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Species diversity and population dynamics of the prevailing land gastropod species on certain crops at Assiut governorate, Egypt

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Abstract

A study was carried out to identify the land gastropod species infesting different host plants and their population dynamics of predominant species at some localities belonging to four districts at Assiut governorate, Egypt. Results revealed that there were five terrestrial snails (*Monacha obstructa*, *Eobania vermiculata*, *Oxyloma elegans*, *Cochlicella acuta* and *Helicodiscus singleyanus inermis*) and three slug species (*Lehmannia valentiana*, *Limax flavus* and *Deroceras leave*). These species belonging to seven families of order: Stylommatophora. The snail, *M. obstructa* was the predominant species, as it was recorded in most of the investigated sites on numerous plants and appeared with high numbers on the majority of vegetable and field crops. Also, *C. acuta* was recorded for the first time in Sedfa and Assiut districts. Regarding population dynamics, it was found that Egyptian clover infested with high numbers of *M. obstructa* snails, followed by cabbage and wheat during spring months as compared with winter and autumn months. Accordingly, these results may contribute to designing an appropriate program to control these pests and reduce their damages.

Keywords: land gastropods, *Monacha obstructa*, diversity, population dynamics, Assiut, Egypt.

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1. Introduction

Molluscs have been widely distributed over the world. Terrestrial molluscs including snails and slugs belonging to class Gastropoda, are increased greatly in their importance value and became dangerous pests in many parts of the world (Barker, 2002). In Egypt, the terrestrial snails and slugs infesting numerous agronomic, horticulture and ornamental plants causing serious economic damage reduces their yield, quality and marketing values. This damage represented in nibbling the leaves of the plants on which they feed and, in some cases, they bore into other parts as the roots, tubers and fruits (Abdel-Rahman, 2017; Godan, 1983; Ismail *et al*., 2003). Besides direct feeding, snails may contaminate plant crops with their bodies, feces and mucous excretions or may transmit plant pathogens like fungi and bacteria (Borkakati *et al*., 2009; Iglesias *et al*., 2003). In different sites of Assiut governorate, Egypt, several investigators reported that, these pests have an economic importance for all crops (Abo-Elnaser, 2013; Ibrahim, 2017; Ramzy, 2009). Ecological studies are considered of great importance to obtain some information which useful in designing some suitable methods for controlling terrestrial snails and slugs. This work aimed to study incidence of terrestrial gastropods infesting different host plants and population dynamics of the prevailing land snail, *M. obstructa* at Assiut governorate, Egypt.

2. Materials and Methods

The ecological trials were performed to study the incidence and seasonal population dynamics of some terrestrial gastropods associated with many host plants in some localities at four districts at Assiut Governorate, Egypt which is situated at (27º 14' N and 31º 11' E). These districts and localities were:

- Assiut district is located in the western of the River Nile and including (Al-Muallimeen (nursery)), Ornamental nursery at Assiut University and Vegetable farm at Assiut University).
- Dirut district is located in the northern of Assiut Governorate and including (Dirut El-Sharif and nursery (Dirut City)).
- El-Fath district is located in the eastern of the River Nile and including (Bossra, Bani Mor (nursery)), Bani Zaid and El-Wasta).
- Sedfa district is in the southern of Assiut Governorate and including (Sedfa (orchard) and Awlad Elias).

2.1 Occurrence of terrestrial gastropods attacking crops

Terrestrial snails and slugs were surveyed monthly during the period from March 2018 to February 2020, in the previous mentioned regions.

