Does Megaselia Scalaris (Diptera: Phoridae) Have Potential as a Biological Control Agent of Fall Armyworm?

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Does *Megaselia scalaris* (Diptera: Phoridae) have potential as a biological control agent of fall armyworm?

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Megaselia scalaris (Loew) (Diptera: Phoridae) has been collected from dead insects in laboratory colonies, as well as from some live insects (Zwart et al. 2005; Disney 2008). *Megaselia* is one of the genera with the largest number of species in Phoridae (Furukawa & Kaneko 1981), with certain species adapting to various biological and environmental conditions. They can act as saprophagous, necrophagous, facultative parasites, and some species even cause myiasis in vertebrates (Koller et al. 2003; Disney 2008).

Two recent works reported *M. scalaris* as a parasitoid of *Spodoptera frugiperda* (Smith) (Lepidoptera: Noctuidae), and it was suggested as a potential biological control agent for this pest (Ruiz-Nájera et al. 2007; Tang et al. 2021). However, there is no empirical data to be sure that this species feeds on live larvae. The objective of this work was to identify the larval development of *M. scalaris* on *S. frugiperda* under laboratory conditions.

A laboratory colony of *M. scalaris* began with 20 adults that emerged during summer of 2020 from a colony of *S. frugiperda* maintained on a meridic diet in the Biological Control laboratory of the Colegio de Postgraduados, Montecillo, Texcoco, Mexico, following the methodology described by Jaraleño-Teniente et al. (2020). The rearing of *M. scalaris* was conducted in laboratory constructed transparent plastic cages (23 × 17 × 17 cm), with 2 holes covered with muslin to promote ventilation. To feed the adults, drops of honey were placed on the walls of the cage, and water was supplied in a cotton wick inserted in a 10 mL glass bottle (Vitro envases, Monterrey, Nuevo León, Mexico), which were replaced every 48 h. In addition, 1 cm^3 of diet and 2 to 3 dead and live larvae of third and fifth instars of *S. frugiperda* also were introduced every 3 to 5 d. Using Borgmeier's keys (1966), and the description of Alam et al. (2016), we corroborated that *M. scalaris* was the only species in the rearing. In addition, some voucher specimens were deposited in the Collection of Insects of the Colegio de Postgraduados (CEAM-D-001).

The oviposition and development success of *M. scalaris* was evaluated in a choice experiment. The experimental arena was a cage as described above. Inside, 2 third instar *S. frugiperda* larvae (1 live, 1 dead), 2 fifth instars (1 live, 1 dead), and 1 cm^3 of meridic diet were placed. Twenty *M. scalaris* adults then were released inside the arena. After 12 h of exposure, the larvae and diet were removed and individualized in Petri dishes (Ø = 3 cm × 1 cm), and after 7 d the number of *M. scalaris* larvae that completed their development in each treatment was recorded. Seven repetitions were performed, each in a different wk. The rearing and the assays were kept at 25 ± 2 °C, 75 ± 5% RH, and 12:12 h (L:D) within a bioclimatic chamber. The comparison of means of the number of larvae that completed their development in each unit was carried out using Kruskal-Wallis One-Way Nonparametric analysis, followed by Kruskal-Wallis All-Pairwise Comparisons ($\alpha = 0.05$).

All the specimens that were identified by the rearing and assays corresponded to *M. scalaris* (Fig. 1) and 134 larvae were recovered from the assays. There were significant differences between treatments (Kruskal-Wallis Statistic = 24.21; $P < 0.001$). Most organisms developed on the meridic diet (84.3%), followed by those as necrophagous of dead larvae of fifth instar (12.7%), and an insignificant percentage as internal parasites of live larvae of the third (2.2%) and fifth instars (0.7%) (Table 1). During the assays, eggs of *M. scalaris* were observed in the diet, but not on the integument of the larvae (live or dead). The eggs in both types of larvae must have been within them. There was emergence of *M. scalaris* larvae (to pupate) from live *S. frugiperda* larvae, but are they a true endoparasitoid? Although the dipteran larvae completed their development as endoparasitoids and kill their host, the question remains whether it is a facultative parasitoid with a high preference for dead larvae or decomposing material.

Megaselia scalaris females appear to locate insects in laboratory or field hatchlings due to olfactory cues from dead organisms (Zwart et al. 2005; Disney 2008). This species also has been associated with *Apis mellifera* L. (Hymenoptera: Apidae), *Rhodnius prolixus* Stål (Hemiptera: Reduviidae), and *Macrodactylus murinus* Bates (Coleoptera: Scarabaeidae) (Arredondo-Bernal & Trujillo-Arriaga 1994; Cazorla-Perfetti et al. 2012; Ricchiuti et al. 2016), but it was not specified whether it attacked live insects in any of the 3 cases. This fly was associated with *S. frugiperda* in previous works without specifying its development (Ruiz-Nájera et al. 2007; Tang et al. 2021); the statement about its potential use as a biological control agent is based on the mere fact of having been collected in association with this pest without proof of real evidence. Our work shows that it preferred to develop as a saprophagous in a meridic diet of *S. frugiperda*, and secondly as necrophagous in larvae. Furthermore, in less than 3% of the

