

Attack Behavior of *Elasmus polistis* Burks (Hymenoptera: Eulophidae) in Nest of *Polistes versicolor* (Oliver) (Hymenoptera: Vespidae) and its Defensive Behavior

Thiago Marinho Alvarenga¹✉, Yuri Fanchini Messas¹, Hebert da Silva Souza¹, Luana Leite Guimarães Santos² & Jobber Fernando Sobczak³

1. Universidade Estadual de Campinas, e-mail: marinho.bio@gmail.com (Autor para correspondência✉), yurimessas@gmail.com, hssouza.bio@gmail.com. 2. Instituto Federal de Ciência e Tecnologia do Triângulo Mineiro, e-mail: luana.santos628@gmail.com. 3. Universidade da Integração Internacional da Lusofonia Afro-brasileira, e-mail: jobczak@gmail.com.

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Abstract. The attack behavior of *Elasmus polistis* Burks in the nest cells of *Polistes versicolor* (Oliver) was recorded for the first time in South America. We observed that *E. polistis* flies in front of the *P. versicolor* nest, enters inside it and oviposits on wasps prepupae and pupae, possibly through the cells that compose the nest. Despite the obvious defensive behavior of the wasps described here, we found that *E. polistis* is efficient in parasitizing the pupae.

Keywords: Ectoparasitoid; Eulophinae; Circular formation; Host; Neotropical.

Comportamento de Ataque de *Elasmus polistis* Burks (Hymenoptera: Eulophidae) a Ninho de *Polistes versicolor* (Oliver) (Hymenoptera: Vespidae) e seu Comportamento de Defesa

Resumo. O comportamento de ataque de *Elasmus polistis* Burks em células do ninho de *Polistes versicolor* (Oliver) foi registrado pela primeira vez na América do Sul. Observou-se que *E. polistis* voa em frente ao ninho de *P. versicolor*, ingressa em seu interior e oviposita sobre as pré-pupas e pupas das vespas, possivelmente através das células que compõem o ninho. Apesar do evidente comportamento de defesa das vespas aqui descrito verificou-se que *E. polistis* é eficiente em parasitar suas pupas.

Palavras-chave: Ectoparasitoide; Eulophinae; Formação circular; Hospedeiro; Neotropical.

Parasitoid wasps can cause high mortality in their population hosts. Thus, any characteristic that helps to reduce the chances that the individual is parasitized tends to be favored by natural selection (HANSON & GAULD 2006).

Arms races are generally viewed as attack-defense “games” which occur over long periods of time, gradually shaping species interactions (FUTUYMA & SLATKIN 1983; DIETL & KELLEY 2002). Thus, the coevolutionary analyzes are increasing their importance to ecological, epidemiological and conservation biology studies, since they began to realize how quickly the results of interactions between species can change (THOMPSON 2001).

According JOLIVET *et al.* (1990), circular defense strategy (cycloaexy) is found irregularly in the animal kingdom, and attains perfection in some leaf-beetles and sawflies. It is intimately linked to aggressive displays (biting, regurgitation, reflex-bleeding). However DURY *et al.* (2014) conducted a review in which they proposed three criteria needed to define this behavior: (1) individuals form a circle; (2) defensive attributes of the individuals are positioned on the periphery of the circle, and as a result, the periphery of the circle uniformly contains either heads or abdomens and, (3) animals preemptively adopt the circle as a resting formation, meaning it is not necessary to observe predation.

Elasmus is the only genus of the Elasmini (Hymenoptera: Eulophidae), which includes 248 described species and has a cosmopolitan distribution (NOYES 2014). The larvae of most

Elasmus species are gregarious and primary ectoparasitoids of Hispinae (Coleoptera: Chrysomelidae) (COOTE 1997) and Lepidoptera larvae or prepupae, but some species are secondary parasitoids of Braconidae and Ichneumonidae prepupae (GIBSON 1993) and others are primary ectoparasitoids of Vespidae (*Polistes*) (COOTE 1997; DORFEY & KOHLER 2011).

