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ASSOCIATION BETWEEN ANTS AND A LEAFHOPPER (CICADELLIDAE: IDIOCERINAE) IN THE CENTRAL BRAZILIAN CERRADO

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ABSTRACT

Associations between ants and Hemiptera are common in the families Membracidae, Coccoidea and Aphidoidea, but there are only a few cases of ants using honeydew of Cicadellidae species. We surveyed plants of *Roupala montana* Aubl. (Proteaceae) in the cerrado area (savanna like vegetation) in the Federal District (Brazil) during the rainy season of 2006 and 2007. In this period the plants produce new leaves, which are consumed by the nymphs of a probable new species of *Rotundicerus* (Cicadellidae: Idiocerinae). The nymph groups are of variable size, with a mean of 20 individuals. We found 83% of them being tended by ants. A total of 21 ant species was documented, with predominance of *Camponotus* spp. and *Cephalotes* spp. There is a clear species turnover of ants on the nymph groups and attendance is not continuous in most of the cases, suggesting an opportunistic association between ants and *Rotundicerus* sp.

Key Words: Formicidae, Hemiptera, honeydew, *Roupala*, *Rotundicerus*, sap-sucking

RESUMEN

Associações entre formigas e Hemiptera são comuns em Membracidae, Coccoidea e Aphidoidea, porém poucos são os casos de formigas utilizando exsudado em espécies da família Cicadellidae. Acompanhamos indivíduos de *Roupala montana* Aubl. (Proteaceae) em área de cerrado no Distrito Federal (Brasil) durante a estação chuvosa de 2006 e 2007. Neste período a planta produz novas folhas utilizadas pelas ninfas de uma provável espécie nova de *Rotundicerus* (Cicadellidae: Idiocerinae). Os grupos de ninfas têm tamanhos variados, com média de 20 ninfas por grupo. Em 83% deles foram encontradas formigas explorando o exsudado das ninfas, num total de 21 espécies de formigas, com predominância de *Camponotus* spp. e *Cephalotes* spp. Ocorre uma variação temporal nas espécies de formigas que utilizam os grupos de ninfas e o atendimento não é contínuo na maioria dos casos, sugerindo uma associação oportunista entre formigas e ninfas de *Rotundicerus* sp.

Translation by the authors.

Foliage-foraging ants use a wide range of plant resources (Rico-Gray et al. 1998) and hemipteran honeydew is the most commonly used food resource (Davidson et al. 2003). Ants play a major role in arboreal ecosystems, being highly biodiverse, resource-dominant and the primary arthropod predator (Hölldobler & Wilson 1990; Floren et al. 2002; Styrsky & Eubanks 2007).

Ant-hemipteran associations are mostly found within treehoppers (Auchenorrhyncha: Membracidae), coccids and aphids (Sternorrhyncha: Coccoidea and Aphidoidea) (Hölldobler & Wilson 1990; Delabie 2001). Associations with leafhoppers (Auchenorrhyncha: Cicadellidae) are not very common (Delabie 2001), and can occur indirectly, without contact between ants and the leafhoppers (Steiner et al. 2004), or directly, with changes in the leafhopper's behavior and honeydew release after ant request (Larsen et al. 1992; Moya-Raygoza & Nault 2000).

The Idiocerinae subfamily is one of the less studied among the Cicadellidae with 20 described genera, many of which are monotypic. The genus

Rotundicerus Maldonado-Capriles has three described species (Lozada-Robles 2004) and *R. minutus* Dietrich has been found associated with ants (Dietrich & McKamey 1990).

In the cerrado vegetation of Central Brazil, *Rotundicerus* sp., probably a new species (G. Mejdalani, personal communication), uses *Roupala montana* Aubl. (Proteaceae) as host plants (Seyfarth 1996). Here we present information about this leafhopper's biology as well as the associated ant species.

MATERIALS AND METHODS

Study Area

The field work took place at the Fazenda Água Limpa (15°30'S-47°25'W), an experimental and protected farm owned by the University of Brasília, in the Federal District, Brazil. The altitude at the area varies between 1048 and 1160 m, with an annual average rainfall of 1416.8 mm (Coefficient of Variation = 19.9%; series from 1980 to

2004; RECOR Meteorological Station, www.recor.org.br) and mean annual temperature of 22.3°C. The region is characterized by a very definite dry season, with the months between May to Sep receiving less than 7% of annual rainfall. The farm's natural vegetation has different phyto physiognomies (Oliveira Filho & Ratter 2002) with the predominance of cerrado *sensu stricto*, where the studies were done. Detailed information about the farm's vegetation can be found in Ratter (1980), Eiten (1984), and Felfili et al. (2000).

