



E-ISSN: 2320-7078

P-ISSN: 2349-6800

JEZS 2016; 4(4): 447-452

© 2016 JEZS

Received: 10-05-2016

Accepted: 11-06-2016

Ângela Gomes Brunismann
Instituto Federal de Educação,
Ciência e Tecnologia do Sul de
Minas Gerais – Câmpus
Inconfidentes, CEP,
Inconfidentes, Minas Gerais,
Brasil.

Marcos Magalhães de Souza
Instituto Federal de Educação,
Ciência e Tecnologia do Sul de
Minas Gerais – Câmpus
Inconfidentes, CEP,
Inconfidentes, Minas Gerais,
Brasil.

Epifânio Porfiro Pires
Laboratório de Sistemática e
biologia de Hymenoptera,
Departamento de Biologia, Setor
de Zoologia, Universidade
Federal de Lavras, CEP, Lavras,
MG, Brasil.

Evando Luiz Coelho
Instituto Federal de Educação,
Ciência e Tecnologia do Sul de
Minas Gerais – Câmpus
Inconfidentes, CEP,
Inconfidentes, Minas Gerais,
Brasil.

Lucas Rocha Milani
Instituto Federal de Educação,
Ciência e Tecnologia do Sul de
Minas Gerais – Câmpus
Inconfidentes, CEP,
Inconfidentes, Minas Gerais,
Brasil.

Correspondence

Epifânio Porfiro Pires
Laboratório de Sistemática e
biologia de Hymenoptera,
Departamento de Biologia, Setor
de Zoologia, Universidade
Federal de Lavras, CEP, Lavras,
MG, Brasil.

Social wasps (Hymenoptera: Vespidae) in Deciduous Seasonal Forest in Southeastern Brazil

Angela Gomes Brunismann, Marcos Magalhães de Souza, Epifânio Porfiro Pires, Evando Luiz Coelho and Lucas Rocha Milani

Abstract

In the latest decade, the information about biodiversity and distribution of social wasps in the state of Minas Gerais has been increasing; however a few regions and ecosystems own no studies, like the Deciduous Seasonal Forest. With the purpose of fulfilling this lacuna of knowledge, work was conducted over the period of June of 2014 to April of 2015, in the “Refúgio da Vida Silvestre do Rio Pandeiros”, northern Minas Gerais. 35 species of social wasps distributed in 14 genera standing out the species *Parachartergus smithii* (de Saussure, 1854), *Brachygastra moebiana* (de Saussure, 1867) and *Mischocyttarus montei* Zikan 1949, recorded for the first time in the state, demonstrating the importance of that phytophysiognomy for the preservation of biodiversity and the need for new studies in that ecosystem.

Keywords: Mata Seca, Polistinae, preservation, inventory, diversity, abundance

1. Introduction

The The Deciduous Seasonal Forest, also known as “Mata Seca”, occurs naturally as disjunct spots throughout the Neotropical region ^[1]. It is characterized for presenting two quite distinct climate seasons (dry and rainy), presenting predominantly deciduous stratum, with at least 50% of leaf loss in the dry season of the year ^[2, 3]. In Brazil, that vegetation occurs in the Central region, distributed through the states of Minas Gerais, Goiás, Mato Grosso and Bahia ^[4], which represents about 6% of the country’s cover ^[2]. In the state of Minas Gerais, that vegetation occupies an area of 3.46% ^[5].

In spite of the “Mata Seca” representing a small part of the plant cover of Minas Gerais, the few studies upon the diversity point out a relevant wealth of species of insects ^[6] and plants ^[7-8]. Nevertheless, the economic use of those areas, specially for log extraction, widening of monoculture and livestock production, has brought about the reduction of the natural vegetation areas, making the studies aiming to know the biodiversity of that ecosystem for its emergency preservation ^[3-11]. Another aggravating circumstance to the “Mata Seca” is that naturally disjunct vegetations trend to accumulate high degree of endemism ^[12], which makes that place vulnerable to any extent of environmental degradation or decrease of the natural area, which has as consequences the increased extinction risk of the species ^[13, 14].

