Revista Brasileira de Zoociências

Rev. Bras. Zoociências | e-ISSN 2596-3325 | 20(1) | 1-7 | 2019

SCIENTIFIC COMMUNICATION

The First Record of the Parasitoid Wasp *Pachysomoides*, Associated with *Mischocyttarus cerberus* Nests and Some Insights About the Parasitoid Wasp's Behavior

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RESUMO

Primeiro registro da vespa parasitoide *Pachysomoides,* associada a ninhos de *Mischocyttarus cerberus* e alguns comentários sobre o comportamento da espécie de vespa parasitoide. Neste trabalho, reportamos pela primeira vez uma vespa parasitoide associada a ninhos da espécie *Mischocyttarus cerberus* e também fornecemos informações em relação ao comportamento do parasitoide quando próximo a seu hospedeiro. Nós acreditamos que o processo de parasitismo não é fácil de ser alcançado, porque as fêmeas hospedeiras que se mantêm nos ninhos atacam toda vez que notam qualquer tipo de abordagem por parte da vespa parasitoide. Nossos resultados fornecem informações mais detalhadas e importantes a respeito da interação comportamental envolvendo *Pachysomoides sp.* e *M. cerberus,* a qual ainda carece na literatura.

Palavras-chave: Comportamento do parasitoide, Polistinae, Vespa parasitoide, Vespas sociais.

ABSTRACT

In this work, we are reporting, for the first time, a parasitoid wasp associated to the nests of *Mischocyttarus cerberus*, also we provide information concerning the parasitoid behavior when close to its host. We believe that the parasitism process is not easily accomplished, because the host resident females keep guarding and attacking whenever they detect any kind of parasitoid approach. Our results provide more detailed and important information about the host-parasitoid interaction behavior involving the *Pachysomoides* sp. and *M. cerberus*, which so far is scarce scientific literature.

Keywords: Parasitoid behavior, Parasitoid wasp, Polistinae, Social wasps.

Recebido em: 23/10/2018
Aceito em: 22/04/2019

The independent-founding wasps from the subfamily Polistinae build small nests without a protector envelope and attached directly to the substrate by one or more petioles (Richards, 1978; Carpenter & Marques, 2001). The absence of a protector envelope might facilitate enemies to access their offspring (Kistner, 1982; Somavilla et al., 2015), which are a rich protein source (Litte, 1977; 1979; Strassmann, 1981; Gadagkar, 1991).

For instance, the parasitic wasps from the family Ichneumonidae are one of the main threats to several Polistinae's nests (Soares et al., 2006; Kudô et al., 2013; Somavilla et al., 2015). *Toechorychus* and *Pachysomoides* are both examples of parasitoid wasps genera that were previously sampled in the nests of both *Polistes* and *Mischocyttarus* (Somavilla et al., 2015). On the other hand, there was no information up to this moment regarding the parasitoid wasp attack behavior toward its nest host. Here, we are reporting for the first time a parasitoid wasp attacking nests of *Mischocyttarus cerberus* Ducke, 1918. In addition, we recorded the parasitoid wasp behaviors toward its host nests. We emphasize that our data has a good potential for understanding some details about the parasitoid-host relationships.

Our work consisted of two different stages: the first was conducted in Ribeirão Preto, São Paulo, Brazil (21°09'47.7"S, 47°51'34.0"W), from November 2016 to February 2017, where we videotaped and described the parasitoid wasp behavior toward five nests of *M. cerberus* – four in pre-worker emergence and one in post-worker emergence - in the field, which resulted in a total of 490 minutes of observation. The records were often done between 08:00 and 17:00. There is only one exceptional register at 06:30, when the host nests were being studied for other purposes. After collecting the data, the videos were analyzed and categorized to allocate the parasitoid wasp behavior. Due to the short time frequency in each recording, we only notified the parasitoid behavior performance and not the quantity of them. Then, from November 2016 to May 2018, 21 nests were collected and taken to the lab, where were kept for a month and checked daily. The nests collected were selected after being observed at least one parasitoid wasp flying around. Besides that, two of the five nests that were previously videotaped were also added to this analysis (Table 1). The development stages of the nests were classified according to the method proposed by Giannotti (1998) (Table 1). The emerged parasitoids were kept in ethanol 70%. Samples of parasitoid wasp were sent to a specialist (Professor Angélica Maria Penteado Martins Dias) for identification at Universidade Federal de São Carlos, São Paulo, Brazil.

