1).

Taxonomy follows the Brazilian Committee of Ornithological Records (CBRO, 2007). Bird species were classified following their endemism after several authors (Ridgely & Tudor, 1989, 1994; Silva, 1995, 1997; Stotz *et al.,* 1996; Sick, 1997; Stattersfield *et al.,* 1998; Brooks *et al.,* 1999; Silva & Bates, 2002; Silva & Santos, 2005). The exceptions are those typical species of the *campos rupestres* considered restricted to the Cerrado region (Silva, 1995; 1997; Silva & Bates, 2002; Silva & Santos, 2005). Here, they were considered endemics to the open-habitats of southeastern Brazilian mountaintops (following arguments presented by Vasconcelos *et al.,* 2003; Lopes, 2008; Vasconcelos, 2008b). These species are *Augastes scutatus, Asthenes luizae, Polystictus superciliaris,* and *Embernagra longicauda.*

RESULTS AND DISCUSSION

Species richness and composition

A total of 231 bird species was recorded in the open-habitats of southeastern Brazilian mountaintops (Appendix 2). The list for the *campos rupestres* has a total of 205 species, while the *campos de altitude* has 123 species (Appendix 2). Ninety-seven species occur both in the *campos rupestres* and in the *campos de altitude.* One hundred and eight species were exclusive to the *campos rupestres,* while 26 species were recorded only in the *campos de altitude* (Appendix 2).

The higher species richness recorded in the *campos rupestres* can be attributed to the Espinhaço Range being in the contact zones among Atlantic Forest, Cerrado, and Caatinga (Giulietti & Pirani, 1988; Ab'Sáber, 1990; Harley, 1995; Giulietti *et al.,* 1997). Such a variety of biomes within the Espinhaço Range leads to an increase in its species richness, especially because birds typical of the open-habitats of the Cerrado and semi-open-habitats of the Caatinga can also live in the *campos rupestres* (*see* Parrini *et al.,* 1999; Vasconcelos & D'Angelo-Neto, 2007). By contrast, the *campos de altitude* can be considered as isolated islands of open-habitat among forested areas in the Atlantic Forest region. Since many forest bird species cannot live in open areas, colonization of the *campos de altitude* by species from nearby habitats is more difficult than in the *campos rupestres.* Low temperature, episodic frosts and even snow (Sick, 1970; Martinelli & Orleans e Bragança, 1996; Safford, 1999b) may also preclude permanent colonization by open-habitat birds found in lower altitudes that could use current man-made pastures to get there. Furthermore, *campos rupestres* areas are more naturally interconnected compared with the *campos de altitude.*

This island feature of the *campos de altitude* could explain their lower species richness (MacArthur & Wilson, 1967). Meanwhile, more systematic surveys and area estimation based on satellite images are still necessary in order to test such hypothesis, as has been done for the northern Andes (Vuilleumier, 1970), Tepuis (Cook, 1974), and Sierras Pampeanas (Nores, 1995).

The differences in bird species composition between the *campos rupestres* and the *campos de altitude,* despite some species being common to both, demonstrate a pattern similar to that recognized for the flora (Safford, 1999a, 2007).

Geographic distribution patterns of the avifauna

Five patterns of distribution among the bird species occurring in the *campos rupestres* and *campos de altitude* can be recognized (Table 2):

- Non-endemic (191 species): Widespread species non-endemic to any biome.
- Atlantic Forest endemics (26 species): Species endemic to the Atlantic Forest region in southeastern Brazil and adjacent areas (eastern Paraguay, northeastern Argentina, and Uruguay).
- Cerrado endemics (6 species): Species restricted to the Cerrado region, except those typical of the *campos rupestres,* included here in another category (*see* materials and methods).
- Caatinga endemic (1 species): Species endemic to the Caatinga region in northeastern Brazil.
- Montane open-habitat endemics (7 species): Species endemic to the open-habitats of southeastern Brazilian mountaintops (*campos rupestres* and *campos de altitude*), including those restricted to *campos rupestres* (*see* above).

The highest proportion of the species living in southeastern Brazilian montane open-habitats is represented by widespread and non-endemic species (82.7%), with only 3.0% endemic to these habitats (Table 2). This is the opposite pattern of that found in the Andean puna and páramo, where 29% of the species are endemics and only 13.5% are widespread species (Vuilleumier, 1986). The high percentage of widespread bird species living in Brazilian montane open-habitats also contrasts to the local flora, which contains many endemic species (Eiten, 1992; Martinelli & Orleans e Bragança, 1996; Giulietti *et al.,* 1997; Safford, 1999a; Menezes & Giulietti, 2000).

The distribution patterns of the birds from *campos rupestres* and *campos de altitude* show remarkable differences between both vegetation types. Although both formations show a dominance of wide-ranging species, their percentage is a little higher in the *campos rupestres* (85.9%) than in the *campos de altitude* (79.7%) (Table 2).

Atlantic Forest birds from southeastern Brazil and adjacent areas account for more species in the *campos de altitude* (17.1%) than in the *campos rupestres* (7.3%) (Table 2). The *campos de altitude* have 21 of the 26 Atlantic Forest endemics (80.8%) that have been recorded in the montane open-habitats of southeastern Brazil, while in the *campos rupestres,* there are only 15 (57.7%) (Table 2). The ranges of many Atlantic Forest species found in the *campos de altitude* do not reach northwest to the *campos rupestres* region. Some examples are: *Stephanoxis lalandi, Drymophila genei, Scytalopus notorius, Hemitriccus obsoletus, Phylloscartes difficilis, Poospiza thoracica,* and *Saltator maxillosus.* Nevertheless, some Atlantic Forest endemics do reach the *campos rupestres,* especially at localities in the southern Espinhaço Range (Vasconcelos *et al.,* 1999b; Vasconcelos & Melo-Júnior, 2001) and their presence can be explained by the geographical proximity of this region to the coastal ranges. Such taxa include: *Leucochloris albicollis, Muscipipra vetula, Tangara desmaresti,* and *Haplospiza unicolor.*

TABLE 2: Distribution of bird species of *campos rupestres* and *campos de altitude,* analyzed as a single unit and separately. Distribution pattern: NE = non-endemic; AF = endemic to the Atlantic Forest region; CA = endemic to the Caatinga region; CE = endemic to the Cerrado region; MT = endemic to the open-habitats of southeastern Brazilian mountaintops (*campos rupestres* and *campos de altitude*).

Distribution pattern	*Campos rupestres* and *campos de altitude*		*Campos rupestres*		*Campos de altitude*	
	N	%	N	%	N	%
NE	191	82.7	176	85.9	98	79.7
AF	26	11.3	15	7.3	21	17.1
CE	6	2.6	6	2.9	1	0.8
CA	1	0.4	1	0.5	0	0
MT	7	3.0	7	3.4	3	2.4
Total	231	100	205	100	123	100

Among the bird species restricted to the Atlantic Forest region, four show a distribution pattern associated with the highlands in southeastern Brazil, despite the fact that they also occur either in lowlands or highlands in subtropical regions of southern Brazil and adjacent areas (south of 23°30'S). Those species are: *Stephanoxis lalandi, Scytalopus iraiensis, Stephanophorus diadematus,* and *Emberizoides ypiranganus.*

This pattern was also recognized in some plant genera (Simpson, 1979; Safford, 1999a), bees (Silveira & Cure, 1993), and a rodent (Gonçalves *et al.,* 2007), suggesting that these taxa probably had larger ranges during the Pleistocene (Simpson, 1979; Silveira & Cure, 1993; Safford, 1999a, 2007; Gonçalves *et al.,* 2007). During interglacial periods, with the predominance of warmer climates, the ranges of these taxa would have retreated southward and upward, with the probable trapping of several taxa in the "glacial refugia" provided by the southeastern Brazilian mountaintops. In the case of *S. diadematus,* populations do not appear to be isolated, with possible connections throughout coastal São Paulo. Nevertheless, *S. lalandi, S. iraiensis,* and *E. ypiranganus* appear to have two main isolated population centers, one in the southeastern Brazilian mountains and another in forests and wetlands south of 23°30'S. We could not find any geographic variation in specimens of *S. iraiensis* and *E. ypiranganus* we collected in southeastern Brazilian highlands compared to southern specimens (*see* Vasconcelos *et al.,* 2006, 2008a). Forest expansion over grasslands in southeastern Brazil appears to be recent (Behling, 2002) and this could explain the absence of morphological differentiation in those species.

Nevertheless, *S. lalandi* is represented by two very different subspecies: *S. l. lalandi* (southeastern Brazilian mountains) and *S. l. loddigesii* (lowlands and/or highlands south of 23°30'S). Since these geographical forms are morphologically distinctive, do not have any known intermediate specimen, and do not present any known range overlap, it is suggested that each one can be considered a valid species.

This same pattern of distribution is shown by *Poospiza lateralis / P. cabanisi* (Assis *et al.,* 2007). The pattern found for *S. lalandi* and *P. lateralis* groups suggests that the original ranges of the ancestral taxa have retreated to two areas with cooler and moister climatic features, with subsequent isolation and differentiation: 1) the high mountains of coastal southeastern Brazil; and 2) southern Brazil and adjacent areas (eastern Paraguay, northeastern Argentina, and Uruguay). This pattern should also be associated to Plio-Pleistocene tectonic movements (Petri & Fúlfaro, 1986) that also appear to have influenciated the differentiation of some forest bird species (Pinto, 1978; Silva & Stotz, 1992; Silva & Straube, 1996).