Social wasps (Hymenoptera: Vespidae), insects known as “marimbondos” and/or “cabas” ^[15], possess cosmopolitan distribution with the greatest species diversity in the Neotropical region ^[16, 17]. In Brazil, the representatives of that group belong to the subfamily Polistinae and are distributed in three tribes: Mischocyttarini (*Mischocyttarus* de Saussure 117 species), Polistini (*Polistes* Latreille 38 species) and Epiponini (19 genera and 164 species) ^[17, 18].

Social wasps play an important paper in the communities, whether in the natural or agricultural ecosystems, by the predation pressure exercised on the populations of other organisms ^[15-19]. Other function which has been being ascribed to those insects is the one of acting as important components of the guild of floral visitors in the Neotropics ^[20-23].

In Minas Gerais, since the last decade, several works have been carried out with the purpose of knowing the fauna of social wasps as well as their nesting habits in areas of Montane Semideciduous Forest, Atlantic Forest, Cerrado, Campo Rupestre, Riparian Forest, agricultural areas and man-modified areas ^[15-27]. Nevertheless, those works are concentrated in the Mesoregions of Zona da Mata, Campo das Vertentes, Triângulo Mineiro/Alto Paranaíba, Sul/Sudeste and Vale do Rio Doce, and studies about the social wasp fauna in the region of the current studies are still unprecedented. This work intended to report, for the first time, the

Social wasp fauna in Deciduous Seasonal Forest in the north of the state of Minas Gerais, aiming to furnish a list of social wasp species (composition), which will aid in the region's biodiversity conservation programs.

2. Materials and Methods

2.1 Study site

This study was conducted in the area of the "Refúgio da Vida Silvestre do Rio Pandeiros" (15°30'19.90" S 44°45'25.71" W and 15°39'50.96" S 44°38'04.62" W), inserted in the municipality of Januária, north of the state of Minas Gerais. The area possesses influence of the Biomas do Cerrado and Caatinga and includes a different phytophysiology, Veredas, Riparian Forest, "Mata Seca", and the largest wetland area in the state [28]. The predominant climate in the region is the semiarid, with quite distinct dry and rainy seasons. The annual average temperature is of 25 °C and annual rainfall is of approximately 1,000 mm, with rains concentrated specially in the months of October to February [29].

2.2 Sampling

The collections were done in four sampling periods: rainy season (spring and summer) and dry season (fall and winter) in the period of June of 2014 to April of 2015. In each season, five days' continuous sampling were carried out, amounting to 20 days of collecting, which comprehended around 10% of the refuge area.

The social wasp species were collected with the use of two methodologies: active collecting and attractive traps [26].

The identifications of the specimens were done on the basis of keys proposed by Carpenter and Marques [17], Carpenter [18], Richards [30] and by comparison with the specimens of the IF-SULDEMINAS social wasp's collection of the "Museu Paraense Emílio Goeldi", Belém, Pará. The "vouchers" were incorporated to the "IF-SULDEMINAS" collection, Inconfidentes campus, Minas Gerais (<http://vespas.ifs.ifsuldeminas.edu.br>) and in the "Coleção de Entomologia do Museu Paraense Emílio Goeldi", Belém, Pará. The corroboration of the species was done by Professor Dr. Orlando Tobias da Silveira, of the "Museu Paraense Emílio Goeldi", Belém, Pará and Professor Dr. Sergio Andena, of the "Universidade Estadual de Feira de Santana", Bahia.

2.3 Literature Data

For the similarity analysis among the social wasp faunas

collected in the state of Minas Gerais, data of the areas of Cerrado of the works by Elpino-Campos *et al.* [31]. In "Uberlândia" (15°57'46.57" S, 48°26'13.36" W and 19°09'15.00" S, 48°23'01.04" W) and Simões *et al.* [32]. In the "Reserva Biológica Unilavras-Boqueirão" (21°20'01.62" S, 44°59'01.41" W); Rupestrian Field of the works by Prezoto and Clemente [33]. in the "Parque Estadual do Ibitipoca" (21°40'00.67" S, 43°52'01.38" W) and Souza *et al.* [34]. In the "APA de São José" (21°05'00.77" S 44°10'03.70" W); in Semideciduous Seasonal Forest in the work by Souza *et al.* [26]. in the municipality of "São Gonçalo do Sapucaí" (21°53'21.23" S, 45°37'24.40" W) and "Parque Estadual Serra do Brigadeiro" (20°42'58.55" S, 42°29'04.47" W); area of Evergreen Broadleaf Forest, Atlantic Forest, of the work by Souza *et al.* [35]. in the "Parque Estadual do Rio Doce" (19°38'00.00" S e 42°31'00.00" W); transition area Cerrado and Semideciduous Seasonal Forest of the works by Souza *et al.* [36]. in the region of "Mata do Baú" (21°12'00.01" S e 43°54'56.44" W).