Host Plant

Roupala montana is an evergreen shrub, reaching up to 3 m high, and very common at the study area (Franco 1998). There is foliar asynchrony between plants of the same population, so there is flush and loss of leaves throughout the year, with a peak of leaf production in the transition between dry and rainy season (Sep and Oct) (Lenza & Klink 2006). *Roupala montana* also occurs in the borders of gallery forests at the Fazenda Água Limpa (Felfili & Abreu 1999).

Sampling

Weekly observations were conducted approximately between 9-11 am from Sep to Oct 2006 and Apr to Oct 2007, with the examination of *R. montana* individuals for the presence of *Rotundicerus* sp. and tending ants.

The presence of nymphs and the number of individuals per group was recorded. The presence of tending ants was recorded and the specimens were collected with an entomological aspirator and kept in plastic vials containing 70% alcohol.

In Nov 2006 and 2007 a 24-h monitoring was done on 7 chosen nymph groups of *Rotundicerus*

sp., in order to record the ant species turnover. We selected 1 group per plant and the groups contained from 5 to 20 individuals.

Adults and nymphs of *Rotundicerus* sp. were sent to Dr. Gabriel Mejdalani (Museu Nacional, Universidade Federal do Rio de Janeiro) for identification. The ants collected were identified by Dr. Jaques H. C. Delabie (Laboratório de Mirmeologia UESC/CEPLAC, Bahia).

RESULTS AND DISCUSSION

Between Sep and Oct 2006, at the weekly samples of the beginning of the rainy season, 56 individuals of *R. montana* were examined of which 28.6% were infested by *Rotundicerus* sp., with a total of 116 groups of nymphs. Between Apr and Oct 2007, 360 plants were examined and 11% of them had groups of nymphs.

Although *Rotundicerus* sp. nymphs occur mainly in groups, some individuals were found alone. In 2006 a mean of 2.65 groups per plant was found (sd = 2.35; min = 1, max = 9) and each group had a mean of 19.4 nymphs (sd = 18.47; min = 1, max = 80). The groups are formed by nymphs of different instars and eventually some imagos. In some cases we observed the presence of an adult female together with the young nymphs, however no egg laying or egg masses were found.

TABLE 1. FREQUENCY OF ANT SPECIES ASSOCIATED WITH GROUPS OF *ROTUNDICERUS* SP. NYMPHS COLLECTED IN 2006 AND 2007 DURING WEEKLY SAMPLING TRIPS IN A CERRADO AREA OF THE FEDERAL DISTRICT, BRAZIL.

Species	2006	2007
	(n = 29)	(n = 38)
MYRMICINAE		
<i>Cephalotes pusillus</i> Klug	5	4
<i>Cephalotes depressus</i> Klug	1	—
<i>Cephalotes grandinosus</i> Smith	2	—
<i>Cephalotes betoi</i> de Andrade	1	—
<i>Cephalotes liepini</i> de Andrade	—	3
<i>Crematogaster stollii</i> Forel	—	2
<i>Crematogaster victima</i> Smith	—	1
<i>Pheidole capillata</i> Emery	—	4
<i>Solenopsis</i> sp.	1	—
FORMICINAE		
<i>Camponotus crassus</i> Mayr	10	13
<i>Camponotus arboreus</i> Smith	2	—
<i>Camponotus (Myrmaphaenus)</i> sp. 2	—	5
<i>Camponotus (Myrmaphaenus)</i> sp. 1	2	3
<i>Brachymyrmex</i> sp.	—	3
DOLICHODERINAE		
<i>Azteca instabilis</i> Smith	2	5

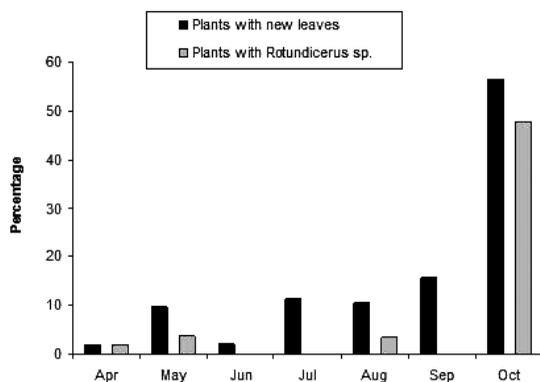


Fig. 1. Percentage of *Roupala montana* (Proteaceae) individuals, examined monthly in 2007, with the presence of new leaves and of *Rotundicerus* sp. (Cicadellidae, Idiocerinae) nymphs in a cerrado area of the Federal District, Brazil.



