

SURVEY OF TERRESTRIAL MOLLUSCS AND PARASITIC NEMATODES AS BIO CONTROL AGENTS IN SOME EGYPTIAN GOVERNORATES

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ABSTRACT: A survey of terrestrial molluscs and their parasitic nematodes was carried out during 2014- 2016 seasons in certain Governorates (Cairo, Giza, Qaluobia, Dakahlia, Menoufia, Ismailia and Arish), where these snails are commonly distributed and infesting many economically important plants. The survey revealed the existence of seven snail species and three slugs. About 45 species of different plants including wheat, clover, citrus, mango, banana, tomato, potato, and amaranths were found to be infested with these gastropods. The survey revealed also the existence of six species of snail parasitic nematodes, which are considered bio control agents against these harmful molluscs.

Key words: Molluscs, nematodes, snails, slugs, control, *Phasmarhabditis*.

INTRODUCTION

Gastropods are very prevalent animals in the world. (Bishara, *et al.*, 1968, Godan, 1983 & Barker, 2002). In Egypt, land molluscs infest medicinal and ornamental plants, vegetables, orchard and field corps, causing damages to all the parts of plants (El-Okda, 1979, 1980, 1984 and Azzam, 1995). The last authors found that land gastropods infested more than 20 species of ornamental plants, 11 species of orchards, 9 species of vegetables, 4 species of field corps and three species of medicinal plants, thus emphasizing the necessity of controlling such harmful gastropods.

A survey for nematodes with potential for bio control of the snails *Ceruella virgata* (Da Costa), *Theba pisana* (Müller), and *Cochlicella acuta* (Müller) and *Cochlicella barbara* (Linneaus) and six local nematodes isolates were tested for their ability to kill these snail species was carried out (Charwat and Davies, 1999). The entomopathogenic nematodes *Stiernerema feltiae* and *Heterorhabditis* sp. and the slug parasitic nematode, *Phasmarhabditis hermaphrodita*

(Schneider) were tested for their ability to kill *Deroceras reticulatum* (Müller). The entomopathogenic nematodes didn't kill slugs but *P. hermaphrodita* could kill them (Wilson *et al.*, 1994).

Coupland, 1995 studied the susceptibility of helcid snails to isolates of *P. hermaphrodita* and found that *Monacha cantiana* (Müller), *Helix aspersa* Müller, *Theba pisana* (Müller), *Ceruella virgata* (Da Costa), *Cochlicella acuta* (Müller) and *Lymnaea stagnalis* L. could be killed by *P. hermaphrodita* in the laboratory (Wilson *et al.* 2000) tested the susceptibility of seven snail species to *P. hermaphrodita*.

Phasmarhabditis tawfiki, Azzam (2003) was first recorded and described by Azzam (2011). Infectivity with this nematode was investigated towards some terrestrial snails and slugs, aquatic snails and some insect larvae in the laboratory by Azzam and Tawfik (2003). Infectivity and persistence of *Phasmarhabditis tawfiki*, Azzam in different soil types were investigated under laboratory and semi field conditions by Azzam (2004). Azzam and

Khatab (2005) investigated the capability of *P. tawfiki* to control *Eobania vermiculata* Müller, *Theba pisana* (Müller) and insect larvae of *Agrotis ipsilon* (Hufengel) and *Spodoptera littoralis* (Boisd.) under greenhouse conditions. Williams and Rae (2015), investigated whether *Achatina fulica* is susceptible to the gastropod parasitic nematode, *Phasmarhabditis hermaphrodita*, which has been developed as a biological control agent for slugs and snails in northern Europe.

A survey of terrestrial molluscs and their parasitic nematodes was carried out during 2001 - 2004 seasons in certain Governorates. The survey revealed the existence of 16 snail species and three slugs infested about 64 species of different plants. The survey revealed also 5 species of snail parasitic nematode (Azzam, 2006).

The present work deals with screening molluscs and nematodes associated with some terrestrial snails and slugs in some Governorates as means of bio control agents against these harmful pests.

MATERIALS AND METHODS

Samples of terrestrial snails and slugs were collected from the infested plants by hand from Cairo, Giza, Qalubia, Dakahlia, Menoufia, Ismailia and Arish.

After identification of gastropods, every species individuals were kept in a terrarium with a suitable size to their number. Suspected and moribund snails and slugs were kept individually for isolation of associated nematodes, using the technique previously described by Azzam (1998 and 2003).

Some of isolated nematodes were prepared for microscopic examination. For this purpose specimens were directly taken from the mollusc's cadavers, killed and fixed by hot TAF (Triethanolamine formalin), composed of 2 ml. Triethanolamine + 7 ml. formalin + 91 ml.

distilled water), then mounted in lactophenol or glycerol. Nematodes were identified according to Chitwood and Chitwood (1950), Andrassy (1976 and 1983), Poinar (1977), Soliman (1996) and Azzam (2003).