Another southern montane species recently found in the southeastern Brazilian mountaintops is *Cinclodes pabsti* (Freitas *et al.,* 2008). Nevertheless, it is necessary to analyze more specimens and voice recordings of this northern population to assess if it can be treated as a new taxon.

No species endemic to the Caatinga was recorded in the *campos de altitude* and only one Cerrado endemic (0.8%) was found in this habitat type. Small percentages of Cerrado (2.9%) and Caatinga endemics (0.5%) were found among the *campos rupestres* avifauna (Table 2).

All Cerrado endemics recorded in the *campos rupestres* have original distributions that do not reach the coastal ranges, except *Cyanocorax cristatellus.* This species have been expanding its range eastward and southward due to the deforestation of the Atlantic Forest (Alvarenga, 1990; Vasconcelos, 1999a; Mallet-Rodrigues *et al.,* 2007; Lopes, 2008), but it is possible that it is a native species in the only area of *campos de altitude* it was recorded (Serra do Ibitipoca), since the region is in a transitional zone between Atlantic Forest and Cerrado, with several bird species typical of each biome (Pacheco *et al.,* 2008).

The Caatinga reaches the borders of the central and northern Espinhaço Range, what explains the occurrence of one of its endemics (*Sakesphorus cristatus*) in the *campos rupestres.* Despite the fact that Marini & Lopes (2005) found *S. cristatus* in the Rio Doce basin at Conceição do Mato Dentro, we still consider it as a Caatinga endemic since it is probably expanding its range due to deforestation, as observed for other typical Caatinga birds in this river valley, such as *Columbina picui, Compsothraupis loricata,* and *Icterus jamacaii* (M.F.V., *pers. obs.*).

Bird species that have ranges restricted to mountaintop open-habitats of southeastern Brazil are represented by low percentages in both formations: 3.4% in the *campos rupestres* and 2.4% in the *campos de altitude* (Table 2). Montane open-habitat endemics with ranges restricted to the *campos rupestres* of the Espinhaço Range are: *Augastes lumachella, Augastes scutatus, Formicivora grantsaui,* and *Asthenes luizae. A. lumachella* and *F. grantsaui* are endemic to the northern Espinhaço Range, while *A. scutatus* and *A. luizae* are restricted to the central and southern regions (Vasconcelos, 2008b). *Oreophylax moreirae* was considered restricted to the *campos de altitude* in coastal mountains (Serra da Mantiqueira, Serra dos Órgãos, and Serra do Caparaó), but was recently discovered in the highest peaks of the southern Espinhaço Range, at Serra do Caraça (Melo-Júnior *et al.,* 1998; Vasconcelos, 2000; Vasconcelos & Melo-Júnior, 2001). *Polystictus superciliaris* and *Embernagra longicauda* were considered endemic to the *campos rupestres* of the Espinhaço Range, and also as Cerrado endemics (Silva, 1995, 1997; Silva & Bates, 2002; Silva & Santos, 2005). Nevertheless, these species were recorded outside the Espinhaço Range, in the Serra da Canastra and in the coastal mountains of the Atlantic Forest region, such as Serra do Mar, Serra da Mantiqueira, and Serra do Caparaó (Sick, 1997; Silveira, 1998; Vasconcelos, 1999a, b, 2003, 2008a, b; Vasconcelos *et al.,* 2003). The occurrence of *E. longicauda,* a typical species of the serras in the Espinhaço Range, in the Caparaó highlands suggests past connections between the *campos de altitude* of this area and the intermost open areas of Central Brazil, a pattern also corroborated by a recent study on *Akodon* rodents (Gonçalves *et al.,* 2007). Therefore, among the seven endemic bird species of the open-habitats of southeastern Brazilian mountaintops, four are restricted to the *campos rupestres* of the Espinhaço Range, but none of them is restricted to the *campos de altitude* of the eastern mountains.

In addition to those endemic species, there are four subspecies that appear to be restricted to the *campos rupestres* area of the Espinhaço Range: *Phaethornis pretrei schwarti, Campylopterus largipennis diamantinensis, Colibri delphinae greenewalti,* and *Knipolegus nigerrimus hoflingi.* Nevertheless, validity of some of those taxa are questionable (Vielliard, 1994; Stiles, 1999; Brammer, 2002) and further taxonomic studies are still necessary.

The majority of birds living in the open-habitats of southeastern Brazilian mountaintops are represented by widespread and non-endemic species. Thus, the Andean-Patagonian influence in the avifauna in those habitats is small. Nevertheless, four endemic species appear to have close relationships with other Andean (*Augastes lumachella, A. scutatus,* and *Oreophylax moreirae*) and Andean-Chacoan-Patagonian (*Asthenes luizae*) species (Sick, 1970, 1985; Silva, 1995; Vielliard, 1996; Vasconcelos *et al.,* 2008b), but in the absence of any phylogenetic analysis, it is impossible to determine the precise evolutionary relationships and biogeographical origins of these species.

Conservation

This review shows that bird species endemic to the Atlantic Forest, Cerrado, and Caatinga may be found together at the montane open-habitats of southeastern Brazil. Besides this contact zone character, those habitats have their own few endemic birds. Among the birds of the montane open-habitats of southeastern Brazil, 16 are considered threatened or near-threatened either globally or in Brazil (Table 3). There are some discrepancies between both checklists. For instance, in Brazil, there are four threatened and two near-threatened species (Machado *et al.,* 2005), while globally there are six threatened and 10 near-threatened species (BirdLife International, 2007) (Table 3). Two examples are *Asthenes luizae* and *Poospiza cinerea,* both not considered as threatened species in Brazil, but classified as globally vulnerable (Table 3).

Despite 32 protected areas established in *campos rupestres* and *campos de altitude,* especially national and state parks (Table 4), those reserves cannot guarantee the conservation of all of their vegetation types and endemic and threatened birds found atop those mountain ranges. The first reason is, following a rule in Brazil and other developing countries, many of the reserves exist only "on paper", and there is neither financial support nor control of illegal activities

TABLE 3: Bird species considered threatened or near-threatened in Brazil and in the world. Status: EN = endangered; NT = near-threatened; VU = vulnerable.

Family/Species	Brazil	Global
Tinamidae		
Nothura minor	VU	VU
Accipitridae		
Harpyhaliaetus coronatus	VU	EN
Psittacidae		
Primolius maracana	NT	NT
Aratinga auricapillus	—	NT
Trochilidae		
Augastes scutatus	—	NT
Augastes lumachella	—	NT
Thamnophilidae		
Drymophila genei	—	NT
Rhinocryptidae		
Scytalopus iraiensis	EN	EN
Furnariidae		
Cinclodes pabsti	NT	NT
Asthenes luizae	—	VU
Tyrannidae		
Polystictus superciliaris	—	NT
Phylloscartes difficilis	—	NT
Culicivora caudacuta	VU	VU
Emberizidae		
Porphyrospiza caerulescens	—	NT
Poospiza cinerea	—	VU
Embernagra longicauda	—	NT

TABLE 4: Reserves in the localities of *campos rupestres* and *campos de altitude* analyzed in this study. Numerical codes for localities are presented in Table 1. Brazilian states: BA = Bahia; ES = Espírito Santo; MG = Minas Gerais; RJ = Rio de Janeiro; SP = São Paulo.

Reserves	States	Localities
Morro do Chapéu State Park, Monumento Natural Cachoeira do Ferro Doido	BA	I.3
Chapada Diamantina National Park, Mucugê Municipal Park	BA	I.5, I.6, I.7, I.8, I.9, I.10
Serra das Almas Municipal Park, Área de Relevante Interesse Ecológico Nascentes do Rio de Contas	BA	I.12, I.15
Serra Nova State Park	MG	I.23
Grão Mogol State Park	MG	I.24
Serra do Cabral State Park	MG	I.27
Biribiri State Park	MG	I.30
Pico do Itambé State Park, Rio Preto State Park	MG	I.32
Serra do Cipó National Park, Serra do Intendente State Park, Salão de Pedras Natural Park, Monumento Natural Serra da Ferrugem	MG	I.35
Monumento Natural Serra da Piedade	MG	I.36
Mangabeiras Municipal Park	MG	I.38
Serra do Rola Moça State Park	MG	I.39
Reserva Particular do Patrimônio Natural do Caraça	MG	I.42
Itacolomi State Park	MG	I.48
Serra do Caparaó National Park	ES/MG	II.1
Serra do Brigadeiro State Park	MG	II.3
Ibitipoca State Park	MG	II.6
Serra do Papagaio State Park	MG	II.7
Itatiaia National Park	MG/RJ	II.8
Itapetinga Grota Funda Municipal Park	SP	II.13
Pedra Azul State Park	ES	III.1
Serra dos Órgãos National Park, Desengano State Park, Três Picos State Park	RJ	III.2
Serra da Bocaina National Park	RJ/SP	III.3

inside their areas. Examples of paper parks with little enforcement are Serra Nova State Park, Grão Mogol State Park, Serra do Cabral State Park, and Sempre Vivas National Park (all in Minas Gerais state), the last one not included in this revision, but in the main massif of Espinhaço Range with large areas of *campos rupestres.* Most of these reserves were decreed without local landowners receiving compensation for their lands. Besides lack of funds, the main reasons for that are the lack of legal titles by the *de facto* owners and the generalized mess of land tenure in Brazil. As a result, there were reports of landowners setting fire to the *campos rupestres* of Serra do Cabral and Grão Mogol State Parks as a way of demanding the money they never received (*see* below).

