Diversity of Social Wasps in the *Campus* of the "Universidade Federal de Viçosa" in Viçosa, Minas Gerais State, Brazil

by

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ABSTRACT

Social wasps can be used as ecological indicators. However, the diversity of species of this group in Minas Gerais State, Brazil, is poorly studied, especially in anthropized environments. The objective was to study diversity of these insects in the *campus* of the "Universidade Federal de Viçosa" in Viçosa, Minas Gerais State, Brazil, from May to June 2011 with two methodologies (attractive traps and active search). Eight hundred and eighty-nine individuals of social wasps of 10 genera and 25 species were collected. The high species richness found can be explained by the diverse environment of the area studied with greater availability of microhabitats, greater protection against predators, and high availability and diversity of food and substrates for nesting which may favor the coexistence of a greater number of species. In addition, combined use of two collecting methodologies provided a greater diversity of wasps captured.

Key words: Vespidae, biodiversity, species richness.

INTRODUCTION

Hymenoptera species have different habits and levels of social complexity, including those of the family Vespidae that are important as pollinators (Hunt *et al*. 1991; Brodmann *et al*. 2008; Mello *et al*. 2011), predators (Prezoto & Machado 1999; Prezoto *et al*. 2006; Silveira *et al*. 2008; Gomes & Noll 2009) and bioindicators (Souza *et al*. 2010). This family includes solitary wasps (Euparigiinae, Masarinae and Eumeninae) and species with some degree of socialization (Stenogastrinae, Polistinae and Vespinae) (Elpino-Campos *et al*. 2007).

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Eusocial wasps (Polistinae) are cosmopolitan and diverse in the Neotropics (Auad *et al*. 2010). Brazilian Polistinae are among the most widespread wasp group in South America, with 22 genera and 316 species of three tribes: Polistini, Mischocyttarini and Epiponini (Prezoto *et al*. 2007). Many species of this subfamily are predators of insects and other arthropods (Richter 2000), but also an important food resource for insectivorous birds and ants (Kumano & Kasuya 2006). Social wasps are viable for biological control programs, but the survey and identification of these insects are the first step for integrated pest management programs (Prezoto *et al*. 2006).

Degradation of natural environments results in losses of biological diversity, with wasp species being endangered before the study of basic aspects of their biology (Nascimento *et al*. 2004). This biodiversity must be known and evaluated in terms of number of species, distribution and interaction aspects to facilitate natural ecosystem preservation (Del-Claro 2004). Social wasps, due to their distribution, abundance and richness of interactions, are considered a special group (Prezoto *et al*. 2009), easily sampled because they forage and return to a central place (nest). Moreover, they are active in all seasons in most tropical ecosystems and can be sampled in a relatively short period (Kumar *et al*. 2009). Sensitivity of these wasps to changes in abiotic conditions (light, temperature and humidity) shows that they can be used as indicators of environmental quality (Souza *et al*. 2010).

The surveying and identification of genera and species of animals and plants are important to know the natural resources available in a specific area and to understand ecological characteristics of an ecosystem (Elpino-Campos *et al*. 2007). Global destruction of rainforests highlights the importance of these studies (Buschini & Woiski 2008).

The diversity of social wasp species in Brazil was studied in "Campos Rupestres" (Silva-Pereira & Santos 2006), Brazilian Savanna (Elpino-Campos *et al*. 2007; Souza & Prezoto 2006), Amazon Rainforest (Silveira 2002; Silveira *et al*. 2008), Semidecidual Forest (Gomes & Noll 2009), Riparian Vegetation (Souza *et al*. 2010; Pereira & Antonialli Junior 2011) and Mangrove, Atlantic Forest and Restinga Vegetation (Santos *et al*. 2007). However, the wasp fauna of Minas Gerais State, mainly in anthropized environments, is poorly studied. The objective was to obtain preliminary data on wasp diversity

within the *campus* of the "Universidade Federal de Viçosa" in Viçosa, Minas Gerais State, Brazil.