Fig. 2. A *Camponotus crassus* worker foraging honeydew from *Rotundicerus* sp. nymph (Cicadellidae, Idiocerinae) in a cerrado area of the Federal District, Brazil.

It is possible, as described for *R. minutus* (Dietrich & McKamey 1990), that eggs may be inserted almost completely into the stem or the leaf vein of the host plant, but we did not observe this.

The occurrence of *Rotundicerus* sp. was concentrated in Oct when the host plants have the peak of leaf production (Fig. 1). Along with the monitoring made between Apr and Oct 2007, we observed a few groups of nymphs in other months, always on *R. montana* individuals that had young leaves. In the borders of a gallery forest groups of nymphs were observed between Sep 2007 and May 2008, always on young leaves. The observed exceptions were recorded in Jun in a nearby cerrado area, and in Apr and May in the border of a gallery forest where nymphs were feeding on inflorescences of *R. montana*. These observations suggest that *Rotundicerus* sp. have a defined reproductive season between Aug and Nov, together with the production of new leaves by the host plant, but can reproduce opportunistically whenever there is available food for the offspring.

Adults of *Rotundicerus* sp. were not found on *R. montana* during the rest of the year in the study site, suggesting that after the development of the nymphs on *R. montana*'s young leaves the adults exploit another unknown host plant species.

Of a total of 66 plants examined in 2006 and 2007 with groups of the leafhopper, 83% had tending ants. We found 15 ant species associated with *Rotundicerus* sp. in the diurnal observations of

2006 and 2007 (Table 1). *Camponotus crassus* was the most frequent ant species found with the nymph (Fig. 2). A group of nymphs could be attended by more than one ant species at the same time, and this was observed twice, with *Cephalotes liepini* attending a *Crematogaster victima* dominated group, but without any agonistic interaction.

During the 24-h monitoring samples made in 2006 we recorded 9 ant species (Table 2 A). Only 1 group had ants in all the 12 periods. The other 6 groups had from 4 to 7 periods without ant presence. Another group had attendance of *C. crassus* on 6 consecutive periods, during the day. A similar result was obtained in 2007 (Table 2 B). With the exception of the groups attended by *Azteca instabilis* and *Pheidole capillata*, all the others had at least 4 periods of ant absence. *Azteca instabilis* species monopolizes the resource and exploit it continuously.

There is a clear ant species turnover during a day, so a single nymph group can be attended by 2 or more ant species in a 24-h period (Table 2). *Camponotus atriceps*, *Camponotus* (*Tanaemyrmex*) sp. and *Crematogaster evallans* were the most frequent during the night and *Camponotus crassus*, *Camponotus arboreus*, *Cephalotes pusillus*, and *Cephalotes depressus* the most frequent during the day.

Altogether, we found 21 ant species associated with groups of nymphs of *Rotundicerus* sp., and

TABLE 2. OCCURRENCE OF ANT SPECIES ASSOCIATED WITH SEVEN GROUPS OF *ROTUNDICERUS* SP. IN A 24-H OBSERVATION, IN NOV 2006 (A) AND 2007 (B) IN A CERRADO AREA OF THE FEDERAL DISTRICT, BRAZIL. PERIODS 18:30 TO 04:30 IN (A) AND 19:00 TO 05:00 IN (B) ARE NIGHT PERIODS. DURING PERIOD 01:00 AND 05:00 IN (B) NO COLLECTIONS WERE MADE DUE TO HEAVY RAIN.

