



Bird community of upper-montane rupestrian fields in South of Minas Gerais State, Southeastern Brazil

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ABSTRACT. Studies about the birds of rupestrian fields in the south of Minas Gerais State in Southeastern Brazil are incomplete, although this region is ornithologically well studied. This bird community has closely associated ecology with fields and the most endangered species of the Cerrado domain. The objective of this manuscript is to create a list of birds which occur in the rupestrian fields of seven municipalities in the south of Minas Gerais State, and further to analyze the birds' distribution, the endangered species (and their conservation *status*), and generate bases for future conservation actions. We evaluated seven cities in the south of Minas Gerais State between 2012 and 2018 by using binoculars and cameras. We found a high richness in relation to other open areas, with the Tyrannidae and Trochilidae families being the most representative. We highlight the endangered species in the Cerrado domain which of these species are closely linked to rupestrian fields. The composition is similar to closer areas, with exception to São Thomé das Letras city because it suffers an influence of mining areas. We suggest creating a wildlife protected area to preserve and conserve a great area of rupestrian fields and consequently the associated biota, especially the bird communities.

Keywords: conservation; list; ecology.

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Introduction

The rupestrian fields are located at altitudes of 900 meters above sea level in Brazil. The mountains present rocks from the pre-Cambrian age, directly related to quartzite, sandstone and iron ore outcrops (Eiten, 1992; Alves & Kolbek, 1994; Giulietti, Pirani, & Harley, 1997; Caiafa & Silva, 2005; Alves, Cardin, & Kropf, 2007; Vasconcellos, 2011).

This vegetation type is distributed along the Espinhaço Range, but isolated areas of this kind of landscape are located in Central Brazil, for example: Chapada dos Veadeiros and Serra dos Pirineus in Goiás State. We also found this vegetation in the west of Minas Gerais State in Serra da Canastra and in the South in the cities of São João Del Rei (Serra do Lenheiro), Tiradentes (Serra de São José), Carrancas (Serra de Carrancas), Minduri (Chapada das Perdizes), Luminárias (Serra Grande), São Tomé das Letras (Serra do Cruzeiro do Canta Galo), Itumirim (Serra de Itumirim), Ingaí (Serra do Boqueirão) and Itutinga. The last nine cities are in Serra da Mantiqueira, with similar geology and floristic compositions to the Espinhaço Range (Eiten, 1992; Alves & Kolbek, 1994; 2009; 2010; Gavilanes, Brandão, Laca-Buendia, & Araujo, 1995; Harley, 1995; Giulietti et al., 1997; Alves et al., 2007; Rapini, Ribeiro, Lambert, & Pirani, 2008; Vasconcellos, 2011).

The bird community in the south of Minas Gerais State in Southeastern Brazil has been well studied (D'Angelo Neto, Venturin, Oliveira Filho, & Costa, 1998; Ribon, 2000; Vasconcelos et al., 2002; Lopes, 2006; Vasconcelos, D'Angelo-Neto, & Nemesio, 2005; Lombardi, Vasconcelos, & D'Angelo Neto, 2007; Vasconcelos, 2008; Corrêa & Moura, 2009; Braga, Zanzini, Cerboncini, Miguel, & Moura, 2010; Moura & Soares-Junior, 2010; Corrêa & Moura, 2010; Moura, Corrêa, & Santos, 2010; Moura & Corrêa, 2011; Santos, Lombardi, D'Angelo-Neto, Miguel, & Faeti, 2011; Mazzoni & Perillo, 2011; Moura & Corrêa, 2012; Santos, 2012; Corrêa, Louzada, & Moura 2012; Lombardi et al., 2012; Rezende et al., 2013; Moura, 2014; Moura,

Camargo, & Correa, 2014; Santos, Miguel, & Lombardi, 2014; Moura, Correa, & Machado, 2015; Moura, Mariano, Machado, Cerboncini, & Fontes, 2017). Papers focusing on bird communities in rupestrian fields are incomplete, despite these communities being threatened with a high risk of extinction (Machado, Fonseca, Machado, Aguiar, & Lins, 1998; Lopes et al., 2009). In this article we present a bird list in rupestrian fields of seven cities in the south of Minas Gerais State, Southeastern Brazil, and analyze the birds' distribution, the endangered species (and its conservation *status*), and generate bases for future conservation actions.

Material and methods

The observations were conducted in rupestrian field areas (Figure 1) (Table 1), located in seven cities in the south of Minas Gerais State: Ingaí, Luminárias, São Thomé das Letras, Carrancas, Minduri, Itumirim and Tiradentes (Figure 2), during 2012 and 2018, in seasonal observations (winter and summer) to obtain occurrence data, with 10 hours (from 6 AM to 4 PM) of sampling effort of in each sampling collection point (similar to Braga et al., 2010). We used Nikon 08x40 and 10x50 binoculars, and Sony H 50, Canon EOS REBEL T1i and Canon Power Shot SX50 HS cameras to help record/sight the birds. The nomenclature follows Piacentini et al. (2015). The climate in the cities and in the studied area is Cwa according to the Köppen classification, with annual average precipitation of 1,529.7 mm concentrated in September to March, and annual average temperature of 19.4°C (Alvares, Stape, Sentelhas, Gonçalves, & Sparovek, 2013). However, the climate in the Chapada das Perdizes between the cities of Carrancas and Minduri is Cwb, common for mountain tops (Alvares et al., 2013).