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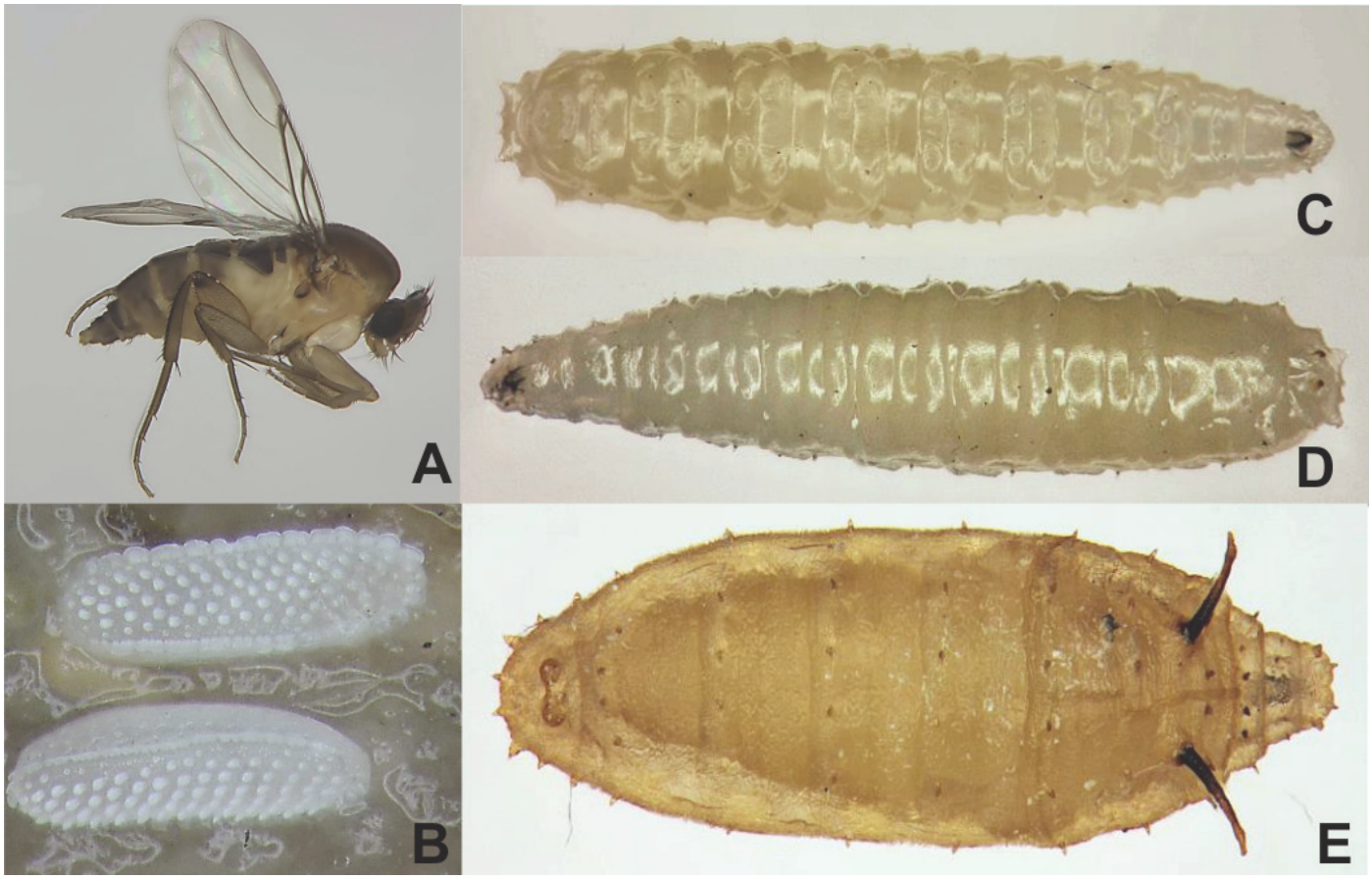

Fig. 1. *Megaselia scalaris* (Diptera: Phoridae): adult female (A); eggs (B); larvae dorsal view (C); larvae ventral view (D); and pupae (E).

cases, it acted as an endoparasitoid of *S. frugiperda*; these results suggest that this species has no potential as a biological control agent for *S. frugiperda*.

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Summary

Megaselia scalaris (Diptera: Phoridae) has been recovered from *Spodoptera frugiperda* (Lepidoptera: Noctuidae) and it has been identified as a possible biological control agent. However, in laboratory tests *M. scalaris* preferred to develop as saprophagous on a meridic diet (84.3%), and secondly as necrophagous of dead larvae (12.7%). Its development as an endoparasitoid occurred in 2.2 and 0.7% in third and fifth instar larvae, respectively. This suggests that it has no potential as a biological control agent for *S. frugiperda*.

Key Words: *Spodoptera frugiperda*; necrophagous insect; *Zea mays*; scuttle fly

Table 1. Number of *Megaselia scalaris* larvae recovered from different treatments.

Treatment	Recovered larvae	value KW stat*	p
Third-instar larvae dead	0	12 b	< 0.0001
Third-instar larvae alive	3	13.857 b	
Meridic diet	113	31.714 a	
Fifth-instar larvae dead	17	18.714 ab	
Fifth-instar larvae alive	1	13.714 b	
TOTAL	134		

*Value KW stat in treatments followed by different letters are significantly different (Tukey's test: $P < 0.05$).

Sumario

Megaselia scalaris (Diptera: Phoridae) se ha recuperado de *Spodoptera frugiperda* (Lepidoptera: Noctuidae), y se señaló como un posible agente de control biológico. Sin embargo, en pruebas de laboratorio *M. scalaris* prefirió desarrollarse como saprófago de una dieta merídica (84.3%), y en segundo lugar como necrófago en larvas muertas (12.7%). Su desarrollo como endoparasitoide sucedió en 2.2 y 0.7% en larvas de tercer y quinto ínstar, respectivamente. Esto sugiere que no tiene potencial como agente de control biológico de *S. frugiperda*.

Palabras Clave: *Spodoptera frugiperda*; insectos necrófagos; *Zea mays*; mosca jorobada

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