The species *Elasmus polistis* Burks (Figure 1) is known as a gregarious parasitoid of *Polistes* prepupae or pupae (NELSON 1976), whereas most of the registrations have occurred in North America (REED & VINSON 1979; MACOM & LANDOLT 1995) and only one in Brazil (Rio Grande do Sul state) (DORFEY & KÖHLER 2011). Despite reports of hosts used by the wasps of the genus *Elasmus*, there are no detailed descriptions of *Polistes versicolor* (Oliver) defensive behavior facing the attacks of *E. polistis*. In this study we describe the behaviors that mediate this interaction in four nests of *P. versicolor*.

The observations were carried out between 3:00 and 6:00 p.m. on March 6, 2013 and February 2 to 10, 2015 on the premises of the Base Ecológica da Serra do Japi (23°15'S, 46°57'W), located in Jundiá, São Paulo, Brazil, at an elevation of 1000 m. The description of the attack behavior of *E. polistis* and defense by *P. versicolor* were made from the analysis of photographs and

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videos captured using a Canon EOS 5D Mark II digital camera with a Canon EF 100mm f/2.8 macro lens. The host wasp nest was collected, and enclosed in a plastic recipient (13 x 11 x 10 cm) maintained in the laboratory to obtain the adult *P. versicolor* and *E. polistis* wasps. After emergence, the specimens were enclosed in a plastic recipient containing 70% ETOH and deposited in the Insetos Entomófagos Oscar Monte (IB-CBE) collection, of the Instituto Biológico, at Campinas, São Paulo State, Brazil (Costa, V.A., curator).

The attack behavior starts with *E. polistis* wasp flying around the nest of *P. versicolor* (SANTOS *et al.* 2013, see 0-14 seconds in the video image; Figure 2). After a few seconds, *E. polistis* approaches the nest cells of *P. versicolor*, passing among the *P. versicolor* wasps who take care of the nest, until reaching the pupae. The attack may occur on the upper (see Figure 2a), middle (Figure 2b) or lower (Figure 2c) portion of the nest. The parasitoid attacks pupae and prepupae, which are located within cells already closed. Thus, the parasitoid wasp reaches the closed cells through adjacent open cells. It was not possible to observe how the oviposition occurs, but it is probably realized by puncturing the wall of the nest with the ovipositor. Subsequently, the parasitoid leaves the nest and lands in regions close to it (Figure 2d). This sequence of behaviors occurred successive times for each *E. polistis* individual with 4-6 assaults per minute.

In all recorded attacks whenever the wasps perceived the presence of the parasitoid, they displayed aggressive behavior characterized by intense vertical open and close wing agitation movements, additionally using its mandibles to attack the parasitoids. This defensive behavior can dispel and avoid parasitoid attack, in addition to increasing the surface patrolling of the nest, probably decreasing the frequency of parasitized pupae. LUTZ *et al.* (1984) also registered the defense behavior of *Polistes exclamans* Viereck and *Polistes instabilis* Saussure against *E. polistis* in

North America.

At certain times during the *E. polistis* attack, the wasps showed a circular formation around the nest with a wasp at the center verifying the open cells, much like the cycloaexy behavior proposed by JOLIVET *et al.* (1990) (see Figure 3). However according to DURY *et al.* (2014) in spite of this circular formation, this behavior is not characterized as cycloaexy because that formation is undertaken only when defending the nest.

The presence of defensive behaviors presented by *P. versicolor* appears not to successfully prevent the occurrence and high-frequency of *E. polistis* attacks, since the attack is made perpendicular to the edges of the nest, avoiding the area of patrolling wasps. Thus parasitism by *E. polistis* still represents a strong selective pressure on *P. versicolor*. In future investigations, we intend to examine differences in wall thickness between nest cells of *P. versicolor*, and also the presence of closed cells surrounding the cells containing pupae and prepupae, which could be possible mechanisms to reduce the efficiency of parasitism.