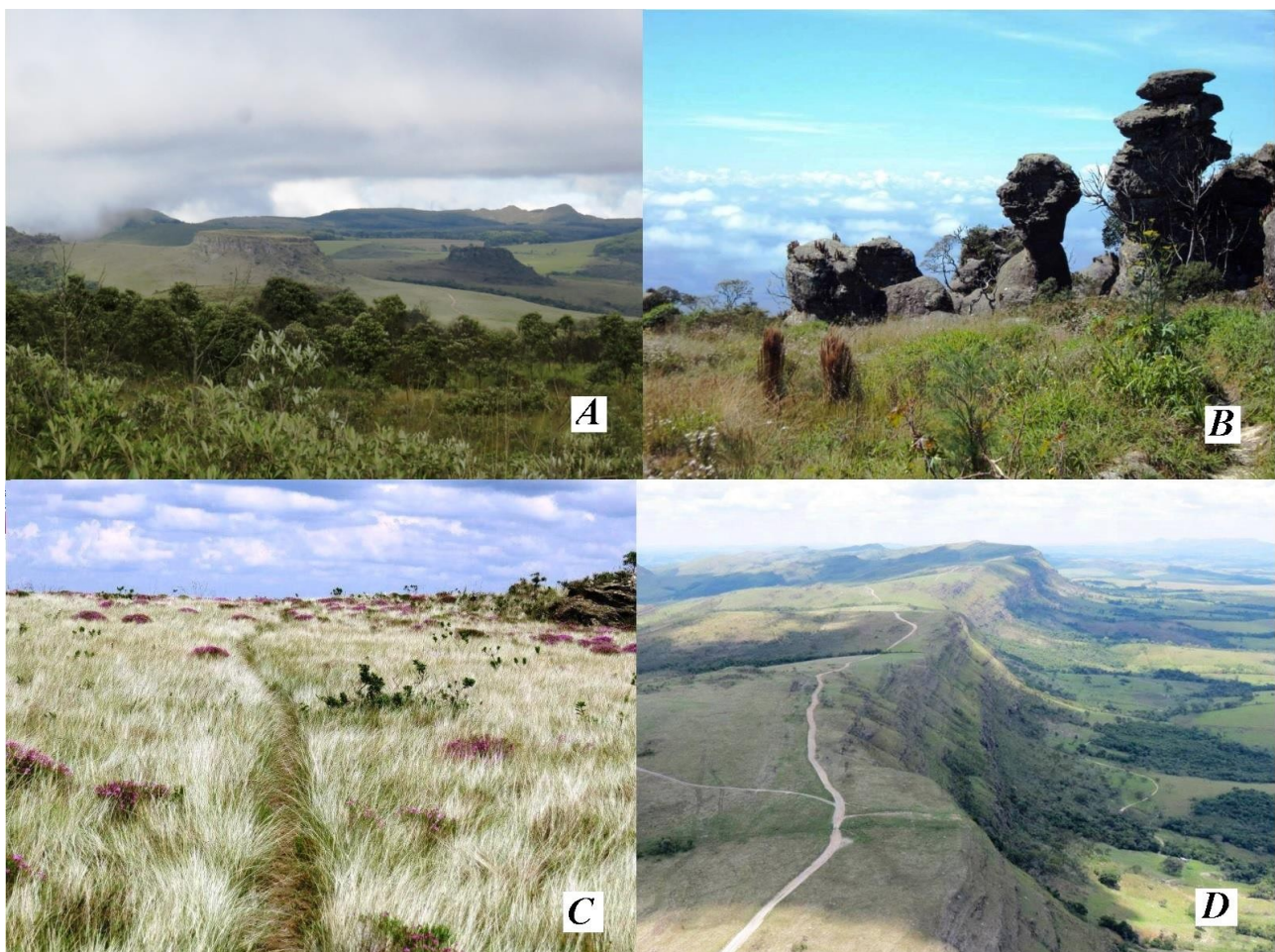


Figure 1. A = Serra das Broas, Chapada das Perdizes region, between Carrancas and Minduri cities, B = rupestrian fields in the Chapada das Perdizes region, between Carrancas and Minduri cities, C = rupestrian fields in Cruzeiro do Canta Galo, São Thomé das Letras cities, D = Serra de Carrancas, Carrancas city (Source: Moura, A. S., personal archive).

Table 1. Georeferenced points of the observation areas.

Counties	Location	Georeferencing	Altitude
São Thomé das Letras	Zé Geraldo Farm	21°43'12.39"S 44°56'53.69"W	1.091 m
São Thomé das Letras	Cruzeiro do Canta Galo Mountain	21°42'36.35"S 44°55'30.75"W	1.367 m
Ingáí	Boqueirão Mountain	21°20'46.29"S 44°55'30.75"W	1.180 m
Ingáí	Coroa Mountain	21°26'07.26"S 44°57'39.80"W	1.153 m
Itumirim	Itumirim Mountain	21°20'30.16"S 44°53'55.51"W	1.066 m
Itumirim	Paraiso waterfall region	21°21'02.02"S 44°53'13.80"W	987 m
Luminárias	Luminárias Mountain	21°31'56.55"S 44°48'51.93"W	1.298 m
Luminárias	Cristo Mountain	21°31'44.71"S 44°53'01.15"W	1.179 m
Carrancas	Carrancas Mountain	21°26'59.45"S 44°40'08.14"W	1.228 m
Carrancas	Broas Mountain	21°36'12.75"S 44°36'46.45"W	1.404 m
Minduri	Perdizes Plateau	21°35'34.72"S 44°34'38.63"W	1.528 m
Minduri	Galinheiro Mountain	21°36'12.42"S 44°34'35.64"W	1.553m
Tiradentes	São José Mountain	21°06'29.61"S 44°11'44.35"W	1.106 m
Tiradentes	São José Mountain	21°05'06.06"S 44°10'05.60"W	1.144 m

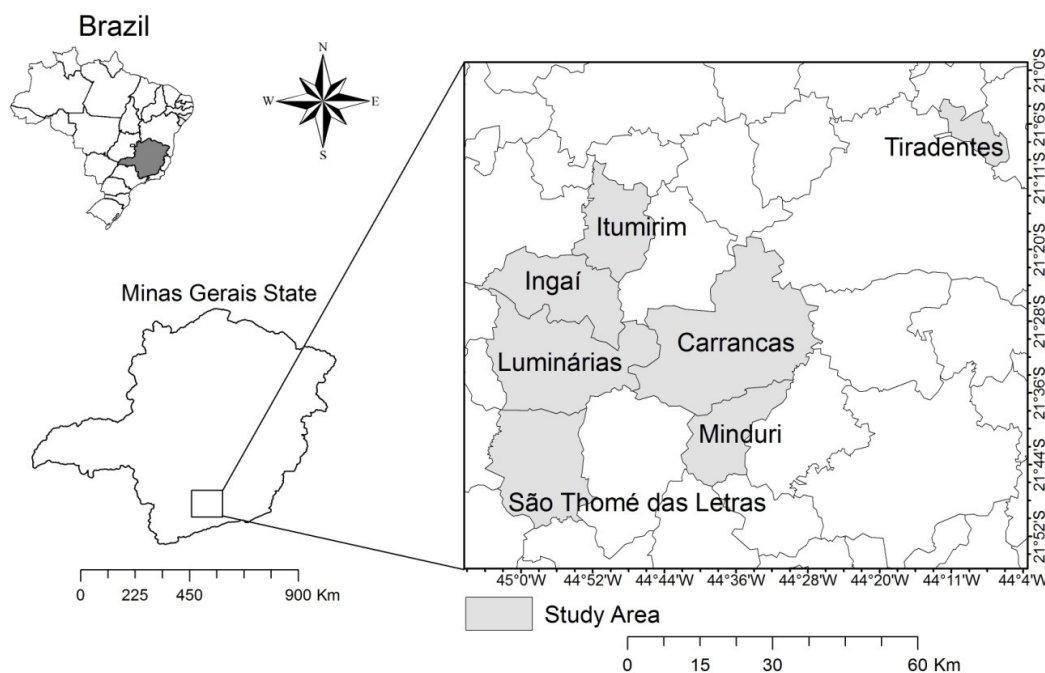


Figure 2. Study area in grey. Observed cities are Ingáí, Luminárias, São Thomé das Letras, Carrancas, Minduri, Itumirim and Tiradentes, South of Minas Gerais State, Southeastern Brazil.