The investigated host plants including Field crops were Egyptian clover, wheat, maize and broad bean; Vegetable crops were cabbage, cauliflower, lettuce and onion; Fruit trees were banana, mandarin, naval orange, guava, fig and pomegranate; Ornamental plants were geranium, latania, duranta, paperflower, yucca, ruellia, dusty Miller, kalanchoe and canna. At each sampling site of the investigated areas, five samples were taken randomly in the early morning from each crop by using the quartered sample size 50×50 cm (Staikou *et al.*, 1990). All snails found on plants, or on soil surface of the sample area were counted, whereas slugs were collected from the surface of the soil or from under the leaf fall and stones or in the detritus or in the grass (South, 1989). The gastropod samples were recorded and transferred in a plastic box to laboratory for examination and identification according to Godan (1983), Genena (2003), Al-Sanabani (2008) and Ramzy (2009).

2.2 Population dynamics of the prevailing land snails

The primary incidence studies of terrestrial gastropods at Assiut governorate revealed that *Monacha obstructa* was the most abundant species in the different study regions. So, the population dynamic of this species was conducted at El-Fath district during two years (2018/2019 and 2019/2020). The land snail, *M. obstructa* specimens were monthly counted on some field crops (Egyptian clover and wheat) and a vegetable crop was cabbage at El-Fath district, Assiut governorate. Five replicates each of 0.25 m^2 were randomly examined from each feddan during the investigated period. Individuals of each land snail species were found on plants, pots and soil surface. The counted snails left in their initial places (Baker, 1988).

3. Results and Discussion

3.1 Gastropod species and their incidence on different host plants in certain districts at Assiut governorate, Egypt

The incidence of terrestrial gastropod (snail and slug) species was conducted in different crops during the period of study from March 2018 to February 2020 at some localities belonging to four districts at Assiut governorate, Egypt. Results illustrated in Table (1) showed that, five terrestrial snails and three slug species were found on numerous host plants belonging to seven families of order: stylommatophora. These families and species were: Hygromiidae (*Monacha obstructa*), Helicidae (*Eobania vermiculata*), Succineidae (*Oxyloma elegans*), Geomitridae (*Cochlicella acuta*, Helicodiscidae (*Helicodiscus singleyanus inermis*), Limacidae (*Lehmannia valentiana* and *Limax flavus*) and Agriolimacidae (*Deroceras leave*). It is extremely important to

mention that the conical snail *Cochlicella acuta* recorded for the first time on Egyptian clover, mandarin, fig, pomegranate, naval orange and guava in Sedfa (orchard), Sedfa districtg and on paperflower and kalanchoe in Al-Muallimeen (nursery), Assiut district, Assiut governorate. Data showed that *M. obstructa* snail was the most prevalent species compared with the other species, where *M. obstructa* was appeared at the most examined sites on field crops (Egyptian clover, wheat, maize and broad bean); vegetable crops (cabbage, lettuce, cauliflower and onion) and on some ornamental plants (geranium, latania, yucca, ruellia, duranta, dusty Miller and paperflower) in Assiut, Dirut and El-Fath districts at Assiut governorate. On the other hand, *E. vermiculata* and *O. elegans* were detected mainly on ornamental plants. However, the latter was recorded on Egyptian clover, mandarin and naval orange in Bani Zaid, El-Fath district. While the land snail *Helicodiscus singleyanus inermis* was recorded on ornamental plants in Al-Muallimeen (nursery), Assiut district. Concerning the slug species, the slugs *Limax flavus* and *Lehmannia valentiana* were observed only in Assiut district on ornamental plants, while *D. leave* was appeared on Egyptian clover, banana and mandarin in El-Fath and Sedfa districts. Also, it was found on some ornamental plants *i.e*. canna, ruellia and paperflower in the examined district at Assiut governorate. Regarding incidence levels, the glassy clover snail, *M. obstructa* was recorded with high numbers on many plants such as Egyptian clover, cabbage and lettuce at Dirut and El-Fath districts, and was found with moderate and low numbers on other plants at the same area. At Sedfa district, high numbers of the conical snail, *C. acuta* was noticed on mandarin, fig, pomegranate, naval orange and guava. To discuss the foregoing results, it was found that many researchers reported that, these pests represent a severe threat to the numerous vegetations all over the world. Also, In Egypt, many terrestrial gastropods recorded in different Governorates have been infesting many important crops. In Sharkia governorate, the field crops (broad bean, clover, wheat, maize and cotton), vegetable crops (eggplant, tomato, pea, cabbage and lettuce) and some fruit trees *i.e*. mango and orange were attacked by *M. cartusiana* and *S. putris* (Shetaia *et al*., 2009). In northwestern Egypt, in Alexandria and EL-Beheira governorates; Eshra (2013) observed the presence of five species of land snail at Abees region on grape orchard including *Eobania vermiculata*, *Theba pisana*, *Helicella vestalis*, *Monacha obstructa* and *Oxychillus alliarius*; however, at El-Mamoura region, two species of land snail, *E. vermiculata* and *T. pisana* were recorded on ornamental plants in Alexandria Governorate. At Abul-Matamir center, three land snail species including *T. pisana*, *H. vestalis* and *M. obstructa* were recorded on navel orange and apple trees at Kafr El-Dawar center and *E.*