Secondly, the staff working in most Brazilian protected areas consists of too few people unable to control and protect large areas against the pillaging of the natural heritage. Also, most reserves are threatened by uncontrolled tourism in southeastern Brazil. The recently created "Estrada Real" touristic route linking the southeastern Brazilian coast (Parati and Rio de Janeiro) to the highlands of Minas Gerais state, is an important threat to the conservation of the *campos rupestres* and *campos de altitude* as the number of tourists visiting these mountainous areas has shown a rapid increase in the last three years without proper control on their activities. A portion of this "ecological road" partially destroyed the *campos rupestres* in the type-locality of *Asthenes luizae,* a globally vulnerable species (BirdLife International, 2007). This kind of development is a serious threat to this endemic bird species, as well as to a restricted-range plant species (Viana *et al.,* 2005). In the *campos de altitude* of Caparaó, Itatiaia, and Serra dos Órgãos National Parks, as well as in the Ibitipoca State Park, large numbers of tourists camp in the mountaintops, trampling the fragile native vegetation and causing fire hazards. It is common to find hundreds of people in those areas during weekends, holidays, or vacations. In Caparaó National Park, mules take the tourists to the highlands of this important area (Vasconcelos, 2003). These animals crush and graze the flora of the *campos de altitude* of Serra do Caparaó, composed of endemic and rare plant species (Leoni, 1997). So, management of these reserves is poor and obviously not conservation-focused. Additionally, some tourists also collect endemic plants like orchids and bromeliads (Conceição, 2000; Vasconcelos, 2000). In Reserva Particular do Patrimônio Natural do Caraça, a private reserve, tourists used to collect endemic "canelas-de-ema" (Velloziaceae) in the *campos rupestres* as firewood (Vasconcelos, 2000).

Fire is another significant problem closely related to uncontrolled touristic activities, and large areas of Chapada Diamantina burn every year (Conceição, 2000). In the Serra do Caraça region, criminal fires affected one of the marshes where *Scytalopus iraiensis,* a globally endangered species at global and national levels, was recorded. After the fire, the species was not recorded again in this marsh (M.F.V., *pers. obs.*).

Unfortunately, many fires in the montane open-habitats are accidentally caused by tourists who camp in those areas, by ranchers renewing their pastures, or by disgruntled landowners who have not been paid for the land expropriated by parks and other reserves. Environmental modifications caused by fire in the *campos rupestres* and *campos de altitude* include floristic impoverishment and later occurrence of invasive plant species, which compete for space and light with native and endemic ones (Martinelli & Orleans e Bragança, 1996; Safford, 1999a; Vasconcelos, 2000; Vasconcelos *et al.,* 2002b).

Other human impacts are widespread in the mountains, such as mining, hunting, and overgrazing by cattle and horses (Safford, 1999a; Vasconcelos, 2000, 2003; Vasconcelos *et al.,* 2002b). In the Quadrilátero Ferrífero, extensive areas of *campos rupestres* growing on rock outcrops rich in iron ore ("canga") have been quickly destroyed for mining (Jacobi *et al.,* 2007; Versieux & Wendt, 2007). The demise of this special type of *campos rupestres* probably led *Augastes scutatus,* a near-threatened species, to local extinction in one locality of Quadrilátero Ferrífero (Vasconcelos, 1999b). In the Cipó Range and Chapada Diamantina region, many families live based on the collection and sale of "sempre-vivas", endemic plants of the family Eriocaulaceae, which are valuable for ornamental purposes.

An important set of endemic and threatened bird species live in the *campos rupestres* and *campos de altitude,* and better efforts must be directed toward the better conservation of those important vegetation types. Safford (1999a) presented a series of actions that should be taken as a base for the conservation of the *campos de altitude* flora. Those can also be applied to avifauna conservation in the highlands of south-eastern Brazil.

RESUMO

Os ambientes abertos das montanhas do sudeste do Brasil são representados pelos campos rupestres (principalmente na Cadeia do Espinhaço) e pelos campos de altitude (nas Serras do Mar e da Mantiqueira). Apesar da ocorrência de espécies endêmicas em ambos os tipos de vegetação, uma análise e síntese de suas comunidades de aves nunca foram realizadas. Nesse estudo, apresentamos uma revisão da avifauna dessas áreas, descrevemos padrões de distribuição geográfica e comentamos sobre a conservação destes ambientes e de sua avifauna. Um total de 231 espécies de aves foi registrado nos ambientes abertos dos topos de montanha do sudeste do Brasil. Nos campos rupestres, 205 espécies foram registradas, enquanto nos campos de altitude o total foi de 123 espécies. Cinco padrões de distribuição são reconhecidos dentre as aves que ocorrem nestes habitats: não-endêmicas (191 espécies), endêmicas da Mata Atlântica (26 espécies), endêmicas do Cerrado (6 espécies), endêmica da Caatinga (1 espécie) e endêmicas dos habitats abertos dos topos de montanha (7 espécies). Apesar da presença de várias unidades de conservação nessas regiões, estas reservas não garantem a conservação de seus importantes tipos vegetacionais e de suas avifaunas sob os atuais níveis de gestão. Uma vez que várias espécies de aves endêmicas e ameaçadas de extinção vivem nos campos rupestres e campos de altitude, maiores esforços devem ser direcionados à sua conservação.

Palavras-chave: Avifauna; Campos rupestres; Campos de altitude; Distribuição; Conservação.

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APPENDIX 1

List of sources used in the revision of the open-habitat avifauna of southeastern Brazilian mountaintops.

Number	Source
1	Spix (1825)
2	Wied (1831)
3	Ule (1895)
4	Hemmendorff & Moreira (1903)
5	Miranda-Ribeiro (1906)
6	Gounelle (1909)
7	Lüderwaldt (1909)
8	Miranda-Ribeiro (1923)
9	Peixoto-Velho (1923a)
10	Peixoto-Velho (1923b)
11	Holt (1928)
12	Miranda-Ribeiro (1930)
13	Snethlage (1930)
14	Naumburg (1937)
15	Naumburg (1939)
16	Pinto (1951)
17	Ruschi (1951)
18	Pinto (1952)
19	Pinto (1954)
20	Sick (1959)
21	Ruschi (1962a)
22	Ruschi (1962b)
23	Ruschi (1963a)
24	Ruschi (1963b)
25	Ruschi (1963c)
26	Sick (1963)
27	Ruschi (1964)
28	Schubart *et al.* (1965)
29	Grantsau (1967)
30	Grantsau (1968)
31	O'Brien (1968)
32	Sick (1970)
33	Ruschi (1975)
34	Sazima (1977)
35	Carnevalli (1980)
36	Carnevalli (1982)
37	Ruschi (1982a)
38	Mattos & Sick (1985)
39	Dorst & Vuilleumier (1986)
40	Grantsau (1988)
41	Ridgely & Tudor (1989)
42	Pearman (1990)
43	Pineschi (1990)
44	Sazima & Sazima (1990)
45	Vielliard (1990a)
46	Vielliard (1990b)
47	Willis & Oniki (1991)
48	Studer & Teixeira (1993)
49	Ridgely & Tudor (1994)
50	Vielliard (1994)

Number	Source
51	Lencioni-Neto (1996)
52	Martinelli & Orleans e Bragança (1996)
53	Vasconcelos & Lombardi (1996)
54	Andrade (1997a)
55	Andrade (1997b)
56	Piratelli (1997)
57	Ribeiro (1997)
58	Sick (1997)
59	Vasconcelos (1997)
60	Andrade (1998)
61	Andrade *et al.* (1998)
62	Cordeiro *et al.* (1998)
63	Machado *et al.* (1998)
64	Melo-Júnior *et al.* (1998)
65	Pacheco & Bauer (1998)
66	Vasconcelos & Brandt (1998)
67	Vasconcelos *et al.* (1998)
68	Almeida & Raposo (1999)
69	Bauer (1999)
70	Funch (1999)
71	Parrini *et al.* (1999)
72	Simon *et al.* (1999)
73	Vasconcelos (1999a)
74	Vasconcelos (1999b)
75	Vasconcelos & Lombardi (1999)
76	Vasconcelos *et al.* (1999a)
77	Vasconcelos *et al.* (1999b)
78	Pacheco (2000)
79	Santos (2000)
80	Vasconcelos & Lombardi (2000)
81	Vasconcelos (2000)
82	Carvalhaes (2001)
83	Gonzaga & Castiglioni (2001)
84	Melo-Júnior *et al.* (2001)
85	Romão *et al.* (2001)
86	Vasconcelos (2001a)
87	Vasconcelos (2001b)
88	Vasconcelos & Ferreira (2001)
89	Vasconcelos & Lombardi (2001)
90	Vasconcelos & Melo-Júnior (2001)
91	Vasconcelos *et al.* (2001)
92	Brammer (2002)
93	Vasconcelos (2002)
94	Vasconcelos *et al.* (2002a)
95	Willis (2002)
96	Coelho & Machado (2003)
97	Faustino & Machado (2003)
98	Faustino *et al.* (2003)
99	Machado (2003)
100	Machado *et al.* (2003a)