We made cumulative species curves with Jackknife of first order estimator to analyze the richness, abundance and sampling sufficiency. These curves were obtained with 1000 randomizations using the EstimateS program version 9.10 (Colwell et al., 2012). The similarity and the groups between the sampling collection points were performed by the Jaccard index (Valentin, 2000), using the UPGMA method to create groups of vegetation types according to species composition. These groups were made in the Primer 6 + Permanova program (Clarke & Gorey, 2006; Anderson, Gorley, & Clarke, 2008).

Results and discussion

We recorded 107 bird species (Table 2) of 29 families in a total of 280 hours of sampling effort. The more representative families in the rupestrian fields were: Thraupidae (N=26), Tyrannidae (N=15) and Trochilidae (N=11). Thraupidae was the more representative family because it presents a great species number in Brazil (n=157) (Piacentini et al., 2015). Moreover, the floristic compositions of these areas were composed of grass and herbaceous species which commonly produce fruits, and are used by the frugivorous birds as food (Sick, 1997), for example plants of the *Miconia* genus (Gavilanes et al., 1995; Baumgratz & Chiavegatto, 2006; Nunes, Landau, & Veloso, 2008).

The Tyrannidae and Trochilidae families were expected to be abundant, because previous studies conducted in the south of Minas Gerais State found similar results (Lombardi et al., 2007; Moura et al., 2015). The representativity of the Trochilidae family (nectarivorous birds popularly called hummingbirds) can also be highlighted due to the abundance of food in the rupestrian fields, as they have a variety of rupicolous flowers of the Bromeliaceae, Orchidaceae and Cactaceae families (Gavilanes et al., 1995; Oliveira-Filho & Fluminhan-Filho, 1999).

From the records of this study, 6.54% are threatened species (n=7): *Amazona vinacea* (Kuhl, 1820), *Geositta poeilopectera* (Wied, 1830), *Alectrurus tricolor* (Vieillot, 1816), *Anthus nattereri* Sclater, 1878, *Coryphaspiza melanotis* (Temminck, 1822), (International Union for Conservation of Nature and Natural Resources [IUCN], 2019), Brasil, 2014), *Culicivora caudacuta* (Vieillot, 1818), and *Polystictus superciliaris* (Wied, 1831) (IUCN, 2019). With the exception of the Vinaceous-breasted amazon (*A. vinacea*), the other recorded threatened species are birds which are closely related to fields, and these species are among the most threatened birds of the Cerrado domain (Machado et al., 1998; Lopes et al., 2009).

As a result, we emphasize the importance of preserving this vegetation type for bird communities. In addition, Oliveira-Filho & Fluminhan-Filho (1999) mention the importance of preserving rupestrian fields due to its specific flora, the high species richness with restricted ecological and geographic distribution, and the presence of floristic endemic elements in the mountains, which together evidence that this type of vegetation and its bird communities deserve high conservation priority.

Table 2. Birds species recorded in the study. Ing= Ingai, Lum= Luminárias, Stl= São Thomé das Letras, Car= Carrancas, Min= Minduri, Itu= Itumirim and Tir= Tiradentes.

Family	Species	Popular name	Ing	Lum	Stl	Car	Min	Itu	Tir
Tinamidae	<i>Crypturellus parvirostris</i> (Wagler, 1827)	Small-billed Tinamou	X	X	X	X		X	
	<i>Rhynchotus rufescens</i> (Temminck, 1815)	Red-winged Tinamou	X	X	X	X	X	X	X
	<i>Nothura maculosa</i> (Temminck, 1815)	Spotted Nothura		X		X	X	X	
Cathartidae	<i>Cathartes aura</i> (Linnaeus, 1758)	Turkey Vulture	X	X	X	X	X	X	X
	<i>Coragyps atratus</i> (Bechstein, 1793)	Black Vulture		X	X	X	X		
	<i>Sarcoramphus papa</i> (Linnaeus, 1758)	King Vulture		X	X	X	X	X	
Accipitridae	<i>Ictinia plumbea</i> (Gmelin, 1788)	Plumbeous Kite		X	X		X		
	<i>Heterospizias meridionalis</i> (Latham, 1790)	Savanna Hawk	X		X		X	X	
	<i>Rupornis magnirostris</i> (Gmelin, 1788)	Roadside Hawk	X	X	X				X
	<i>Geranoaetus albicaudatus</i> (Vieillot, 1816)	White-tailed Hawk	X	X	X	X	X	X	X
	<i>Geranoaetus melanoleucus</i> (Vieillot, 1819)	Black-chested Buzzard-Eagle			X	X	X		
Charadriidae	<i>Buteo brachyurus</i> Vieillot, 1816	Short-tailed Hawk		X	X				
	<i>Vanellus chilensis</i> (Molina, 1782)	Southern Lapwing	X					X	
Columbidae	<i>Columbina talpacoti</i> (Temminck, 1810)	Ruddy Ground-Dove	X		X		X		
	<i>Patagioenas picazuro</i> (Temminck, 1813)	Picazuro Pigeon	X	X	X	X	X	X	X
	<i>Patagioenas cayennensis</i> (Bonnaterre, 1792)	Pale-vented Pigeon			X	X			
Strigidae	<i>Zenaida auriculata</i> (Des Murs, 1847)	Eared Dove	X	X	X	X	X		X
	<i>Megascops choliba</i> (Vieillot, 1817)	Tropical Screech-Owl			X				
	<i>Athene cunicularia</i> (Molina, 1782)	Burrowing Owl			X	X	X	X	
Caprimulgidae	<i>Nyctidromus albicollis</i> (Gmelin, 1789)	Common Pauraque	X		X	X	X		
Caprimulgidae	<i>Hydropsalis longirostris</i> (Bonaparte, 1825)	Band-winged Nightjar		X		X	X	X	X
Apodidae	<i>Streptoprocne zonaris</i> (Shaw, 1796)	White-collared Swift		X		X	X	X	X
Trochilidae	<i>Phaethornis pretrei</i> (Lesson & Delattre, 1839)	Planalto Hermit	X	X	X	X	X	X	X
	<i>Eupetomena macroura</i> (Gmelin, 1788)	Swallow-tailed Hummingbird	X	X	X	X	X	X	X
	<i>Colibri serrirostris</i> (Vieillot, 1816)	White-vented Violetear	X	X	X	X	X	X	X
	<i>Chlorostilbon lucidus</i> (Shaw, 1812)	Glittering-bellied Emerald	X	X	X	X	X	X	X
	<i>Thalurania glaucopis</i> (Gmelin, 1788)	Violet-capped Woodnymph			X	X	X		

