

Diversity of Social Wasps on the *campus* of the “Universidade Federal de Viçosa” in Viçosa, Minas Gerais State, Brazil

by

Gabriel de Castro Jacques, Gabriely Köerich Souza, Ancidérítion Antonio de Castro, Reinildes Silva-Filho, Marcos M. de Souza & José Cola Zanuncio

INTRODUCTION

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

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

Degradation of natural environments results in loss 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, and their distribution, interaction aspects, in order 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

editor's note: please provide a footnote with an email address for the corresponding author(s)

period (Kumar *et al.* 2009). Sensitivity of these wasps to changes in abiotic conditions (light, temperature and humidity) could be related to changes in the environmental degradation levels and serve as potential indicators of environmental quality (Souza *et al.* 2010).

The survey and identification of genera and species of animals and plants are important to know the available natural resources in a certain area and contribute to the study of the 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), Seasonal Semi Deciduous Forest (Gomes & Noll 2009), Riparian Vegetation (Souza *et al.* 2010; Pereira & Antonialli Junior 2011), Mangrove, Atlantic Forest and Restinga Vegetation (Santos *et al.* 2007). However, little is known about wasp fauna in Minas Gerais State, mainly in anthropized environments. This study aimed to obtain preliminary data on wasp diversity within the *campus* of “Universidade Federal de Viçosa” in Viçosa, Minas Gerais State, Brazil.

MATERIALS AND METHODS

This study was carried out on the *campus* of “Universidade Federal de Viçosa” (UFV) in Viçosa, Minas Gerais, Brazil. This area features very diverse anthropized environments including buildings, agriculture areas, artificial lakes, and Atlantic Forest fragments. Samples were collected from May to June 2011 using two methodologies.

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 the base (Prezoto & Souza 2006).

Attractive substances were: 1- natural passion fruit juice (*Passiflora edulis* f. *flavicarpa* Deg.; Passifloraceae) prepared 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.

A total of twenty bottles for each attractive trap ($N=60$) were mounted at 1.5 m above the ground. These traps were set up in different places on the *campus* of “Universidade Federal de Viçosa”. Wasps were collected from the traps after seven days and then preserved in 70% alcohol for identification.

Active search:

Active searches were performed on the *campus* of “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 identification keys (Richards 1978; Carpenter 2004); diversity and species dominance were 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 in the city of Belém, Pará State, Brazil.

RESULTS AND DISCUSSION

Eight hundred and eighty-nine social wasps of 10 genera and 26 species were collected (Table 1). High species richness (Table 2) is explained by the diverse environment of the area studied, because heterogeneous substrate may favor the coexistence of a greater number of species due to greater availability of microhabitats, greater protection from predators, and increased availability and diversity of food resources and substrates for nesting (Santos *et al.* 2007). In addition, combined use of collection methods provides a greater diversity in the number of wasps captured (Silveira 2002; Souza & Prezoto 2006; Elpino-Campos *et al.* 2007; Silva & Silveira 2009; Auad *et al.* 2010; Souza *et al.* 2010).

Only sixteen of the collected species were present in a riparian area in the city of Barroso, Minas Gerais State (Souza *et al.* 2010), despite the proximity of the cities of Viçosa and Barroso (± 160 km). Two of our species, *Mischocyttarus bertonii* Ducke and *Mischocyttarus surinamensis surinamensis* (Saussure) were recorded for the first time in Minas Gerais State, and *Mischocyttarus surinamensis occidentalis* Richards was first recorded in Brazil. These findings