Number	Source
101	Machado *et al.* (2003b)
102	Vasconcelos (2003)
103	Vasconcelos & Silva (2003)
104	Vasconcelos *et al.* (2003)
105	Hoffmann & Rodrigues (2005)
106	Machado (2005)
107	Abreu (2006)
108	Alves *et al.* (2006)
109	Colaço *et al.* (2006)
110	Costa & Rodrigues (2006a)
111	Costa & Rodrigues (2006b)
112	Domingues & Rodrigues (2006)
113	Faustino & Machado (2006)
114	Gomes (2006)
115	Gomes & Guerra (2006)
116	Gomes & Rodrigues (2006a)
117	Gomes & Rodrigues (2006b)
118	Guerra & Alves (2006)
119	Guerra *et al.* (2006)
120	Hoffmann (2006)
121	Hoffmann & Rodrigues (2006a)
122	Hoffmann & Rodrigues (2006b)
123	Hoffmann & Rodrigues (2006c)
124	Raposo *et al.* (2006)
125	Ribon *et al.* (2006)
126	Santana & Machado (2006)
127	Vasconcelos *et al.* (2006)
128	Zorzin *et al.* (2006)
129	Alves, A.C.F. *et al.* (2007)
130	Assis *et al.* (2007)
131	Costa & Rodrigues (2007)
132	Gonzaga *et al.* (2007)
133	Hoffmann *et al.* (2007)
134	Machado *et al.* (2007a)

Number	Source
135	Machado *et al.* (2007b)
136	Mallet-Rodrigues *et al.* (2007)
137	Olmos (2007)
138	Vasconcelos (2007)
139	Vasconcelos & D'Angelo-Neto (2007)
140	Vasconcelos *et al.* (2007a)
141	Vasconcelos *et al.* (2007b)
142	Freitas & Rodrigues (2008)
143	Vasconcelos (2008a)
144	Vasconcelos & Endrigo (2008)
145	Costa & Rodrigues (*pers. com.*)
146	Costa *et al.* (2008)
147	Freitas *et al.* (2008)
148	Pacheco *et al.* (2008)
149	Vasconcelos *et al.* (2008a)
150	Vasconcelos *et al.* (2008b)
151	AMNH
152	DZUFMG
153	MBML
154	MCN
155	MCP
156	MHNT
157	MNRJ
158	MPEG
159	MZUSP
160	SG
161	F.F. Vasconcelos (*pers. com.*)
162	F. Mallet-Rodrigues (*pers. com.*)
163	F.S. Leite (*pers. com.*)
164	G.B. Malacco (*pers. com.*)
165	J.F. Pacheco (*pers. com.*)
166	R. Parrini (*pers. com.*)
167	Personal observation

APPENDIX 2

Checklist of the avifauna recorded in the *campos rupestres* and *campos de altitude* of southeastern Brazilian mountaintops and patterns of endemism. Numerical codes for localities and sources are presented in Table 1 and Appendix 1, respectively. Endemism: AF = endemic to the Atlantic Forest region; CA = endemic to the Caatinga region; CE = endemic to the Cerrado region; MT = endemic to the open-habitats of southeastern Brazilian mountaintops (*campos rupestres* and *campos de altitude*).

Family/Species	*Campos rupestres*	*Campos de altitude*	Sources	Endemism
Tinamidae				
Crypturellus parvirostris	I.5, I.10, I.15, I.18, I.20, I.23, I.24, I.25, I.27, I.32, I.35, I.36, I.37, I.43, I.44		70, 71, 84, 106, 139, 167	
Rhynchotus rufescens	I.10, I.15, I.24, I.25, I.26, I.33, I.35, I.37, I.40, I.44	II.6, II.8	3, 5, 7, 8, 11, 16, 19, 39, 58, 70, 71, 82, 84, 139, 145, 148, 167	
Nothura minor	I.30		1, 18	CE
Nothura maculosa	I.5, I.10, I.25, I.26, I.30, I.32, I.35, I.50	II.6, II.8	5, 8, 11, 16, 18, 19, 54, 84, 106, 139, 145, 148, 152, 167	
Threskiornithidae				
Theristicus caudatus	I.32		93, 167	
Cathartidae				
Cathartes aura	I.10, I.15, I.18, I.20, I.24, I.25, I.26, I.32, I.35, I.37, I.42, I.43, I.44, I.46, I.50, I.51	II.1, II.6, II.8	11, 16, 19, 47, 84, 90, 106, 139, 145, 148, 167	
Coragyps atratus	I.3, I.5, I.10, I.18, I.20, I.24, I.25, I.26, I.27, I.35, I.36, I.37, I.38, I.40, I.42, I.43, I.46, I.47, I.48, I.50, I.51	II.2, II.6, II.7, II.8, II.11, II.12, III.1, III.2	5, 8, 11, 16, 19, 39, 47, 59, 70, 71, 84, 90, 106, 136, 138, 139, 145, 148, 162, 164, 166, 167	
Sarcoramphus papa	I.3, I.27, I.35, I.42, I.46, I.48		70, 71, 84, 90, 145, 167	
Accipitridae				
Elanus leucurus		II.6	148	
Ictinia plumbea	I.5		106	
Geranospiza caerulescens	I.32, I.35		61, 167	
Heterospizias meridionalis	I.35	II.6	145, 148	
Harpyhaliaetus coronatus	I.5, I.35, I.39		57, 71, 128	
Percnohierax leucorrhous		II.8	11, 16, 19	
Rupornis magnirostris	I.5, I.10, I.15, I.20, I.21, I.24, I.25, I.26, I.27, I.32, I.35, I.36, I.38, I.40, I.42, I.43, I.44, I.46, I.47, I.48, I.50	II.6, II.8, II.11	84, 86, 90, 106, 138, 139, 145, 148, 164, 167	
Buteo albicaudatus	I.18, I.26, I.27, I.32, I.35, I.36, I.38, I.40, I.42, I.44, I.46, I.50, I.51	II.1, II.2, II.6, II.8, II.10, II.11, III.1, III.2	47, 52, 84, 90, 136, 137, 138, 139, 145, 148, 162, 164, 167	
Buteo melanoleucus	I.5, I.15, I.20, I.25, I.35, I.38, I.42, I.46	II.6	47, 70, 71, 82, 88, 90, 138, 139, 145, 148, 167	
Buteo albonotatus	I.18, I.35, I.36, I.42		84, 86, 90, 145, 167	
Falconidae				
Caracara plancus	I.3, I.10, I.26, I.27, I.33, I.35, I.36, I.37, I.38, I.40, I.42, I.43, I.44, I.46, I.48, I.50, I.51	II.6, II.7, II.8	70, 71, 82, 84, 90, 106, 138, 139, 143, 145, 148, 164, 167	
Milvago chimachima	I.3, I.5, I.10, I.15, I.24, I.25, I.26, I.27, I.32, I.33, I.35, I.36, I.38, I.40, I.42, I.43, I.50, I.51	II.6, II.8	7, 8, 47, 70, 71, 82, 84, 86, 90, 138, 139, 145, 148, 164, 167	
Herpetotheres cachinnans	I.20, I.35, I.42	II.6, II.7	90, 145, 148, 167	
Falco sparverius	I.3, I.10, I.15, I.25, I.27, I.32, I.35, I.36, I.38, I.42, I.43, I.44, I.49	II.6, II.7, II.8	7, 8, 11, 16, 19, 39, 47, 71, 82, 84, 90, 138, 145, 148, 152, 167	