Family	Species	Popular name	Ing	Lum	Stl	Car	Min	Itu	Tir
	<i>Leucochloris albicollis</i> (Vieillot, 1818)	White-throated Hummingbird				X	X		
	<i>Amazilia versicolor</i> (Vieillot, 1818)	Versicolored Emerald			X	X	X	X	
	<i>Amazilia lactea</i> (Lesson, 1832)	Sapphire-spangled Emerald	X	X	X	X	X	X	X
	<i>Heliothryx auritus</i> (Gmelin, 1788)	Black-eared Fairy			X				
	<i>Heliomaster squamosus</i> (Temminck, 1823)	Stripe-breasted Starthroat		X		X	X		
	<i>Calliphlox amethystina</i> (Boddaert, 1783)	Amethyst Woodstar	X		X				
Bucconidae	<i>Nystalus chacuru</i> (Vieillot, 1816)	White-eared Puffbird	X	X	X	X	X	X	X
Ramphastidae	<i>Ramphastos toco</i> Statius Muller, 1776	Toco Toucan	X	X	X	X	X	X	X
Picidae	<i>Colaptes campestris</i> (Vieillot, 1818)	Campo Flicker	X	X	X	X	X	X	X
Cariamidae	<i>Cariama cristata</i> (Linnaeus, 1766)	Red-legged Seriema	X	X	X	X	X	X	X
Falconidae	<i>Caracara plancus</i> (Miller, 1777)	Southern Caracara	X	X	X	X	X	X	X
Falconidae	<i>Milvago chimachima</i> (Vieillot, 1816)	Yellow-headed Caracara	X	X		X	X	X	
	<i>Herpotheres cachinnans</i> (Linnaeus, 1758)	Laughing Falcon			X				
	<i>Falco sparverius</i> Linnaeus, 1758	American Kestrel	X	X	X	X	X	X	X
	<i>Falco femoralis</i> Temminck, 1822	Aplomado Falcon	X	X		X	X		X
Psittacidae	<i>Primolius maracana</i> (Vieillot, 1816)	Blue-winged Macaw		X		X			
	<i>Psittacara leucophthalmus</i> (Statius Muller, 1776)	White-eyed Parakeet	X		X			X	
	<i>Eupsittula aurea</i> (Gmelin, 1788)	Peach-fronted Parakeet	X	X	X	X	X	X	X
	<i>Pionus maximiliani</i> (Kuhl, 1820)	Scaly-headed Parrot	X	X					
	<i>Amazona vinacea</i> (Kuhl, 1820)	Vinaceous-breasted Parrot				X	X		
Scleruridae	<i>Geositta poeciloptera</i> (Wied, 1830)	Campo Miner				X	X		X
Furnariidae	<i>Anumbius annumbi</i> (Vieillot, 1817)	Firewood-Gatherer			X	X	X		
	<i>Synallaxis spixi</i> Sclater, 1856	Spix's Spinetail	X	X	X	X		X	X
Cotingidae	<i>Phibalura flavirostris</i> Vieillot, 1816	Swallow-tailed Cotinga				X	X		
Melanopareidae	<i>Melanopareia torquata</i> (Wied, 1831)	Collared Crescentchest	X	X	X	X	X	X	X
Tyrannidae	<i>Hirundinea ferruginea</i> (Gmelin, 1788)	Cliff Flycatcher	X	X	X	X	X	X	X
	<i>Elaenia flavogaster</i> (Thunberg, 1822)	Yellow-bellied Elaenia	X	X	X	X	X	X	X
	<i>Elaenia chiriquensis</i> Lawrence, 1865	Lesser Elaenia		X		X	X		
	<i>Elaenia obscura</i> (d'Orbigny & Lafresnaye, 1837)	Highland Elaenia	X	X	X	X	X	X	X
	<i>Culicivora caudacuta</i> (Vieillot, 1818)	Sharp-tailed Tyrant		X		X	X		
Tyrannidae	<i>Polystictus superciliaris</i> (Wied, 1831)	Gray-backed Tachuri			X				X
	<i>Myiarchus ferox</i> (Gmelin, 1789)	Short-crested Flycatcher	X	X				X	X
	<i>Tyrannus savana</i> Daudin, 1802	Fork-tailed Flycatcher	X	X	X	X	X	X	X
	<i>Colonia colonus</i> (Vieillot, 1818)	Long-tailed Tyrant	X	X	X	X	X	X	X
	<i>Alectrurus tricolor</i> (Vieillot, 1816)	Cock-tailed Tyrant				X	X		
	<i>Knipolegus lophotes</i> Boie, 1828	Crested Black-Tyrant	X	X	X	X	X	X	X
	<i>Knipolegus nigerrimus</i> (Vieillot, 1818)	Velvety Black-Tyrant	X	X		X	X		X
	<i>Xolmis cinereus</i> (Vieillot, 1816)	Gray Monjita	X	X	X	X	X	X	X
	<i>Xolmis velatus</i> (Lichtenstein, 1823)	White-rumped Monjita	X	X	X	X	X	X	X
	<i>Muscipira vetula</i> (Lichtenstein, 1823)	Shear-tailed Gray Tyrant		X		X	X	X	X
Corvidae	<i>Cyanocorax cristatellus</i> (Temminck, 1823)	Curl-crested Jay	X	X	X	X	X	X	X
Hirundinidae	<i>Tachycineta leucorrhoa</i> (Vieillot, 1817)	White-rumped Swallow	X	X		X		X	X
Troglodytidae	<i>Troglodytes musculus</i> Naumann, 1823	Southern House Wren	X	X	X	X	X	X	X
	<i>Cistothorus platensis</i> (Latham, 1790)	Sedge Wren		X		X	X		X
Motacillidae	<i>Anthus lutescens</i> Pucheran, 1855	Yellowish Pipit	X		X	X	X		X
	<i>Anthus nattereri</i> Sclater, 1878	Ochre-breasted Pipit		X	X	X	X		X
	<i>Anthus hellmayri</i> Hartert, 1909	Hellmayr's Pipit		X	X	X	X		X
Passerellidae	<i>Zonotrichia capensis</i> (Statius Muller, 1776)	Rufous-collared Sparrow	X	X	X	X	X	X	X
	<i>Ammodramus humeralis</i> (Bosc, 1792)	Grassland Sparrow	X	X	X	X	X	X	X
Icteridae	<i>Molothrus bonariensis</i> (Gmelin, 1789)	Shiny Cowbird			X				
Thraupidae	<i>Porphyrospiza caerulescens</i> (Wied, 1830)	Blue Finch	X	X	X	X	X	X	X
Thraupidae	<i>Pipraeidea melanonota</i> (Vieillot, 1819)	Fawn-breasted Tanager	X	X		X	X		
	<i>Stephanophorus diadematus</i> (Temminck, 1823)	Diademed Tanager				X	X		
	<i>Schistochlamys ruficapillus</i> (Vieillot, 1817)	Cinnamon Tanager	X	X	X	X	X	X	X
	<i>Tangara cyanoventris</i> (Vieillot, 1819)	Gilt-edged Tanager	X	X	X	X	X	X	X
	<i>Tangara desmaresti</i> (Vieillot, 1819)	Brassy-breasted Tanager				X	X		
	<i>Tangara sayaca</i> (Linnaeus, 1766)	Sayaca Tanager	X	X	X	X	X	X	X
	<i>Tangara cayana</i> (Linnaeus, 1766)	Burnished-buff Tanager	X	X	X	X	X	X	X
	<i>Nemosia pileata</i> (Boddaert, 1783)	Hooded Tanager	X			X	X	X	
	<i>Sicalis citrina</i> Pelzeln, 1870	Stripe-tailed Yellow-Finch	X	X	X	X	X	X	X
	<i>Sicalis luteola</i> (Sparrman, 1789)	Grassland Yellow-Finch	X	X	X	X	X	X	X

