MYRMELEON BRASILIENSIS'S PARASITOIDS (NEUROPTERA: MYRMELEONTIDAE) IN THE SOUTH PANTANAL, BRAZIL

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Antlions (Myrmeleontidae) are neuropteran predators commonly found in tropical regions. More than 1,500 species in 201 genera and 14 tribes of myrmeleontids are described (Stange 2004).The larvae of *Myrmeleon* species are generalist predators of arthropods that move along the soil surface. They are known for their foraging behavior: building funnel-shaped traps in friable or sandy soil, under which they wait for prey that falls inside these snares (Napolitano 1998; Missirian et al. 2006).

A positive correlation between larval length and funnel diam in optimum substratum has been observed (Dias et al. 2006). As the larvae grow more energy is needed, which is supplied by the consumption of larger and/or higher number of prey items (Dias et al. 2006). The prey of *Myrmeleon brasiliensis* (Navás 1914) (Neuroptera: Myrmeleontidae) are mainly epigeic walking arthropods (ants, isopods, etc.) and phytophagous insects, such as the larvae of frugivorous Tephritoidea (Tephritidae and Lonchaeidae: Diptera) that in their last instar (3rd) leave the fruits or flowers of their host, and fall to the ground, where they crawl in search of soft soil to pupate (Uchôa 2012). The mature larva builds a cocoon with silk, plant debris and/or soil particles. The pupal stage is completed inside the cocoon. Adult emergence of *M. brasiliensis* occurs approximately one month after pupation (Arnett & Gotelli 2001; Missirian et al. 2006). All species of insects are vulnerable to the attack of natural enemies, which in many cases are important regulators of population density of the host or prey (Hawkins et al. 1997). The natural enemies of the insects can be grouped into 4 main categories: pathogens, predators, parasites and parasitoids. Neuropterans are commonly attacked by a very diverse guild of parasitoids in the field (Feener & Brown 1997; Matsura et al. 1998). Parasitoids require only 1 host to complete development and reach adulthood, and generally they kill their host.

Although myrmeleontids are quite common in Brazil, there are few studies about their parasitoids. The aim of this study was to collect samples of *Myrmeleon brasiliensis* larvae in natural conditions to identify their parasitoid species and calculate the levels of parasitism. The study was conducted in the Forest Reserve of the Universidade Estadual de Mato Grosso do Sul (UEMS), located about 12.5 km from Aquidauana, Mato Grosso do Sul, Brazil (N 20° 26.25' W 55° 39.2'). The vegetation is typical of tropical semideciduous forest, with great diversity of plants, especially of the families Myrtaceae, Sapotaceae, Fabaceae, Mimosaceae, Melastomataceae, Moraceae and Dileniaceae.

First to third instar larvae of *M. brasiliensis* were collected randomly during 6 months (Feb to Sep 2001). Larvae were found in friable soil (sandy or silt-sandy) in protected places, such as under tree canopies, shrubs, under rocks or fallen logs, and rarely in unprotected places. The larvae were collected from their funnels (Fig. 1A) with a tablespoon used to scoop a sample of soil of approximately 2 cm around the funnel and to 4 cm depth. The soil samples containing *M. brasiliensis* larvae were transported in plastic trays to the Laboratorio de Controle Biologico de Insetos, Universidade Federal de Mato Grosso do Sul, Campo Grande, Mato Grosso do Sul, Brazil, and kept from Feb 2001 through Jan 2002. Each larva was isolated in a transparent plastic container (13.5 cm H × 10.2 cm diam), containing 6 cm height of sterile soil from the collection sites. The size of the soil particles ranged from 0.08 to 0.60 mm diam. The containers were covered with tulle, tied with a rubber band to prevent the escape of the adults of *M. brasiliensis* or its parasitoids, after their emergence.

Larvae (Fig. 1B), pupae (Fig. 1C) and adults (Fig. 1D) were reared at room temperature of 26.0 ± 3.50 °C, mean ± standard deviation; 65.2 ± 5.6% RH; 12:12 h L:D. In total, 161 larvae of *M. brasiliensis* were reared until adult emergence. They were fed daily with adults of leaf-cutting ants workers, *Atta sexdens rubropilosa* Forel 1908 and *Atta laevigata* F. Smith 1858, (Hymenoptera: Formicidae) and larvae of the fruit flies (Tephritidae: *Anastrepha fraterculus* (Wied. 1830), *Anastrepha obliqua* (Macquart 1835), and *Ceratitis capitata* (Wied. 1824) (Diptera: Tephritidae).

