

Natural history and foraging behavior of the carpenter ant *Camponotus sericeiventris* Guérin, 1838 (Formicinae, Camponotini) in the Brazilian tropical savanna

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Abstract *Camponotus sericeiventris* is a polymorphic ant living in populous colonies at tropical forests and cerrado formation. This study provides a detailed account of the natural history and foraging biology of *C. sericeiventris* in cerrado at Ecological Station of Panga, Southeast of Brazil. The nest distribution according to vegetation physiognomies, activity rhythm, diet, and foraging patterns were described. Results showed that nests occur inside dead or live trunks, and also in branches of soft wood at cerradão and gallery forest physiognomies (approximately 1 nest/100m²), but not in the mesophytic forest. Ant activity is correlated with temperature and humidity. There is overlap in the foraging area among neighbor colonies (as far as 28 m) without evidence of agonistic interactions. Foragers leave the nest independently or in groups and frequently searched for food individually. Workers are generalistic feeders visiting flowers and extrafloral nectaries, attending Hemiptera (aphids and membracids) and Lepidoptera (Lycaenidae larvae), collecting seeds and fruits, and hunting for live preys as well as scavenging for dead animals. The great number of interactions with different plant and animals suggests that this species has an important participation in the interaction web in this environment.

Keywords Ant–plant interaction · Ecology · Feeding behavior · Nesting behavior · Cerrado

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Introduction

The literature related to ants is abundant in examples of taxonomy, diversity, ecology, and behavior (e.g., Hölldobler and Wilson 1990), but still nowadays, more information about natural history and quantitative data on general characteristics of different species is needed to a better comprehension of several selective pressures observed in this taxa (e.g., Fourcassié and Oliveira 2002). Ants outnumber all other terrestrial organisms and occur in virtually all types of habitats (Wheeler 1910), being its dominance particularly conspicuous in the tropical region (Fittkau and Klinge 1973). The Brazilian tropical savanna, or the cerrado vegetation, is admitted as an endangered ecosystem possessing the highest ant diversity between all savannas (Oliveira and Marquis 2002). Indeed, Formicinae is a much diversified subfamily in cerrado, being the most speciose in some areas (Silva et al. 2004), but with the major part of species almost completely unknown, mainly in aspects of its natural history, ecology, and behavior.

The diversity of feeding habits and food sources in ants is enormous, including other arthropods (Fourcassié and Oliveira 2002; Cogni and Oliveira 2004), animal and vegetal exsudates (Beattie 1985; Del-Claro 2004a), mould (Wilson 1980), seeds (Davidson et al 1980), and same carrion (see Carrol and Janzen 1973 to a review). The foraging strategy in ants can vary also strongly in a spectrum between species that forage solitary to highest levels of cooperation between workers (Hölldobler and Wilson 1990). According to Traniello (1989), a full understanding of an ant colony's foraging system requires the determination of both the individual and social components of the foraging behavior, as well as of the ecological setting in which the colonies occurs, like resources and competitive environment. In cerrado, the wide use of plant resources as fruits, extrafloral nectar,

and mutualist herbivores by ants can contribute to the ubiquity of these insects in this vegetation (Del-Claro 2004a). *Camponotus* is one of the most diverse genus in Formicinae and the most prevalent in world scale (Wilson 1976). Nowadays, this genus is also one of the most engaged in several food webs at cerrados (Oliveira and Brandão 1991; Del-Claro and Oliveira 2000).

The carpenter ant *Camponotus (Myrmepomis) sericeiventris* (Guérin-Méneville 1838) received this denomination due its habit of nesting inside the wood. This ant is strongly polymorphic, and their colonies are populous (Wheeler 1931), having hundreds to thousands of workers in mature colonies (Kohl et al. 2003). Nests occur inside dead or live trunks (Longino 2002). Many studies were cited this species but almost exclusively in diversity (e.g., Wilson 1987; Davidson and Patrell-Kim 1996; Ribas et al. 2003) or interaction aspects (e.g., Rico-Gray et al. 1998; Del-Claro and Oliveira 1999; Davidson et al. 2003). Busher et al. (1985) studied polymorphism and labor division providing a description of the caste system of this carpenter ant in captivity. However, despite its importance in Neotropical food webs, the natural history and ecology of *C. sericeiventris* in nature has not been investigated yet. Thus so, the aim of our study was to provide details of natural history and foraging behavior of *C. sericeiventris* emphasizing the nest distribution in distinct cerrado physiognomies. We also present a foraging diary activity of the species, besides the diet composition during the seasons an estimating of spatial foraging range.