Family	Species	Popular name	Ing	Lum	Stl	Car	Min	Itu	Tir
	<i>Volatinia jacarina</i> (Linnaeus, 1766)	Blue-black Grassquit	X	X	X	X	X	X	X
	<i>Coryphospingus pileatus</i> (Wied, 1821)	Pileated Finch	X		X	X	X	X	
	<i>Tachyphonus coronatus</i> (Vieillot, 1822)	Ruby-crowned Tanager			X	X	X	X	
	<i>Tersina viridis</i> (Illiger, 1811)	Swallow Tanager	X	X	X	X	X	X	X
	<i>Dacnis cayana</i> (Linnaeus, 1766)	Blue Dacnis	X	X	X	X	X	X	X
	<i>Coereba flaveola</i> (Linnaeus, 1758)	Bananaquit	X	X	X	X	X	X	X
	<i>Sporophila lineola</i> (Linnaeus, 1758)	Lined Seedeater	X	X		X		X	
	<i>Sporophila nigricollis</i> (Vieillot, 1823)	Yellow-bellied Seedeater	X	X	X	X	X	X	X
	<i>Sporophila ardesiaca</i> (Dubois, 1894)	Dubois's Seedeater	X			X		X	
Thraupidae	<i>Sporophila caerulescens</i> (Vieillot, 1823)	Double-collared Seedeater	X	X	X	X	X	X	X
	<i>Coryphaspiza melanotis</i> (Temminck, 1822)	Black-masked Finch		X		X	X	X	
	<i>Embernagra platensis</i> (Gmelin, 1789)	Great Pampa-Finch	X	X	X	X	X	X	X
	<i>Emberizoides herbicola</i> (Vieillot, 1817)	Wedge-tailed Grass-Finch		X		X	X		X
	<i>Saltatricula atricollis</i> (Vieillot, 1817)	Black-throated Saltator	X	X	X	X	X	X	X
	<i>Saltator similis</i> d'Orbigny & Lafresnaye, 1837	Green-winged Saltator	X	X	X	X	X	X	X
Cardinalidae	<i>Piranga flava</i> (Vieillot, 1822)	Hepatic Tanager	X	X	X	X	X	X	X
Fringillidae	<i>Spinus magellanicus</i> (Vieillot, 1805)	Hooded Siskin	X	X	X	X	X	X	X
	<i>Euphonia chlorotica</i> (Linnaeus, 1766)	Purple-throated Euphonia	X	X	X	X	X	X	X
	<i>Euphonia cyanocephala</i> (Vieillot, 1818)	Golden-rumped Euphonia				X		X	

The species accumulation curve did not reach the asymptote, and the Jackknife of first order estimator curve presented a small slope at the curve end (Figure 3). The estimator presented a richness of 96.87% of the total diversity, with 109.43 species. This high value demonstrates that the sampling effort was satisfied. The number of records, the representativity and the threatened species show that the rupestrian fields are of extreme importance in order to preserve and conserve the bird fauna which are more specific to these fields.

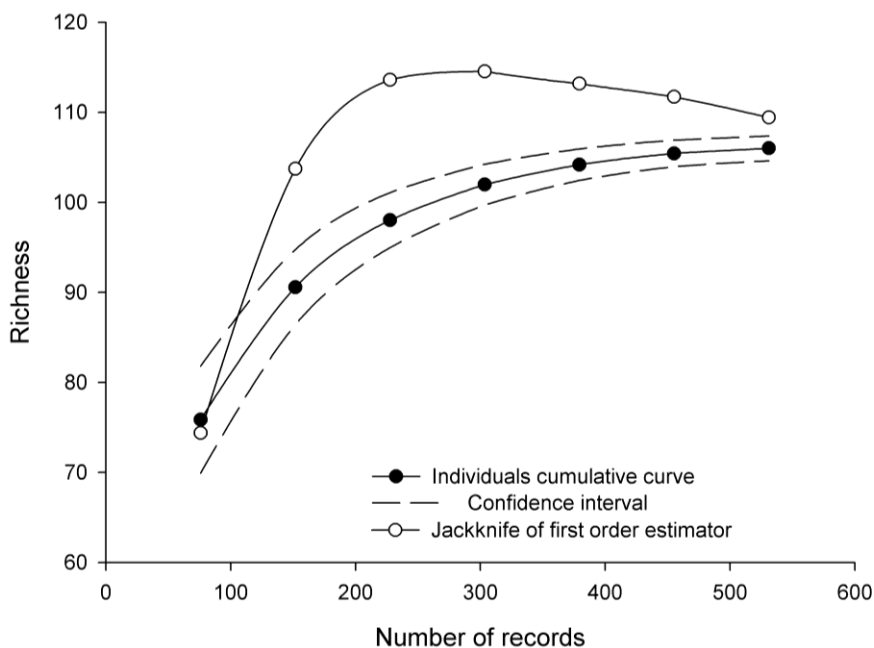


Figure 3. Cumulative species curve, confidence interval and Jackknife of first order estimator of the studied areas.

The cluster demonstrated a similarity between the bird community of rupestrian fields from the counties of Tiradentes and Luminárias; Minduri and Carrancas, Itumirim and Ingaí. The community from São Thomé das Letras city is the most different when compared among the other communities (Figure 3). The similarity is related to geographical proximity, considering that the sampling areas are continuous from a mountain range, and also the similarities are explained to their disturbance degree. In contrast, although the sampled vegetation type from São Thomé das Letras city is in good condition (Figure 1C), the landscape contains the presence of mining companies and has a great number of mining tailings (see Chiodi Filho, Artur, & Rodrigues, 2005), and therefore natural vegetation is absent in several areas, in turn presenting a human effect on the bird fauna (Figure 5).