Adults of *M. brasiliensis* and its parasitoids were fixed in 70% ethanol, pinned, labeled and

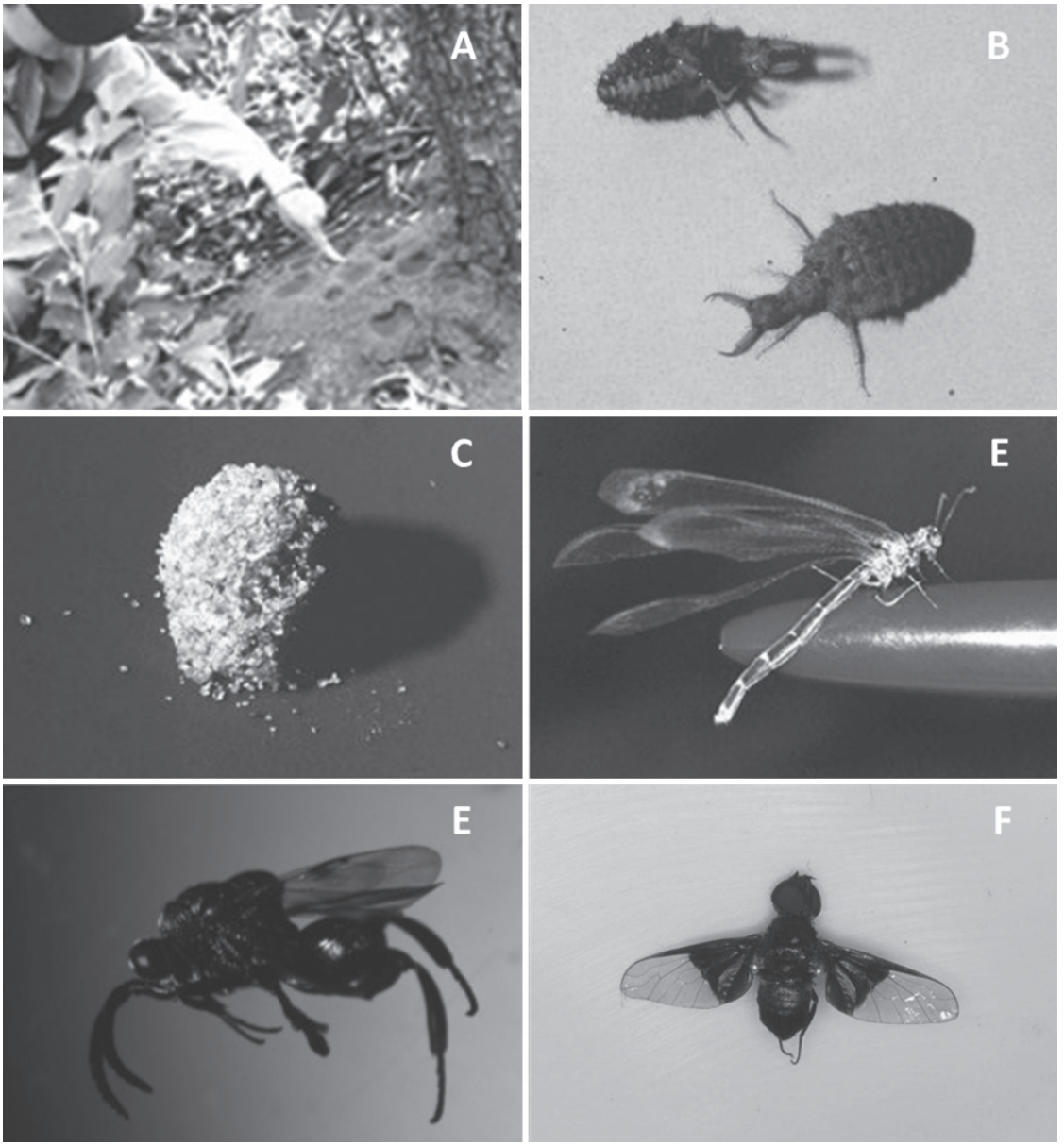

Fig. 1. A. *Myrmeleon brasiliensis* funnels in the field; B. Larvae of *Myrmeleon brasiliensis* (3rd instar); ventral view (top), and dorsal view (bottom); C. Cocoon of *Myrmeleon brasiliensis* with the pupa inside; D. Newly emerged adult of *Myrmeleon brasiliensis* on a pen; E. *Hockeria eriensis* emerged from a pupa of *Myrmeleon brasiliensis* collected as first instar larva from the field (Aquidauana-MS, Brazil, Feb 2001 and Jan 2002); F. *Paravilla* nr. *stheno* emerged from a pupa of *Myrmeleon brasiliensis* collected from the field as first and second instar larvae (Aquidauana-MS, Brazil, Feb 2001 and Jan 2002).

deposited in the Coleção Zoológica da Universidade Federal de Mato Grosso do Sul, Campo Grande, Mato Grosso do Sul, Brazil. The parasitoids from the families Bombyliidae (Diptera) and Chalcididae (Hymenoptera), were identified by Carlos José Einicker Lamas (Museu de Zoologia, Universidade de Sao Paulo, São Paulo-SP, Brazil), and Marcelo Teixeira Tavares (Universidade Federal do Espírito Santo, Vitória-ES, Brazil), respectively. From a total of 161 *M. brasiliensis* collected larvae, 26 were parasitized. The parasitoids included 20 individuals of *Hockeri*a *eriensis* (Wallace 1942) (Chalcididae: Hymenoptera) (Fig. 1E), and six adults of *Paravilla* sp.

nr. *stheno* (Wiedemann 1828) (Fig. 1F) (Diptera: Bombyliidae), representing 12.42% and 3.73% parasitism, respectively. The combined level of parasitism for *M. brasiliensis* was 16.15%. Both parasitoid species emerged from pupae of the antlion. The adults of *H. eriensis* emerged from Mar to Oct, and the adults of *P.* nr. *stheno*, from Mar to Sep. The identification of the Bombyliidae to the species level was not possible because the genus *Paravilla* is in need of a taxonomic review for the Neotropical Region.