2.4 Data Analysis

The comparison among the social wasp fauna collected in the state of Minas Gerais was made by cluster analysis (UPGMA) by means of Jaccard's similarity coefficient [37], which takes into account the occurrence of the species in each area.

In similarity analysis only the species with identification to the species level were used. Listed species only as "sp." in Souza *et al.* [35], Elpino-Campos *et al.* [31]. In this work were not included in the analysis. The identifications at the subspecies level of the work of Elpino-Campos *et al.* [31], Souza *et al.* [34], Souza *et al.* [35]. Souza *et al.* [36]. in this work were not considered in analysis.

The analysis of Pearson (r) [38]. Was used to establish possible relationship of similarity among the faunas of social wasps of nine areas studied in Minas Gerais with their distances using the Statistica for Windows Software [39]. In the analysis accomplished, the level of significance (α) of 0.05 was considered. The data of the distances (km) between the areas were obtained by the "ruler" tool of Google Earth Pro [40].

3. Results

Thirty-five social wasps species distributed in 14 genera belonging to the tribes Polistini (two species), Mischocyttarini (eight species) and Epiponini (12 genera and 25 species) were recorded (Table. 1).

Table 1: Social wasp species (Hymenoptera: Vespidae) and number of colonies found in the "Refúgio da Vida Silvestre do Rio Pandeiros", northern Minas Gerais and their occurrence per season (+ present, but no record of colonia; - absence; F - Fall; Sp - Spring; S - Summer; W - Winter).

Species	"Mata Seca"				Total of colonies
	F	Sp	S	W	
<i>Agelaia multipicta</i> (Haliday, 1836)	+	-	+	+	0
<i>Agelaia vicina</i> (Saussure, 1854)	1	-	+	+	1
<i>Apoica gelida</i> (Van Der Vecht 1973)	+	1	-	1	2
<i>Apoica pallens</i> (Lepeletier, 1836)	-	-	-	2	2
<i>Apoica thoraxica</i> (Buysson, 1906)	+	-	-	-	0
<i>Brachygastra augusti</i> (Saussure, 1854)	+	-	-	-	0
<i>Brachygastra lecheguana</i> (Latreille, 1824)	1	0	+	0	1
<i>Brachygastra moebiana</i> (de Saussure, 1867)	+	-	-	+	0
<i>Chartergellus communis</i> Richards, 1978	8	2	2	0	12
<i>Chartergellus globiventris</i> (Saussure, 1854)	2	2	1	3	8
<i>Clypearia angustior</i> (Ducke, 1906)	-	-	+	-	0
<i>Metapolybia cingulata</i> (Fabricius, 1804)	7	2	2	1	12
<i>Mischocyttarus cassununga</i> (R. von Ihering, 1903)	45	4	-	6	55
<i>Mischocyttarus cerberus</i> (Richards, 1940)	-	+	-	-	0
<i>Mischocyttarus drewseni</i> (Saussure, 1857)	+	-	6	-	6

<i>Mischocyttarus montei</i> Zikan 1949	24	5	12	3	44
<i>Mischocyttarus bertonii</i> Ducke 1918	2	-	2	-	4
<i>Mischocyttarus rotundicolis</i> (Cameron, 1912)	+	-	-	-	0
<i>Mischocyttarus</i> sp. 01	+	+	+	-	0
<i>Mischocyttarus</i> sp. 02	+	-	+	-	0
<i>Parachartergus fraternus</i> (Griboldo, 1892)	1	1	1	3	6
<i>Parachartergus smithii</i> (de Saussure, 1854)	+	0	2	+	2
<i>Polistes simillimus</i> (Zikán, 1951)	-	-	+	-	0
<i>Polistes subsericius</i> (Saussure, 1854)	+	-	-	-	0
<i>Polybia chysothorax</i> (Lichtenstein, 1796)	+	-	1	-	1
<i>Polybia ignobilis</i> (Haliday, 1836)	+	0	1	+	2
<i>Polybia jurinei</i> (Saussure, 1854)	+	2	4	3	9
<i>Polybia occidentalis occidentalis</i> (Oliver, 1971)	18	12	23	17	70
<i>Polybia sericea</i> (Oliver, 1971)	+	-	+	+	0
<i>Polybia punctata</i> Buysson, 1908	-	+	-	-	0
<i>Polybia ruficeps</i> Schrottky, 1902	-	4	3	0	7
<i>Protopolybia exigua exigua</i> (Saussure, 1854)	13	4	17	4	38
<i>Protopolybia sedula</i> (Saussure, 1854)	1	2	1	2	6
<i>Protonectarina sylveirae</i> (Saussure, 1854)	+	1	+	2	3
<i>Synoeca surinama</i> (Linnaeus, 1767)	1	2	5	2	10
Total colonies recorded by season	125	44	83	49	301