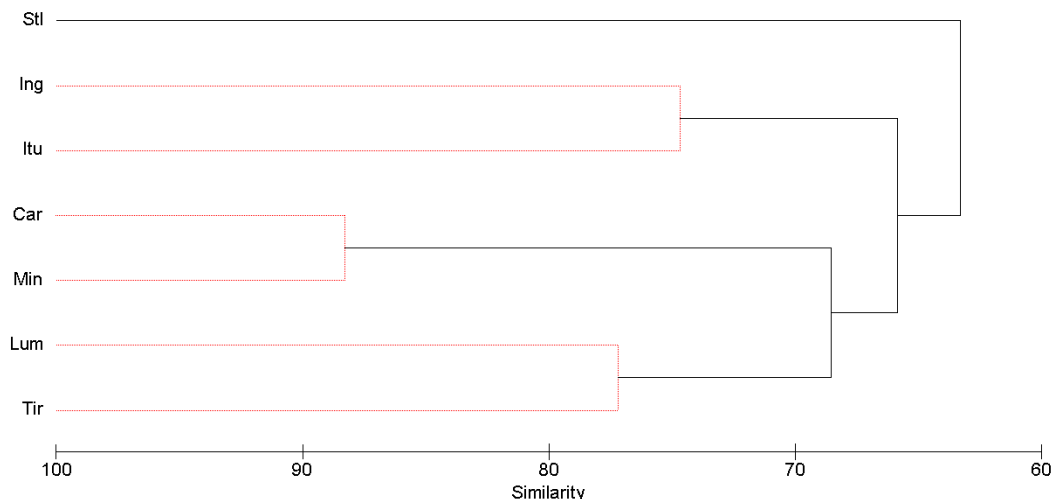


Figure 4. Bird community cluster between sampling areas. Cities: Stl= São Thomé das Letras, Ing= Ingaí, Itu= Itumirim, Car= Carrancas, Min= Minduri, Lum= Luminárias and Tir= Tiradentes.

Despite the rupestrian fields being considered components of the Cerrado domain (Oliveira-Filho & Fluminhan-Filho, 1999), we recorded five species commonly found in the Atlantic Forest (Silva, 1995; Silva & Santos, 2005): *Thalurania glaucopis* (Gmelin, 1788), *Primolius maracana* (Vieillot, 1816), *Knipolegus nigerrimus* (Vieillot, 1818), *Tachyphonus coronatus* (Vieillot, 1822) and *Sporophila ardesiaca* (Dubois, 1894). The sampling areas (Figure 2) presented high influence of Atlantic Forest due to its location near to an ecotonal region between both domains, which may have altered the bird community.



Figure 5. Photo of rupestrian fields from São Thomé das Letras city, highlighting the mining area and mining tailings, and the absence of natural vegetation (Source: Google images).

Despite expressive richness recorded for the bird communities of the rupestrian fields in the south of Minas Gerais State, the species list presented herein needs to be completed because this fauna group is dynamic. We also need to consider that Rodrigues et al. (2011) recorded 151 bird species in the rupestrian fields in Serra do Cipó National Park, in central Minas Gerais State, thus suggesting that our sampling area can present higher richness because they are identical vegetation types and present a larger area than that presented by Rodrigues et al. (2011).

Part of the sampled areas is considered a priority for biological conservation (Chapada das Perdizes, bordering the cities of Carrancas/Minduri) (Drummond, Martins, Machado, Sebaio, & Antonini, 2005), not only presenting rare, endangered and endemic species of birds, but also other species (Oliveira-Filho et al., 2004) which are present in these rupestrian fields such as mammals (Machado, Gregorin, & Mouallem, 2013;

Pecora et al., 2016; Machado et al., 2017), and plants (Oliveira-Filho et al., 2004). Lawton (1996) mentions that the knowledge about vertebrate composition in different areas and comparisons between them are important for conservationist projects. Therefore, the characteristics of the area, the large dimensions, its location, and the vegetation type make the area relevant for creating a conservation unit (wildlife protected area – Brasil, 2000) in the region. In addition, this (or these) conservation unit(s) will create an ecological corridor of rupestrian fields in association with other areas, such as the Serra de São José Environmental Protection Area (APA Serra de São José).

Conclusion

Our study found a high richness in relation to other open areas, with the Tyrannidae and Trochilidae families being the most representative. We highlight the endangered species in the Cerrado domain which of these species are closely linked to rupestrian fields. The composition is similar to closer areas, with exception to São Thomé das Letras city because it suffers an influence of mining areas. We suggest creating a wildlife protected area to preserve and conserve a great area of rupestrian fields and consequently the associated biota, especially the bird communities.

References

- Alvares, C. A., Stape, J. L., Sentelhas, P. C., Gonçalves, J. L. M., & Sparovek, G. (2013). Köppen's climate classification map for Brazil. *Meteorologische Zeitschrift*, 22(6), 711-728. doi: 10.1127/0941-2948/2013/0507
- Alves, R. J. V., Cardin, L., & Kropf, M. S. (2007). Angiosperm disjunction “campos rupestres – restingas”: a re-evaluation. *Acta Botanica Brasilica*, 21(3), 675-685. doi: 10.1590/S0102-33062007000300014
- Alves, R. J. V., & Kolbek, J. (1994). Plant species endemism in savanna vegetation on table mountains (campo rupestre) in Brazil. *Vegetatio*, 113, 125-139. doi: 10.1007/BF00044230
- Alves, R. J. V., & Kolbek, J. (2009). Summit vascular flora of Serra de São José, Minas Gerais, Brazil. *Check List – The Journal of Biodiversity Data*, 5(1), 35-73. doi: 10.15560/5.1.35
- Alves, R. J. V., & Kolbek, J. (2010). Can campo rupestre vegetation be floristically delimited based on vascular plant genera? *Plant Ecology*, 207(1), 67-79. doi: 10.1007/s11258-009-9654-8
- Anderson, M. J., Gorley, R. N., & Clarke, K. R. (2008). *PERMANOVA + for PRIMER: Guide to Software and Statistical Methods*. Plymouth, UK: PRIMER-E.
- Baumgratz, J. F. A., & Chiavegatto, B. (2006). New species of *Miconia* Ruiz & Pav. (Melastomataceae) from Minas Gerais State, Brazil. *Acta Botanica Brasilica*, 20(2), 483-486. doi: 10.1590/S0102-33062006000200023
- Braga, T. V., Zanzini, A. C. S., Cerboncini, R. A. S., Miguel, M., & Moura, A. S. (2010). Avifauna em praças da cidade de Lavras (MG): riqueza, similaridade e influência de variáveis do ambiente urbano. *Revista Brasileira de Ornitologia*, 18(1), 26-33.
- Brasil. (2000). *Lei Nº 9.985, de 18 de julho de 2000. Sistema Nacional de Unidades de Conservação da Natureza - SNUC*. Retrieved on January 9, 2017 from <http://www.mma.gov.br/port/conama/legiabre.cfm?codlegi=322>
- Brasil. Ministério do Meio Ambiente (2014). *Portaria nº 444, de 17 de dezembro de 2014. Lista nacional oficial de espécies da fauna ameaçadas de extinção*. Brasília, DF: Ministério do Meio Ambiente.
- Caiafa, A. N., & Silva, A. F. (2005). Composição florística e espectro biológico de um campo de altitude no Parque Estadual da Serra do Brigadeiro, Minas Gerais – Brasil. *Rodriguésia*, 56(87), 163-173. doi: 10.1590/2175-78602005568712
- Chiodi Filho, C., Artur, A. C., & Rodrigues, E. P. (2005). Aspectos geológicos, petrográficos e químicos de interesse para o aproveitamento econômico dos quartzitos foliados de São Thomé das Letras–Minas Gerais. *Geociências*, 24(2), 163-172.
- Clarke, K. R., & Gorey, R. N. (2006). *PRIMER v6: user manual/tutorial*. Plymouth, UK: PRIMER-E
- Colwell, R. K., Chao, A., Gotelli, N. J., Lin, S.-Y., Mao, C. X., Chazdon, R. L., & Longino, J. T. (2012). Models and estimators linking individual-based and sample-based rarefaction, extrapolation, and comparison of assemblages. *Journal of Plant Ecology*, 5(1), 3–21. doi: 10.1093/jpe/rtr044