This is the first record of *Hockeria eriensis* and *Paravilla* nr. *stheno* parasitizing larvae of *Myrmeleon brasiliensis*. Most Diptera parasitoids develop completely inside the body of their hosts (= endoparasitoids); however, some bombyliids can develop as endoparasitoids or exoparasitoids (Feener & Brown 1997; Yeates & Greathead 1997). Bombyliids can shift their developmental strategy in different instars. According to Matsura et al. (1998), *Villa myrmeleonostena* Baba 1953 (Diptera: Bombyliidae), changes its life-style from an endoparasitoid in the first instar to exoparasitoid in the last instar upon pupae of *Myrmeleon bore* (Tjeder 1941), (Neuroptera: Myrmeleontidae), in Japan.

Most Bombyliidae are ectoparasitoids, with first instar triungulin larvae that actively search and attach to the body of the hosts. Bombyliid hosts usually are insect larvae living in concealed places, such as burrows or nests. Although most bee flies attack aculeate Hymenoptera, some species of Bombyliidae are found seeking for hosts over open, sandy ground environments, attacking orthopteran egg pods or larvae of Myrmeleontidae (Kits et al. 2008).

The species of the genus *Paravilla* are widespread in the New World, with records in the Nearctic Region (Southern Canada, south through central and southeastern USA (Kits et al. 2008), and the Neotropical Region (Evenhuis & Greathead 1999, 2003; Papavero & Ibanez-Bernal 2003).

In this study, both parasitoid species of *M. brasiliensis* (*Paravilla* nr. *stheno* and *H. eriensis*) emerged as adults from the pupae. Larvae of the antlion parasitized by both parasitoid species exhibited an apparently normal behavior until pupation, and the juveniles of *M. brasiliensis* died only after complete pupation. This was also observed in larvae of *Myrmeleon immaculatus* DeGeer 1773, parasitized by the bee fly *Dipalta serpentina* (Osten Sacken 1877) in California, USA (Leech & MacDonald-Leech 1989).