vermiculata, *T. pisana* and *C. acuta* were found on ornamental plants in El-Beheria governorate, Egypt. Gazzy *et al*. (2018) recorded three species *M. cantiana*, *C. acuta* and *T. pisana* on *Citruc sinesis* and *Pesidium guava* at Kafr El-Sheikh governorate, Egypt. In addition to Aisha (2019) noticed that the glassy clover snail *Monacha cartusiana* (Müller) and the amber snail, *Succinea putris* (Linnaeus). *M. cartusiana* infested all inspected fields of clover, wheat and lettuce in the nine surveyed localities while *S. putris* was detected on clover and wheat in two localities only at Ghrabia governorate, Egypt. Regarding Assiut governorate, Ramzy (2009) observed *M. obstructa* in clover, wheat, naval orange, mandarin, mango, mulberry, geranium, pomegranate and added sugar cane, okra, royal palm and basil.

Table (1): Occurrence and prevalence of terrestrial gastropods on different plants in certain districts at Assiut governorate, Egypt.

Districts	Examined Sites	Terrestrial gastropods	Host plants
Assiut	Al- Muallimeen (nursery)	*Monacha obstructa* *Eobania vermiculata* *Limax flavus* *Cochlicella acuta* *Helicodiscus singleyanus inermis*	Paperflower (+) , Duranta (++) Yucca (+), Kalanchoe(++) Duranta (+) Kalanchoe (+), Paperflower (+) Paperflower (+++), Yucca (++)
	Ornamental nursery of Assiut University	*Monacha obstructa* *Eobania vermiculata* *Oxyloma elegans* *Lehmannia valentiana* *Limax flavus* *Deroceras laeve*	Geranium (++), Latania (++), Yucca (+), Ruellia (++), Duranta(+) Dusty Miller (+), Canna (+) Yucca(+), Geranium (++), Paperflower (+), Ruellia (++) Ruellia (++), Paperflower (++), Geranium (+) Latania (+), Yucca (+) Canna (+), Ruellia (+), Paperflower (+)
	Vegetable farm of Assiut University	*Monacha obstructa*	Lettuce (+), Cabbage (+++)
Dirut	Dirut El-Sharif	*Monacha obstructa*	Egyptian clover (+++), Cabbage (++), Wheat (+)
	Nursery (Dirut City)	*Monacha obstructa*	Dusty Miller (+)
El-Fath	El-Wasta	*Monacha obstructa* *Deroceras laeve*	E. clover (+++), Wheat (+++), Cabbage (+++), Maize (+) Onion (+), Banana (+), Pomegranate (+), Lettuce (+++), Cauliflower (++) Egyptian clover (+), Banana (+)
	Bossra	*Monacha obstructa*	Egyptian clover (+++), Wheat (++), Fig (++), Mandarin (+)
	Bani Mor (nursery)	*Monacha obstructa* *Eobania vermiculata* *Oxyloma elegans* *Helicodiscus singleyanus inermis*	Duranta (++), Paper Flower (++), Latania (+) Geranium (++), Paperflower (+) Latania (+) Duranta (+)
	Bani Zaid	*Oxyloma elegans* *Deroceras laeve*	Egyptian clover (+), Mandarin (++), Naval orange (+) Egyptian clover (+), Mandarin (+)
Sedfa	Sedfa (orchard)	*Cochlicella acuta* *Deroceras leave*	E. clover(++), Mandarin(+++),Fig (+++), Pomegranate(+++), Naval orange (+++), Guava (+++) Egyptian clover (+)
	Awlad Elias	*Monacha obstructa*	Broad bean (++), Egyptian clover (++), Mandarin (+)

