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Potential of *Megaselia scalaris* (Diptera: Phoridae), as biocontrol agent of *Eobania vermiculata* under semi field conditions

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Abstract:

Terrestrial gastropods are economic important pests that distributed in many Governments in Egypt causing severe damage to different important plants. The overuse of molluscicides against these destructive pests leads to more environmental pollution. So, searching for biological control agent became necessary to avoid the hazard of molluscicides. *Megaselia scalaris* (Lowe) (Diptera: Phoridae) has a potential to become a biocontrol agent of terrestrial snail *Bradybaena similaris* (Ferussac) . This study aimed to shed light on the role of malacophagous insect *M. scalaris* in controlling terrestrial snails *Eobania vermiculata* (Müller) (Gastropoda: Helicidae) under semi field conditions. Results of releasing *M. Scalaris* within *E.vermiculata* plots indicate an extrusive relation between time and mortality rates either of juvenile or mature snails and time needed for total mortality was reported significantly longer period in mature snails than juvenile snails. It could be concluded that *M. scalaris* may play an important role in controlling terrestrial gastropods.

Introduction

Terrestrial gastropods are economic important pests that distributed in many Governments in Egypt causing severe damage to different important plants (Desoky, 2018; Azzam and Abd El-Hady, 2018). The overuse of molluscicides against these destructive pests leads to more environmental pollution (Godan, 1983). So, searching for biological control agent became necessary. Azzam and Tawfik (2005) recorded the existence of 16 species of terrestrial malacophagous insects, including four sarcophagid species of which *Wohlfartia* sp. was reported only on slugs. Two drosophilid species and two sphaerocerid and four Phorid were also reported. Zaki *et al.* (2019) carried out a survey of aquatic and terrestrial malacophagous insects associated with snails during 2016-2018 in Sharquia Governorate. The survey revealed the existence of four terrestrial and three aquatic snail species associated with three aquatic and three terrestrial malacophagous insect species including *Megaselia scalaris* (Loew) and *Petrostecus barbarous.* Phorids are amongst the most biologically diverse families of insects (Brown, 2018). Many phorid flies are parasitoids of injured hosts, (Brown, 2000 and Hash, 2014).

The definition of a scavenger is an organism that consumes dead or

decaying organic material (Lincoln *et al*., 1998), whereas a parasitoid is one that feeds on a single host, ultimately causing its death (As opposed to predators that feed on more than one host or true parasites that feed on a host, but do not kill it (Godfray, 1994). Females of the phorid fly *Megaselia steptoeae* Hartop *et al*. (Diptera: Phoridae) were found to be quickly attracted to crushed glass snails of the species *Oxychilus draparnaudi* (Beck) (Gastropoda: Oxychilidae) (Brown and Vendetti, 2020). *M. scalaris* was recorded to parasitize only certain species of adult insect or larvae and snails (Ahmad and Ho, 1980; Robinson, 1975 and Idris and Abdullah, 1997). Idris and Abdullah (1997) found in laboratory studies that *M. scalaris* has a potential to become a biocontrol agent of *Bradybaena similaris* (Ferussac). They reported that 55% of *B. similaris* ,exposed to *M. scalaris* was parasitized. However, percent parasitism of the snail in the field is ranged between10 and 35%. Lower parasitism rate was probably due to low parasitoid population in the field as a result of heavy use of pesticides. The larval developmental time was significantly longer ($p<0.05$) when larvae were fed on live *B. similaris* than on its tissue extract (Idris *et al.,* 2001). Disney (1994) reported that the development of *M. scalaris* larva and its parasitism rate is quite dependent on host species, temperature and nutrient provided by the host. Bohart and Gressit (1951) recorded nine species of *Megaselia* including *M. scalaris* as a snail predator in larval stage. Tawfik *et al.* (1999) studied the biology of *M. scalaris* by feeding on three terrestrial snail species ,as malacophagous insects through its larval stages which predate many snails through each larval instar in gregarious behavior . Rare investigation in the role of malacophagous insects in semi field conditions.

Therefore, this study aimed to shed light on the role of malacophagous insect *M. scalaris* in controlling terrestrial snails *Eobania vermiculata* (Müller) under semi field conditions to reduce the overuse of pesticides which increase the environmental pollution .

Materials and methods

1. Samples collection:

Samples of terrestrial snails were collected from infested plants by hand picking from Great Cairo, Egypt during 2016 -2019 .Snails and slugs were identified according to Godan (1983); Cowie (2002); Auffenberg and Stange (2009) and Baker (2009) .

2. Rearing of predator:

Rearing of *M. scalaris* started with collecting the larvae attacking snails from natural habitats. When the larvae pupated, the pupae were transferred individually into test tubes covered with piece of cotton. Emerged flies were confined as coupled in similar test tubes .Small ribbon of rice paper soaked with sucrose solution was hanging down in the tube as a source of sucrose ,one small crushed snail was added to each tube as a source of protein.

3. Rearing of gastropods:

After collecting and identification gastropods, they washed thoroughly in fine metallic net under strong stream of tape water then washed by distilled water, take some individuals in petri-dish with distilled water and examined it under research microscope to check the presence of microorganisms . This process repeated several times until look remove all external associated organisms.