The species *Parachartergus smithii* (de Saussure, 1854), *Brachygastra moebiana* (de Saussure, 1867) and *Mischocyttarus montei* Zikan 1949 were first recorded in

Minas Gerais (Fig. 1) [30], increasing to 104 the number of known species for the state (<http://vespas.ifs.ifsuldeminas.edu.br>).



Fig 1: New Records of social wasp (Hymenoptera: Vespidae) in Minas Gerais State: 1. *Parachartergus smithii* (de Saussure, 1854), 2. *Brachygastra moebiana* (de Saussure, 1867), 3. *Mischocyttarus montei* Zikan 1949. Scale bar 2mm.

The genus *Mischocyttarus* was the most representative in number of species (eight spp.), followed by *Polybia* Lepelletier (seven spp.), *Apoica* Lepelletier and *Brachygastra* Perty (three spp. each), and *Agelaia* Lepelletier, *Parachartergus* R. von Ihering, *Polistes* and *Protopolybia* Ducke (two spp. each). The genera *Chartergus* Lepelletier, *Chartergellus* Bequaert, *Clypearia* Ducke, *Metapolybia* Ducke, *Protonectarina* Ducke and *Synoeca* de Saussure were represented by only one species each (Table. 1).

Three hundred and one colonies belonging to 22 species were recorded (Table. 1). Among these, *Polybia occidentalis occidentalis* (Olivier, 1791) nests (70 nests) were the most abundant, followed by *Mischocyttarus cassununga* (von Ihering, 1903) (55 nests), *M. montei* (44 nests), *Protopolybia exigua exigua* (Saussure, 1854) (38 nests) and *Synoeca surinama* (Linnaeus, 1767) (10 nests). The other species obtained records inferior to ten colonies (Table. 1).

On the basis of the Jaccard similarity coefficient among faunas of social wasps, some surveys done in the state of Minas Gerais, it was possible to observe the formation of basically two groups. One formed by the “Parque Estadual do Rio Doce” region, area of evergreen forest, Atlantic Forest [35], and the other by the other areas [26-36] and present study. Greater similarity value between the composition of the species of “Refugio da Vida Silvestre do Rio Pandeiros”

with “Mata do Baú” and “Parque Estadual Serra do Brigadeiro” and “São Gonçalo do Sapucaí” “with around 33% of similarity, followed by Refugio da Vida Silvestre do Rio Pandeiros” with “Uberlândia” (31%). The other areas obtained similarity below 26% with “Refugio da Vida Silvestre do Rio Pandeiros” (Fig. 2).

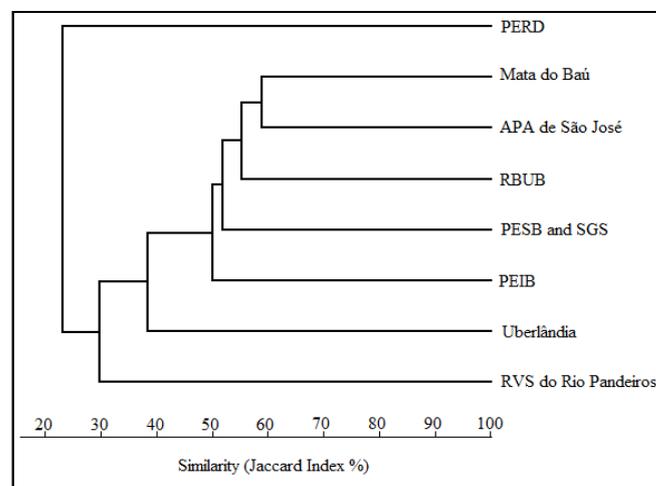


Fig 2: Dendrogram similarity Jaccard among the fauna of social wasps eight areas studied in Minas Gerais.