Family/Species	*Campos rupestres*	*Campos de altitude*	Sources	Endemism
Falco femoralis	I.15, I.27, I.35, I.38, I.42	II.6	47, 70, 71, 82, 90, 138, 148, 167	
Falco peregrinus	I.42		86, 167	
Rallidae				
Porzana albicollis	I.35		167	
Cariamidae				
Cariama cristata	I.5, I.10, I.15, I.20, I.24, I.26, I.27, I.32, I.33, I.35, I.36, I.37, I.42, I.43, I.50, I.51	II.1, II.6, II.7, II.8, III.2, III.3	7, 11, 16, 19, 52, 58, 70, 71, 82, 84, 90, 106, 136, 139, 143, 145, 148, 162, 167	
Scolopacidae				
Gallinago paraguaiae	I.15, I.27		70, 71, 167	
Gallinago undulata	I.32, I.35		167	
Columbidae				
Columbina minuta	I.10		71, 82	
Columbina talpacoti	I.35, I.38, I.40	II.1	10, 47, 84, 102, 164, 167	
Columbina squammata	I.32, I.35, I.43		84, 167	
Columbina picui	I.5, I.10, I.23, I.24		106, 139, 167	
Patagioenas picazuro	I.26, I.27, I.35, I.36, I.38, I.40, II.5		84, 138, 139, 145, 164, 167	
Patagioenas cayennensis	I.35, I.42	II.6	84, 90, 145, 148	
Patagioenas plumbea	I.40	II.8	5, 7, 8, 11, 16, 19, 43, 164	
Zenaida auriculata	I.18, I.35		145, 152, 167	
Leptotila verreauxi	I.38, I.42		90, 138, 167	
Psittacidae				
Primolius maracana		II.6	148	
Diopsittaca nobilis	I.27		167	
Aratinga leucophthalma	I.20, I.25, I.26, I.32, I.36, I.42, I.43, I.44, I.49	II.6, II.7, II.8	90, 139, 143, 148, 152, 167	
Aratinga auricapillus	I.27		167	
Aratinga aurea	I.24, I.27, I.32, I.35, I.38, I.41, I.46, I.47, I.50		47, 84, 138, 139, 145, 152, 159, 167	
Aratinga cactorum	I.3, I.5, I.10, I.15, I.19, I.20, I.21, I.23, I.24, I.25		70, 71, 82, 106, 139, 167	
Pyrrhura frontalis	I.5, I.15, I.27	II.8, III.2	5, 8, 16, 19, 71, 82, 136, 166, 167	AF
Forpus xanthopterygius	I.35		47, 84, 167	
Brotogeris chiriri	I.24, I.26, I.27, I.36		139, 167	
Pionopsitta pileata		II.8	7, 8, 11, 16, 19	AF
Pionus maximiliani	I.20, I.26, I.27, I.42, I.43		90, 139, 167	
Amazona aestiva	I.5		106	
Cuculidae				
Piaya cayana	I.5, I.27, I.35, I.40, I.42		71, 82, 90, 145, 164, 167	
Crotophaga ani	I.5, I.10, I.15, I.32, I.35, I.42, I.46		47, 71, 82, 84, 90, 106, 167	
Guira guira	I.26, I.35	II.1, II.8	10, 11, 16, 19, 84, 102, 139, 145, 167	
Tytonidae				
Tyto alba		II.6	148	
Strigidae				
Megascops choliba		II.6	148	
Glaucidium brasilianum	I.26, I.27, I.32		139, 167	
Athene cunicularia	I.18, I.33, I.35, I.46	II.6	47, 84, 148, 167	
Nyctibiidae				
Nyctibius griseus	I.35		84, 167	

Family/Species	*Campos rupestres*	*Campos de altitude*	Sources	Endemism
Caprimulgidae				
Chordeiles pusillus	I.25, I.43		139, 167	
Caprimulgus longirostris	I.10, I.20, I.26, I.27, I.30, I.32, I.35, I.36, I.38, I.40, I.42, I.44, I.46, I.49, I.50	II.1, II.2, II.6, II.8, II.10, III.2	20, 26, 28, 58, 67, 69, 70, 71, 76, 82, 84, 90, 102, 136, 138, 139, 145, 148, 152, 155, 156, 157, 159, 163, 164, 165, 167	
Caprimulgus parvulus	I.35		145	
Hydropsalis torquata	I.35, I.42, I.46, I.50	II.6	84, 90, 148, 152, 167	
Apodidae				
Cypseloides senex	I.15, I.35		70, 71, 82, 152, 167	
Streptoprocne zonaris	I.10, I.15, I.21, I.35, I.38, I.40, I.42, I.50	II.6, II.8, III.2	11, 16, 19, 70, 71, 82, 84, 90, 106, 136, 138, 145, 148, 152, 162, 164, 167	
Streptoprocne biscutata	I.5, I.10, I.20, I.21, I.26, I.27, I.32, I.35, I.36, I.38, I.42, I.43, I.46, I.51	II.6, II.8, III.2	5, 8, 70, 71, 82, 88, 90, 136, 148, 152, 156, 159, 165, 166, 167	
Chaetura meridionalis	I.38, I.40, I.42	II.6, II.12	90, 138, 148, 164, 167	
Trochilidae				
Phaethornis pretrei	I.3, I.5, I.8, I.10, I.15, I.18, I.20, I.21, I.23, I.24, I.25, I.26, I.27, I.30, I.32, I.33, I.35, I.36, I.38, I.42, I.43, I.44, I.46, I.47, I.48, I.50, II.5	II.1, II.3, II.13	6, 10, 25, 29, 33, 47, 50, 56, 68, 70, 71, 72, 75, 82, 84, 89, 90, 96, 98, 99, 100, 102, 106, 109, 126, 134, 135, 138, 139, 145, 152, 167	
Phaethornis eurynome		II.6, II.8	7, 16, 19, 148, 167	AF
Campylopterus largipennis	I.24, I.27, I.30, I.32, I.35, I.42		6, 25, 27, 50, 64, 89, 90, 139, 151, 152, 153, 167	
Eupetomena macroura	I.3, I.8, I.15, I.24, I.25, I.26, I.27, I.30, I.32, I.35, I.36, I.38, I.42, I.43, I.47, I.50	II.3, II.7	6, 25, 47, 50, 70, 71, 72, 74, 75, 82, 84, 89, 90, 91, 109, 118, 139, 145, 152, 167	
Florisuga fusca	I.30, I.38, I.42, I.45	II.3	25, 72, 75, 89, 90, 138, 158, 167	AF
Colibri delphinae	I.5, I.8, I.9, I.10		22, 50, 68, 70, 71, 82, 151	
Colibri serrirostris	I.3, I.5, I.9, I.10, I.15, I.18, I.20, I.23, I.24, I.25, I.26, I.27, I.30, I.32, I.33, I.35, I.36, I.38, I.42, I.43, I.44, I.45, I.46, I.47, I.48, I.50, I.51	II.1, II.2, II.3, II.6, II.7, II.8, II.11, II.13, III.1, III.2	6, 7, 8, 11, 16, 19, 25, 29, 34, 39, 44, 47, 50, 52, 56, 58, 68, 69, 70, 71, 72, 75, 80, 82, 83, 84, 89, 90, 96, 98, 102, 106, 126, 134, 136, 138, 139, 143, 145, 148, 152, 159, 162, 167	
Anthracothorax nigricollis		II.3	72	
Chrysolampis mosquitus	I.3, I.5, I.8, I.10, I.20, I.35		50, 68, 70, 71, 82, 96, 98, 100, 106, 134, 145, 152, 167	
Stephanoxis lalandi		II.1, II.2, II.3, II.6, II.8, II.10, II.11, II.12, III.2, III.3	5, 6, 7, 8, 10, 11, 16, 17, 19, 50, 52, 58, 69, 72, 102, 136, 137, 148, 151, 152, 159, 162, 166, 167	AF
Chlorostilbon lucidus	I.3, I.5, I.8, I.10, I.15, I.18, I.20, I.24, I.27, I.30, I.35, I.36, I.37, I.38, I.40, I.42, I.43, I.44, I.46, I.47, I.48, I.50	II.1, II.3, II.7, II.8, II.13	6, 10, 17, 25, 29, 44, 47, 50, 56, 68, 70, 71, 72, 74, 75, 82, 84, 86, 89, 90, 96, 98, 99, 100, 102, 106, 109, 126, 134, 138, 139, 143, 145, 152, 164, 167	
Thalurania furcata	I.30, I.35, I.42		25, 90, 167	
Thalurania glaucopis	I.8, I.42, I.50	II.11, II.13	50, 56, 89, 90, 167	AF
Hylocharis cyanus		II.1, II.3	17, 72	
Leucochloris albicollis	I.40, I.42, I.50	II.1, II.2, II.3, II.6, II.7, II.8, II.11, II.13, III.1, III.2	5, 6, 7, 8, 10, 11, 16, 17, 19, 52, 56, 72, 80, 90, 102, 136, 143, 148, 152, 162, 167	AF
Amazilia versicolor	I.8, I.30, I.36		25, 50, 167	
Amazilia fimbriata	I.3, I.8, I.24, I.27, I.30		25, 50, 68, 152, 167	