All gastropods were identified according to Kassab and Daoud (1964), Bishara *et al.* (1968), Godan (1983) and Nichols and Cooke (1990), Azzam and Tawfik (2011).

RESULTS AND DISCUSSION

Collected land snail and slugs with their host plants were recorded in Table, (1). They were listed in an alphabetic arrangement, while their associated nematodes were recorded in Table, (2). The survey revealed the existence of seven snail species belonging to two families (*Eobania vermiculata* (Müller), *Monacha obstructa* (Ferussac), *Monacha cartusiana* (Müller), *Theba pisana* (Müller), *Theba* spp. (Family: Helicidae), *Opeas pyrgula* (Schmacker and Boettger) and *Opeas pumilum* (Pfeiffer) (Family: Subulinidae) and three slugs from two families (*Limax flavus* L. and *Lehmania marginata* (Müller) (Family: Limacidae) and *Deroceras laeve* (Müller) (Family: Agriolimacidae).

The snails were infesting about 45 species of different plants. The most abundant and important snails species were: *Monacha obstructa* (Ferussac) and *Eobania vermiculata* (Müller). The first infested 29 plant species including, Citrus, Banana, Mango, Alfalfa, Tomato, Pepper, Lettuce, Cucumber, Mint, Pot marigold, Dracaena, Keshda plant, Garden palm, Camel thorn and Silver wattle. The second snail species infested 16 plant species including Citrus, Mango, Papaya, Chamomile, Cabbage, Squash, Lettuce, Celery, Asparagus, Pot Marigold, Mandalay, Wild porcelain, and Keshda plant (Table1).

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Table (1) : Molluscs and their host plants occurred in Egypt governorates

Scientific name of host plant	Common name	Governorates
1- Family : Helicidae		
1-1. <i>Eobania vermiculata</i> (Müller)		
<i>Amaranthus caudatus</i>	Amaranth	Cairo
<i>Anthemis nobilis</i>	Chamomile	Cairo, Giza & Qaluobia
<i>Aplum graveolens</i>	Celery	Giza
<i>Asparagus spregrii</i>	Asparagus	Cairo , Giza & Qaluobia
<i>Brassica oleracea</i>	Cabbage	Cairo , Giza & Qaluobia
<i>Calendula officinalis</i>	Pot Marigold	Cairo
<i>Certeia papaya</i>	Papaya	Giza
<i>Citrus sp.</i>	Citrus	Cairo , Giza & Qaluobia
<i>Chrysanthemum frutescens</i>	Mandeleya	Cairo
<i>Cucurbita pepo</i>	Squash	Giza
<i>Euophorbia pelpus</i>	Wild porcelain	Cairo , Giza & Qaluobia
<i>Lacttucu sativa</i>	Lettuce	Giza
<i>Lolium prene .</i>	Gazonasa	Giza
<i>Monestra deliciosa</i>	Keshda plant	Giza
<i>Mangifera indica</i>	Mango	Giza & Ismailia
<i>Amaranthus caudatus</i>	Amaranth	Cairo& Ismailia
1-2. <i>Monacha obstructa</i> (Ferussac)		
<i>C. officinalis</i>	Pot marigold	Cairo, Giza ,Menoufia& Arish
<i>Capsicum sp.</i>	Pepper	Giza,
<i>Citrus sp.</i>	Citrus	Giza Menoufia, Dakahlia
<i>Cichorium intylous</i>	Chicory	Giza
<i>Cucumis sativus</i>	Cucumber	Giza
<i>C.dactylon</i>	Grass	Cairo Giza,Qaluobia Menoufia
<i>Duranta repens</i>	Duranta	Cairo , Giza& Qaluobia
<i>Dracaena sp.</i>	Dracaena	Cairo , Giza
<i>L. sativa</i>	Lettuce	Giza Menoufia, Dakahlia
<i>Lycopersicum crispum</i>	Tomato	Giza
<i>Menthe sp.</i>	Mint	Giza
<i>M.deliciosa</i>	Keshda plant	Giza
<i>Musa sp.</i>	Banana	Giza
<i>Petroselinum crispum</i>	Parsley	Giza
<i>P.zonal</i>	Pelargonium	Cairo , Giza
<i>Phonentix sp.</i>	Garden palm	Cairo , Giza
<i>Medicago sativa</i>	Alfalfa	Menoufia, Arish& Dakahlia
<i>Alhagi maurorum</i>	Camel Thorn	Arish
<i>Acacia dealbata</i>	Silver Wattle	Arish
<i>Mangifera indica</i>	Mango	Giza & Ismailia
<i>Amaranthus caudatus</i>	Amaranth	Cairo& Ismailia

Table (1) : Cont.