There was a significant negative relation between the distance and similarity among the faunas of social wasps, but the percentage of variation of the data explained by the

regression was considered low ($r^2 = 0.4638$, $P = 0.00000$) (Fig. 3).

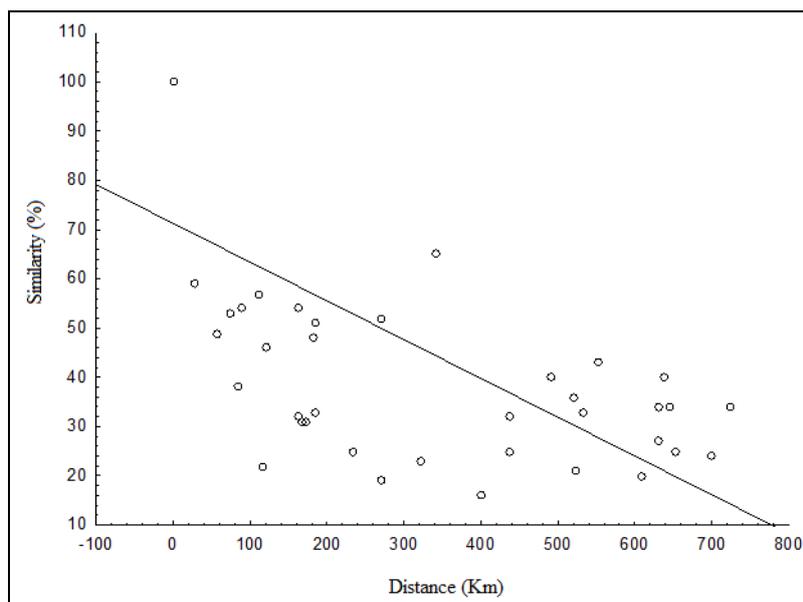


Fig 3: Correlation Pearson between the similarity (Jaccard) and the faunas of social wasps of nine areas studied in Minas Gerais with their respective distances.

4. Discussion

The number of genera recorded in this study is the largest for the state of Minas Gerais. In studies conducted in different ecosystems of the state, this number has varied between eight and eleven genera [25-33, 35-41].

The area of the present study is characterized as a transition area between the Cerrado and Caatinga, which may have contributed to the number of recorded genera. These transition areas can provide vegetation heterogeneity, with great richness of flora and vertical stratification, generating variety of niches, enabling the occurrence of a lot of social wasp species. This hypothesis is grounded on the fact of the occurrence of some species such as *Chartergellus communis* Richards, 1978, *Chartergus globiventris* (Saussure, 1854), *Metapolybia cingulata* (Fabricius, 1804) and *Polybia ruficeps* Schrottky, 1902 recorded in the Cerrado in Minas Gerais and in caatinga areas in various states of the Northeast region [31-44].

The reason for *Mischocyttarus* to present the greatest wealth of species is related to the fact that it is the largest genus of social wasps, with 240 described species and cumulative distribution stretching from southeastern Canada to northern Argentina. One hundred and seventeen species are found in Brazil and, among them, 78 are endemic [17]. In other studies of Minas Gerais, taking into consideration different ecosystems, the genus was also the most representative [25-45].

The high representativeness of *P. occidentalis occidentalis* as to the number of nests may be related to its wide ecological tolerance, being regarded as one of the dominant species in open ecosystems and under adverse conditions, being very important in the structure of communities subject to rigorous ecological conditions [46, 47], which would also explain its lower frequency in other biomes of Minas Gerais, the Semideciduous Seasonal Forest [45], and Atlantic forest [35], where the water stress is lower relative to the “Mata Seca”.

The month of July is a transition period of the rainy period

to the beginning of the dry season and plants begin to shed their leaves, a fact which positively reflected on the records of social wasp colonies. The absence of leaves enabled the viewing of the colonies while the air low humidity and high temperatures influenced positively on foraging activity and as at this time the availability of food resources decrease, the distance covered for foraging may be longer by optimizing the active search and making attractive traps an alternative resource source, which makes them efficient in that period [31-45].