Nymph Group	Ant species	16:30	18:30	20:30	22:30	00:30	02:30	04:30	06:30	08:30	10:30	12:30	14:30
(A)													
1	<i>Camponotus crassus</i> Mayr	x	x										
	<i>Camponotus melanoticus</i> Emery			x									
	<i>Crematogaster evallans</i> Forel			x	x	x	x						
2	<i>Camponotus crassus</i> Mayr	x	x								x	x	x
	<i>Camponotus (Tanaemyrmex)</i> sp.			x	x								
3	<i>Cephalotes depressus</i> Klug	x								x	x		x
	<i>Camponotus crassus</i> Mayr									x	x	x	
4	<i>Camponotus crassus</i> Mayr	x									x	x	
	<i>Brachymyrmex</i> sp.			x	x					x			
5	<i>Azteca instabilis</i> Smith	x	x	x	x	x	x	x	X	x	x	x	x
6	<i>Camponotus (Myrmaphaenus)</i> sp.2	x											x
	<i>Camponotus (Tanaemyrmex)</i> sp.			x		x		x					
	<i>Azteca instabilis</i> Smith				x								
	<i>Camponotus (Myrmaphaenus)</i> sp.1											x	
7	<i>Azteca instabilis</i> Smith	x		x	x	x	x	x	x				
	<i>Camponotus (Tanaemyrmex)</i> sp.				x								
(B)													
1	<i>Azteca instabilis</i> Smith	x	x	x	x	x	x	x		x		x	x
	<i>Cephalotes liepini</i> de Andrade		x										
2	<i>Camponotus arboreus</i> Smith	x	x	x	x								
	<i>Nesomyrmex spininodis</i> (Mayr)					x							
	<i>Camponotus (Tanaemyrmex)</i> sp.							x					
3	<i>Pheidole capillata</i> Emery	x	x	x	x	x	x	x		x		x	x
	<i>Camponotus (Myrmaphaenus)</i> sp.2	x											
	<i>Pseudomyrmex tenuis</i> (Fabricius)						x						
4	<i>Camponotus crassus</i> Mayr	x	x	x	x								x
	<i>Cephalotes pusillus</i> Klug	x		x	x								x
	<i>Camponotus (Tanaemyrmex)</i> sp.						x				x		

TABLE 2. (CONTINUED) OCCURRENCE OF ANT SPECIES ASSOCIATED WITH SEVEN GROUPS OF *ROTUNDICERUS* SP. IN A 24-H OBSERVATION, IN NOV 2006 (A) AND 2007 (B) IN A CER-
RADO AREA OF THE FEDERAL DISTRICT, BRAZIL. PERIODS 18:30 TO 04:30 IN (A) AND 19:00 TO 05:00 IN (B) ARE NIGHT PERIODS. DURING PERIOD 01:00 AND 05:00 IN (B)
NO COLLECTIONS WERE MADE DUE TO HEAVY RAIN.

Nymph Group	Species	11:00	13:00	15:00	17:00	19:00	21:00	23:00	01:00	03:00	05:00	07:00	09:00
(B) 5	<i>Camponotus crassus</i> Mayr	x	x	x	x								x
	<i>Camponotus (Tanaemyrmex)</i> sp.							x					
6	<i>Camponotus crassus</i> Mayr	x	x		x								x
	<i>Camponotus (Myrmaphaenus)</i> sp.2	x		x									
	<i>Camponotus atriceps</i> (Smith)							x					
7	<i>Camponotus crassus</i> Mayr	x	x	x									x
	<i>Cephalotes pusillus</i> Klug		x		x								x
	<i>Cephalotes liepini</i> de Andrade												
	<i>Camponotus atriceps</i> (Smith)						x	x		x			

the species composition, with predominance of *Camponotus* spp. and *Cephalotes* spp., is similar to that found in Membracidae and extrafloral nectaries ant associations in the cerrado (e.g., Oliveira et al. 1995; DelClaro & Oliveira 1999; Moreira & DelClaro 2005).

The Idiocerinae are phloem feeders and the nymphs of *Rotundicerus* sp. are gregarious and non-jumping. These characteristics help the association with ants (Delabie 2001), and it seems to be a characteristic of the genus (Dietrich & McKamey 1990).

Ant attendance to the nymphs most of the time is not continuous, and there is a temporal variation of the ant species associated to *Rotundicerus* sp. groups. This suggests that the ants explore *Rotundicerus* sp. nymph's honeydew opportunistically, contrasting with other ant-hemipteran associations. This characteristic makes this association interesting to compare costs and benefits to the involved species.

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