- Corrêa, B. S., Louzada, J. N. C., & Moura, A. S. (2012). Structure of avian guilds in a bird fragment-corridor community in Lavras county, Minas Gerais, Brazil. *Brazilian Journal of Ecology*, 1, 25-34.
- Corrêa, B. S., & Moura, A. S. (2009). Levantamento da comunidade de aves em um sistema de fragmentos florestais interconectados por corredores ecológicos no município de Lavras - Minas Gerais. *Revista Agrogeoambiental*, 94-106. doi: 10.18406/2316-1817v1n2200981
- Corrêa, B. S., & Moura, A. S. (2010). Novo registro de andorinha-de-bando *Hirundo rustica* (Hirundinidae) para o município de Lavras, Sul de Minas Gerais, Brasil. *Atualidades Ornitológicas*, 155, 20-21.
- D'Angelo Neto, S., Venturin, N., Oliveira Filho, A. T., & Costa, F. A. F. (1998). Avifauna de quatro fisionomias florestais de pequeno tamanho (5-8 ha) no campus da UFLA. *Revista Brasileira de Biologia*, 58(3), 463-472. doi: 10.1590/S0034-71081998000300011
- Drummond, G. M., Martins, C. S., Machado, A. B. M., Sebaio, F. A., & Antonini, Y. (2005). *Biodiversidade em Minas Gerais: um atlas para sua conservação* (2a ed.). Belo Horizonte, BH: Fundação Biodiversitas.
- Eiten, G. (1992). Natural Brazilian vegetation types and their causes. *Anais da Academia Brasileira de Ciências*, 64, 35-65.
- Gavilanes, M. L., Brandão, M., Laca-Buendia, J. P., & Araujo, M. G. (1995). Cobertura vegetal da Serra de São José, MG, municípios de São João Del Rei e Tiradentes. *Daphne*, 5, 40-72.
- Giulietti, A. M., Pirani, J. R., & Harley, R. M. (1997). Espinhaço range region, eastern Brazil. In S.D. Davis, V.H. Heywood, O. H. MacBryde, J. Villa-Lobos & A.C. Hamilton (Eds.), *Centres of plant diversity: a guide and strategy for their conservation* (Vol. 3, p. 397-404). Cambridge: WWFN.
- Harley, R. M. (1995). Introduction. In B. L. Stannard, Y. B. Harvey, & R. M. Harley (Eds.), *Flora of the Pico das Almas - Chapada Diamantina - Bahia, Brazil* (p. 1-42). Kew, UK: Royal Botanic Gardens.
- International Union for Conservation of Nature and Natural Resources [IUCN]. (2019). *The IUCN Red List of Threatened Species. Version 2018-2*. Retrieved on October 20, 2019 from www.iucnredlist.org
- Lawton, J. H. (1996). Population abundances, geographic ranges and conservation: 1994 Witherby lecture. *Bird Study*, 43(1), 3-19. doi: 10.1080/00063659609460991
- Lombardi, V. T., Santos, K. K., D'Angelo Neto, S., Mazzoni, L. G., Rennó, B., Faetti, R. G., ... Miguel, M. (2012). Registros notáveis de aves para o sul do estado de Minas Gerais, Brasil. *Cotinga*, 34, 32-45.
- Lombardi, V. T., Vasconcelos, M. F., & D'Angelo Neto, S. (2007). Novos registros ornitológicos para o centro-sul de Minas Gerais (Alto Rio Grande): municípios de Lavras, São João Del Rei e adjacências, com a listagem revisada da região. *Atualidades Ornitológicas*, 139, 33-42.
- Lopes, L. E. (2006). As aves da região de Varginha e Elói Mendes, sul de Minas Gerais, Brasil. *Acta Biologica Leopoldensia*, 28(1), 46-54.
- Lopes, L. E., Pinho, J. B., Bernardon, B., Oliveira, F. F., Bernardon, G., Ferreira, L. P., ... Rubio, T. C. (2009). Aves da chapada dos Guimarães, Mato Grosso, Brasil: uma síntese histórica do conhecimento. *Papéis Avulsos de Zoologia*, 49(2), 9-47. doi: 10.1590/S0031-10492009000200001
- Machado, A. B. M., Fonseca, G. A. B., Machado, R. B., Aguiar, L. M. S., & Lins, L. V. (1998). *Livro vermelho das espécies ameaçadas de extinção da fauna de Minas Gerais*. Belo Horizonte, MG: Fundação Biodiversitas.
- Machado, F. S., Gregorin, R., & Mouallem, P. S. B. (2013). Small mammals in high altitude phytophysiognomies in southeastern Brazil: are heterogeneous habitats more diverse?. *Biodiversity and Conservation*, 22(8), 1769-1782. doi: 10.1007/s10531-013-0511-7
- Machado, F. S., Moura, A. S., Santos, K. K., Mendes, P. B., Abreu, T. C. K., & Fontes, M. A. L. (2017). Registros ocasionais de mamíferos de médio e grande porte na microrregião de Lavras e São João del Rei, Campo das Vertentes, Minas Gerais. *Revista Agrogeoambiental*, 9(1), 35-44. doi: 10.18406/2316-1817v9n12017930
- Mazzoni, L. G., & Perillo, A. (2011). Range extension of *Anthus nattereri* Sclater, 1878 (Aves: Motacillidae) in Minas Gerais, southeastern Brazil. *CheckList - The Journal of Biodiversity Data*, 7(5), 589-591. doi: 10.15560/7.5.598
- Moura, A. S. (2014). Registro de um novo item alimentar na dieta de *Phibalura flavirostris*. *Atualidades Ornitológicas*, 178, 24-25.
- Moura, A. S., Camargo, J. E. R., & Côrrea, B. S. (2014). Nota: Primeiro registro de *Polioptila dumicola* (Passariformes: Polioptilidae) para o sul do estado de Minas Gerais, Brasil. *Regnella Scientia*, 1(2), 35-64.