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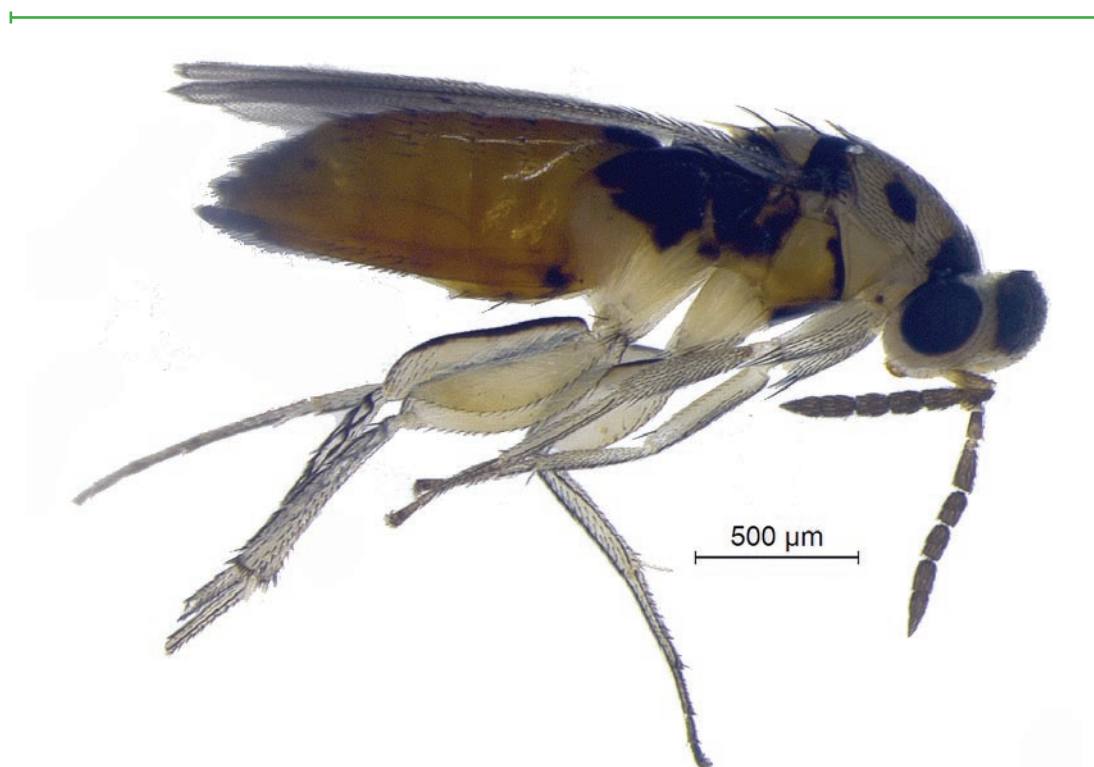


Figure 1. Adult female of *Elasmus polistis* collected on prepupae of *Polistes versicolor*.