1-3. <i>Monacha cartusiana</i> (Müller)		
<i>B. oleracea</i>	Cabbage	Giza
<i>L. sativa</i>	Lettuce	Giza
<i>M. sativa</i>	Lucerne	Giza
<i>Sorghum vulgare</i>	Sweet sorghum	Giza
<i>Alhagi maurorum</i>	Camel Thorn	Arish
<i>Medicago sativa</i>	S Alfalfa	Arish, Dakahlia
<i>Acacia dealbata</i>	Silver Wattle	Arish
<i>Citrus</i> sp	Citrus	Cairo, Giza & Dakahlia
<i>Mangifera indica</i>	Mango	Giza & Ismailia
<i>Amaranthus caudatus</i>	Amaranth	Cairo & Ismailia
1-4. <i>Theba pisana</i> (Müller) & <i>Theba</i> spp.		
<i>A. nobilis</i>	Chamomile	Cairo , Giza & Qaluobia
<i>C. officinalis</i>	Pot marigold	Cairo , Giza & Qaluobia
2- Family : Subulinidae		
<i>Opeas pyrgula</i> (Schmacker and Boettger) <i>Opeas pumilum</i> (Pfeiffer)		
<i>Chrysanthemum frutescens</i>	Marguerite daisy	Cairo & Giza
<i>Chrysanthemum</i> sp.	Zonal geranium	Cairo & Giza
<i>Pelargonium zonal</i>	Horseshoe geranium	Cairo & Giza
<i>Pothos aurus</i>	Golden pothos	Cairo & Giza
<i>Sterlizia reginae</i>	Crane flower	Cairo & Giza
<i>Tegates erecta</i>	Marigold	Cairo & Giza
<i>Tradescantia fluminensis</i>	Wandering jew	Cairo & Giza
<i>Winka rosa</i>	Rose	Cairo & Giza
<i>Zinnia elegans</i>	Zinnia	Cairo & Giza
<i>Asparagus sprengeri prene</i>	Marigold	Cairo & Giza
<i>Monestra deliciosa</i>	Keshda plant	Cairo & Giza
<i>Euophorbia pelpus</i>	Wild porcelain	Cairo & Giza
<i>Petunia hybrida</i>	Petunia	Cairo & Giza
<i>Rosa</i> sp.	Wild rose	Cairo & Giza
3- Family : Limacidae Slugs: <i>Limax flavus</i> L. <i>Lehmania marginata</i> (Müller)		
<i>A. spengeri</i>	Asparagus	Cairo
<i>Coleus blimei</i>	Coleus	Cairo
<i>Chrysanthemum</i> sp.	Chrysanthemum	Cairo
<i>C. frutescens</i>	Mandeliya	Cairo
<i>E.pelpus</i>	Wild porcelain	Giza
<i>P. zonal</i>	Pelargonium	Cairo & Giza
<i>P.hybrida</i>	Petunia	Cairo & Giza
<i>P.aureus</i>	Pothos	Cairo & Giza
<i>T. fluminensis</i>	Reptile Jew plant	Cairo & Giza
4- Family : Agriolimacidae Slug: <i>Deroceras laeve</i> (Müller)		
<i>Amaranthus caudatus</i>	Amaranth	Cairo & Giza

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Table (2): Parasitic nematodes associated with gastropods in Egyptian Governorates

Nematode species	Gastropod species	Governorates
1- <i>Phasmarhabditis tawfiki</i>, Azzam	<i>Eobania vermiculata</i> (Müller) <i>Theba pisana</i> (Müller) <i>Theba</i> spp. <i>Limax flavus</i> L. <i>Lehmaninia marginata</i> (Müller) <i>Opeas pyrgula</i> (S and B) <i>Opeas pumilum</i> (Pfeiffer) <i>Deroceras reticulatum</i> (Müller)	Cairo , Giza & Qaluobia Cairo , Giza & Qaluobia Cairo , Giza & Qaluobia Cairo , Giza & Qaluobia Cairo , Giza & Qaluobia Cairo , Giza & Qaluobia Cairo & Giza Cairo & Giza
2- <i>Phasmarhabditis hermaphrodita</i> (Schneider)*	<i>E. vermiculata</i> <i>L. flavus</i> <i>L. marginata</i>	Cairo , Giza & Qaluobia Cairo, Giza & Menoufia Dakahlia
3- <i>Rhabditis</i> sp.	<i>E. vermiculata</i> <i>Monacha obstructa</i> (Ferussac) <i>L. flavus</i> <i>L. marginata</i> <i>Opeas pyrgula</i> <i>Opeas pumilum</i>	Cairo & Giza Cairo, Giza, Menoufia & Arish Cairo Cairo & Giza Cairo & Giza Cairo & Giza
4- <i>Cephalobus</i> sp.	<i>E. vermiculata</i> <i>Opeas pyrgula</i> <i>Opeas pumilum</i>	Giza, Qaluobia, Dakahlia Giza, Qaluobia, Dakahlia, Menoufia & Arish
5- <i>Diploscapler</i> sp.	<i>M.obstructa</i> <i>T. pisana</i>	Cairo, Giza & Menoufia Cairo, Giza & Menoufia
6- <i>Agfa</i> sp.	<i>Monacha</i> spp	Menoufia, Dakahlia, Cairo & Giza

