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Research Article
Preliminary Study on Survey and Population Dynamic of the Terrestrial Snail *Monacha obstructa* (Pfeiffer) (Hygromiidae, Mollusca) at Crop Fields in Fayoum Governorate, Egypt

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Abstract

Background and Objective: *Monacha obstructa* has a serious harmful impact as agricultural pest infested field crops, fruits, vegetables and ornamental plants nurseries in multiple Egyptian governorates. The objective of this research was estimating the population dynamic of the terrestrial gastropod species *Monacha obstructa* (Pfeiffer) (Hygromiidae) on two economic crop fields and its correlation with temperature degree and relative humidity, the level of infestation on other economic crops had been estimated as well. **Materials and Methods:** This study was conducted in three sites in Fayoum governorate, 1) Forkous village at Tamiya District, 2) Dar Ramadsite including the Experimental farm and research station of the Faculty of Agriculture, Fayoum University, Fayoum District and 3) Feedimeen village at Sannoris District. The distribution and population dynamics of *Monacha obstructa* were assessed as one of dominant species on two field crops Egyptian clover *Trifolium alexandrinum* L. and wheat *Triticum aestivum* L. at Forkous village, Tamiya District and Dar Ramad site, Fayoum District, during two successive seasons 2016/2017 and 2017/2018. **Results:** Majority of the examined crops in the sites were found with heavy infestation of this species, while the two species *Cochlicella acuta* (Müller) (Geomitridae) and *Massylaea vermiculata* (Müller) (Helicidae) recorded in December, 2017 and in January, 2018, respectively, on mango trees in Feedimeen at Sannoris district for only one time. High density of *M. obstructa* recorded on Egyptian clover more than wheat at Forkous village and Dar Ramad site for the both seasons in this study. **Conclusion:** Results concluded that *Monacha obstructa* has a serious harmful impact as agricultural pest infested field crops, fruits, vegetables and ornamental plants nurseries in Forkous village and Dar Ramad site, respectively.

Key words: Survey, population dynamic, *Monacha obstructa*, fayoum governorate, Egypt

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

The terrestrial gastropods as major economic pests such as snails and slugs, are attacking wide range of agricultural and horticultural crops in temperate and humid habitats worldwide[1], causing poor quality of vegetables and fruits in addition to remarkable economic and financial loose[2].

The pulmonate land snail *Monacha obstructa* spread in wide natural geographical distribution of Mediterranean countries and Middle East region[3-9] and also in Egyptian governorates as the most broadly spread agricultural pest on different field crops, fruit orchards, vegetables, ornamental plants and another various plantations[10-13].

Furthermore, the veterinary importance of this species as intermediate host i.e. trematode parasite *Brachylaima* sp.[14-16], nematode parasite *Angiostrongylus cantonensis* in Egypt[17] and other parasitic diseases that infected human and animals world wide[18].

The distribution range of land snail species are rapidly increased and expanded from Delta region, where more humid and low temperature, to Upper Egypt region such as Fayoum where more dry and warm weather, therefore, more ecological aspects such as field distribution and population dynamic were studied for many successive years on field crops[19-21].

Recently, Fayoum is one of the interesting governorates to carry out malacological studies and veterinary aspects due to the presence of different species of gastropods such as freshwater snails[22]. The two terrestrial snail species *Monacha* sp. and *Massylaea vermiculata* were recorded on Egyptian clover *Trifolium alexandrinum* L. and cotton *Gossypium* sp. in Fayoum governorate[23].

This current research is the first study to assess the population dynamic of the terrestrial snail species *Monacha obstructa* (Pfeiffer) on the two economic field crops, Egyptian clover *Trifolium alexandrinum* L. (Fabaceae) and wheat *Triticum aestivum* L. (Poaceae), through the activity season of this pest species.