The greatest similarity between the “Refugio da Vida Silvestre do Rio Pandeiros”, “Uberlândia”, “Mata do Baú” e “Parque Estadual Serra do Brigadeiro” and “São Gonçalo do Sapucaí” may be related to the characteristics of the vegetation, which is inserted in the transition area Cerrado Semideciduous Forest. However, concerning the low similarity to the “Parque Estadual do Rio Doce”, the latter is formed by evergreen forest, with peculiar characteristics which do not occur in other areas of Minas Gerais, featuring high degree of endemism of the species, which has its occurrence limited to this environment [35]. Souza *et al.* [26] demonstrated and discussed factors that can influence the similarity among the structures of assembly of social wasps sampled in Minas Gerais. To the authors, factors such as the particular characteristics of vegetation, climate, and the distance between the areas are important factors in determining the similarity among the composition of the social wasp fauna.

On the basis of the data obtained, the “Mata Seca” is an ecosystem important to the biodiversity of social wasps in the state of Minas Gerais. Destruction or alteration of that environment may negatively impact the diversity of those insects in the state, so it is vital that further studies are carried out in areas that house this phytophysiognomy which has peculiar characteristics, to better known the assembly of social wasps, especially those of occurrence restricted to “Mata Seca”.

5. Acknowledgments

The trainees Danielle Cristina de Padua, Fernanda Coltri, Gabriela Santos Francisco and João Batista Dallo, through Collaboration in the sampling; Orlando Tobias Silveira and Sergio Andena for species identification; The Instituto Estadual de Florestas de Minas Gerais (IEF) and IFSULDEMINAS assistance in project realization.