Parasitoid wasps (Figure 1) emerged from four out of 21 nests that were kept in the lab (Table 1). The parasitoid wasp found was determined as *Pachysomoides* sp. Furthermore, we registered a total of

12 behaviors performed by the parasitoid wasps during their attempts to access the host nests:

1. Keep inactive: The parasitoid stays apparently inactive next to the host nest (Figure 2 B, C);
2. Stay close to the nest and vibrating parts of the body: The parasitoid stays next to the host nest vibrating wings and antennae;
3. Standing on top of the nest: The parasitoid walks along the back part of the nest and apparently oviposition does not occur;
4. Oviposition: The parasitoid walks along the rear part of the nest and lays an egg. This behavior was observed just once and the parasitoid took less than five seconds;
5. Landing close to the nest: The parasitoid lands on the substrate where the nest is attached, generally after a flight;
6. Get closer slowly: The parasitoid walks in the direction of the host nest slowly and stops next to it.
7. Get closer slowly and flyaway: The parasitoid walks in the direction of the host nest slowly, but when detected by a host wasp, the parasitoid flies away.
8. Get closer and get off from the nest slowly: The parasitoid walks slowly in the direction of the host nest and again returns slowly backwards to its initial position.
9. Touching the nest with the antennae: The parasitoid keeps closer to the host nest and touches it with its antennae, generally in the back part, next to the petiole.
10. Fly around the nest: The parasitoid performs short circular flights around the nest.
11. Get closer to the nest during the flight: The parasitoid tries to get close to the nest, but it is expelled by the resident host wasps;
12. Self-grooming: The parasitoid stays near to the host nest and performs in its antennae and legs cleaning behavior.

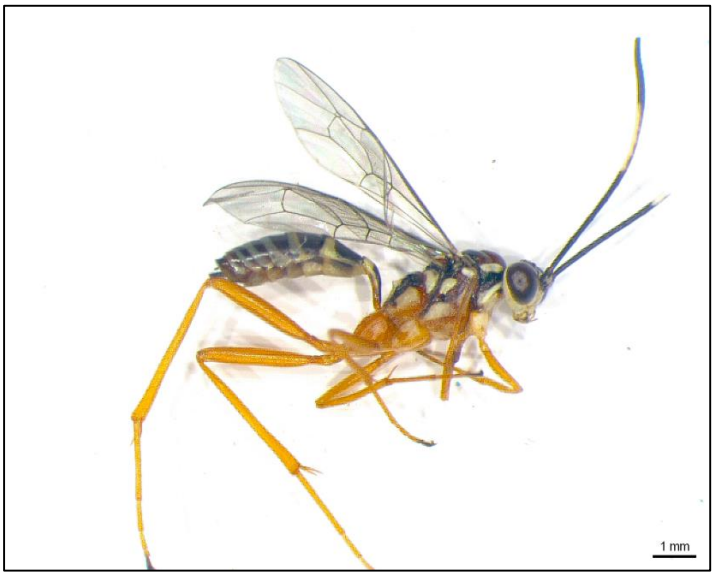

Figure 1. Newly emerged parasitoid wasp *Pachysomoides* sp. from one nest of *M. cerberus* that was kept into the lab.

Table 1. Detailed information concerning to each collected nest. (*) These numbers refer to individuals sampled when nests were collected.

Number nest	Phase nest	Data collection	Year	Nº females*	Nº males*	Nº eggs	Nº larvae	Nº pupae	Nº cells	Nº parasitoids emerged in the lab
1	Post-emergence - decline	April	2018	9	9	-	-	1	71	-
2	Post-emergence - producing males	April	2018	7	2	5	16	6	45	-
3	Post-emergence - not producing males	April	2018	11	-	2	16	10	36	-
4	Post-emergence - producing males	April	2018	8	1	9	30	10	45	-
5	Post-emergence - producing males	April	2018	5	2	-	5	15	45	-
6	Post-emergence - producing males	April	2018	6	1	6	26	17	50	-
7	Post-emergence - producing males	April	2018	10	2	10	30	2	54	-
8	Post-emergence - producing males	April	2018	6	1	10	10	6	40	-
9	Post-emergence - producing males	April	2018	8	3	6	52	10	73	-
10	Post-emergence - not producing males	April	2018	7	-	4	54	5	67	-
11	Post-emergence - decline	April	2018	5	-	24	2	-	65	-
12	Post-emergence - decline	April	2018	3	-	15	15	2	55	-
13	Post-emergence - not producing males	April	2018	5	-	5	25	8	41	-
14	Post-emergence - not producing males	April	2018	6	-	4	9	3	32	-
15	Pre-emergence - only foundress	April	2018	2	-	-	15	6	35	-
16	Pre-emergence - only foundress	April	2018	2	-	3	8	3	17	-
17	Pre-emergence - only foundress	April	2018	2	-	5	8	3	16	-
18	Pre-emergence - only foundress	March	2018	2	-	2	9	2	22	1
19	Pre-emergence - only foundress	May	2018	5	-	4	13	3	20	1
20	Post-emergence - not producing males	November	2016	4	-	?	?	5	25	2
21	Post-emergence - not producing males	November	2016	16	-	?	?	24	60	7

