Mutualism is an interaction where two organisms obtain higher reproductive success when together than would if they lived without such relationship. Mutualism is clearly profitable for both parts and it is known as an important interaction for survival (Stefani et al., 2015; Del-Claro et al., 2016). There are many forms of mutualism in nature, for instance, the widely known case of the trophobiosis observed between ants and hemipterans (Del-Claro & Oliveira, 1999; Styrsky & Eubanks, 2007). This relationship is based on the hymenopteran use of honeydew, a sweet flavored, carbohydrate rich substance that is excreted by sap sucking insects. The honeydew is exploited as a food resource by ants, which establish a mutualistic relationship with the hemipterans by offering protection in exchange (Del-Claro & Oliveira, 2000).

Wasps can also use honeydew as a food resource (Letourneau & Choe, 1987). Therefore, competition between ants and wasps for access to hemipterans may occur. Wasps establish a foraging territory and exclude ants that attempt to disrupt this exploitative interaction (Dejian & Turillazzi, 1992). In this case, wasps are benefited with the resource exploration while there is no mutualistic relationship with the hemipterans. The opportunistic foraging, also known as kleptobiosis (or kleptoparasitism), is a behavior observed in social wasps, which steal the resource during foraging (Grangier & Lester, 2011; Breed et al., 2012).

In this study, we observed the interaction between Camponotus crassus (Hymenoptera: Formicidae) and Aethalion reticulatum (Linnaeus, 1767) (Hemiptera: Cicadomorpha) on Crecopiapa chystachya Trécul (Urticaceae), where ants collected the honeydew from the hemipterans in exchange for protection (Oliveira & Del-Claro, 1999). More surprisingly, we observed the exploitation of this interaction by the wasp Pseudopolybia vespiceps (de Saussure, 1854) (Hymenoptera: Vespidae, Polistinae), which, besides collecting the honeydew and not protecting the hemipteran, kick the ants out of the plant using their forelegs while hovering.

Field work was conducted in the Federal University of São Carlos Campus in São Carlos, São Paulo, Brazil, during...
three consecutive days in March 2016. We made *ad libitum* behavioral observations using video footage (Fuji Finepix HS10). We noted the behavior of *P. vespiceps* when collecting honeydew from *A. reticulatum* and excluding ant competitors. The observations were carried out between 10:00AM and 02:00PM.

While the ants were attending the hemipterans (Fig 1a), *P. vespiceps* wasps hovered in circles around the ants and stroke them with the forelegs (supplementary video 1) and landed on the hemipterans (Fig 1b). This behavior started when the wasps flew up, stretched the forelegs and flew down towards the ants, which fell from the plant (Fig. 1c, N =12). Moreover, the hemipterans did not remain inert. The hemipterans attempted to use their hind legs to hit and avoid the wasp, without success. When the wasps had removed most of the ants, the wasps landed on the hemipterans and started to antennate their abdomen (supplementary video 2). Ants and wasps exhibit this tactile stimulus that leads the hemipterans to flick a droplet of honeydew (Styrsky & Eubanks, 2007), however, the wasp did not appear to focus on a specific area, antennating all along the hemipteran body. The wasp spent around 30 seconds hovering in circles and kicking the ants off the plant, and 26.5 seconds (N=2) antennating the hemipterans. The interactions occurred in the lower surface of the leaf, close to the petiole.

This wasp-hemipteran interaction is usually considered non-mutualistic, but a parasitism. Differently from the ant-hemipteran interaction, the wasps provide no protection to the hemipterans. Thus, the wasps only parasitize the ant-hemipteran interaction and exploit the resource without further costs. Furthermore, the wasps may imply costs to hemipterans because the interaction with ants is interrupted by force and because the honeydew is lost in a non-profitable interaction. However, although this interaction apparently only benefits wasp, another study suggests that wasps may defend a territory around hemipterans (Dejean & Turillazzi, 1992). In this case, although wasp protection may not be as effective as it would be with ants, wasps may ultimately provide an indirect benefit to hemipterans.

The ant-hemipteran interaction is no novelty. The same mutualism is very usual in nature between ants and aphids (Stadler & Dixon, 2005) and lepidopteran larvae (Kaminski et al., 2013). Wasp-hemipteran interactions can also be commonly found (Letorneau & Choe, 1987; MacCarroll & Reeves, 2004), however, the interference behavior adopted by wasps is rarely reported (Dejean & Turillazzi, 1992). As a rare case, *Vespula vulgaris* wasps pick ant workers with their mandibles, fly backwards and drop them far from the food resource (Grangier & Lester, 2011). The interaction between *C. crassus* and *P. vespiceps* can be considered an exploitative interaction, where wasps exclude ant competitors and exploit a coevolutionary trait of ant-hemipteran interactions.

Several insect species have been reported to collect honeydew from *A. reticulatum*, such as the stingless bees *Trigona branneri* (Barônio et al., 2012), *T. spinipes* (Vieira et al., 2007), *T. hyalinata* (Oda et al., 2009), *Oxytrigona tataira* (Hymenoptera: Apidae, Meliponini) (Oda et al., 2014), and *Camponotus crassus* ants (Brown, 1975). Here we show the case of *P. vespiceps*, which is a species considered an indicator of high conservation status of riparian forests (de Souza et al., 2010). Therefore, we suggest that Hemiptera-hymenopteran interactions in the Brazilian Cerrado may be an important factor for insect conservation and maintenance of ecological processes (Styrsky & Eubanks, 2007).

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**Supplementary material**

Video 1
http://dx.doi.org/10.13.102/sociobiology.v64i1.1199.s1374
http://periodicos.ufs.br/index.php/sociobiology/rt/suppFileMetadata/1199/0/1374

Video 2
http://dx.doi.org/10.13.102/sociobiology.v64i1.1199.s1375
http://periodicos.ufs.br/index.php/sociobiology/rt/suppFileMetadata/1199/0/1375

![Fig 1](image-url).

*Fig 1.* (a) *Camponotus crassus* ants, and (b) *Pseudopolybia vespiceps* wasps collecting honeydew from *Aethalion reticulatum*, and (c) kicking ants out of the plant.
References