6. References

1. Werneck FP, Costa GC, Colli GR, Prado DE, Sites JW. Revisiting the historical distribution of Seasonally Dry Tropical Forests: new insights based on palaeodistribution modelling and palynological evidence. *Global Ecology and Biogeography* 2011; (20):272-288.
2. Veloso HP, Rangel-Filho ALR, Lima JCA. Classificação da vegetação brasileira, adaptada a um sistema universal. Rio de Janeiro: IBGE, 1991, 1-124.
3. Collevatti RG. Drawbacks to palaeodistribution modelling: the case of South American seasonally dry forests. *Journal of Biogeography*. 2013; (40):345-358.
4. Rizzini CT. Tratado de Fiteogeografia do Brasil. Hucitec and Edusp, 1979, 1-747.
5. Belém RA. Zoneamento ambiental e os desafios da implementação do Parque Estadual Mata Seca, Município de Manga, Norte de Minas Gerais. Tese de Doutorado- Universidade Federal de Minas Gerais, Belo Horizonte, Minas Gerais, 2008, 1-170.
6. Oliveira VHF, Mota-Souza JG, Vaz-de-Mello FZ, Neves FS, Fagundes M. Variação na fauna de besouros rola-bosta (Coleoptera:Scarabaeinae) entre habitats de Cerrado, Mata Seca e Mata Ciliar em uma região de transição Cerrado-Caatinga no norte de Minas Gerais. *MG Biota* 2011; 4:4-16.
7. Sales HR, Santos RM, Nunes YRF, Morais-Costa F, Souza SCA. Caracterização florística de um fragmento de cerrado na APA Estadual do Rio Pandeiros-Bonito de Minas/MG. *MG Biota* 2009; 2:22-30.
8. Sales HR, Souza SCA, Luz GR, Morais-Costa F, Amaral VB, Santos RM *et al.* Flora arbórea de uma floresta estacional decidual na APA Estadual do Rio Pandeiros, Januária/MG. *MG Biota* 2009; 2:31-41.
9. Sevilha AC, Scariot A, Noronha S. Estado atual da representatividade de unidades de conservação em florestas estacionais deciduais no Brasil. In:55 Congresso Nacional de Botânica e Simpósio Unidades de Conservação nos Biomas Brasileiros, 2004, 1-60.
10. Bahia TO, Luz GR, Veloso MDM, Nunes YRF, Neves WV, Braga LL *et al.* As veredas da APA do Rio Pandeiros: importância, impactos ambientais e perspectivas. *MG Biota* 2009; 2(3):4-13.
11. Bahia TO, Luz GR, Braga LL, Menino GCO, Nunes YRF, Veloso MDM *et al.* Florística e fitossociologia de veredas em diferentes estágios de conservação na APA do Rio Pandeiros, norte de Minas Gerais. *MG Biota* 2009; 2(3):14-21.
12. Givnish TJ. Adaptive plant evolution on islands: classical patterns, molecular data, new insights. In: Grant PR. (Ed.), *Evolution on island*. University Press, 1998, 281-304.
13. Triantis KA, Borges PAV, Ladle RJ, Hortal J, Cardoso P, Gaspar C *et al.* Extinction debt on oceanic islands. *Ecography* 2010; 33(2):285-294.
14. Işık K. Rare and endemic species: why are they prone to extinction? *Turkish Journal of Botany*. 2011; 35(4):411-417.
15. Souza MM, Zanuncio JC. Marimbondos: vespas sociais (Hymenoptera: Vespidae). Editora UFV, 2012, 1-79.
16. Carpenter JM. The phylogenetic relationships and natural classification of the Vespoidea (Hymenoptera). *Systematic Entomology* 1981; 7(1):11-38.
17. Carpenter JM, Marques OM. Contribuição ao estudo dos vespídeos do Brasil (Insecta, Hymenoptera, Vespoidea, Vespidae). Cruz das Almas, Universidade Federal da Bahia - Publicações digitais, 2001, 1-147.
18. Carpenter JM. Synonymy of the genus *Marimbonda* Richards 1978, with *Leipomeles* Mobius, 1856 (Hymenoptera: Vespidae; Polistinae), and a new key to the genera of paper wasps of the New World. *American Museum Novitates* 2004; 3465:1-16.
19. Richter MR. Social wasp (Hymenoptera, Vespidae) foraging behavior. *Annual Review of Entomology* 2000; 45:121-150.
20. Aguiar CML, Santos GMM. Compartilhamento de recursos florais por vespas sociais (Hymenoptera:Vespidae) e abelhas (Hymenoptera: Apoidea) em uma área de Caatinga. *Neotropical Entomology* 2007; (36):836-842.
21. Santos GMM, Aguiar CML, Mello MAR. Flower-visiting guild associated with the Caatinga flora: trophic interaction networks formed by social bees and social wasps with plants. *Apidologie* 2010; (41):466-475.
22. Mello MAR, Santos GMM, Mechi MR, Hermes MG. High generalization in flower-visiting networks of social wasps. *Acta Oecologica* 2011; 37:37-42.
23. Clemente MA, Lange D, Dattilo W, Del Claro K, Prezoto F. Social Wasp-Flower Visiting Guild Interactions in Less Structurally Complex Habitats are More Susceptible to Local Extinction. *Sociobiology* 2013; 60:337-344.
24. Jacques GC, Souza MM, Coelho HJ, Vicente LO, Silveira LCP. Diversity of Social Wasps (Hymenoptera: Vespidae: Polistinae) in an Agricultural Environment in Bambuí, Minas Gerais, Brazil. *Sociobiology* 2015; 62:439-445.
25. Souza MM, Pires EP, Eugênio R, Silva-Filho R. New Occurrences of Social Wasps (Hymenoptera: Vespidae) in Semideciduous Seasonal Montane Forest and Tropical Dry Forest in Minas Gerais and in the Atlantic Forest in the State of Rio de Janeiro. *Entomo Brasilis* 2015; 8(1):65-68.
26. Souza MM, Pires EP, Silva-Filho R, Ladeira TE. Community of social wasps (Hymenoptera: Vespidae) in areas of Semideciduous Seasonal Montane Forest. *Sociobiology* 2015; 62(4):598-603.
27. Souza MM, Silva HNM, Dallo JB, Martins LF, Milani LR, Clemente MA. Biodiversity of social wasps Hymenoptera: Vespidae at altitudes above 1600 meters in the Parque Estadual da Serra do Papagaio state of Minas Gerais Brazil. *Entomo Brasilis* 2015; 8(3):174-179.
28. Instituto Estadual de Florestas de Minas Gerais. APA Pandeiros, 2008. (IEF) Web site2008; Accessed on 14 December 2015: <http://www.ief.mg.gov.br>.
29. Santos RM, Vieira FA, Fagundes M, Nunes YRF, Gusmão E. Riqueza e similaridade florística de oito remanescentes florestais no norte de Minas Gerais. *Revista Árvore* 2007; 31:135-144.
30. Richards OW. *The social Wasps of the Americas, Excluding the Vespinae*. London: British Museum,