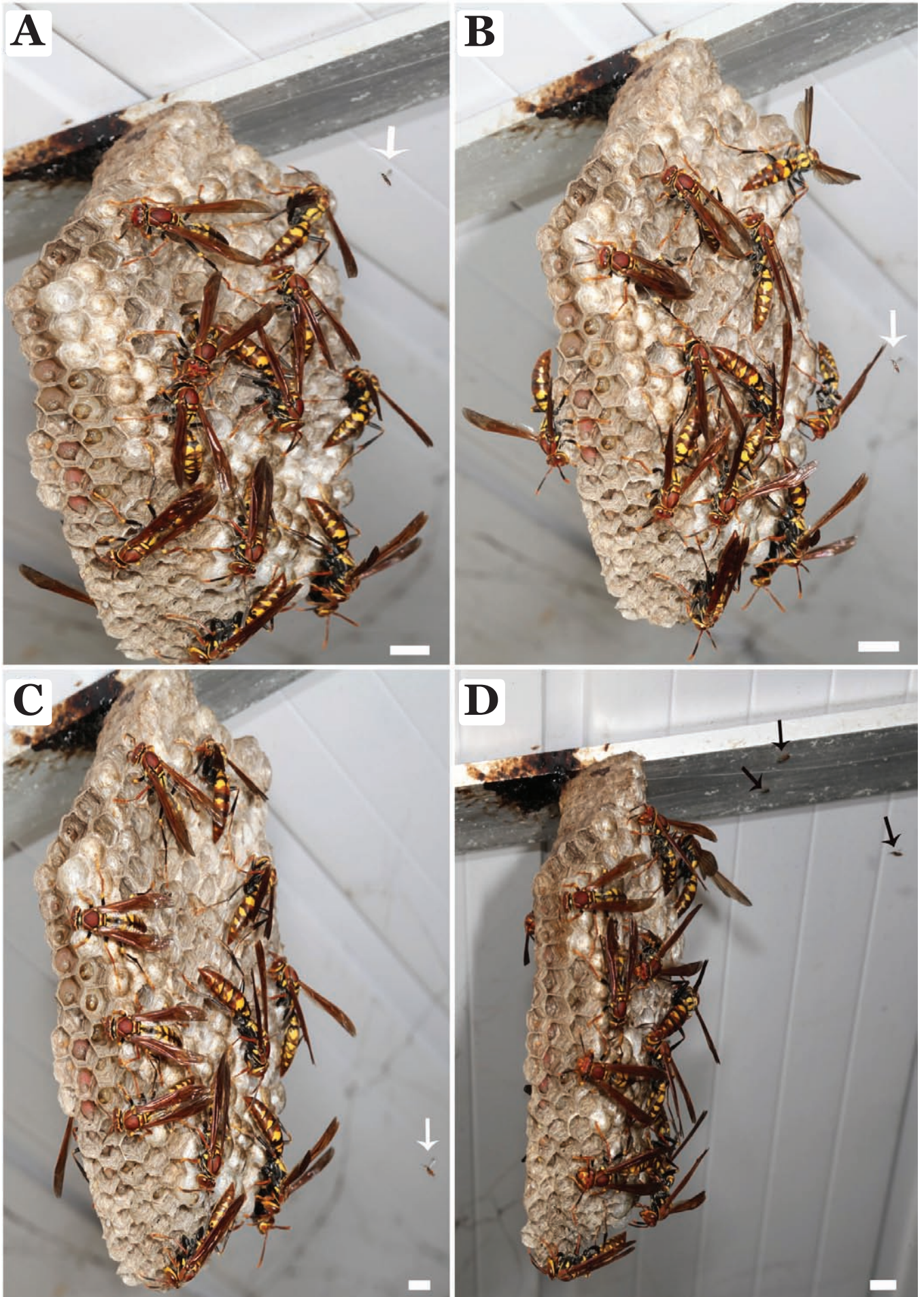


Figure 2. A - *Elasmus polistis* flying in front of and at the upper portion of the *Polistes versicolor* nest, seconds before the attack; B - flying in front and at the middle position; C - flying at the bottom of the nest; D - after the attack, *Elasmus polistis* lands near the nest of the host wasp. Scale bars = 1 mm.

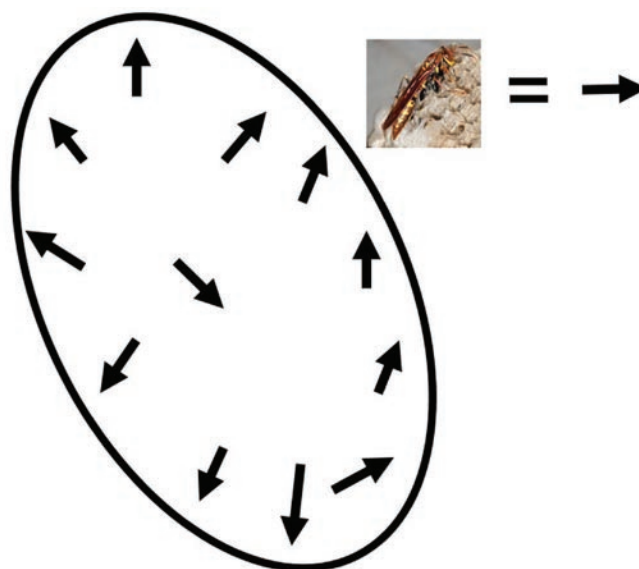


Figure 3. Schematic drawing of the *Polistes versicolor* nest with wasps patrolling the cells. The arrows represent *P. versicolor* individuals facing the edge of the nest.

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