Materials and methods

Study site

Field work was carried out from October 2002 to December 2003 at Ecological Station of Panga, (19°09'20" and 19°11'10" S, 48°23'20" and 48°23'35" W) in Uberlândia, Minas Gerais State, Southeast of Brazil (740–840 m a.s.l.). The area has 409.5 ha bearing distinct cerrado physiological vegetations, including cerrado *sensu lato*, mesophytic seasonal forest, and riverine forest (Schiavini and Araújo 1989). The Cerrado *sensu lato* encompasses a series of vegetation physiognomies from open grasslands to dense woodland. The physiognomies descriptions are according to Oliveira Filho and Ratter (2002). Cerrado *sensu stricto* physiognomy is dominated by trees and shrubs often 3–8 m tall and given more than 30% crown cover but with still fair amount of herbaceous vegetation between them. Cerradão is in almost closed woodland with crown cover of 50% to 90%, made up of trees, often of 8–12 or even taller, casting a considerable shade so that the ground layer is much reduced. Mesophytic forest comprises both deciduous and

semi-deciduous forests, the climax vegetation of cerrado. And riverine forest includes the gallery forest, the narrow forest strips, found along streams and flanked by grassland or cerrados. There is a pronounced difference between two seasons: a hot and wet season generally from October to March, and a dry season during April to September, the coldest months. The annual temperature and precipitation ranged from 18°C to 24°C and 1,300 to 1,700 mm, respectively (Rosa et al. 1991).

Nest distribution and nidification places

Previous observations showed that *C. sericeiventris* colonies constructed their nests mainly inside trunks of cerrado trees. In the study area phytophysiognomies of cerradão, mesophytic forest and gallery forest, all of them showed conditions to host *C. sericeiventris*' nests. Thus, to evaluate the occurrence of nests and to estimate its density in Panga field station, we sampled ten quadrants (10×10 m) in each one of the three phytophysiognomies. We tagged each colony we found and registered: host plant, structure used to nidification (trunk, branch, root), host high and circumference at 1 m far from the ground. The number and height of nest entrances were also registered. The wood hardness was determinate according to Lorenzi (1998).

Cerradão is a common landscape in central Brazil and in this vegetation is relatively easier to follow ants and mark distances with certainty when compared with the other phytophysiognomies. Thus so, the first founded nest tagged in cerradão area was used as reference for distance and locates determination of the remaining nests, useful to construct a nest map. The map was made based on the 17 nearest nests (21,000 m²) to visualize nests distribution and to determine the foraging area of each colony in a same site.

Activity schedule

Two colonies in cerradão were monitored at field to identify the species pattern of daily foraging. It was made during the dry and the wet season. All individuals going inside or outside colony entrances were recorded, during the first 15 min/h, between 6:00 A.M. to 7:00 P.M. Previously, observation was used to decide the observations time. Temperature and humidity were recorded in each session using a dry and wet thermometer.

Survey of food items

All colonies found in the field were observed about food items. Several observation sessions were carried out from April 2003 to October 2003, resulting in a total of 66 h of observation on dry season and 110 h on wet season, in

sessions of variable time per colonies (“ad libitum” sensu Altmann 1974; Del-Claro 2004b) about the species food preferences.

The solid food items retrieved by the workers were surveyed by removing them from the mandibles of foragers. The colonies used to activity schedule did not use to survey of food items sampling. Food items were conserved dry or in 70% alcohol, depending on the composition, and brought to the laboratory for more detailed identification. The minor and major diameters of the items were measured. Also in laboratory, each collected item was kept in an oven at 60°C for 24 h, and its dry weight was determined. The liquid items, like nectar and animal secretion, used by this species were recorded, but for technical limitation, they had not been quantified.

Spatial foraging patterns

In order to determine the foraging area occupied by a colony, workers ($N=50$ individuals in each nest) from two colonies were marked with a non toxic paint (Sakura[®] pen touch) and followed in the field. It was recorded maximum distance reached for the ants in terms of colony distance and height. These data were used to calculate an estimation of the volume of foraging area. All resources visited on plants by *C. sericeiventris* were registered and identified, plant species too. Additionally, we also registered and identified all trees and shrubs in a ray of 10 m around each colony. So, we could compare the available and effectively used substrate.

Seasonal variation in the availability of arthropods preys was evaluated with sticky strip traps placed nearby the colonies during July (dry season) and December 2003 (wet season). The traps consisted of a 21×16 cm white cardboard with a thin layer of Tanglefoot[®] (Tanglefoot Co., GranRapids, Michigan). In each period, 20 traps were left for 24 h on the ground (ten traps) and on the foliage (ten traps).

Statistical analyses

All mean values were accompanied by standard deviation. The Spearman’s coefficient was used to express the correlation between number of workers and temperature and humidity. We analyzed the effects of the season (dry and wet) and the substratum (ground and vegetation) on arthropods abundance at stick traps using two-way ANOVA.

Results

Nest distribution and host plants

The ant nests occurred in a density of approximately 1 nest/100 m² (0.9 ± 0.31 , mean \pm SD) in cerradão and gallery forest areas (0.9 ± 0.74); nests were not found in mesophytic forest. The colonies were located preferentially in living trunks and branches (69.81%), but we also observed colonies using dead trunks (30.19%) for nidification. Fourteen host plant families were identified (Table 1). The species hosting *C. sericeiventris* nests had inside trunk with barks

Table 1 Nest’s places used by *Camponotus sericeiventris* (Formicinae: Camponotini) in cerrado area at Ecological Station of Panga, Uberlândia, Minas Gerais State, Southeast of Brazil