(+) = low numbers (1-15 individuals /0.25 m^2), (++) = moderate numbers (15-30 individuals /0.25 m^2), (+++) = high numbers (more than 30 individuals /0.25 m^2).

While, the ornamental plants, oleander, geranium, rubber plant, basil and royal palm, in addition to fruit trees, naval orange, pomegranate, mandarin, mulberry and mango were attacked by *E. vermiculata*. Also, *O. elegans* was found on the same hosts in addition to, fig, banana, guava and sour orange. Abo-Elnaser (2013) recorded three species of land snails (*M. obstructa*, *E. vermiculata* and *O. elegans)* and one species of slugs *Limax flavus* at Assiut district while,

Desoky *et al*. (2015) recorded two species of land snails, *M. obstructa* and *E. vermiculata* at Sohag governorate, Egypt as a first record.

3.2 Population dynamics of Monacha obstructa on certain field and vegetable crops at El-Fath district

The present data of incidence cleared that, *M. obstructa* was the most widely distributed species on the various host plants. So, the monthly average dynamics of *M. obstructa* snails was studied on certain field crops (*i.e*. Egyptian clover and wheat) and cabbage as vegetable crop at El-Fath district, Assiut governorate during the period from March 2018 to February 2020 and illustrated in Figures (1 and 2). During the first year 2018/2019, data in Figure (1) revealed that, the highest values of population densities of snail were determined during April 2018 on Egyptian clover and cabbage and during March 2018 on wheat.