Rearing of *E. vermiculata* snail was carried out by placing the examined individuals in plastic cages after sterilizing it by ethanol alcohol and substrates with sterilized clay and

irrigated with distilled water. After egg laying, the eggs were washed gently by distilled water and transfers to sterilize petri dishes contained sterilized clay. The petri dishes were then placed in dark place until hatching. The newly hatched snails were transferred gently to new sterilized cages as mentioned above and supplied with some lettuce leaves after washing it thoroughly by strong stream of tape water to remove associated organisms then wash with distilled water and introduced to the newly hatching snails.

4. Experimental test:

Twelve transparence plastic boxes, each measured (50 x25x20 cm) were used as mini plot experiments. Each box was sterilized by ethanol alcohol 70% and substrates with sterilized clay (5cm height), moisten with dechlorinated water. Six of these boxes were provided with 100 mature snails of *E. vermiculata* for each, while the other six boxes provide with 100 juvenile snails per box from the same species. Some lettuce leaves were added to every plot as a source of food .Every plot was covered with perlon gauze and confirmed by rubber band.

100 couples (Male and female) of *M. scalaris* flies were confined in ten plastic test tubes(10 males and females /tube) ,partially covered with piece of cotton and contained mall ribbon of rice paper soaked with sucrose solution as source of food for flies .One tube was added to every cage from five plots for both mature and juvenile snails. The sixth box from mature and juvenile snails was left without adding the tube contained flies, as a control treatment. Through the first five days the mini plots were observed from the transparence wall boxes to avoid escaping of the flies before mating and oviposition which take 1-4 days (Tawfik *et al.*,1999), and dead snails were recorded.

After five days mini plots began examined daily and number of dead snails was recorded and collected at the corner of plots without removing it from the cages to excuse propagation of the flies and gave chance to larvae to attack another snails. Escaping flies during cages examination was neglected to imitate that was occur in nature .

5. Statistical Analysis:

Differences between mortality rates for mature and juvenile snails were analyzed by ANOVA and T test value using PSPP program and time needed for mortality analyzed by Qui square test using Ldp line program .

Results and discussion

Mortality of both juvenile and mature stages of *E. vermiculata* snail was summarized in Table (1). As seen in this table, high extrusive relation between time and mortality rates either of juvenile or mature snails. It was noticed that the first three and four days for juvenile or mature snails respectively, have no mortality this was maybe due to lacking larvae which predate the snails where pre oviposition period and incubation period of eggs take from 1-4 days (Tawfik *et al.*, 1999) . Table (1) showed also that time needed for total mortality was reported longer period in mature snails than juvenile snails. This is because larvae consumed a greater number of small snails than large or mature snails. Tawfik *et al.* (1999) reported high consumption rate of *M .scalaris* on *E. vermiculata* immature snails than mature snails and also on other snails that were smallest in size than *E. vermiculata* snail . Disney (1994) reported that the development of *M. scalaris* larva and its parasitism rate is quite dependent on host species, and nutrient provided by the host. It was noticed also that daily mortality rate increase day after day due to progress of larval development that predate a greater number of snails

through late instars than early instars . Tawfik *et al.* (1999), mentioned that daily consumption of different larval instars of *M .scalaris E. vermiculata* increase as the larval predator develops to reach the maximum in the mature larva. Idris and Abdullah, 1997, found in laboratory studies that *M. scalaris* has a potential to become a biocontrol agent of *Bradybaena similaris* (Fer.).

Table (2) showed high correlation between time and mortality r=0.9and 0.72 for both juvenile and mature snails respectively. Lt 25, 50, 75,and 99 were significantly longer in mature snails than in juvenile snails. Sallam and El-Wakeil (2012) mentioned that juvenile snail stages were more vulnerable for predator attacking, than adults .

Table (1): Daily and accumulation mortality rate of *Eobania* predating by *Megaselia scalaris* under semi field conditions .

Time /day	Mortality of *Eobania vermiculata*			
	Juvenile snail		Mature snails	
	Rate % of dead snails in day	Rate % of accumulated dead snails in day	Rate %of dead snails in day	Rate % of Accumulated dead snails Consumption in day
1	0	0	0	0
2	0	0	0	0
3	0	0	0	0
4	5.67	5.67	0	0
5	6.5	12.165	3	3
6	11.335	23.5	4.165	7.165
7	15.835	39.335	5.665	12.835
8	21.67	61	7.165	19,99
9	22.5	83.5	9	28.995
10	16,5	100	10.835	39.835
11			13.335	53.165
12			15.335	68.5
13			17.5	86
14			11	97
15			3	100

Table (2): Time mortality relationship of *Eobania vermiculata* snail predating by *Megaselia scalaris* under semi field conditions .

Mortality ratios %	Probity linear of time in days needed for *Eobania* snail mortality of			
	Juvenile snails		Mature snails	
25	5,8677		8.3104	
50	7.0361		11.6415	
75	8.4371		16.3079	
99	13.1619		37.2295	
Slope	8.5530		4.6077	
P	0.0008		00000	
	Calculated	Tabulated	Calculated	Tabulated
X^2	26.7837	15.5	3203223	22.35
R	0.8969 (0.09)	0.632	0.7174 (0.72)	0.514

It could be concluded that *M .scalaris* may play an important role in controlling terrestrial gastropods. However, further study needs to be carried out before any decision can be made regarding for using in field application of gastropod control .Such studies may probably on the safety for useful organisms .These studies should be done in laboratory before field-testing is conducted in fields .

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