- Natural History, 1978, 1-580.
31. Elpino-Campos A, Del-Claro K, Prezoto F. Diversity of social wasps (Hymenoptera: Vespidae) in Cerrado fragments of Uberlândia, Minas Gerais State, Brazil. *Neotropical Entomology* 2007; 5:685-692.
 32. Simões MH, Cuozzo MD, Frieiro-Costa FA. Diversity of social wasps (Hymenoptera, Vespidae) in Cerrado biome of the southern of the state of Minas Gerais, Brazil. *Iheringia, Série Zoologia* 2012; 10:292-297.
 33. Prezoto F, Clemente MA. Vespas sociais do Parque Estadual do Ibitipoca, Minas Gerais, Brasil. *MG Biota* 2010; 3:22-32.
 34. Souza MM, Ladeira TE, Assis NRG, Elpino-Campos A, Carvalho P, Louzada JNC. Ecologia de vespas sociais (Hymenoptera, Vespidae) no Campo Rupestre na Área de Proteção Ambiental, APA, São José, Tiradentes, MG. *MG Biota* 2010; 3:15-32.
 35. Souza MM, Pires EP, Ferreira M, Ladeira TE, Pereira M, Elpino-Campos A, Zanuncio JC. Biodiversidade de vespas sociais (Hymenoptera: Vespidae) do Parque Estadual do Rio Doce, Minas Gerais, Brasil. *MG Biota* 2012; 5(1):4-19.
 36. Souza MM, Silva MJ, Silva MA, Assis NRG. Barroso, capital dos marimbondos: vespas sociais Hymenoptera, Vespidae do município de Barroso, Minas Gerais. *MG Biota* 2008; 1:24-38.
 37. Krebs CJ. *Ecological Methodology*. Ed. 2. New York: Benjamin/ Cummings, 1999, 1-620.
 38. Zar JH. *Bio statistical analysis*. Ed. 4. New Jersey, Prentice-Hall, Inc. 1999; 1(663):212.
 39. Stat soft. *Statistica for Windows*. Tulsa: Stat Soft. 1998.
 40. Google. Google Earth website. <http://earth.google.com/>. Accessed in, 2015.
 41. Jacques GC, Castro AA, Souza GK, Silva-Filho R, Souza MM, Zanuncio JC. Diversity of social wasps in the Campus the Universidade Federal de Viçosa in Viçosa, Minas Gerais State, Brazil. *Sociobiology* 2012; 59:1053-1062.
 42. Andena SR, Carpenter JM. Check list das espécies de Polistinae (Hymenoptera, Vespidae) do semiárido Brasileiro. In: Bravo F, Calor A. (Eds.), *Artrópodes do Semiárido: biodiversidade e conservação*. Universidade Estadual de Feira de Santana: Printmídia press, 2014, 169-180.
 43. Melo AC, Barbosa BC, Castro MM, Santos MGM, Prezoto F. The social wasp community (Hymenoptera, Vespidae) and new distribution record of *Polybia ruficeps* in an area of Caatinga Biome, northeastern Brazil. *Check List* 2015; 11(1):1530.
 44. Santos GMM, Cruz JD, Marques OM, Gobbi N. Diversidade de Vespas Sociais (Hymenoptera: Vespidae) em Áreas de Cerrado na Bahia. *Neotropical Entomology* 2009; 38(3):317-320.
 45. Souza MM, Prezoto F. Diversity of social wasps (Hymenoptera, Vespidae) in Semideciduous Forest and Cerrado (Savanna) regions in Brazil. *Sociobiology* 2006; 47:135-147.
 46. Santos GMM. Comunidades de vespas sociais (Hymenoptera - Polistinae) em três ecossistemas do estado da Bahia, com ênfase na estrutura da guilda de vespas visitantes de flores de Caatinga. Tese de doutorado - Faculdade de Filosofia, Ciências e Letras de Ribeirão Preto, Ribeirão Preto, São Paulo, 2000, 1-129.
 47. Almeida SM, Andena SR, Anjos-Silva EJ. Diversity of the nests of social wasps (Hymenoptera: Vespidae: Polistinae) in the northern Pantanal, Brazil. *Sociobiology* 2014; 61:107-114.