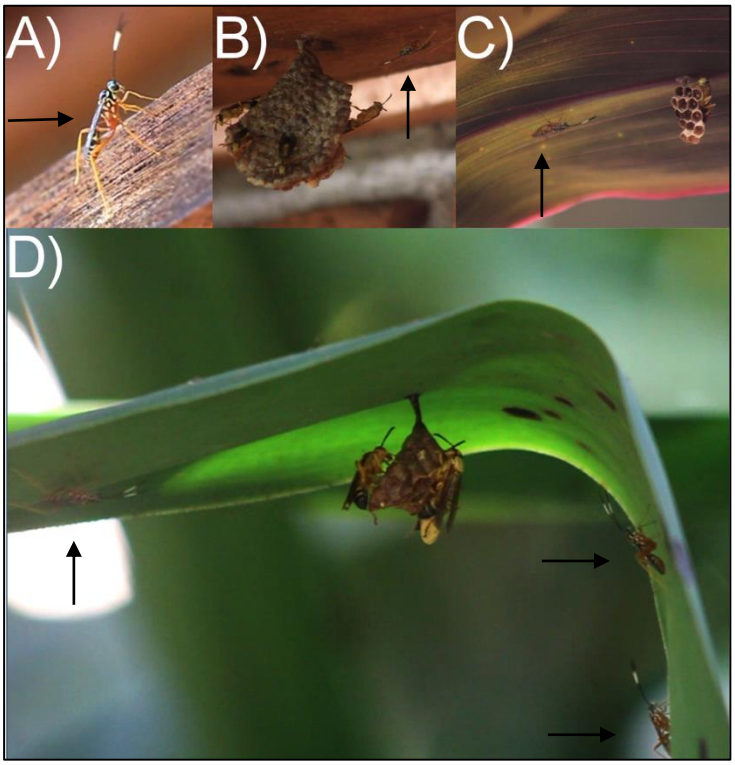

Figure 2. A) Parasitoid wasp *Pachysomoides* sp. standing and shaking its antennae; B e C) Parasitoid wasp standing next to a nest; D) Three parasitoid wasps *Pachysomoides* sp. trying to approach the *M. cerberus* colony at the same time (see https://www.youtube.com/watch?v=H8pXwLDP_YE&feature=youtu.be).

Whenever the females of *M. cerberus* detected the presence of a parasitoid wasp around their nest they raised their wings and initiated to move around from one side to another. We state that the parasitoid wasps cannot get closer to the host nest easily, which might explain why we barely saw parasitoid wasps performing oviposition during the observation phase and so it could be a reason for the low presence of parasitoid wasps in the sampled nests. Furthermore, it was also registered the presence of one parasitoid wasp *Pachysomoides* sp. close to one nest at 6:30 am, which suggests that parasitoid activity may not be only in the hottest hours of the day. In one video, we registered three parasitoid wasps trying to get close to one host nest at the same time, what suggests that this parasitoid wasp species might compete per host nest (Figure 2D). The use of the same host by different parasitoids can be directly related with the specific host quality parameters (Rusina, 2010). It was not possible to identify any clear parasitism symptom in the four nests from where parasitoid wasps emerged. We suggest that it is because of the size of the parasitoid larva, which possibly occupies a small space within a host cell. Finally, even though parasitoid wasps emerged only from four out of the 21 collected nests, the number of host females seemed not to determine the chance of their nests being parasite or not, because in one case of parasitism the nest was composed by 16 females and in another case the nest was composed by two females (Table 1), however, to consolidate this idea it is necessary more studies.

Although *Pachysomoides* sp. belongs to the most common parasitoid subfamily (Icheneumonidae) (Broad & Barthélémy, 2012), there is still a lack of information concerning to its behavioral and ecological aspects, perhaps because these events are rare to be seen (Soares et al., 2006). Thus, the present work besides being the first to detect the *Pachysomoides* sp. parasitoid wasp in *M. cerberus* colonies, still presented some insights about parasitoid wasp behavior toward its host. Even though the nests of the host wasps are not protected by an envelope, the videotaping somehow revealed that parasitoid success might be something difficult to be achieved, maybe because *M. cerberus* females kept standing and protecting their nests against parasitoid wasp all the time. Besides that, there might not to be a correlation between parasitism rate and the number of wasps available defending nests. We expect that our report might encourage future studies concerning to host-parasite wasp interactions, which is not often done and consequently remains still obscure in the literature.

ACKNOWLEDGMENTS

We would like to thank Professor Angélica Maria Penteado Martins Dias for parasitoid wasp identification. This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES) - Finance Code 001 (RCS) and by Fundação de Amparo à Pesquisa do Estado de

São Paulo – FAPESP under grant RCS [proc. nº 2018/22461-3], APS [proc. nº 2016/11887-4], DSA [proc. nº 2015/17358-0]) and FSN [proc. nº 2018/10996-0].

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