The survey revealed the presence of six parasitic nematodes (Table 2).

The surveyed parasitic nematodes were: *Phasmarhabditis tawfiki* Azzam, *Phasmarhabditis hermaphrodita* (Schneider), *Rhabditis* sp., *Cephalobus* sp. and *Diploscapler* sp. and *Agfa* sp. The first species was recorded and described as a new species of snail parasitic nematode in Egypt by Azzam (2003). Azzam (1998) recorded *Rhabditis* sp. for the first time in Egypt. All the isolated nematode species except the last one (*Agfa* sp.) were previously recorded in Egypt by Azzam, 2006.

P. tawfiki Azzam was isolated from *E. vermiculata*, *T. pisana*, *Theba* spp., *Opeas pyrgula* and *Opeas pumilum*

snails and *L. flavus* L. , *L. marginata* and *Deroceras* lave slugs , while *P. hermaphrodita* was isolated from *E. vermiculata*, *L. flavus* and *L. marginata*. *Rhabditis* sp. was isolated from *E. vermiculata*, *Monacha obstructa*, *Opeas pyrgula* and *Opeas pumilum* snails and *L. flavus*, *L. marginata* slugs (Table 2). *Cephalobus* sp. was isolated from land snails (*E. vermiculata* , *O. pyrgula* and *O. pumilum*). Meanwhile, *Diploscapler* sp. was isolated from *M. obstructa* and *T. pisana* and *Agfa* sp. was isolated from land snails only *Monacha* sp .

Glen and Wilson (1997) listed 8 species of snails including one aquatic snail, all of them were susceptible to infection with *P. hermaphrodita* but non of the exposed insects accepted the

infection with it. Azzam recorded five species of snails including one aquatic, two species of slugs and three species of insects that were susceptible to infection with *Rhabditis* sp., Azzam and Tawfik (2003) recorded five species from each aquatic and terrestrial snails, two slugs, and three insect species were susceptible to infection with *Phasmarhabditis tawfiki* Azzam. Charwat and Davies (1999) recorded high mortality of *Cochlicella acuta* when exposed to two Cephalobid isolates. Williams and Rae (2015) found that *Deroceras panormitanum* killed in less than 30 days of exposure to *P. hermaphrodita* at 30 and 150 nematodes per cm² for 70 days while *Achatina fulica* show remarkably resistant to the nematode at both doses.

From the obtained results, it could be concluded that parasitic nematodes specially *P. tawfiki*, *P. hermaphrodita*, *Rhabditis* sp. and *Cephalobus* sp., represent active biocontrol agents of land gastropods in Egypt and should be taken into consideration in the control of these harmful pests.

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حصر للرخويات الارضية والنيماطودا المتطفلة عليها كعوامل للمكافحة الحيوية فى بعض المحافظات المصرية

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الملخص العربي

فى هذه الدراسة أجرى حصر للرخويات الارضية وعوائلها النباتية والنيماطودا المتطفلة عليها خلال الفترة من 2014- 2016 فى عدة محافظات هي (القاهرة ، الجيزة ، القليوبية ، الدقهلية ، المنوفية ، الاسماعيلية ، العريش) حيث تنتشر تلك الآفات وتصيب العديد من النباتات ذات الأهمية الإقتصادية. وقد أسفر الحصر عن وجود 7 أنواع من القواقع الأرضية وثلاثة أنواع من البزاقات تصيب حوالي 45 نوعا مختلفا من النباتات التي تتضمن البرسيم، الموالح، الموز، والمانجو، الطماطم، الكرنب، الخيار، الخس، الفلفل ونباتات الزينة وغيرها. كما أسفر الحصر أيضا عن وجود ستة أنواع من النيماطودا المتطفلة على القواقع والتي تعتبر من عوامل المكافحة البيولوجية التي يمكن الإستفادة منها فى مكافحة تلك الآفات .

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