- Moura, A. S., & Corrêa, B. S. (2011). Novos registros ornitológicos para o município de Lavras, sul de Minas Gerais, Brasil. *Atualidades Ornitológicas*, 160, 18-19.
- Moura, A. S., & Corrêa B. S. (2012). Aves ameaçadas e alguns registros notáveis para Carrancas, sul de Minas Gerais, Brasil. *Atualidades Ornitológicas*, 165, 18-22.
- Moura, A. S., Corrêa, B. S., & Machado, F. S. (2015). Riqueza, composição e similaridade da avifauna em remanescente florestal e áreas antropizadas no sul de Minas Gerais. *Revista Agrogeoambiental*, 7(1), 41-52. doi: 10.18406/2316-1817v7n12015656
- Moura, A. S., Corrêa, B. S., & Santos, K. K. (2010). Novo registro de plumagem aberrante (Leucismo) em sairá-viúva *Pipraeidea melanonota* (Passeriforme: Thraupidae) no sul de Minas Gerais, Brasil. *Atualidades Ornitológicas*, 158, 6-7.
- Moura, A. S., Mariano, R. F., Machado, F. S., Ceboncini, R. A. S., & Fontes, M. A. L. (2017). Frugivory by birds in *Siphoneugena widgreniana* O. Berg (Myrtaceae) in the Chapada dos Perdizes, Minas Gerais, Brazil. *Natureza online*, 18(3), 035-040.
- Moura, A. S., & Soares-Júnior, F. J. (2010). Ornitofilia (polinização por aves) em *Aechmea maculata* L. B. Smith (Bromeliaceae), registrada em um pequeno fragmento florestal no município de Lavras, região sul de Minas Gerais, Brasil. *Atualidades Ornitológicas*, 158, 57-60.
- Nunes, Y. R. F., Landau, E. C., & Veloso, M. D. M. (2008). Diversidade de Melastomataceae em diferentes altitudes de campos rupestres na Serra do Cipó, MG. *Unimontes Científica*, 10(1/2), 34-45.
- Oliveira-Filho, A. T., Carvalho, D. A., Fontes, M. A. L., Berg, E. V. D., Curi, N., & Carvalho, W. A. C. (2004). Variações estruturais do compartimento arbóreo de uma floresta semidecídua alto-montana na chapada das Perdizes, Carrancas, MG. *Revista Brasileira de Botânica*, 27(2), 291-309. doi: 10.1590/S0100-84042004000200009
- Oliveira-Filho, A. T., & Fluminhan-Filho, M. (1999). Ecologia da vegetação do Parque Florestal Quedas do Rio Bonito. *Cerne*, 5(2), 51-64.
- Pecora, H. B., Moura, A. S., Machado, F. S., Alvarenga, G., Lacerda, L., & Gregorin, R. (2016). Marsupiais em três vertentes da Chapada das Perdizes, ecotone Cerrado-Mata Atlântica no sul do estado de Minas Gerais. *Regnella Scientia*, 3(1), 1-12.
- Piacentini, V. Q., Aleixo, A., Agne, C. E., Maurício, G. N., Pacheco, J. F., Bravo, G. A., ... Cesari, E. (2015). Annotated checklist of the birds of Brazil by the Brazilian Ornithological Records Committee / Lista comentada das aves do Brasil pelo Comitê Brasileiro de Registros Ornitológicos. *Revista Brasileira de Ornitologia*, 23(2), 91-298.
- Rapini, A., Ribeiro, P. L., Lambert, S., & Pirani, J. R. (2008). A flora dos campos rupestres da Cadeia do Espinhaço. *Megadiversidade*, 4(1-2), 16-24.
- Rezende, M. A., Vasconcelos, M. F., Nogueira, W., Silva, J. C., Becho, D. P., Silva, L. F., & Souza, T. O. (2013). Novas ocorrências de híbridos entre *Chiroxiphia caudata* e *Antilophia galeata* em Minas Gerais, Brasil, com a primeira descrição de uma fêmea híbrida e comentários sobre os riscos da hibridação. *Atualidades Ornitológicas*, 174, 33-39.
- Ribon, R. (2000). Lista preliminar da avifauna do município de Ijaci, Minas Gerais. *Revista Ceres*, 47(274), 665-682.
- Rodrigues, M., Freitas, G. H. S., Costa, L. M., Dias, D. F., Varela, M. L. M., & Rodrigues, L. C. (2011). Avifauna, Alto do Palácio, Serra do Cipó National Park, state of Minas Gerais, southeastern Brazil. *Check List – The Journal of Biodiversity Data*, 7(2), 151-161. doi: 10.15560/7.2.151
- Santos, K. K. (2012). Predação de ninhegos de *Bubulcus ibis* por *Nycticorax nycticorax* e breve caracterização de um ninhal poliespecífico no Campus da UFLA, Lavras, Minas Gerais, Brasil. *Atualidades Ornitológicas*, 167, 12-15.
- Santos, K. K., Lombardi, V. T., D'Ângelo-Neto, S., Miguel, M., & Faeti, R. G. (2011). Registros de plumagens aberrantes em *Patagioenas picazuro* (Columbiformes, Columbidae), *Knipolegus lophotes* (Passeriformes: Tyrannidae) e *Turdus rufiventris* (Passeriformes, Turdidae) no estado de Minas Gerais. *Atualidade Ornitológicas*, 160, 4-6.
- Santos, K. K., Miguel, M., & Lombardi, V. T. (2014). Novos registros do caburé-acanelado *Aegolius harrisii* (Cassin, 1849) para o estado de Minas Gerais e comentários sobre sua biogeografia. *Atualidade Ornitológicas*, 181, 7-11.

- Sick, H. (1997). *Ornitologia Brasileira*. Rio de Janeiro, RJ: Nova Fronteira.
- Silva, J. M. C. (1995). Birds of the Cerrado region, South America. *Steenstrupia*, 21, 69-92.
- Silva, J. M. C., & Santos, M. P. D. (2005). *A importância relativa dos processos biogeográficos na formação da avifauna do Cerrado e de outros biomas brasileiros*. In A. Scariot, J. C. Sousa-Silva & J.M. Felfili (Eds.), *Cerrado: ecologia, biodiversidade e conservação* (p. 219-233). Brasília: Ministério do Meio Ambiente.
- Valentin, J. L. (2000). *Ecologia numérica: uma introdução à análise multivariada de dados ecológicos*. Rio de Janeiro, RJ: Interciência.
- Vasconcelos, M. F. (2008). Aves registradas na Serra do Papagaio, município de Aiuruoca, Minas Gerais. *Atualidades Ornitológicas*, 142, 6-7.
- Vasconcelos, M. F., D'Angelo-Neto, S., Brand, L. F. S., Venturin, N., Oliveira-Filho, A. T., & Costa, F. A. F. (2002). Avifauna de Lavras e municípios adjacentes, sul de Minas Gerais, e comentários sobre sua conservação. *Revista Unimontes Científica*, 4(2), 1-14.
- Vasconcelos, M. F., D'Angelo-Neto, S., & Nemésio, A. (2005). Observações sobre o Rei-dos-tangarás *Chiroxiphia caudata* X *Antilophia galeata* em Minas Gerais, Brasil. *Cotinga*, 23, 65-69.
- Vasconcelos, M. F. (2011). O que são campos rupestres e campos de altitude nos topos de montanha do leste do Brasil? *Revista Brasileira de Botânica*, 34(2), 241-246. doi: 10.1590/S0100-84042011000200012.