MATERIALS AND METHODS

Distribution and dispersal of *Monacha obstructa*: Monthly surveying of land snails was carried out at three localities Forkous village (Tamiya District) (29°26.49'N 30°58.53'E), Dar Ramad site, the Experimental farm and research station of the Faculty of Agriculture, Fayoum University, Fayoum District (29°19.32'N 30°51.42'E) and Feedimeen village, Sannoris District (29°23.00'N 30°47.13'E) Fayoum governorate during the two activity successive seasons (October, 2016/May, 2017 and October, 2017/May, 2018) Fig. 1 and 2(a-c). *Monacha obstructa* spread in cultivated areas and documented on different field crops, vegetables, fruit and field wild weeds recording the level of infestation.

The survey was conducted on different host plants including field crops, i.e. Egyptian clover *Trifolium alexandrinum* L. Fabaceae, wheat *Triticum aestivum* L. Poaceae, garlic *Allium sativum* L. Amaryllidaceae, onion *Allium cepa* L. Amaryllidaceae, broad bean *Vicia faba* L. Fabaceae, vegetables i.e. lettuce *Lactuca sativa* L. Asteraceae, eggplant *Solanum melongena* L., tomato *Solanum lycopersicum* L. Solanaceae, cabbage *Brassica oleracea* L. Brassicaceae, fruit i.e. Guava *Psidium guajava* L. Myrtaceae, Mango *Mangifera indica* L. Anacardiaceae and citrus *Citrus sinensis* L. Rutaceae.

Population dynamics of *Monacha obstructa*: Seasonal population dynamic of *M. obstructa* was recorded on Egyptian clover and wheat at two districts, Forkous village, Tamiya District and Dar Ramad site, the Experimental farm and research station of the Faculty of Agriculture, Fayoum District during two activity growing seasons through October, 2016/ May, 2017 and October, 2017/ May 2018.

The living samples of snails were counted in the early hours of morning starting from 6 am by using the quadrate method size 50×50 cm^2[24,25], where ten randomly quadrate samples were taken at one day from each field every month. The all required data were recorded i.e. the locality, host plants and collecting date. All snails that were found, on plants or on soil surface in the quadrate, counted and left in their initial places for the next month[26].

The snail identification was after good wash of the shells and noticing the main shell characters of *M. obstructa* and their external features by direct observation. Few samples were transferred to the laboratory for more accurate identification according to the key given by Kerney and Cameron[27], Godan[18], Cameron[28] and Ali and Ramdane[29]. Temperature and relative humidity data of the study period were obtained from meteorological station of Fayoum. These data have been interpreted and linked with the results and explained in the tables.

RESULTS

In late October, 2016, large number of empty broken shells of *M. obstructa* were observed in sites under study before the weather getting colder Fig. 3(a-c). The snails

Fig. 1: Surveyed sites of *Monacha obstructa* at fayoum governorate that had been recorded in this study Forkous village: Tamiya District (29°26.49'N 30°58.53'E) (site: 1), Dar Ramad site: The agricultural experiments and research station belong Fayoum University Fayoum District (29°19.32'N 30°51.42'E) (site: 2) and Feedimeen village: Sannoris District in fayoum governorate (29°23.00'N 30°47.13'E) (site: 3)

Fig. 2(a-c): Surveyed habitat locations of *Monacha obstructa* that had been recorded, (a) Forkous village (site: 1) the area is covered with Egyptian clover, (b) Dar Ramad site (site: 2) the area covered with Egyptian clover and (c) Feedimeen village (site: 3) the area is covered with Egyptian clover and with some Fruit trees

Fig. 3(a-c): *Monacha obstructa* on Egyptian clover, the locality is Forkous village Tamyia District (29°26.49'N 30°58.53'E), (a) Empty shells of snails in summer months where all the snails are dead in big number during mid-October, 2016 and (b, c) Closer picture of *Monacha obstructa* empty shells hidden under the grass and field wild weeds

become more active and increased in number in winter, starting from November, till April, especially on field wild weeds such as Chicory *Cichorium pumilum* Jacq. and annual Sowthistle *Sonchus oleraceus* L. Asteraceae where high humidity and more shade.

The snails were recorded on the Egyptian clover and wheat starting from December, 2017 to April, 2018, where low temperature and high humidity that are good conditions for the snail's activity.