MATERIALS AND METHODS

Social wasps were collected in the *campus* of the "Universidade Federal de Viçosa" (UFV) in Viçosa, Minas Gerais State, Brazil from May to June 2011 using two methodologies. This area has very diverse anthropized environments including buildings, agriculture areas, artificial lakes and Atlantic Forest fragments.

Attractive traps

Traps were prepared with two-liter plastic bottles with three triangular lateral openings (2 x 2 x 2 cm) located 10 cm from their base (Souza & Prezoto 2006).

Attractive substances were: 1- natural passion fruit juice (*Passiflora edulis* f. *flavicarpa* Deg.; Passifloraceae) with 1 kg of fruit mixed with 250 g of granulated sugar and two liters of water; 2- 250 g of sardine (*Sardinella brasiliensis* Steindachner 1789) with two liters of water, and 3- pure honey. Each bottle received 150 mL of attractive substance.

Twenty bottles were used per attractive substance. These traps were set up at 1.5m high in different places in the *campus* "Universidade Federal de Viçosa". Wasps were collected from the traps every seven days and preserved in 70% alcohol for identification.

Active search

Active searches were performed in the *campus* of the "Universidade Federal de Viçosa". Trunks and natural cavities (empty termite nests and rocks), broadleaf vegetation, flowers and buildings were inspected (Souza & Prezoto 2006; Elpino-Campos *et al*. 2007).

The species collected were identified with keys (Richards 1978; Carpenter 2004); diversity and species dominance calculated using the Shannon-Wiener diversity index (H') and the Berger-Parker dominance (D_{pb}), through the Dives program (Diversity of Species v2.0) at the base 10 logarithm (Rodrigues 2005). Identifications were confirmed by Dr. Orlando Tobias Silveira from Emílio Goeldi Museum of Belém, Pará State, Brazil.

RESULTS AND DISCUSSION

Eight hundred and eighty-nine social wasps of 10 genera and 25 species were collected (Table 1). The number of Vespidae species was the sixth highest in collections of this group in Brazil (Table 2). Heterogeneous substrates may favor the coexistence of a greater number of species due to greater availability of microhabitats, protection against predators, and a high availability and diversity of food resources and substrates for nesting (Santos *et al*. 2007). In addition, combined use of collecting methods provides a greater diversity of wasps captured (Silveira 2002; Souza & Prezoto 2006; Elpino-Campos

Table 1. Frequency of social wasp species collected in the *campus* of the "Universidade Federal de Viçosa" in Viçosa, Minas Gerais State, Brazil through active search (AS) and attractive traps (AT)

Species	Frequency		
	AS	AT	Total
Agelaia multipicta (Haliday)	48	53	101
Agelaia vicina Saussure	0	295	295
Apoica pallens (F.)	0	1	1
Brachygastra lecheguana (Latreille)	7	0	7
Mischocyttarus atramentarius Zikán	6	0	6
Mischocyttarus sp.1	1	0	1
Mischocyttarus cassununga (Von. Ihering)	24	219	243
Mischocyttarus drewseni Saussure	1	1	2
Mischocyttarus parallellogrammus Zikán	2	2	4
Mischocyttarus sp.2	2	0	2
Parachartergus fraternus (Gribodo)	1	0	1
Polistes actaeon Haliday	6	0	6
Polistes simillimus Zikán	16	0	16
Polistes versicolor Olivier	32	5	37
Polybia bifasciata Saussure	0	2	2
Polybia fastidiosuscula Saussure	38	8	46
Polybia ignobilis (Haliday)	0	6	6
Polybia jurinei Saussure	1	4	5
Polybia platycephala (Richards)	72	9	81
Polybia paulista (Von. Ihering)	0	1	1
Polybia sericea (Olivier)	5	13	18
Polybia sp.	2	1	3
Protonectarina sylveirae (Saussure)	1	0	1
Protopolybia exígua (Saussure)	12	0	12
Synoeca cyanea (Fabricius)	1	0	1
	279	620	899

