Antrocephalus mitys (Hymenoptera: Chalcididae) in Laboratory Cultures of Tenebrio molitor (Coleoptera: Tenebrionidae), and Possible Role in Biological Control of Ephestia cautella (Lepidoptera: Pyralidae)

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ANTROCEPHALUS MITYS (HYMENOPTERA: CHALCIDIDAE) IN LABORATORY CULTURES OF *TENEBRIO MOLITOR* (COLEOPTERA: TENEBRIONIDAE), AND POSSIBLE ROLE IN BIOLOGICAL CONTROL OF *EPHESTIA CAUTELLA* (LEPIDOPTERA: PYRALIDAE)

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Adequate food sources are shortcomings for mass rearing predators (Molina-Rugama et al. 1998; Silva et al. 2009) and parasitoids (Pratissoli et al. 2004a; Soares et al. 2007). The yellow mealworm, *Tenebrio molitor* L. (Coleoptera: Tenebrionidae), is used to feed captive mammals, birds, reptiles, amphibians because this mealworm is easy to propagate, harvest and feed (Klasing et al. 2000; Zanuncio et al. 2008). Also pupae of *T. molitor* are an alternative prey for laboratory mass rearing Neotropical predatory and parasitoid insects with low costs and labor requirements (Zanuncio et al. 2008; Bortoli et al. 2011).

Ephestia spp. (Lepidoptera: Pyralidae) species are worldwide pests of stored grains and byproducts, and they feed on wheat flour or meal (Ammouneh et al. 2011), the main food substrate of *T. molitor* larvae and adults. *Ephestia* spp. moths are generally managed by fogging with insecticides in storage units (Scholler & Flinn 2000). However, public health concerns regarding pesticide residues in food mandate alternative strategies, such as biological control, to manage these insects (Scholler 1998). Natural enemies frequently parasitize immature Coleoptera and Lepidoptera in stored product systems (Toews & Subramanyam 2004), but their biological and ecological functions and applications have not been studied adequately (Pikart et al. 2011).

Some chalcids of the genus, *Antrocephalus* spp. (Hymenoptera: Chalcididae) were recently found on our *T. molitor* rearing facilities parasitizing *Ephestia cautella* (Walker) pupae and identified by the fourth author as *Antrocephalus mitys* (Walker). This species originated in the old world (Delvare & Arias-Penna 2006) and was accidentally introduced into Brazil (Boucek 1988). *Antrocephalus* spp. are natural enemies of stored product moth pests such as *Corcyra cephalonica* Stainton (Lepidoptera: Pyralidae) (Sastry & Appanna 1960; Gates 1993; Konishi et al. 2004), *Opisina arenosella* Walker (Lepidoptera: Xyloryctinae) (Abdurahiman et al. 1983; Mohandas & Abdurahiman 1992, 1995) and *Galleria mellonella* L. (Lepidoptera: Pyralidae) (Subba Rao 1955).

Antrocephalus mitys males and females were collected manually with a vacuum flask (150 mL) from the mealworm laboratory colony in the Insectary (Universidade Federal de Viçosa/UFV) in Viçosa, Minas Gerais State, Brazil at 25 ± 2 °C, 60 ± 10% RH and 10:14 h L:D.

Detailed morphological descriptions of *A. mitys* adults and larvae were made with aid of a Sony DSC-W70 Cyber-shot (7.2 megapixels) digital camera in macro mode using magnifications of up to 20 × with the lens of the camera directly coupled to the ocular of a stereomicroscope.

Each of 10 pairs of *A. mitys* were held separately in glass tubes (2.5 cm × 5 cm) plugged with cotton wool and fed on 50% honey solution. Eight pairs of *A. mitys* were reared without honey solution to evaluate starvation effect on their longevity. One *Ephestia cautella* pupa was introduced into each glass tube and the behavior of *A. mitys* was observed. Each pupae was immediately removed after parasitism to avoid superparasitism (Gates 1993), and a fresh pupa was provided. Longevity and the parasitism rate of 12 *A. mitys* females on *E. cautella* pupae were evaluated.

To observe the behavior of *A. mitys* adults, 10 individuals were maintained in plastic trays (30 × 15 cm) with abundant wheat flour and healthy

24-48 h old *E. cautella* pupae. A glass cover was placed on to the top of the tray to allow observations and to prevent escape. The chalcids were allowed to forage and oviposit until their death. Observations were carried out daily, each day for a 2-h period.

The entire body of *A. mitys* is black. The chalcid has brown-black eyes and 8-segmented antennae. The entire dorsal surface of the thorax is densely set with thimble-like pits. Wings are hyaline. The legs are dark brown and the outer margins of the hind femora are minutely serrated. The dorsal surface of the abdomen is black, but the ventral surface is slightly brown. The abdomen of the female is pointed whereas that of the male is blunt.