Only 1 adult of each species of parasitoid emerged per pupa of *M. brasiliensis*. The same solitary pattern was observed in *Myrmeleon bore* pupae parasitized by *Villa myrmeleonostena* in Japan (Matsura et al. 1998), and *Myrmeleon immaculatus* parasitized by larvae of *Dipalta serpentina* (Bombyliidae) in California (Leech & MacDonald-Leech 1989).

Females of most bombyliid species carry grains of soil in a "sand chamber" close to the ovipositor and coat eggs with soil particles before oviposition. While hovering about 3 to 5 cm above the ground female bee flies drop their eggs on the funnels of the antlion (Yeates & Greathead 1997). If this is the case for the bombyliid *Paravilla* species found in this study, larvae of *M. brasiliensis* have little chance to avoid the small triungulin larvae of *Paravilla* attaching and penetrating their body orifices (e.g., such as the spiracles) or the intersegment membranes.

The percentage of combined parasitism in this work (16.15%) is lower than the level of parasitism found in California for larvae of *M. immaculatus* attacked by the bombyliid *D. serpentina*, that was 70% ($n = 10$) (Leech & MacDonald-Leech 1989). Additional studies are needed to determine the strategy that both parasitoids species use to parasitize *M. brasiliensis*.

Summary

Antlions (Neuroptera: Myrmeleontidae) are predators commonly found in the tropical regions. There are few studies on their biology and natural enemies in the Neotropics. The aim of this study was to sample larvae of *Myrmeleon brasiliensis* (Navás 1914) in natural environments in order to identify their parasitoids and estimate levels of parasitism. Larvae of *M. brasiliensis*, from first to third instars, were collected in a natural forest in Aquidauana, Mato Grosso do Sul state, Brazil from Feb 2001 to Jan 2002. In total, 161 larvae of *M. brasiliensis* were collected and reared in the laboratory. They were fed daily with leaf-cutting antworkers and third instar larvae of fruit flies. Two parasitoid species emerged from larvae of *M. brasiliensis*: *Hockeri*a *eriensis* (Wallace 1942) (Hymenoptera: Chalcididae) and *Paravilla* sp. near *stheno* (Wiedemann 1828) (Diptera: Bombyliidae, Anthracina). This is the first record of *M. brasiliensis*'s parasitoids in Brazil. All juveniles of the antlion were killed by the parasitoids after pupation, and only an adult of both parasitoid species have emerged per pupa of *M. brasiliensis*.

Key Words: Antlion, Bombyliidae, Chalcididae, *Hockeri*a *eriensis*, *Paravilla* sp.

Resumo

"Formigas-leão" (Neuroptera: Myrmeleontidae) são predadores comumente encontrados nas regiões tropicais. No entanto, na região Neotropical existem poucos estudos sobre a sua biologia e seus inimigos naturais. O objetivo deste estudo foi amostrar larvas de *Myrmeleon brasiliensis* (Navás 1914) em ambientes naturais para estimar as taxas de parasitismo e identificar as espécies de seus parasitóides. Larvas de *M. brasiliensis*, do

primeiro ao terceiro instar, foram coletados em uma floresta natural em Aquidauana, Mato Grosso do Sul, Brasil, de fevereiro de 2001 a janeiro 2002. Um total de 161 larvas de *M. brasiliensis* foram coletados no campo e criados em laboratório. Elas foram alimentados diariamente com operárias de formigas cortadeiras e com larvas de terceiro instar de moscas das frutas. Das larvas de *M. brasiliensis* emergiram duas espécies de parasitoides: *Hockeria eriensis* (Wallace 1942) (Hymenoptera: Chalcididae) e *Paravilla* aff. *stheno* (Wiedemann 1828) (Diptera: Bombyliidae, Anthracina). Este é o primeiro registro de parasitóides de *M. brasiliensis* no Brasil. Todos os juvenis da "formiga-leão" foram mortos pelos parasitóides após a fase de pupa, e apenas um adulto de ambas as espécies de parasitóides emergiu por pupa de *M. brasiliensis*.

Palavras-Chave: "Formiga-leão", Bombyliidae, Chalcididae, *Hockeri*a *eriensis*, *Paravilla* aff. *stheno*

Endnotes

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