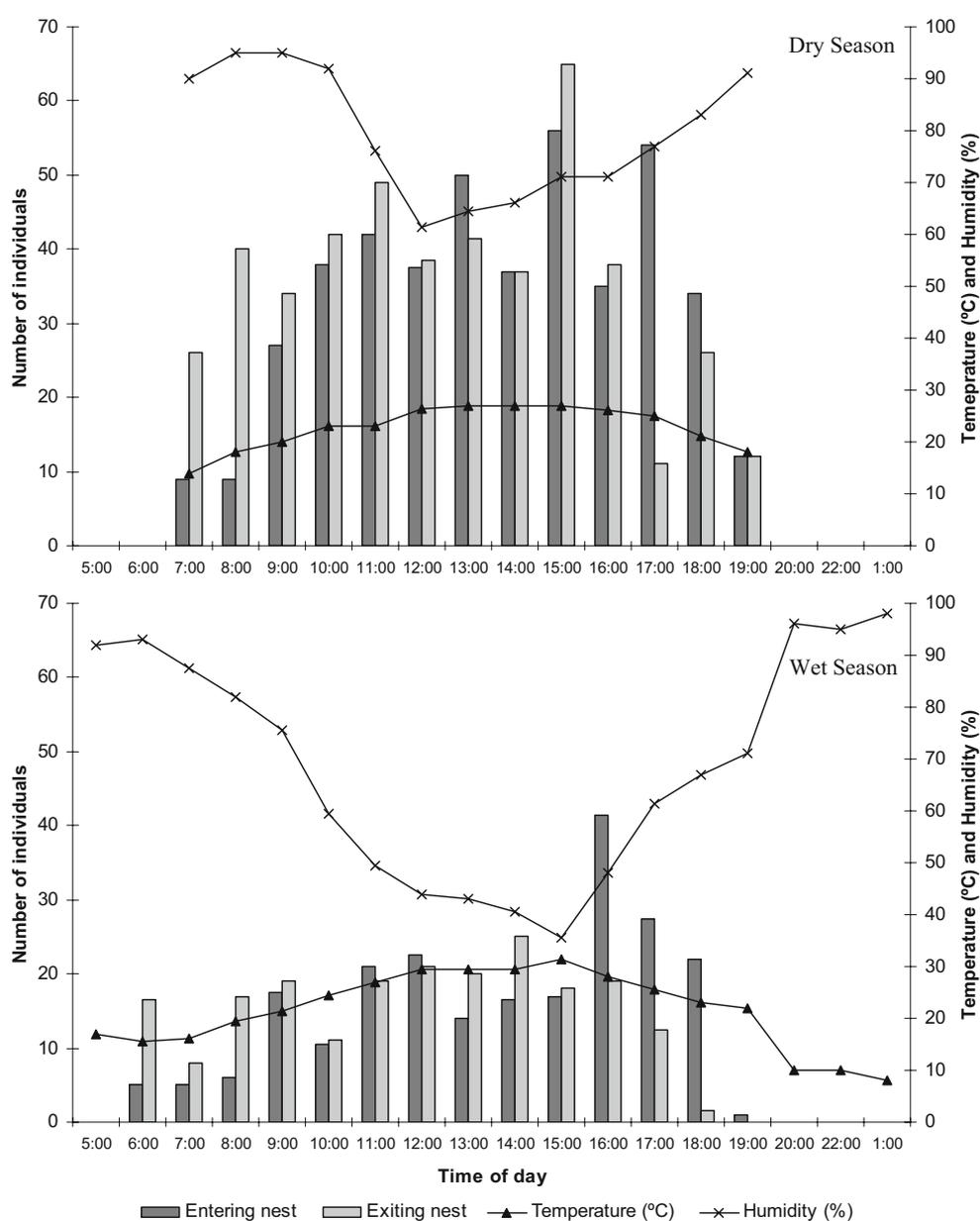
Nest’s place	Family	Number	Frequency (%)	Wood hardness (Lorenzi 1998)
Life plants				
<i>Bowdichia virgilioides</i> H. B. and K.	Fabaceae	2	3.78	Fibrous
<i>Caryocar brasiliense</i> Camb.	Caryocaraceae	4	7.54	Soft
<i>Coccoloba mollis</i> Casar	Polygonaceae	2	3.78	Soft
<i>Copaifera langsdorffii</i> Desf.	Caesalpinaceae	7	13.21	Moderate resistant
<i>Ficus enormis</i> (Mart. ex Miq.)	Moraceae	1	1.88	Moderate resistant
<i>Matayba guianensis</i> Aubl.	Sapindaceae	1	1.88	Moderate resistant
<i>Ocotea corymbosa</i> (Miers.) Mez	Lauraceae	1	1.88	Moderate resistant
<i>Pera glabrata</i> (Schott.) Baill.	Euphorbiaceae	1	1.88	Soft
<i>Rudgea viburnoides</i> (Cham.) Benth.	Rubiaceae	2	3.78	Soft
<i>Tapirira guianensis</i> Aubl.	Anacardiaceae	2	3.78	Soft
<i>Virola sebifera</i> Aubl.	Myristicaceae	1	1.88	Moderate resistant
<i>Vochysia tucanorum</i> Mart.	Vochysiaceae	5	9.44	Soft
<i>Xylopia aromatica</i> (Lam.) Mart.	Annonaceae	2	3.78	Soft
Unidentified	Undetermined	5	9.44	Undetermined
Liana	Malpighiaceae	1	1.88	Undetermined
Dead trunk	Undetermined	16	30.19	Undetermined