The newly hatched *A. mitys* larva has a translucent white color, and lies freely in the body fluid of the host pupa. Each adult emerged through an exit hole at the anterior end of the host. Females lived longer than males (55.48 ± 4.00 days and 47.50 ± 2.54 days, respectively) even in conditions of starvation (10.00 ± 2.50 days and 6.58 ± 1.56 days, respectively). Neither sexual gender of *Antrocephalus mitys* adults fed on the host.

Antrocephalus mitys females and males mated soon after emergence. Upon finding the host pupa, the female with her antennae outstretched touched it. Females held the host with their tarsi and kept their antennae directed downwards during oviposition. Eggs were laid on the naked pupae, on pupae within cocoons inside galleries, or on those buried in the wheat flour. Chalcid females, when unable to reach the host with their ovipositors, dug as deep as 5 cm into wheat flour to find host pupae. This searching behavior of *A. mitys* females to locate and parasitize hosts is similar to that of *Trichogramma* spp. wasps in stored peanuts (Scholler et al. 1996) and may be important in using these wasps to manage *Ephestia* spp., because these pests develop within the substrate where pesticides may not penetrate (Bowditch & Madden 1996).

Antrocephalus mitys parasitized up to 20% of the *E. cautella* pupae offered. Host finding is influenced by several factors in a cereal storage ecosystem, such as environmental conditions (Hong & Ryoo 1991), host density and food availability (Steidle & Schöller 2002). Despite the lower parasitism level showed by *A. mitys* in this work, it was higher than for other *Antrocephalus* species (Gothilf 1969; Ndemah et al. 2001; Dhileepan et al. 2005).

Antrocephalus mitys females reared in plastic trays did not discriminate between parasitized and unparasitized host pupae, as shown by more than 1 puncture per host pupa. However, only one egg per host completed its development irrespective of host size, as observed for *Antrocephalus hakonensis* Ashmead (Hymenoptera: Chalcididae) (Abdurahiman et al. 1983). Both species seem to be solitary parasitoids in that only 1 adult develops per host (Hubbard et al. 1987). In this case, females could deposit more than 1 egg in a single host but mechanisms of competition lead to the survival of just 1 larva as in *Nemeritis canescens* (Grav.) (Hymenoptera: Ichneumonidae) (Hubbard et al. 1987). Female parasitoids may deposit internal marks into the host to indicate those that have been exploited (Hofsvang 1990). Thus, external punctures on *E. cautella* pupae could be due to examination of the pupa with the ovipositor by *A. mitys* females (Nufio & Papaj 2001).

Ephestia cautella pupae were successfully parasitized by *A. mitys* and fertile offspring were produced. The presence of *A. mitys* in the yellow mealworm rearing facility suggests that it is adapted to artificial environments and to this host. Since *Ephestia* spp. presumably compete for resources with *T. molitor* the addition of *A. mitys* might improve mealworm mass-rearing efficacy. Eggs, larvae and pupae of *Ephestia* spp. are used to rear parasitoids, predators and mites for biological control programs and research (Oliveira et al. 2004; Pratissoli et al. 2004b; Momen & El-Laithy 2007). Egg parasitoids of the genus *Trichogramma* spp. are utilized in stored systems against *Ephestia* spp. moths (Steidle et al. 2001) and reared on this insect (Smith 1996).

Antrocephalus mitys may be a tool for the biological control of stored product moth pests in Brazil; and *Ephestia cautella* is an adequate factitious host for mass rearing this chalcid wasp.

Summary

Ephestia cautella (Walker) (Lepidoptera: Pyralidae) is a cosmopolitan pest of stored products. It was found abundantly in a yellow mealworm mass rearing facility in Viçosa, Minas Gerais State, Brazil feeding on wheat flour and associated with a chalcid parasitoid. This wasp was identified as *Antrocephalus mitys* (Walker) (Hymenoptera: Chalcididae), a pupal parasitoid of moth stored products pests. In the laboratory, *E. cautella* pupae were successfully parasitized by *A. mitys* and fertile offspring were obtained. The presence of *A. mitys* in the mealworm colony suggests that this chalcid is adapted to artificial environments and has the potential to be deployed as a biological control agent in postharvest stored product facilities.

Key Words: *Antrocephalus mitys*, biological control, *Ephestia cautella*, host, parasitoids

Resumo

Ephestia cautella (Walker) (Lepidoptera: Pyralidae) é uma praga cosmopolita de produtos armazenados. Esta foi encontrada em abundância em uma criação massal de tenébrio em Viçosa, Minas Gerais, Brasil alimentando-se em farelo de trigo

associado com um parasitoide chalcidídeo. Esta vespa foi identificada como *Antrocephalus mitys* (Walker) (Hymenoptera: Chalcididae), parasitoide de pupas de mariposas praga de produtos armazenados. Em laboratório, pupas de *E. cautella* foram parasitadas com sucesso por *A. mitys* e descendentes férteis foram obtidos. A ocorrência de *A. mitys* na criação de tenébrio sugere que este chalcidídeo está adaptado a ambientes artificiais e possui potencial para ser utilizado como controlador biológico.

Palavras-Chave: *Antrocephalus mitys*, controle biológico, *Ephestia cautella*, hospedeiro, parasitoides

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