Table 2. Comparison between total number of species in this research (*) and other studies in the literature

Source	Number of species
Silveira 2002 (Amazon Rainforest)	79
Silva & Silveira 2009 (Amazon Rainforest)	65
Souza & Prezoto 2006 (Cerrado and Semidecidual Forest)	38
Souza *et al*. 2010	36
Elpino-Campos *et al.* 2007 (Cerrado)	29
* This research	26
Hermes & Köhler 2004 (Atlantic Forest)	25
Santos *et al*. 2009 (Cerrado)	19
Pereira & Antonialli Junior 2011 (Riparian Vegetation)	18
Santos *et al.* 2007 (Atlantic Forest)	18
Santos *et al*. 2007 (Restinga Vegetation)	16
Auad *et al*. 2010 (Silvipastoral System)	13
Silva-Pereira & Santos 2006 (Campos Rupestres)	11
Arab *et al.* 2010 (Atlantic Forest)	10
Santos et al. 2007 (Mangrove)	8
Gomes & Noll 2009 (Semidecidual Forest)	7
Silveira *et al.* 2008 (Amazon Rainforest)	6

Table 3. Richness, diversity and dominance calculated with active search (AS) and attractive traps (AT) of social wasps in the *campus* of the "Universidade Federal de Viçosa" in Viçosa, Minas Gerais State, Brazil

	AS	AT	Total
Species richness (S')	21	15	26
Shannon-Wiener diversity index (H')	0.9814	0.5753	0.8584
Berger-Parker dominance index (D_{pb})	0.2581	0.4758	0.3281

et al. 2007; Silva & Silveira 2009; Auad *et al*. 2010; Souza *et al*. 2010). Only sixteen of the species collected were present in a riparian area in the city of Barroso, Minas Gerais State (Souza *et al*. 2010), despite the distance of 160 km between the cities of Viçosa and Barroso. Records of new species of the

genus *Mischocyttarus* are due to a sum of factors such as small nests with few individuals. Moreover, this genus is the largest group of social wasps, with nine subgenera and 245 species. For this reason, surveys of richness and diversity can increase the chance of obtaining new records for this genus (Cooper 1998; Silveira *et al*. 2008).

The diversity index of social wasps in the UFV *campus* was H'= 0.8584 and richness S'= 25, which was lower than those obtained in Atlantic Forest area (H'= 2.61) and with lower number of species (S'= 18) (Santos *et al*. 2007). This difference is explained by high dominance (D_{pb}= 0.3281) of a few species in our study. In addition, the period of collections was cold and dry, which may interfere in the number of wasps collected and thus leading to dominance of a few species. The rainy season increases plant biomass and food resources such as nectar and prey (Auad *et al*. 2010). A greater number of species and colonies of wasps were reported in periods with higher temperature and rainfall (Souza & Prezoto 2006).

Collection of social wasps in various locations at different times produced different insects even in areas with similar conditions. This is due to the fact that a number of species are represented by one or few individuals. Thus, the number of individuals per species and a list of species in the sample are important, and may differ in the space and time (Buschini & Woiski 2008).

Agelaia vicina Saussure and *Mischocyttarus cassununga* (Von. Ihering) were the most collected species with over 60% of the total individuals sampled. *Agelaia* is the most common genus in Brazil (Arab *et al*. 2010). Nests of this genus were not observed but, some of its species can establish colonies with an estimated population up to one million adults (Zucchi *et al*. 1995), which increases the chances of capturing specimens of this group (Hunt *et al*. 2001). The high abundance of this genus was also reported in different ecosystems in Brazil (Gomes & Noll 2009; Arab *et al*. 2010; Pereira & Antonialli Junior 2011).