texture ranging from smooth to rough, and they were more frequent in soft wood (35.85%) such as *Vochysia tucanorum* (Vochysiaceae), *Caryocar brasiliense* (Caryocaraceae), in moderately resistant wood (18.87%) like *Copaifera langsdorffii* (Caesalpinaceae) and fibrous wood (3.77%) such as *Bowdichia virgiloides* (Fabaceae); wood classification in agreement with Lorenzi (1998). Host plants had one to three nest entrances (1.25±0.55, $n=53$), each one presenting 24–241 cm of trunk circumference in a distance of 1.5 m of the soil (72.68±46.18 cm, $n=53$). The nests entrance had 0.4–0.6 cm in diameter (0.53±0.07 cm, $n=53$): 3.5–18.6 m height in relation to the ground level (8.23±2.99 m, $n=53$). We did not observe differences among nests found at cerradão and gallery forest.

Activity schedule

At 6:00 A.M., the *C. sericeiventris* had already started their activities outside of colonies with an increasing activity, which remains intense until 6:00 P.M. (Fig. 1). We did punctual observations (5:00 A.M., 8:00 P.M., 10:00 P.M., and 1:00 A.M.), and we did not register ant activity in these times. The activity rhythm monitored in the colonies was positively correlated with temperature, between 10°C and 30°C (Spearman Coefficient $r=0.8014$, $p=0.0001$, $n=2$ colonies, 74 h) and negatively correlated with humidity, between 47% to 97% air humidity (Spearman Coefficient $r=-0.7583$, $p=0.0004$, $n=2$ colonies, 74 h). We observed more intense frequency in activity schedule at the same

Fig. 1 Activity rhythm of *Camponotus sericeiventris* (Formicinae, Camponotini) at the same colony in cerrado area at Ecological Station of Panga, Uberlândia, Minas Gerais State, Southeast of Brazil, during dry season (mean of 2 days within 1 week, 18 h) and wet season (mean of 2 days consecutively on September, 27 h)



colony during dry season than the wet season (Fig. 1). The activity rhythm showed significant correlation with temperature and humidity at dry season (Spearman coefficient temperature $r=0.8882$, $p\leq 0.0001$; humidity $r=-0.7717$, $p=0.0005$, $n=1$ colony, 18 h) and the wet season (Spearman coefficient temperature $r=0.7067$, $p=0.0047$; humidity $r=-0.6468$, $p=0.0124$, $n=1$ colony, 27 h).

Occasional natural history observations showed that minor workers were observed transporting particles used mainly in feeding or in nest maintenance. Medium workers were observed usually foraging and with smaller frequency transporting particles. When mechanical or sound disturbances happened nearby the nest, major workers were frequently observed near to the nest entrance showing some aggressive behavior as opening mandibles and directing the abdomen forward in a position to flick formic acid.

Survey of food items

We collected 100 solid items transported by *C. sericeiventris*, including dead arthropods, living prey, dung, agglomerate material unidentified and little wooden pieces, the latter items probably resulting from nest maintenance (Table 2). During the rainy season, arthropod preys were collected at higher frequency, richness, and abundance than during dry season (Table 2). The transported particles, including preys, diameter ranged from 0.12 to 1.65 cm (0.66 ± 0.34 cm, $n=100$). The size variation of transported

Table 2 List of solid items collected by *Camponotus sericeiventris* (Formicinae, Camponotini) during the dry (from April to August 2003) and wet season (from October 2002 to March 2003) in cerrado area at Ecological Station of Panga, Uberlândia, Minas Gerais State, Southeast of Brazil

Collected item	Dry season no. of records (%), $n=57$ items	Wet season no. of records (%), $n=43$ items)
Arthropoda		
Aranae	–	3 (6.98)
Exoskeleton	–	1 (2.33)
Blattodea	1 (1.75)	–
Coleoptera	–	3 (6.98)
Hymenoptera	–	3 (6.98)
Formicidae	–	9 (20.93)
Lepidoptera	13 (22.81)	7 (16.28)
Parts of Arthropoda	3 (5.26)	9 (20.93)
Dung	12 (21.05)	4 (9.30)
Leaf	1 (1.75)	–
Seed	–	2 (4.65)
Wood	10 (17.54)	–
Unidentified ^a	17 (29.82)	2 (4.65)

^aAgglomerate material, usually white color, fibrous, without starch or fibrous material, brown or green color

Table 3 List of collected material from the Tanglefoot® traps during the dry (July 2003) and wet season (December 2003) in cerrado area at Ecological Station of Panga, Uberlândia, Minas Gerais State, Southeast of Brazil