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

Species	Frequency		Total
	AS	AT	
<i>Agelaia multipicta</i> (Haliday)	48	53	101
<i>Agelaia vicina</i> Saussure	0	295	295
<i>Apoica pallens</i> (F.)	0	1	1
<i>Brachygastra lecheguana</i> (Latreille)	7	0	7
<i>Mischocyttarus atramentarius</i> Zikán	6	0	6
<i>Mischocyttarus bertonii</i> Ducke	1	0	1
<i>Mischocyttarus cassununga</i> (Von. Ihering)	24	219	243
<i>Mischocyttarus drewseni</i> Saussure	1	1	2
<i>Mischocyttarus parallelogrammus</i> Zikán, 1935	2	2	4
<i>Mischocyttarus surinamensis</i>	2	0	2
<i>Parachartergus fraternus</i> (Gribodo)	1	0	1
<i>Polistes actaeon</i> Haliday	6	0	6
<i>Polistes simillimus</i> Zikán	16	0	16
<i>Polistes versicolor</i> Olivier	32	5	37
<i>Polybia bifasciata</i> Saussure	0	2	2
<i>Polybia fastidiosuscula</i> Saussure	38	8	46
<i>Polybia ignobilis</i> (Haliday)	0	6	6
<i>Polybia jurinei</i> Saussure	1	4	5
<i>Polybia platycephala</i> (Richards)	72	9	81
<i>Polybia paulista</i> (Von. Ihering)	0	1	1
<i>Polybia sericea</i> (Olivier)	5	13	18
<i>Polybia</i> sp.	2	1	3
<i>Protonectarina sylveirae</i> (Saussure)	1	0	1
<i>Protopolybia exigua</i> (Saussure)	12	0	12
<i>Synoecca cyanea</i> (Fabricius)	1	0	1
Total	279	620	899

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

Source	Number of species
Silveira 2002 (Floresta Amazônica)	79
Silva & Silveira 2009 (Floresta Amazônica)	65
Souza & Prezoto 2006 (Cerrado e Floresta semidecidual)	38
Souza <i>et al.</i> 2010	36
Elpino-Campos <i>et al.</i> 2007 (Cerrado)	29
* Presente trabalho	26
Hermes & Köhler 2004 (Mata Atlântica)	25
Santos <i>et al.</i> 2009 (Cerrado)	19
Pereira & Antonialli Junior 2011 (Mata Ciliar)	18
Santos <i>et al.</i> 2007 (Mata Atlântica)	18
Santos <i>et al.</i> 2007 (Restinga)	16
Auad <i>et al.</i> 2010 (Sistema silvipastoril)	13
Silva-Pereira & Santos 2006 (Campos Rupestres)	11
Arab <i>et al.</i> 2010 (Mata Atlântica)	10
Santos <i>et al.</i> 2007 (Mangue)	8
Gomes & Noll 2009 (Floresta semidecidual)	7
Silveira <i>et al.</i> 2005 (Floresta Amazônica)	6

show the importance of surveys of richness and diversity of social wasp species. Records of new species of the genus *Mischocyttarus* are scarce due to a sum of factors such as small nests with a few individuals. Moreover, this genus forms the largest group of social wasps, with nine subgenera and 245 species, which in addition to the relative lack of surveys of richness and diversity, increase the chance of unpublished records (Cooper 1998; Silveira 2008).

On the UFV *campus* the social wasp diversity index was $H' = 0.8584$ and richness $S' = 26$, which were lower than values obtained in the Atlantic Forest area ($H' = 2.61$, $S' = 18$) (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 have interfered with the amount of wasps collected and led to dominance of a few species. The rainy

season increases the plant biomass and the food resources such as nectar and prey (Aquad *et al.* 2010). A greater number of species and colonies of wasps were reported in periods with higher temperature and precipitation (Prezoto & Souza 2006).

Collection of social wasps in various locations and at different times produced samples that differ considerably. This is due to the effects of sampling because a large number of species is represented by only one or a few individuals in the samples. Thus, the number of individuals per species and list of species in the sample are important, and may differ according to space and time (Buschini & Woiski 2008).

