DROSOPHILA AS A NEW BIOCONTROL AGENT AGAINST LAND SNAILS

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ABSTRACT
It is the first record that the vinegar fly insect or so-called fruit fly, Drosophila melanogaster Meigen (Diptera: Drosophilidae), plays an important role as a biocontrol agent against the land snails.

By chance when contamination occurred in a culture of the land snail Eremina irrigularis (Férussac) with this fly from its mass-rearing place in a genetic laboratory; we observed its maggots (larvae) penetrating the snail body during its aestivation period, and destroying it in a short time according to their number.

These maggots were fed on the contents of dead snail body as well as the microorganisms decomposed the snail body contents to a dark liquid with a bad smell. The maggots were grown inside the shell and encapsulated in the puparium (the thickened, hardened, barrel-like larval skin within which the pupa is formed). After few days, adult fly emerged from the shell opening and recycled its life.

Keywords: Drosophila melanogaster – Eremina irrigularis

INTRODUCTION
There are many different methods utilized for controlling the injurious agricultural land snail pests from which;

1. The cultural methods such as the removal of weeds within crops that may reduce the available food and increase feeding damage to crops at least in the short term (Godan, 1983). Baker (1992) mentioned that some farmers drag prickles chains or iron bars across fields in summer to dislodge aestivating gastropods from the vegetation. He added that the dislodged animals often die apparently from the exposure to extreme climatic conditions on the soil surface or starvation. Baker

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(2002) stated that farmers have relied on tillage and the burning of pasture residues and stubbles before sowing new crops to kill both white and conical snails.

2. The chemical methods, where there are many molluscicides are available in a range of formulations according to Godan (1983); Bowan and Antonie (1995). On the other hand, Baker (2002) indicated that fumigants (e.g., CO₂, Phosphine) could kill white and conical snails contaminating grain stored in soils.

3. The biological methods, where few animals are known to prey upon or parasitize white and conical snails in Australia. Some birds, Lizards and mice feed upon them, but their impact on pest numbers is considered trivial. While, a wide range of invertebrate and vertebrate predators (molluscs, beetles, lizards, birds, small mammals and insects parasitoids (sarcophagid, sciomyzid, phorid and calliphorid flies) feed on white and conical snails in Europe and the Mediterranean region (Baker, 1986; Hopkins and Baker, 1993; Coupland, 1994). On the other hand, Chock et al. (1961), Godan (1983), Baker (1986), Gormally (1987), Maharaj et al. (1992) and Baker (2002) mentioned that sciomyzid flies have most commonly been considered as potential biological control agents of aquatic and semi-aquatic as well as terrestrial gastropods. Capinera (2001) reported that *Tetanocera* spp. marsh flies (Diptera: Sciomyzidae) paralyze and parasitize slugs and snails as well as several beetles, including ground beetles (Coleoptera: Carapidae, Lampyridae and Staphylinidae).

This investigation is considered the first record of the vinegar fly insect or so-called fruit fly *Drosophila melanogaster* Meigen (Diptera: Drosophilidae) as a new natural enemy for land snails all over the world especially it spreads in the Egyptian ecosystem and perhaps it plays an important role in attacking the land snails.

This phenomenon has never been observed before and needs further intensive studies to focus the biological control role of the fly against land snail pests.

**MATERIALS AND METHODS**

During August and September 2014, a contamination with the vinegar fly (fruit fly) *Drosophila melanogaster* Meigen was observed in a culture of the land snail *Eremina irrigularis* (Férussac) and possibly came from its mass-rearing place in the genetic laboratory, which situated near by the snail research laboratory at the Faculty of Agriculture, Cairo University. In this study, twenty-one snail shells were found infested with immature stages of this fly.

The contents of each shell was removed by using camel brush and placed on a small petri dish (5 cm diameter). The shell was rinsed with few drops of water to remove all stages attached inside the shell. Then snail shells were individually examined, sorted to maggots (larvae) or pupae and counted by using a stereomicroscope.
RESULTS

During August and September 2014, it was observed that twenty-one snail individuals of *Eremina irrigularis* were infested with *Drosophila melanogaster* within their aestivation (inactive) period. Examination indicated that when contamination occurred in the snail’s culture, female fly firstly drawn towards the mucus layer, which covered the opening of an inactive snail shell and lick it. As a result, an opening was formed in which the fly laid its eggs on the snail body. After the end of egg incubation period, hatching occurred.

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Figure 1. Maggots (Larvae).

Figure 2. Puparium.
The resulting maggots penetrated the snail body and fed on its contents. It is assumed that the associating microorganisms decomposed the contents into dark liquid with a bad smell. These maggots remained inside the shell and fed on the contents of this liquid to complete their growth period and then encapsulated in the puparium (Figure 1 & 2). Finally, after the pupae completed their duration inside the shell (Figure 3), adult females and males of the
voltage fly emerged and left behind the dark empty snail shell (Figure 4). Table 1 presents the numbers of different voltage fly stages, which found inside the snail shells.

**Table 1. Number of different stages of D. melanogaster inside E. irrigularis snail shells**

<table>
<thead>
<tr>
<th>Stages</th>
<th>Maggots</th>
<th>Pupae</th>
<th>Both Stages</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Maggots</td>
</tr>
<tr>
<td>Average</td>
<td>33.7 ± 3.9</td>
<td>33.8 ± 3.3</td>
<td>13.0 ± 6.8</td>
</tr>
<tr>
<td>Range</td>
<td>28 - 41</td>
<td>29 - 39</td>
<td>8 - 27</td>
</tr>
</tbody>
</table>

The examination of the twenty-one snail shells indicated that nine of them (42.8%) contained maggots with different sizes and ages according to hatching time with an average of 33.7 ± 3.9, six shells (28.6%) were pupae with an average of 33.8 ± 3.3 and six shells contained both maggots and pupae with an average of 13.0 ± 6.8 and 14.8 ± 6.4, respectively. Pupae were sorted puparium with an average of 8.8 ± 5.0 and pupae with an average of 6.0 ± 4.0. It is easily to differentiate between puparium and pupa according to color and site.

Puparium is in white color and found floating over the dark liquid inside the snail shell; while pupa is in brown color and attached to the internal sides of the same shell.

**DISCUSSION**

The previous literatures mentioned that several insect families such as Sciomyzidae and Sarcophagidae (Order: Diptera) as well as Carabidae, Lampyridae and Staphylinidae (Order: Coleoptera) were considered potential biological control agents of aquatic, semi-aquatic and terrestrial gastropods. This research paper is the first to document that family Drosophilidae belonging to order Diptera may be successfully used as a biocontrol agent of land snails.

The recent research has focused on a role of the vinegar fly *Drosophila melanogaster* (Diptera: Drosophilidae) as a natural enemy against the land snails. This role was observed by chance when a contamination with this fly occurred in a culture of the land snail *Eremina irrigularis*.

Examinations proved that maggots of this fly attacked and killed the snails during their aestivation period and then fed on their bodies. The microorganisms are supposed to turn the contents into dark liquid with a bad smell. As a result, the maggots were able to complete their life duration, and then encapsulated in the third larval instar integument as a puparium within which the pupae formed. Puparium observed floating over the dark liquid, it is white according to color of the last larval skin; then pupa appeared with brown color as a result of dead cells of its cover as well as dryness. The pupa attached itself to the internal sides of the shell to help adult fly to emerge.

These observations need further studies to estimate the duration of each stage from egg, maggot, puparium and pupa inside the snail shell.
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REFERENCES