Collected item	Dry season no. of records (%), $n=199$	Wet season no. of records (%), $n=2309$ items
Acarina	1 (0.50)	2 (0.09)
Aranae	2 (1.01)	6 (0.26)
Blattodea	7 (3.52)	14 (0.61)
Coleoptera	2 (1.01)	15 (0.65)
Collembola	19 (9.55)	935 (40.49)
Diptera	83 (41.71)	669 (28.97)
Exoskeleton	1 (0.50)	–
Hemiptera	2 (1.01)	41 (1.78)
Hymenoptera	29 (14.57)	250 (10.83)
Isoptera	–	52 (2.25)
Larva	8 (4.02)	7 (0.30)
Lepidoptera	–	3 (0.13)
Unidentified	–	164 (7.10)
Orthoptera	–	1 (0.04)
Parts of Arthropoda	45 (22.61)	111 (4.81)
Thysanoptera	–	39 (1.69)

items has no relation with the kind of collected item, and the mean dry weight was about 7.5 ± 6.1 mg ($n=100$). The arthropod availability sampled with sticky traps showed interaction among season (dry and wet) and substratum (ground and vegetation) on arthropods abundance ($F=8.425$, $p=0.008$; Table 3; Fig. 2). The arthropods were more abundant in wet season ($F=127.821$, $p=0.00001$). The ground offered a significant ($F=8.797$,

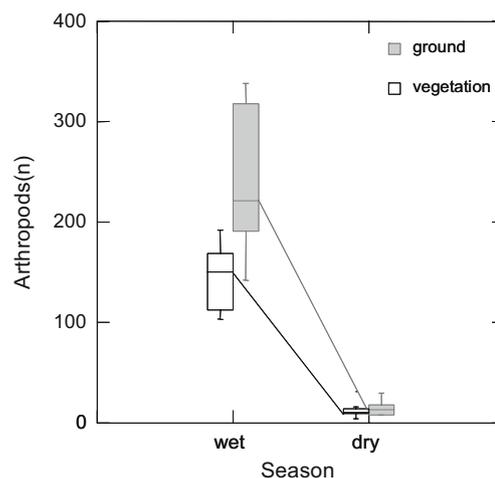


Fig. 2 Significant interaction among season (dry and wet) and substratum (ground and vegetation) on arthropods abundance collected in stick traps ($F=8.4247$, $p=0.00826$). The arthropods were more abundant in wet season ($F=127.821$, $p=0.00001$). The ground offered a significant ($F=8.797$, $p=0.007$) abundant diet only in wet season

$p=0.007$) richer diet (61.12% of the total sampled, $n=1,531$ potential preys) than the vegetation (38.88%, $n=974$ potential preys) only in wet season. In the dry season, no differences were observed. The resources used by *C. sericeiventris* in plants at cerrado included extrafloral nectaries, flowers, fruits, exudates producer's hemipterans (Afididae, Membracidae and Coccididae), and lepidopterans (Lycaenidae; Table 4).

Spatial foraging

We identified 33 species of plants visited by *C. sericeiventris*, and most of them were placed within a ray of 10 m far from the nests (Table 4). The field observations (210 h in a total) showed that the foragers left the nest individually, sometimes in small groups (two to four individuals) and rarely in large groups about 40 including minor and medium workers. Following the marked workers was possible to observe

that this species presents some fidelity to a foraging area because they can use the same trajectory at liana and plant branches near the nest during several days. Depending on the size of the food items, its transportation could be done by a single worker or by a group of individuals, without characterizing a clear recruitment.

The life area used by *C. sericeiventris* from the nest allocated in *Vochysia tucanorum* revealed the mean distance traveled by workers of 7.5 m (7.44 ± 7.12 m, $n=7$), estimating 138.38 m² of forage area and 1,616.43 m³ of estimate foraged volume. There is an overlapping in the foraging area (as far as 28 m) of neighbor colonies (Fig. 3). Workers from distinct colonies shared the same trails at entangled lianas and branches, and their behavior differed depending on the origin of the conspecific. When the trail of a colony met workers from the other colony, the workers inspected the intruder (antennal contact), snapping their mandible, and sometimes they chased the foreigner, with