Mischocyttarus cassununga, a species with a high degree of synanthropism and easily found near buildings, was the second most abundant and the most commonly found around the *campus* buildings. The high degree of anthropization enables this species to establish many colonies (Alvarenga *et al*. 2010). Moreover, the presence of more than one inseminated female per colony, with well developed ovaries and the ability to oviposit viable

eggs enables a wider dispersal of *M. cassununga* (Murakami & Shima 2006; Murakami *et al*. 2009).

Nests were found for 13 of the 25 species collected: *Mischocyttarus atramentarius* Zikán, *Mischocyttarus cassununga* (Von. Ihering), *Mischocyttarus* sp.1, *Mischocyttarus* sp.2, *Parachartergus fraternus* (Gribodo), *Polistes actaeon* Haliday, *Polistes simillimus* Zikán, *Polistes versicolor* Olivier, *Polybia fastidiosuscula* Saussure, *Polybia platycephala* (Richards), *Protonectarina sylveirae* (Saussure), *Protopolybia exigua* and *Synoeca cyanea* (Fabricius). This is due to the fact that nests of *Mischocyttarus, Protopolybia, Polybia* and *Polistes* are commonly found on buildings which facilitate their location (Alvarenga *et al*. 2010).

The greater number of wasps collected with traps may be due to the cold and dry period of the survey where water availability became a survival factor, due to decreasing food resources (nectar and insects) (Elpino-Campos *et al*. 2007). Traps represented a resource to be explored during this period of the year when the water is used by the wasps for colony thermoregulation, while the nectar and other sugary substances are the main food item for adult wasps (Prezoto & Gobbi 2003).

The total number of species collected and the Shannon-Wiener diversity (') showed that the active searching methodology was more effective than the traps (Table 3). Ten species were collected only with this method. This was also observed in other studies (Silveira 2002; Souza & Prezoto 2006; Elpino-Campos *et al*. 2007; Pereira & Antonialli Junior 2011). However, only five species were collected with traps which demonstrates the importance of active search. *Apoica pallens* (F.) is generally captured with attractive traps because it forages mostly at night (Hunt *et al*. 1995; Pickett & Wenzel 2007) which makes it less likely to be captured during the day by active search. These results show the importance of using combined sampling methods.

CONCLUSIONS

Social wasp fauna showed high diversity in the *campus* of the "Universidade Federal de Viçosa" in Viçosa, Minas Gerais State, Brazil, and with high diversification and species richness. The number of species was higher than that observed by other authors, even with the shorter collection period of social wasps and unfavorable weather conditions. Moreover, the active search

and attractive traps showed the importance of using more than one method to register the largest possible number of species of these wasps.

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REFERENCES

Alvarenga, R.B., M.M. Castro, E.H. Santos-Prezoto & F. Prezoto 2010. Nesting of social wasps (Hymenoptera, Vespidae) in urban gardens in southeastern Brazil. Sociobiology 55 : 445-452.

Arab, A., I. Cabrini & C.F.S. Andrade 2010. Diversity of Polistinae wasps (Hymenoptera, Vespidae) in fragments of Atlantic Rain Forest with different levels of regeneration in southeastern Brazil. Sociobiology 56 : 515-525.

Auad, A.M., C.A. Carvalho, M.A. Clemente & F. Prezoto 2010. Diversity of social wasps (Hymenoptera) in a silvipastoral system. Sociobiology 55 : 627-636.

Brodmann, J., R. Twele, W. Francke, G. Hölzler, Q. Zhang & M. Ayasse 2008. Orchids mimic green-leaf volatiles to attract prey-hunting wasps for pollination. Current Biology 18 : 740-744.

Buschini, M.L.T. & T.D. Woiski 2008. Alpha-beta diversity in trap-nesting wasps (Hymenoptera: Aculeata) in Southern Brazil. Acta Zoologica 89 : 351-358.

Carpenter, J.M. 2004. 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 3465 : 1-16.

Cooper, M. 1998. New species of the artifex group of *Mischocyttarus* de Saussure (Hymenoptera: Vespidae) with a partial key. Entomologist's Monthly Magazine 134 : 293-306.