Family/Species	*Campos rupestres*	*Campos de altitude*	Sources	Endemism
Amazilia lactea	I.10, I.30, I.35, I.36, I.38, I.40, I.42, I.43, I.45, I.46, I.50	II.3	6, 18, 25, 72, 75, 84, 89, 90, 96, 100, 106, 134, 138, 145, 159, 164, 167	
Clytolaema rubricauda	I.42	II.1, II.3, II.7, II.8, II.11, II.12, III.2	5, 6, 7, 8, 10, 11, 16, 17, 19, 52, 72, 90, 102, 136, 143, 159, 167	AF
Augastes scutatus	I.20, I.24, I.25, I.26, I.27, I.29, I.30, I.32, I.33, I.35, I.36, I.37, I.39, I.40, I.42, I.43, I.44, I.45, I.46, I.47, I.48, I.50, I.51		6, 17, 18, 21, 23, 24, 25, 29, 30, 34, 37, 40, 42, 44, 47, 50, 58, 60, 61, 62, 64, 74, 77, 81, 84, 89, 90, 91, 93, 95, 107, 108, 115, 129, 131, 139, 145, 151, 152, 153, 157, 158, 159, 160, 161, 164, 167	MT
Augastes lumachella	I.1, I.2, I.3, I.4, I.5, I.8, I.9, I.10, I.11, I.12, I.13, I.14, I.15, I.16, I.17		21, 23, 24, 29, 30, 38, 50, 58, 68, 70, 71, 82, 85, 96, 100, 101, 106, 107, 134, 151, 153, 159, 167	MT
Heliactin bilophus	I.9, I.15, I.27, I.30, I.33, I.35		25, 68, 70, 71, 82, 84, 89, 145, 159, 167	
Calliphlox amethystina	I.8, I.10, I.30, I.35, I.36, I.42	II.3	25, 29, 47, 50, 72, 89, 90, 96, 98, 100, 106, 134, 167	
Bucconidae				
Nystalus chacuru	I.15, I.32, I.35, I.46, I.48, I.49		84, 145, 152, 167	
Ramphastidae				
Ramphastos toco		II.6	148	
Picidae				
Picumnus cirratus	I.35, I.36, I.40, I.42, I.50		90, 164, 167	
Melanerpes candidus	I.32, I.35	II.1, II.6	10, 47, 102, 148, 167	
Veniliornis mixtus	I.35		145	
Colaptes campestris	I.5, I.10, I.15, I.21, I.23, I.24, I.25, I.26, I.27, I.32, I.33, I.35, I.36, I.37, I.38, I.40, I.42, I.43, I.44, I.46, I.47, I.48, I.50, II.5	II.1, II.6, II.7, II.8	5, 7, 8, 10, 11, 16, 19, 39, 47, 71, 82, 84, 90, 102, 106, 138, 139, 143, 145, 148, 164, 167	
Melanopareiidae				
Melanopareia torquata	I.5, I.10, I.15, I.19, I.20, I.25, I.27, I.34, I.35, I.38, I.44, I.46, I.49, I.50		53, 62, 70, 71, 77, 82, 84, 139, 152, 167	CE
Thamnophilidae				
Mackenziaena leachii	I.35, I.36, I.42, I.46, I.48	II.1, II.8, III.2	7, 8, 11, 14, 16, 18, 19, 58, 60, 78, 90, 102, 136, 159, 162, 166, 167	AF
Taraba major	I.27		167	
Sakesphorus cristatus	I.3, I.20, I.24, I.26		70, 71, 139, 167	CA
Thamnophilus doliatus	I.23, I.24		139, 167	
Thamnophilus caerulescens		II.6, II.8, II.10, III.2	5, 7, 11, 16, 19, 136, 137, 148, 165, 166	
Thamnophilus torquatus	I.5, I.10, I.15, I.19, I.20, I.35, I.36		70, 71, 77, 82, 84, 106, 145, 167	
Thamnophilus ruficapillus	I.42, I.48, I.50	II.1, II.6, II.8, II.10, III.2	10, 11, 14, 16, 18, 19, 43, 58, 65, 69, 90, 102, 136, 137, 148, 162, 166, 167	
Myrmorchilus strigilatus	I.15, I.20, I.21, I.24, I.26		139, 152, 167	
Herpsilochmus atricapillus	I.20, I.27		167	
Formicivora serrana	I.36, I.42, I.43		77, 90, 167	AF
Formicivora melanogaster	I.20		167	
Formicivora rufa	I.15, I.26, I.27		70, 71, 82, 139, 167	
Formicivora grantsaui	I.5, I.6, I.7, I.9, I.10		70, 71, 82, 132	MT
Drymophila genei		II.1, II.2, II.8, II.10, III.1, III.2	7, 11, 15, 16, 18, 19, 58, 65, 102, 136, 137, 159, 162, 166, 167	AF

Family/Species	*Campos rupestres*	*Campos de altitude*	Sources	Endemism
Conopophagidae				
Conopophaga lineata		II.1, II.8, III.2	5, 7, 8, 11, 14, 16, 18, 19, 28, 52, 58, 102, 136, 151, 159, 165, 166	
Rhinocryptidae				
Scytalopus notorius		II.1, II.2, II.6, II.7, II.8, II.10, II.11, II.12, III.2	5, 7, 8, 11, 12, 13, 16, 18, 19, 28, 39, 45, 52, 58, 102, 124, 136, 137, 148, 151, 152, 157, 159, 162, 166, 167	AF
Scytalopus speluncae	I.32, I.35, I.36, I.37, I.40, I.42, I.44, I.46, I.48		47, 77, 84, 90, 152, 155, 159, 167	
Scytalopus iraiensis	I.35, I.42		149, 167	AF
Dendrocolaptidae				
Lepidocolaptes angustirostris	I.20, I.21, I.24, I.25, I.26, I.27, I.35, I.42		47, 84, 90, 139, 167	
Furnariidae				
Cinclodes pabsti	I.35		147, 152	AF
Furnarius rufus	I.15, I.26, I.27, I.32, I.35, I.36, I.40, I.46, I.48	II.1	10, 47, 84, 102, 139, 164, 167	
Oreophylax moreirae	I.42	II.1, II.8, II.9, II.10, III.2	5, 7, 8, 9, 10, 11, 16, 19, 32, 39, 43, 52, 58, 64, 69, 79, 81, 90, 102, 104, 136, 137, 141, 151, 152, 155, 156, 157, 159, 162, 165, 166, 167	MT
Synallaxis frontalis	I.3, I.5, I.15, I.18, I.20, I.24, I.26, I.27, I.35		71, 82, 84, 139, 152, 167	
Synallaxis albescens	I.23, I.24, I.25, I.26, I.35, I.50		84, 139, 145, 167	
Synallaxis spixi	I.5, I.10, I.15, I.20, I.21, I.25, I.26, I.27, I.32, I.35, I.36, I.38, I.40, I.42, I.44, I.46, I.48, I.50	II.1, II.3, II.6, II.7, II.8, II.11, III.2	39, 47, 70, 71, 72, 82, 84, 90, 102, 104, 136, 138, 139, 148, 152, 162, 164, 166, 167	AF
Cranioleuca pallida	I.42	II.1, II.8, III.2	5, 8, 11, 16, 19, 90, 136, 166, 167	
Asthenes luizae	I.21, I.25, I.26, I.32, I.33, I.34, I.35		42, 46, 48, 61, 62, 84, 93, 94, 114, 115, 116, 117, 119, 139, 145, 150, 152, 156, 157, 159, 167	MT
Phacellodomus rufifrons	I.15, I.21, I.25, I.26, I.33, I.35, I.46, I.50	II.1	47, 84, 102, 139, 167	
Anumbius annumbi	I.35, I.37, I.48, I.51	II.7	84, 167	
Lochmias nematura	I.21, I.23, I.25, I.32, I.35, I.42, I.46, I.48	II.1, II.6, II.7, II.8, III.2	7, 8, 10, 11, 16, 19, 84, 102, 136, 148, 152, 159, 166, 167	
Tyrannidae				
Hemitriccus obsoletus		II.8, II.10	5, 7, 8, 11, 16, 19, 137, 159	AF
Hemitriccus margaritaceiventer	I.10, I.15, I.18, I.20, I.25, I.26, I.27, I.32, I.35		71, 82, 106, 139, 145, 152, 167	
Todirostrum cinereum	I.15		167	
Phyllomyias fasciatus	I.32, I.35, I.36, I.42, I.43, I.44, I.46	II.8	7, 11, 16, 19, 47, 84, 152, 159, 167	
Elaenia flavogaster	I.15, I.20, I.21, I.24, I.25, I.26, I.27, I.32, I.33, I.35, I.38, I.40, I.42, I.43, I.47, I.48, I.50		47, 70, 71, 84, 90, 138, 139, 145, 152, 164, 167	
Elaenia albiceps		II.6	148	
Elaenia parvirostris	I.43		167	
Elaenia mesoleuca	I.42, I.44	II.8, III.2	11, 16, 19, 43, 136, 152, 159, 162, 167	
Elaenia cristata	I.5, I.10, I.15, I.18, I.20, I.21, I.23, I.24, I.25, I.26, I.27, I.32, I.33, I.35, I.50, II.5		47, 70, 71, 82, 84, 113, 118, 139, 145, 152, 167	
Elaenia chiriquensis	I.20, I.27, I.35, I.42, I.43, I.50		84, 90, 145, 167	