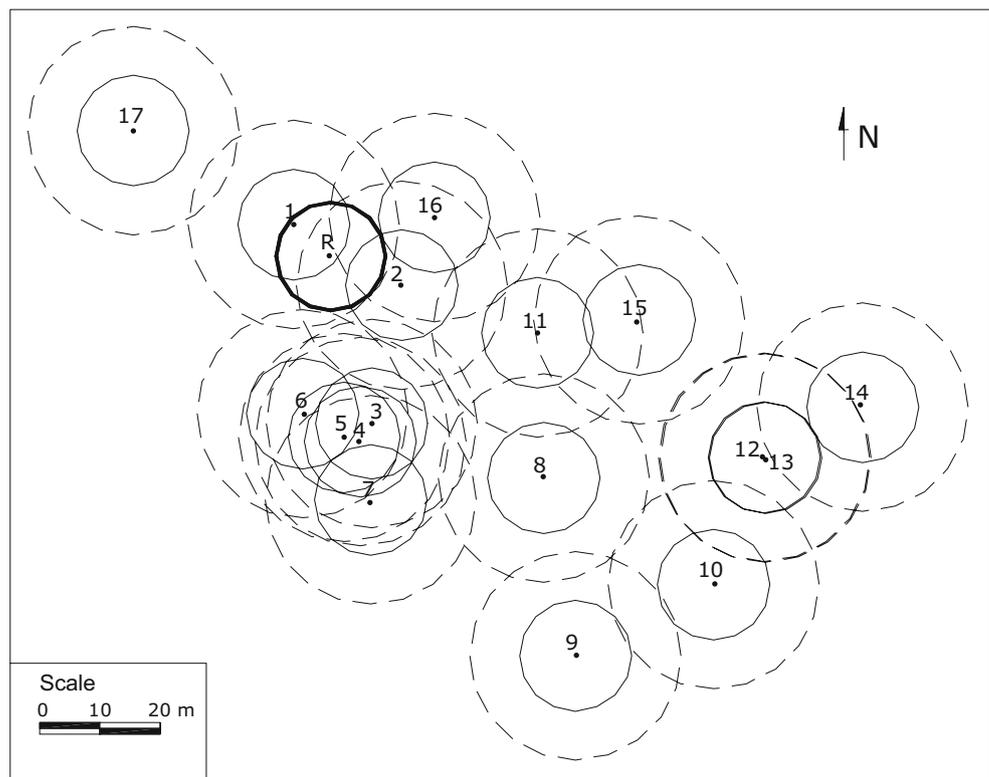
Table 4 Plant species visited by *Camponotus sericeiventris* (Formicinae, Camponotini) during October 2002 to December 2003 in cerrado area at Ecological Station of Panga, Uberlândia, Minas Gerais State, Southeast of Brazil

Visited species	Family	Resource
<i>Alibertia sessilis</i> (Vell.) K. Schum.	Rubiaceae	Efn, flo, fru
<i>Banisteriopsis</i> sp	Malpighiaceae	efn
<i>Bowdichia virgilioides</i> H. B. and K. ^a	Fabaceae	–
<i>Caryocar brasiliense</i> Camb. ^a	Caryocaraceae	–
<i>Cecropia</i> sp ^a	Cecropiaceae	–
<i>Copaifera langsdorffii</i> Desf. ^a	Caesalpinaceae	–
<i>Coussarea hydrangeaefolia</i> Benth. Hook. f.	Rubiaceae	–
<i>Davilla elliptica</i> St. Hil.	Dilleniaceae	flo
<i>Eugenia cf florida</i> DC. ^a	Myrtaceae	fru
<i>Ficus</i> sp ^a	Moraceae	hem
<i>Guapira graciliflora</i> (Mart. ex Schimidt) Lund ^a	Nyctaginaceae	–
<i>Guapira noxia</i> (Netto) Lund	Nyctaginaceae	flo, fru, hem
<i>Hirtella glandulosa</i> Spreng.	Chrysobalanaceae	hem
<i>Lamanonia cf ternata</i> Vell.	Cunnoniaceae	hem
Liana ^a	Malpighiaceae	–
<i>Miconia albicans</i> (Sw.) ^a	Melastomataceae	–
<i>Neea theifera</i> Oesrt. ^a	Nyctaginaceae	hem
<i>Ouratea hexasperma</i> (St. Hil.) Baill. ^a	Ochnaceae	flo, lep, efn
<i>Palicourea rigida</i> H. B. and K. ^a	Rubiaceae	–
<i>Peixotoa tomentosa</i> A. Juss.	Malpighiaceae	–
<i>Qualea grandiflora</i> Mart. ^a	Vochysiaceae	efn
<i>Qualea parviflora</i> Mart. ^a	Vochysiaceae	–
<i>Rourea induta</i> Planch.	Connaraceae	flo
<i>Rudgea viburnoides</i> (Cham.) Benth. ^a	Rubiaceae	–
<i>Schefflera macrocarpa</i> (Seem.) D. D. Frodin ^a	Araliaceae	hem
<i>Siparuna guianensis</i> Aubl. ^a	Monimiaceae	hem
sp 1 ^a	Bignoniaceae	–
<i>Symplocos cf platyphylla</i> (Pohl) Benth. ^a	Symplocaceae	–
<i>Tapirira guianensis</i> Aubl. ^a	Anacardiaceae	–
<i>Tocoyena formosa</i> (Cham. and Schlecht.) K. Schum. ^a	Rubiaceae	–
<i>Virola sebifera</i> Aubl. ^a	Myristicaceae	–
<i>Vochysia tucanorum</i> Mart. ^a	Vochysiaceae	–
<i>Xylopia aromatica</i> (Lam.) Mart.	Annonaceae	–

efn Extrafloral nectaries, flo flower or inflorescence, fru fruit, hem Hemiptera nymph, lep Lepidoptera larvae and, – unidentified

^aSpecies found within a ray of 10 m around each nest.

Fig. 3 Map showing the nests distribution and overlapping in the foraging area of *Camponotus sericeiventris* (Formicinae, Camponotini) in cerradão area (21,000 m²) at Ecological Station of Panga, Uberlândia, MG, Southeast Brazil. *R* indicates the reference nest and numbers indicate other nests. The *continuous circle* indicates the ant's foraging area (ca 7.44 m, $n=7$) and the *dotted circle* the range possible area (SD=7.12 m, $n=7$). Foraging area/nest= 138.38 m², foraging volume/nest=1,616.43 m³



opening mandibles, recruiting major workers. However, we did not observe any real fight between workers from different colonies. During our field work (53 nests found for 15 months), we observed two events of moving: In one case, the trunk was and almost destroyed by moulting action, and in the second case, a storm knocked down the trunk tree. At the same point, we observed the workers transport in *C. sericeiventris*.