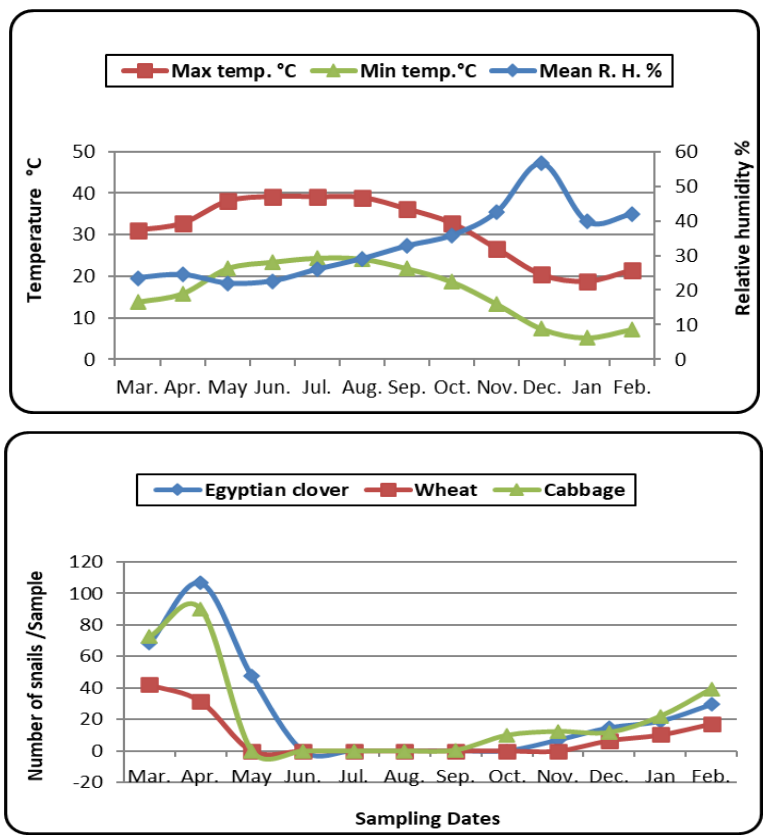

Figure (1): Monthly average numbers of the land snail, *Monacha obstructa* on certain crops at El-Fath district, Assiut governorate, Egypt during the period from March 2018 to February 2019.

Numbers of counted snails per sample were (106.80, 90.20 and 42.20 individuals) respectively. While the lowest infestation of *M. obstructa* were observed during November 2018 on Egyptian clover and during December 2018 on wheat as well as during September 2018 on cabbage. Numbers of counted snails per sample were (6.80, 6.60 and 0.60 individuals) respectively.

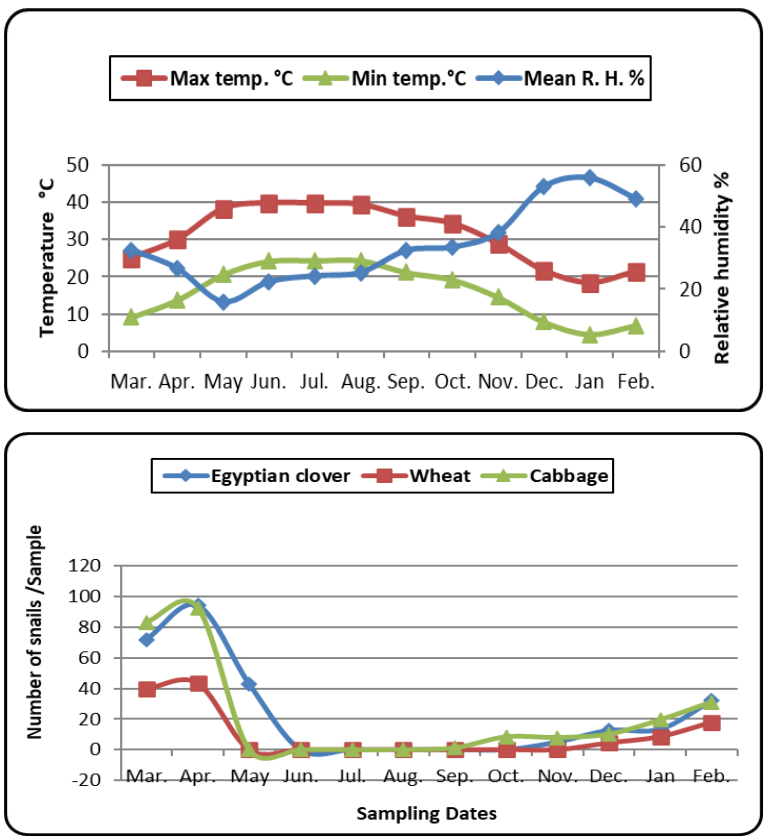

Figure (2): Monthly average numbers of the land snail, *Monacha obstructa* on certain crops at El-Fath district, Assiut Governorate during the period from March 2019 to February 2020.