Del-Claro, K. 2004. Multitrophic relationships, conditional mutualisms, and the study of interaction biodiversity in Tropical Savannas. Neotropical Entomology 33 : 665-672.

Elpino-Campos, A., K. Del-Claro & F. Prezoto 2007. Diversity of social wasps (Hymenoptera: Vespidae) in Cerrado fragments of Uberlândia, Minas Gerais State, Brazil. Neotropical Entomology 36 : 685-692.

Gomes, B. & F.B. Noll 2009. Diversity of social wasps (Hymenoptera, Vespidae, Polistinae) in three fragments of semideciduous seasonal forest in the northwest of São Paulo State, Brazil. Revista Brasileira de Entomologia 53 : 428-431.

Hermes, M.G. & A. Kohler 2004. The genus *Agelaia* Lepeletier (Hymenoptera, Vespidae, Polistinae) in Rio Grande do Sul, Brazil. Revista Brasileira de Entomologia 48 : 135-138.

Hunt, J.H., R.L. Jeanne & M.B. Keeping 1995. Observations on *Apoica pallens*, a nocturnal neotropical social wasp (Hymenoptera: Vespidae, Polistinae, Epiponini). Insectes Sociaux 42 : 223-236.

Hunt, J.H., P.A. Brown, K.M. Sago & J.A. Kerker 1991. Vespid wasps eat pollen (Hymenoptera: Vespidae). Journal of the Kansas Entomological Society 64 : 127-130.

Hunt, J.H., S. O'Donnell, N. Chernoff & C. Brownie 2001. Observations on two neotropical swarn-founding wasps *Agelaia yepocapa* and *Agelaia panamaensis* (Hymenoptera: Vespidae). Annals of the Entomological Society of American 94 : 555-562.

Kumano, N. & E. Kasuya 2006. An alternative strategy for maintenance of eusociality after nest destruction: New nest construction in a primitively eusocial wasp. Insect Sociaux 53 : 149-155.

Kumar, A., J.T. Longino, R.K. Colwell & S. O'Donnell 2009. Elevational patterns of diversity and abundance of eusocial paper wasps (Vespidae) in Costa Rica. Biotropica 41 : 338-346.

Mello, M.A.R., M.M.S. Santos, M.R. Mechi & M.G. Hermes 2011. High generalization in flower-visiting networks of social wasps. Acta Oecologica 37 : 37-42.

Murakami, A.S.N. & S.N. Shima 2006. Nutritional and social hierarchy establishment of the primitively eusocial wasp *Mischocyttarus cassununga* (Hymenoptera, Vespidae, Mischocyttarini) and related aspects. Sociobiology 48 : 183-207.

Murakami, A.S.N, S.N. Shima & I.C. Desuó 2009. More than one inseminated female in colonies of the independent-founding wasp *Mischocyttarus cassununga* von Ihering (Hymenoptera, Vespidae). Revista Brasileira de Entomologia 53 : 653-662.

Nascimento, F.S., E. Tannure-Nascimento & R. Zucchi 2004. Vespas sociais brasileiras. Ciência Hoje 34 : 18-23.

Pereira, M.G.C & W.F. Antonialli Junior 2011. Social wasps in riparian forest in Batayporã, Mato Grosso do Sul State, Brazil. Sociobiology 57 : 153-163.

Pickett, K.M. & J.W. Wenzel 2007. Revision and cladistic analisys of the nocturnal social wasp genus, *Apoica* Lepeletier (Hymenoptera: Vespidae; Polistinae, Epiponini). American Museum Novitates 3562 : 1-30.

Prezoto, F. & V.L.L. Machado 1999. Ação de *Polistes (Aphanilopterus) simillimus* Zikán (Hymenoptera, Vespidae) no controle de *Spodoptera frugiperda* (Smith) (Lepidoptera, Noctuidae). Revista Brasileira de Zoologia 16 : 841-850.