Discussion

Although the genus *Camponotus* has been called carpenter ants, some species did not nest inside wood. For example, *C. sericeus* can build a nest on the ground (Mody and Linsenmair 2003); *C. senex*, construct a silk nest in trees with dense copes (Santos 2002); *C. mirabilis*, inside bamboos stems (Davidson et al. 2006), other ants can nest either in the ground or inside the wood, as *C. pennsylvanicus* (Cannon 1998), *C. gigas* (Pfeiffer and Linsenmair 2000), and finally nesting inside wood as *C. herculeanus* (Bowser 2002) and *C. sericeiventris* (see Table 5). The nidification in dead or live trunks and branches of trees corroborate the observations of other authors to *C. sericeiventris* in forests of Peru (Davidson et al. 2003) and Costa Rica (Longino 2002). Our results indicated that the ants' choice of plant species to nidification place was

casual, and the nests abundance at degraded trunks can be explained by the facility for ants excavate in dead material. Even though we observed a suggestive preference by the studied colonies to nest in plant species with soft wood, it cannot be a rule; other factors as abundance and distribution of plants, that can bear ants nest, may be alternative answers and need to be tested. *Camponotus sericeiventris* seemed to be a very resident ant moving to new nest locations after long periods of time or when problems occurred. Nests of the genera *Atta*, *Myrmecocystus*, *Formica* and *Camponotus* located in secure areas can remain for several years in the same place (Hölldobler and Wilson 1990). This behavior probably avoids unnecessary waste of energy and reduces the predation risks of moving to another place.

Our results pointed that *C. sericeiventris* colonies occurred in the same plant species at cerradão and gallery forest with few differences. This fact can explain the absence of difference among nest structure and basic characteristics between these phytophysiognomies. The absence of *C. sericeiventris* nests at mesophytic forest contradicts Machado and Freitas (2001). The mesophytic forest in the study area had similar physiognomic aspects with gallery forest including a moderate declivity in the ground; the medium height of this semi-deciduous forest is 20 m, presenting dense covering close to 100%, resulting in bad conditions to the establishment of a herbaceous-grass

Table 5 Review of published papers presenting data about natural history of carpenter ants, *Camponotus* genus

Species of <i>Camponotus</i>	Nest	Activity schedule	Food items	Foraging patterns	Study area	Source
<i>C. gigas</i>	Mostly in the soil between the buttress roots of emergent trees	Foraging 24 h; mainly nocturnal	Mainly honeydew (90%), insect prey and bird droppings; most common food was fungus although arthropods, vertebrates remain small fruit and seeds	With recruitment system, workers forage singly or in small groups on the ground	Rain forest—Malaysia; rain forest—Borneo	Pfeiffer and Linseimair (2000); Orr and Charles (1994)
<i>C. herculeanus</i>	Inside the wood with satellites	Daily activity	Honeydew, fluids of its preys			Bowser (2002)
<i>C. mirabilis</i>	Inside bamboo stems	Mainly nocturnal	Honeydew from coccids, preys like coleopters, moths, diplopods and so on	Bamboo specialist	Tropical Rain forest—Peru	Davidson et al. (2006)
<i>C. pennsylvanicus</i>	Soil and wood cavity	Daily activity; can forage at night	Preys, carrion, honeydew	Group and mass recruitment	Virginia—USA	Cannon (1998)
<i>C. quercicola</i>	Soil and under leaves	Primarily at night	Extrafloral nectar, honeydew, arthropods		Oak woodland	Gadau et al. (1999)
<i>C. rufipes</i>	Soil and under leaves	Diurnal and nocturnal			Cerrado, Brazil	Oliveira et al. (1987); Schilman and Roces (2005)
<i>C. senexs</i>	Silk nest in trees with dense cup	Daily activity	Feed small arthropods and animal and vegetal secretions	Foraging around the host tree, on vegetation and the ground	Cerrado, Brazil	Santos (2002)
<i>C. sericeiventris</i>	Dead and live trunks	Diurnal	Generalistic feeders visiting flowers and extrafloral nectaries, attending Hemiptera (aphids and membracids) and Lepidoptera (Lycaenidae larvae), collecting seeds and fruits, and hunting for live preys as well as scavenging for dead animals	There is overlap in the foraging area among neighbor colonies (as far as 28 m). Foragers leave the nest independently or in groups, and frequently searched for food individually	Cerrado, Brazil	Present study
<i>C. sericeus</i>	In the ground	Strictly diurnal	Extrafloral nectar (only?)	Foraging radius is at least 26 m around the nest. Fidelity to host trees	Savannah – Republic of Côte-Guinea	Mody and Linseimair (2003)

stratum (Schiavini and Araújo 1989). To the opposite, cerrado and gallery forest present a strong herbaceous stratum, contributing to *C. sericeiventris* foraging, besides other abiotic conditions as shade and humidity.