Whereas the monthly numbers of *M. obstructa* snail infested Egyptian clover, wheat and cabbage during the second year 2019/2020, data in Figure (2) showed that, the lowest monthly numbers of snail were recorded during November, 2019 on Egyptian clover and during December, 2019 on wheat also, during September, 2019 on cabbage with (5.00, 4.40, and 1.20 individuals/sample) respectively, While the highest monthly numbers of snails were determined during April, 2019 on Egyptian clover, wheat and cabbage with (94.40, 43.60

and 92.80 individuals/ sample) respectively. In general, the highest values of population density of *M. obstructa* were recorded during spring months (March and April) as compared to population density during winter and autumn months. Whereas the weather conditions in spring months were suitable for snail activity. Also, the peaks of *M. obstructa* were varied from host plant to another and from month to another. These results were matched with Abd El-karim (2007) reported that the initial infestation of *M. obstructa* was recorded in November 2002 on Egyptian clover, guava, navel orange and pear with relatively low population densities. Also, appeared in the beginning of December 2002 with low numbers on wheat and broad bean. Egyptian clover harbored the highest numbers of *M. obstructa* followed by wheat, while broad bean showed the lowest number. In addition to Abo-Elnaser (2013) found that the population density of *M. obstructa* on Egyptian clover was the highest compared to wheat. Hassan (2015) reported that the lowest population of *M. obstructa* was in November on Egyptian clover and in December on broad bean and wheat, while reached to the highest in March number on Egyptian clover and broad bean and in April on wheat. Abou Senna *et al*. (2016) reported that the land snail, *M. cartusiana* was more active during March on Egyptian clover and wheat and during February on sugar beet. While the low density was observed during November, December and February respectively on Egyptian clover, sugar beet and wheat respectively for the two successive growing season 2014-2016 in Sharkia governorate, Egypt.

3.3 The relationship between population densities of M. obstructa and weather factors

Results in Table (2) showed that there was a negative correlation between maximum temperature and densities of *M. obstructa* on cabbage and between minimum temperature and densities on Egyptian clover during 2019/2020, while the population densities of *M. obstructa* were positively correlated with both maximum and minimum temperature on Egyptian clover, cabbage and wheat during 2018/2019. This correlation was insignificant in almost crops except between max. temperature and wheat was significant correlation. On the other hand, there was significant a negative correlation between mean relative humidity and the abundance of *M. obstructa* on E. clover and wheat during 2018/2019 while highly significant a negative correlation with wheat during the second year. Abd El-naser (2013) revealed that there was a positive correlation between numbers of *M. obstructa* and both max. and min. temperature on fruit trees while, it was a negative correlation with highly significant on Egyptian clover during 2010/2011, and with significant during 2011/2012.

Table (2): Effect of weather factors on population density of *M. obstructa* on certain vegetable crops.

Weather factors / Host plants	Maximum temperature (°C)		Minimum temperature (°C)		Mean R. H. (%)	
	2018/2019	2019/2020	2018/2019	2019/2020	2018/2019	2019/2020
Egyptian clover	-0.643 ns	0.358 ns	0.517 ns	-0.245 ns	-0.765 *	-0.618 ns
Wheat	0.918 *	0.878 *	0.875 ns	0.795 ns	-0.912 *	-0.978 **
Cabbage	0.176 ns	-0.117 ns	0.268 ns	0.256 ns	-0.659 ns	-0.454 ns

ns = correlation is not significant, * = correlation is significant at 0.05 level, ** = correlation is high significant at 0.01 level.

On the other hand, maximum and minimum relative humidity was insignificant negative correlation with numbers of *M. obstructa* on Egyptian clover and wheat during the two years. Abou Senna *et al.* (2016) showed insignificant positive effect between numbers of *M. cartusiana* and temperature on wheat and Egyptian clover during growing seasons 2015/2016. Also, found insignificant negative correlation on Egyptian clover during 2014/2015 and on sugar beet during 2015/2016. In contrast, highly significant negative effect was observed on sugar beet during season 2014/2015. Insignificant negative correlation was observed on Egyptian clover during growing seasons 2014/2015 and 2015/2016 for sugar beet. While highly significant negative correlation was noticed on Egyptian clover during 2015/2016 and during 2014/2015 for sugar beet. In respect to wheat insignificant positive correlation was noticed during 2014/2015 and significant negative correlation during 2015/2016.

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