Agelaia vicina Saussure and *Mischocyttarus cassununga* (Von. Ihering) were the most collected species, over 60% of the sample total, and *Agelaia* was the most common genus in Brazil (Arab *et al.* 2010). Although nests of this genus have not been observed, some species can establish colonies with a estimated population of up to one million adults (Zucchi *et al.* 1995), which translates into greater foraging capacity and increases the chances of capturing species of this group (Hunt *et al.* 2001). A 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 was the second most abundant and the most commonly found around the *campus* buildings. A high degree of anthropization enables this species to establish many colonies. Wasps of this species show a high degree of synanthropism and are easily found near buildings (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 only in 13 of the 26 species collected: *Mischocyttarus atramentarius* Zikán, *Mischocyttarus cassununga* (Von. Ihering), *Mischocyttarus surinamensis surinamensis* (Saussure), *Mischocyttarus surinamensis occidentalis* Richards, *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 likely due to the fact that *Mischocyttarus*, *Protopolybia*, *Polybia* and *Polistes* are

Table 3: Richness, diversity and dominance of social wasps collected by active search (AS) and attractive traps (AT) on the *campus* of the “Universidade Federal de Viçosa”, 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

genera commonly found in buildings which facilitates discovery of their nests (Alvarenga *et al.* 2010).

A greater number of wasps was collected with traps and this is due to the cold and dry period of the survey where water availability became a survival factor, due the decrease in food resources (nectar and insects) (Elpino-Campos *et al.* 2007). Traps have become a new resource to be explored during this period of the year and the water used by the wasps is linked to colony thermoregulation, while the nectar and other sugary substances are the main food source of adult wasps (Prezoto & Gobbi 2003).

The active searching methodology in relation to the total number of species collected and the Shannon-Wiener diversity (H') was more effective than the use of traps (Table 3) and 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 and this demonstrated its importance. *Apoica pallens* (F.) is generally captured with attractive traps because it forages mostly at night (Hunt *et al.* 1995; Pickett & Wenzel 2007) and makes it less likely to be captured during the day by an active search. These results show the importance of using combined sampling methods.

CONCLUSIONS

Social wasp fauna showed high diversity on the *campus* of “Universidade Federal de Viçosa” in Viçosa, Minas Gerais State, Brazil, and also showed that diversification increases the richness of species. The number of species collected was higher than that observed by other authors, even in a shorter

period with unfavorable weather conditions. Moreover, the results of 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.

REFERENCES

- Alvarenga, R.B., Castro, M.M., Santos-Prezoto, E.H. & Prezoto, F. 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(2): 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(2): 627-636.
- 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.
- 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.
- 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(5): 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(3): 428-431.
- Hermes, M.G. & A. Kohler 2004. The genus *Agelaia* Lepelletier (Hymenoptera, Vespidae, Polistinae) in Rio Grande do Sul, Brazil. *Revista Brasileira de Entomologia* 48(1): 135-138.
- Hunt, J.H., P.A. Brown, K.M. Sago & J.A. Kerker. 1991. Vespidae Wasp seat pollen (Hymenoptera: Vespidae). *Journal of the Kansas Entomological Society* 64: 127-130.
- 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., 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(4): 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 Societies* 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(3): 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(4): 653-662.
- Nascimento, F.S., E. Tannure-Nascimento & R. Zucchi. 2004. *Vespas sociais brasileiras*. *Ciência hoje* 34(202): 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 analysis 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., Prezoto, H.H.S., Machado V.L. & Zanuncio, J.C. 2006. Prey captured and used in *Polistes versicolor* (Olivier) (Hymenoptera: Vespidae) nourishment. *Neotropical Entomology* 35(2): 707-709.
- Prezoto, F., Ribeiro Júnior, C., Oliveira, S.A. & Elisei, T. 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., 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.
- 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(3): 317-320.
- Silva, S.S. & O.T. Silveira. 2009. Vespas sociais (Hymenoptera, Vespidae, Polistinae) de floresta pluvial Amazônica de terra firme em Caxiuana, Melgaço, Pará. *Iheringia, Série Zoologia* 99(3): 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., 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.
- Silveira, O.T. 2002. Surveying neotropical social wasps. An evaluation of methods in the “Ferreira Penna” research station (ECFPn), in Caxiuana, 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. *Agelais vicina*, a swarm-founding polistine with the largest colony size among wasps and bees (Hymenoptera: Vespidae). *Journal of the New York Entomological Society* 103(2): 129-137.