The diurnal activity pattern observed in *C. sericeiventris* is in agreement with other studies at cerrado (Del-Claro and Oliveira 1999), at semi-deciduous forests (Machado and Freitas 2001) and mangrove (Cogni and Freitas 2002). The increase in ant activities in the hottest hours of the day, with reduction in periods of high humidity and during rains, is a common pattern in diurnal ant species in the tropics (Del-Claro and Oliveira 1999; Oliveira et al. 1999; Cogni and Freitas 2002). We point out that the pattern observed in *C. sericeiventris* can be different in other ants of the same taxa, other *Camponotus* species can forage during the day too, either at night or both (Table 5). We observed an increase in workers activity during dry season probably because the reduction in resources caused mainly by the lack of rains. On wet season, the resources offered can reduce ants foraging, even though the activity had correlation with temperature and humidity. The wide range of food items, mainly preys, observed between seasons reflects the large abundance of arthropods during the wet season in the tropical savanna (Price et al. 1995; Ribas et al. 2003). In other ecosystems which present high availability of food sources in the wet season, ants can diversify their foraging array in this season. In addition, ants can present a good plasticity and change food sources along the seasons according to the environmental availability (Carroll and Janzen 1973; Smythe 1982; Rico-Gray 1993).

Formicinae ants can express a widely spectrum of food sources (Hölldobler and Wilson 1990), and *C. sericeiventris* is not an exception. Other species demonstrate similar behavior in cerrado, such as the weaver ant *C. senex* (Santos et al. 2005) and the arboreal *C. crassus* (Del-Claro and Oliveira 1999). The *C. sericeiventris* abilities to forage in the ground as in the vegetation using a wide range of food items suggest a high adaptability to environmental changes. These skills can be essential to the survival in tropical savannas, where fire is a common factor of pressure and modification of the landscape (Oliveira and Marquis 2002) besides the climate variation. Nowadays, this vegetation is a hot spot (Myers et al. 2000) and one of the endangered ecosystem of Brazil (Oliveira and Marquis 2002), mainly due the growing crops like soybean, and pasture to cattle in the center of the country.

Camponotus sericeiventris is cited as a consumer of floral and extrafloral nectar (EFN) and also animal exudates in the Mexican rain forest (Rico-Gray 1993; Rico-Gray et al. 1998). At cerrado, Del-Claro and Oliveira (1999) observed that this species can use hemipteran honeydew. Our results suggested that *C. sericeiventris* is a common species in ant–plant interactions at cerrado, vegetation

which frequently has plants bearing EFN, sometimes used by this carpenter ant as host plant (e.g., *Caryocar brasiliensis*). Despite the difficulties to sample it, our observations suggest that nectar and also honeydew are important food sources in the diet of this species (see also Davidson et al. 2003). The majority of plants in a ray of 10 m distant from ant nests had either EFN or honeydew producing by hemipterans (see Table 4), resources commonly used by ants. In fact, *Camponotus* is an important genus involved in ant–plant interactions in the tropical America (e.g., Oliveira and Brandão 1991; Rico-Gray et al. 1998; Del-Claro 2004a; Oliveira and Del-Claro 2005). Our natural history observations corroborated with other authors (e.g., Busher et al. 1985; Hölldobler and Wilson 1990) that minor and medium workers of *C. sericeiventris* are the members of the colony that in fact hunt for live arthropods and other prey items. In other ant species with polymorphic workers, such as *Pheidole* and *Solenopsis*, the minor ones generally hunt, whereas major workers arrived after the prey item was subdued (Carroll and Janzen 1973; Cogni and Freitas 2002).

The foraging radius found to *C. sericeiventris* in our study is similar to *C. sericeus*, also studied in savannas, which the home range was at least 26 m around the nest (Mody and Linsenmair 2003). *Camponotus* can forage singly or in small groups, with recruitment system (*C. gigas*, Pfeiffer and Linsenmair 2000; *C. pennsylvanicus*, Cannon 1998) and fidelity to host trees (*C. sericeus*, Mody and Linsenmair 2003), corroborating with our results (see Table 5). Although *C. sericeiventris* colonies at our study site had shown a large overlapping in the foraging area, they did not demonstrate a conspicuous aggressive behavior between individuals of distinct colonies. Busher et al. (1985) related *C. sericeiventris* tolerance to foreign ants, from the same and other species, in captivity conditions. The tolerance among arboreal ants, having a wide foraging area, seems to be common (Carroll and Janzen 1973). We suggest that the tolerance among colonies of *C. sericeiventris* can represent an advantage in the success of this species on competition with other ants in cerrado. Intra-specific nest aggregation indicates weak competition and may be associated with factors as aggregated distribution of adequate microhabitats, colony budding, and mutualistic interactions (Soares and Schoederer 2001). Although we did not observe a worker entering in conspecific nest, the polydomy, colonies formed by several nests with workers and brood exchange, should be investigated.

Considering that carpenter ants like *C. sericeiventris* have a large neotropical distribution and that the general information showed here indicates great involvement in several and distinct trophic relationship, we suggest that this ant species can have a great impact in the tropical savanna diversity of interactions.

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