Family/Species	*Campos rupestres*	*Campos de altitude*	Sources	Endemism
Elaenia obscura	I.15, I.24, I.25, I.26, I.27, I.32, I.35, I.36, I.40, I.42, I.43, I.44, I.46, I.49, I.50	II.6, II.8, II.10, II.11, III.2	5, 8, 16, 19, 47, 84, 90, 104, 136, 137, 139, 145, 148, 152, 159, 164, 165, 166, 167	
Camptostoma obsoletum	I.3, I.5, I.10, I.15, I.18, I.20, I.21, I.23, I.24, I.25, I.26, I.27, I.35, I.36, I.38, I.40, I.42, I.43, I.46, I.50	II.1, II.6, II.7	47, 71, 82, 84, 90, 138, 139, 143, 145, 148, 152, 164, 167	
Serpophaga nigricans	I.42	II.8	86, 159, 167	
Serpophaga subcristata	I.35, I.42, I.43	II.1, II.7, II.8	7, 11, 16, 19, 90, 102, 167	
Phaeomyias murina	I.20, I.24, I.32, I.35, I.42, I.43		84, 90, 139, 167	
Polystictus superciliaris	I.3, I.5, I.15, I.20, I.22, I.25, I.26, I.32, I.33, I.35, I.36, I.37, I.38, I.39, I.40, I.42, I.43, I.44, I.46, I.48, I.50	II.6, II.7, II.8, III.3	2, 35, 38, 42, 47, 49, 53, 58, 60, 62, 66, 70, 71, 73, 74, 77, 81, 82, 84, 90, 93, 104, 105, 115, 119, 120, 121, 122, 123, 133, 138, 139, 143, 145, 148, 151, 152, 159, 164, 167	MT
Phylloscartes ventralis	I.40	II.6, II.7, II.8, II.11	5, 7, 8, 11, 16, 19, 43, 148, 164, 167	
Phylloscartes difficilis		II.8, III.2	5, 7, 8, 11, 16, 19, 52, 136, 165, 166	AF
Culicivora caudacuta	I.35		167	
Myiophobus fasciatus	I.18, I.20, I.25, I.26, I.27, I.32, I.35, I.36, I.38, I.40, I.42, I.43, I.46, I.48, I.50	II.1, II.7	10, 47, 84, 90, 102, 138, 139, 143, 145, 152, 167	
Hirundinea ferruginea	I.3, I.5, I.10, I.15, I.20, I.23, I.24, I.25, I.27, I.32, I.35, I.36, I.38, I.42, I.43, I.44, I.46, I.48, I.50, II.5	II.2, II.3, II.6, II.11	60, 70, 71, 72, 82, 84, 90, 106, 138, 139, 148, 152, 167	
Pyrocephalus rubinus		II.3	72	
Knipolegus cyanirostris	I.35, I.42	II.1, II.2, II.6, II.8, II.10	5, 7, 8, 10, 11, 16, 19, 52, 90, 102, 137, 148, 167	
Knipolegus lophotes	I.26, I.32, I.35, I.36, I.38, I.40, I.42, I.44, I.45, I.48, I.50, I.51, II.5	II.1, II.6, II.7, II.8	7, 8, 11, 16, 18, 19, 47, 58, 60, 84, 90, 102, 138, 139, 143, 145, 148, 159, 164, 167	
Knipolegus nigerrimus	I.3, I.5, I.10, I.15, I.20, I.21, I.23, I.24, I.25, I.26, I.27, I.29, I.32, I.33, I.35, I.36, I.37, I.38, I.40, I.41, I.42, I.43, I.44, I.46, I.48, I.49, I.50, I.51, II.5	II.1, II.2, II.6, II.7, II.8, II.10, II.11, II.12, III.1, III.2	4, 5, 7, 8, 10, 11, 16, 19, 51, 54, 58, 66, 69, 70, 71, 82, 84, 90, 92, 97, 102, 104, 106, 113, 119, 136, 137, 138, 139, 143, 145, 148, 151, 152, 159, 162, 164, 165, 166, 167	
Xolmis cinereus	I.10, I.24, I.25, I.26, I.27, I.32, I.35, I.38, I.42, I.46	II.8	4, 5, 8, 11, 16, 19, 47, 70, 71, 82, 84, 90, 138, 139, 145, 167	
Xolmis velatus	I.25, I.35, I.40, I.43, I.51	II.6, II.7, II.8	7, 8, 47, 84, 143, 145, 148, 152, 164, 167	
Muscipipra vetula	I.35, I.42, I.46, I.48	II.1, II.8, II.11	5, 8, 10, 11, 16, 19, 60, 90, 102, 167	AF
Myiozetetes similis	I.15, I.26, I.42		90, 139, 167	
Pitangus sulphuratus	I.5, I.10, I.24, I.32, I.35, I.38, I.40, I.42, I.46	II.1, II.8	7, 10, 11, 16, 19, 47, 84, 90, 102, 106, 138, 139, 145, 164, 167	
Megarynchus pitangua	I.5, I.15, I.40, I.42		90, 106, 164, 167	
Tyrannus albogularis	I.40		164	
Tyrannus melancholicus	I.5, I.10, I.15, I.24, I.32, I.35, I.38, I.40, I.42, I.43, I.50	II.6, II.8	5, 8, 11, 16, 19, 71, 84, 90, 106, 145, 148, 152, 164, 167	
Tyrannus savana	I.35, I.38, I.40, I.43		138, 145, 164, 167	
Myiarchus swainsoni	I.27, I.42		90, 167	
Myiarchus ferox	I.26, I.27, I.35, I.36, I.38, I.42, I.46, I.48, I.50	II.6	47, 84, 90, 139, 148, 152, 167	
Myiarchus tyrannulus	I.42		90	

Family/Species	*Campos rupestres*	*Campos de altitude*	Sources	Endemism
Ramphotrigon megacephalum		II.1	18, 102	
Tityridae				
Tityra cayana	I.27		167	
Vireonidae				
Cyclarhis gujanensis	I.10, I.18, I.20, I.21, I.23, I.24, I.25, I.27, I.32, I.35, I.36, I.38, I.40, I.42, I.43, I.46, I.50	II.1, II.6, II.7, II.8, III.2	5, 7, 10, 11, 16, 19, 28, 47, 52, 84, 90, 97, 102, 106, 113, 136, 138, 145, 148, 164, 166, 167	
Hylophilus amaurocephalus	I.21		167	
Corvidae				
Cyanocorax cristatellus	I.25, I.27, I.32, I.35, I.38	II.6	84, 138, 145, 148, 167	CE
Cyanocorax cyanopogon	I.27		167	
Hirundinidae				
Progne tapera	I.5, I.10, I.24	II.6	106, 148, 167	
Progne chalybea	I.24, I.36, I.38, I.51		138, 167	
Pygochelidon cyanoleuca	I.5, I.10, I.15, I.20, I.21, I.24, I.26, I.35, I.36, I.37, I.38, I.42, I.44, I.46, I.47, I.50, I.51	II.1, II.6, II.7, II.8, II.11, II.12, III.1, III.2	5, 11, 16, 19, 47, 58, 70, 71, 82, 84, 90, 136, 138, 139, 143, 145, 148, 152, 165, 167	
Alopochelidon fucata	I.25, I.35, I.38		47, 84, 138, 167	
Stelgidopteryx ruficollis	I.15, I.21, I.24, I.25, I.26, I.27, I.32, I.35, I.36, I.38, I.40, I.42, I.43, I.46, I.50		47, 71, 82, 84, 90, 138, 139, 145, 164, 167	
Troglodytidae				
Troglodytes musculus	I.5, I.10, I.15, I.18, I.20, I.21, I.23, I.24, I.25, I.26, I.27, I.32, I.33, I.35, I.36, I.38, I.40, I.42, I.43, I.44, I.46, I.48, I.50, II.5	II.6, II.7, II.11	47, 71, 82, 84, 90, 106, 138, 139, 145, 148, 152, 164, 167	
Pheugopedius genibarbis	I.5, I.10, I.15		70, 71, 82, 167	
Polioptilidae				
Polioptila plumbea	I.3, I.10, I.15, I.18, I.20, I.25		70, 71, 139, 167	
Turdidae				
Turdus flavipes	I.35, I.42	II.8	5, 7, 8, 11, 16, 19, 43, 52, 145, 167	
Turdus rufiventris	I.5, I.27, I.35, I.40, I.42	II.1, II.6, II.8, III.2	7, 10, 11, 16, 19, 52, 84, 102, 106, 136, 148, 159, 164, 166, 167	
Turdus leucomelas	I.3, I.5, I.10, I.15, I.18, I.20, I.21, I.24, I.25, I.26, I.27, I.32, I.35, I.36, I.38, I.42, I.46, I.50, II.5	II.6, II.8	7, 11, 47, 71, 82, 84, 90, 97, 106, 113, 138, 139, 145, 148, 152, 167	
Turdus amaurochalinus	I.27, I.35, I.40	II.7, II.8	16, 19, 84, 159, 164, 167	
Turdus albicollis		II.6	148	
Mimidae				
Mimus saturninus	I.5, I.10, I.15, I.21, I.23, I.24, I.26, I.27, I.32, I.35, I.36, I.37, I.38, I.40, I.42, I.46, I.43, I.47, I.48, I.50	II.1, II.6, II.7	10, 47, 70, 71, 84, 90, 102, 106, 145, 148, 164, 167	
Motacillidae				
Anthus hellmayri	I.32, I.35, I.46, I.48, I.49, I.50, I.51	II.1, II.6, II.7, II.8, III.2	5, 7, 8, 11, 16, 19, 39, 47, 54, 55, 58, 84, 102, 125, 136, 143, 145, 148, 152, 159, 165, 167	
Coerebidae				
Coereba flaveola	I.3, I.5, I.10, I.15, I.18, I.20, I.24, I.25, I.26, I.27, I.35, I.36, I.38, I.42, I.43, I.48, I.50	II.1	10, 28, 71, 82, 84, 90, 98, 102, 106, 113, 126, 138, 139, 152, 167	