Prezoto, F. & N. Gobbi 2003. Patterns of honey storage in nests of the Neotropical paper wasp *Polistes simillimus* Zikán, 1951 (Hymenoptera, Vespidae). Sociobiology 41 : 437-442.

Prezoto, F., H.H.S. Prezoto, V.L. Machado & J.C. Zanuncio 2006. Prey captured and used in *Polistes versicolor* (Olivier) (Hymenoptera: Vespidae) nourishment. Neotropical Entomology 35 : 707-709.

Prezoto, F., C. Ribeiro Júnior, S.A. Oliveira & T. Elisei 2007. Manejo de vespas e marimbondos em ambientes urbanos. In: Pinto, A.S.; Rossi, M.M.; Salmeron, E. (Ed.) Manejo de pragas urbanas. Piracicaba: CP2, 123-126.

Prezoto, F., M.M. Souza, A. Elpino-Campos & K. Del-Claro 2009. New records of social wasps (Hymenoptera, Vespidae) in the Brazilian Tropical Savanna. Sociobiology 54 : 759-764.

Richards, O.W. 1978. The social wasps of the America, excluding the Vespinae. London, British Museum (Natural History), 580p.

Richter, M.R. 2000. Social wasp (Hymenoptera, Vespidae) foraging behavior. Annual Review of Entomology 45 : 121-150.

Rodrigues, W.C. 2005. DivEs - Diversidade de espécies. Versão 2.0. Software e Guia do Usuário. Disponível em: <http://www.ebras.bio.br/dives>. Acesso em: 21.06.2011.

Santos, G.M.M., J.D. Cruz, O.M. Marques & N. Gobbi 2009. Diversidade de vespas sociais (Hymenoptera: Vespidae) em áreas de cerrado na Bahia. Neotropical Entomology 38 : 317-320.

Santos, G.M.M., C.C.B. Filho, J.J. Resende, J.D. Cruz & O.M. Marques 2007. Diversity and community structures of social wasps (Hymenoptera: Vespidae) in three ecosystems in Itaparica Island, Bahia State, Brazil. Neotropical Entomology 36 : 180-185.

Silva, S.S. & O.T. Silveira 2009. Vespas sociais (Hymenoptera, Vespidae, Polistinae) de floresta pluvial Amazônica de terra firme em Caxiuanã, Melgaço, Pará. Iheringia, Série Zoologia 99 : 317-323.

Silva-Pereira, V. & G.M.M. Santos 2006. Diversity in bee (Hymenoptera: Apoidea) and social wasp (Hymenoptera: Vespidae, Polistinae) community in "campos rupestres", Bahia, Brazil. Neotropical Entomology 35 : 163-174.

Silveira, O.T. 2002. Surveying neotropical social wasps. An evaluation of methods in the "Ferreira Penna" research station (ECFPn), in Caxiuanã, PA, Brazil (Hymenoptera, Vespidae, Polistinae). Papéis Avulsos de Zoologia 42 : 299-323.

Silveira, O.T., S.V. Costa Neto & O.F.M. Silveira 2008. Social wasps of two wetland ecosystems in Brazilian Amazonia (Hymenoptera, Vespidae, Polistinae). Acta Amazonica 38 : 333-344.

Souza, M.M. & F. Prezoto 2006. Diversity of social wasps (Hymenoptera, Vespidae) in Semideciduous Forest and Cerrado (Savanna) regions in Brazil. Sociobiology 47 : 135-147.

Souza, M.M., J. Louzada, J.E. Serrão & J.C. Zanuncio 2010. Social wasps (Hymenoptera: Vespidae) as indicators of conservation degree of riparian forests in Southeast Brazil. Sociobiology 56 : 387-396.

Zucchi, R., S.F. Sakagami, F.B. Noll, M.R. Mechi, S. Mateus, M.V. Baio & S.N. Shima 1995. *Agelaia vicina*, a swarm-founding polistine with the largest colony size among wasps and bees (Hymenoptera: Vespidae). Journal of the New York Entomological Society 103 : 129-137.