Family/Species	*Campos rupestres*	*Campos de altitude*	Sources	Endemism
Thraupidae				
Schistochlamys ruficapillus	I.3, I.5, I.10, I.15, I.18, I.20, I.21, I.24, I.25, I.26, I.27, I.29, I.32, I.33, I.35, I.36, I.38, I.37, I.40, I.41, I.42, I.43, I.44, I.46, I.48, I.50	II.1, II.3, II.6, II.8, III.2	10, 47, 52, 70, 71, 72, 82, 84, 90, 97, 102, 106, 112, 113, 118, 119, 136, 138, 139, 145, 148, 152, 159, 162, 164, 167	
Cypsnagra hirundinacea	I.26, I.35		84, 115, 139, 145, 167	
Trichothraupis melanops	I.50		152, 167	
Piranga flava	I.5, I.10, I.15, I.24, I.27, I.32, I.35, I.36, I.38, I.42, I.50	II.6, II.8	5, 11, 16, 19, 70, 71, 82, 84, 90, 97, 106, 113, 138, 145, 148, 167	
Tachyphonus rufus	I.20		167	
Thraupis sayaca	I.5, I.10, I.20, I.24, I.26, I.27, I.35, I.36, I.38, I.40, I.42, I.43, II.5		47, 84, 90, 106, 139, 164, 167	
Stephanophorus diadematus		II.1, II.2, II.6, II.7, II.8, II.10, II.11, II.12, III.1, III.2	5, 7, 8, 10, 11, 16, 18, 19, 43, 52, 58, 69, 73, 102, 104, 136, 137, 143, 148, 152, 159, 162, 166, 167	AF
Pipraeidea melanonota	I.35, I.42, I.50	II.8	5, 8, 11, 16, 19, 90, 145, 152, 167	
Tangara desmaresti	I.40, I.42	II.1, II.6, II.7, II.8, II.11, III.2	7, 8, 10, 11, 16, 19, 43, 90, 102, 136, 143, 148, 152, 159, 164, 166, 167	AF
Tangara cyanoventris	I.10, I.15, I.36, I.38, I.40, I.42, I.49		66, 71, 77, 82, 90, 138, 164, 152, 167	AF
Tangara cayana	I.5, I.10, I.15, I.18, I.20, I.21, I.24, I.26, I.27, I.32, I.35, I.36, I.38, I.42, I.43, I.46, I.48, I.50, II.5	II.6, II.7, II.11	47, 71, 82, 84, 90, 106, 138, 139, 143, 145, 148, 152, 167	
Tersina viridis	I.35, I.42		90, 118	
Dacnis cayana	I.25, I.27, I.36, I.38, I.40, I.42		90, 138, 139, 164, 167	
Hemithraupis guira	I.27		167	
Conirostrum speciosum	I.48		167	
Emberizidae				
Zonotrichia capensis	I.3, I.5, I.10, I.15, I.18, I.20, I.21, I.23, I.24, I.25, I.26, I.27, I.32, I.33, I.35, I.36, I.37, I.38, I.40, I.42, I.43, I.44, I.46, I.47, I.48, I.50, I.51, II.5	II.1, II.6, II.7, II.8, II.10, II.11, II.12, III.2, III.3	4, 5, 7, 8, 10, 11, 16, 19, 39, 43, 47, 52, 58, 68, 71, 82, 84, 90, 97, 102, 106, 113, 136, 137, 138, 139, 143, 145, 148, 151, 152, 159, 162, 164, 166, 167	
Ammodramus humeralis	I.5, I.10, I.15, I.20, I.24, I.25, I.26, I.27, I.32, I.35, I.40, I.43, I.48	II.6	47, 70, 71, 82, 84, 139, 145, 148, 152, 164, 167	
Porphyrospiza caerulescens	I.15, I.20, I.24, I.25, I.27, I.32, I.35, I.38, I.39, I.40, I.47		53, 70, 71, 77, 82, 84, 115, 139, 145, 152, 164, 167	CE
Haplospiza unicolor	I.36, I.42	II.1, II.8	10, 11, 16, 19, 43, 90, 102, 152, 167	AF
Donacospiza albifrons	I.35, I.42, I.48	II.1, II.8, III.2	16, 19, 58, 102, 136, 159, 166, 167	
Poospiza thoracica		II.1, II.7, II.8, II.10, II.11, II.12, III.2, III.3	4, 5, 7, 8, 10, 11, 16, 19, 52, 73, 102, 136, 137, 143, 152, 158, 159, 162, 166, 167	AF
Poospiza lateralis		II.1, II.7, II.8, II.11, II.12, III.3	7, 8, 10, 11, 16, 19, 52, 69, 102, 130, 143, 151, 159, 157, 167	AF
Poospiza cinerea	I.27, I.35, I.38		53, 111, 115, 119, 145, 167	CE
Sicalis citrina	I.5, I.10, I.15, I.18, I.20, I.21, I.23, I.24, I.25, I.26, I.27, I.32, I.34, I.35, I.36, I.37, I.38, I.42, I.43, I.46, I.48, I.49, I.50, II.5	II.2, II.6, II.7, II.11, II.12	60, 62, 70, 71, 82, 84, 90, 138, 139, 140, 143, 144, 145, 148, 152, 167	

Family/Species	*Campos rupestres*	*Campos de altitude*	Sources	Endemism
Sicalis flaveola	I.5, I.10	II.1, II.6, II.8	7, 8, 10, 11, 16, 19, 54, 55, 102, 106, 167	
Emberizoides herbicola	I.15, I.24, I.25, I.26, I.27, I.35, I.38, I.42, I.46, I.48, I.50, II.5	II.6, II.8	7, 8, 11, 16, 19, 47, 54, 55, 70, 71, 82, 84, 86, 104, 139, 145, 148, 167	
Emberizoides ypiranganus	I.32, I.35		127, 146, 152, 167	AF
Embernagra platensis		II.1, II.8, II.10	5, 8, 11, 16, 19, 38, 43, 58, 102, 137, 167	
Embernagra longicauda	I.3, I.5, I.10, I.15, I.19, I.20, I.21, I.23, I.24, I.25, I.26, I.27, I.28, I.29, I.30, I.31, I.32, I.33, I.34, I.35, I.36, I.38, I.39, I.40, I.42, I.43, I.44, I.45, I.46, I.47, I.48, I.50, I.51, II.4, II.5	II.1	31, 35, 36, 38, 41, 42, 47, 53, 58, 60, 61, 62, 63, 64, 70, 71, 74, 77, 81, 82, 84, 87, 90, 93, 102, 103, 104, 115, 119, 127, 138, 139, 142, 145, 151, 152, 154, 157, 159, 167	MT
Volatinia jacarina	I.5, I.10, I.24, I.35, I.38, I.40, I.43, I.46, I.50		70, 71, 82, 84, 106, 138, 139, 145, 152, 164, 167	
Sporophila plumbea	I.24, I.25		139, 167	
Sporophila nigricollis	I.5, I.10, I.20, I.24, I.25, I.27, I.32, I.35, I.36, I.40, I.42, I.43		84, 90, 106, 139, 164, 167	
Sporophila caerulescens	I.35	II.1	47, 84, 102, 167	
Sporophila bouvreuil	I.25		167	
Coryphospingus pileatus	I.35, I.43, I.50	II.1	10, 84, 102, 167	
Cardinalidae				
Saltator similis	I.10, I.15, I.20, I.21, I.27, I.35, I.38, I.40, I.42		90, 97, 113, 138, 164, 167	
Saltator maxillosus		II.8, III.3	5, 7, 8, 11, 16, 19, 43, 159	AF
Saltator atricollis	I.3, I.5, I.10, I.15, I.26, I.27, I.32, I.35, I.42		47, 68, 70, 71, 82, 84, 90, 115, 139, 145, 152, 167	CE
Parulidae				
Parula pitiayumi	I.20, I.27		167	
Geothlypis aequinoctialis	I.5, I.10, I.15, I.25, I.26, I.27, I.35, I.38, I.42, I.43, I.44, I.46, I.48, I.50	II.1	28, 69, 70, 71, 82, 84, 90, 102, 138, 139, 145, 152, 167	
Icteridae				
Gnorimopsar chopi	I.5, I.10, I.15, I.24, I.25, I.26, I.27, I.32, I.33, I.35, I.46	II.6	47, 70, 71, 82, 84, 106, 139, 145, 148, 152, 167	
Pseudoleistes guirahuro	I.35		84, 119, 145, 152, 167	
Molothrus bonariensis	I.26, I.35, I.36, I.37, I.38	II.8	7, 11, 16, 19, 46, 84, 110, 139, 145, 167	
Fringillidae				
Carduelis magellanica	I.5, I.24, I.35, I.50	II.6, II.7, II.8	5, 7, 8, 11, 16, 19, 43, 71, 82, 84, 139, 145, 148, 167	
Euphonia chlorotica	I.5, I.10, I.15, I.18, I.21, I.27, I.35, I.38, I.40, I.42, I.44		71, 82, 84, 90, 106, 164, 167	
Euphonia cyanocephala	I.24, I.35, I.42		139, 152, 167	
Chlorophonia cyanea	I.36, I.42, I.44		90, 152, 167	