Monacha obstructa was abundant in to be located beneath Egyptian clover, among the vegetation, attached to the field wild weeds, herbaceous plants in shady places, on the soil ground and under leaf-litter in high numbers in the three sites Forkous village, Dar Ramad site and Feedimeen village Fig. 4(a-f).

Individuals of other snail species accompanied the species *M. obstructa,* which were *Massylaea vermiculata* (Helicidae) (Fig. 5) and *Cochlicella acuta* (Geomitridae) with only two individuals of each species found accidentally for one time in December, 2017 and January, 2018, respectively in Feidmeen village on Mango trees' leaves.

Distribution and dispersal of *Monacha obstructa*: Majority of the examined crops, at Forkous village, Tamiya District, Dar Ramad site, Fayoum District and Feedimeen village, Sannoris District, were found with heavy infestation around more than 40 terrestrial snails in 50×50 cm^2. The species were adult with fully-grown developed lip on around 13 host plants of field crops, vegetables, ornamental plants and fruits. The infestation level on each crop was assessed during the two activity seasons October, 2016/May, 2017 and October, 2017/May, 2018 Table1.

The most infested crops were Egyptian clover (as preferred host plant), wheat, garlic, lettuce, broad bean and onion, while eggplant was undoubtedly susceptible vegetable to infestation.

Population dynamics of *Monacha obstructa*: The densities of *M. obstructa* varied monthly and seasonally according to temperature and relative humidity that has influence on the distribution of the land snails in Fayoum govern orate and to avoid drought periods and adverse climatic conditions i.e.

Fig. 4(a-f): (a) Individuals of *Monacha obstructa* that found on vegetation, (b) On Broad Bean *Vicia faba* L. Fabaceae, (c) *Monacha obstructa* found inside the leaves where more shade and humidity of chicory *Cichorium pumilum* Jacq. Asteraceae, (d) On Egyptian clover *Trifolium alexandrinum* L. Fabaceae, (e) Accumulations of *Monacha obstructa* in the soil ground close to Egyptian clover and (f) Accumulations of *Monacha obstructa* beside the field wild weeds under shade spots

Fig. 5: *Massylaea vermiculata* was recorded on the mango trees leaves found on January, 2019 for only one time in Feedimeen village, Sannoris District

high temperature degree and low humidity, the snails were found in soil cracks or closer to the water canals and then inter an aestivation period.

Population dynamics of *Monacha obstructa* at Forkous village Tamiya District: Data in Table 2 revealed that in April, 2017 the highest average of snail/quadrate was 27.8±25.4 on soil surface of the Egyptian clover and 13.5±6.69 snail/quadrate on plant with total number of snails1226 snails during activity season starting from October, 2016 till May, 2017.

For wheat in December, 2016, the highest average of snail/quadrate was 2.9±2.51on only soil surface and no snails had been recorded on the plants with 36 snails for the activity season as the total number of snails on wheat.

Data in Table 3 revealed that in season 2017/2018, the highest average was 23.1±5.82 snail/quadrate on plant of Egyptian clover in mid of April, 2018, where the total number of snails recorded 2054 snails for this season.

The highest average was 27.2±9.96 snail/quadrate on soil and 14.8±5.27 snail/quadrate on plant of wheat crop in March, 2018. The total number of snails during the activity season was 724 snails on wheat.

Population dynamics of *Monacha obstructa* at Dar Ramad site, Fayoum district: During 2016/2017, the highest average of snail/quadrate was 41.7±5.29 snail/quadrate on the soil

Table 1: Average numbers of terrestrial snail *Monacha obstructa* that collected of different sites and crops at fayoum governorate during the two active seasons 2016/2017 and 207/2018

Active season	Location	Field crops under study											
		Egyptian clover	Wheat	Garlic	Mint	Basil	Onion	Cabbage	Lettuce	Broad bean	Eggplant	Guava	Mango	Orange
October 2016 /May 2017	Forkous village-Tamiya District	128.87±70.57	15.13±13.53	80.25±79.48	10.12±7.55	12.50±10.94	10.37±8.37	7.87±5.11	-	-	-	-	-	-
	Dar Ramad site-Fayoum District	32.62±26.93	5.25±3.58	-	-	-	-	-	15.87±8.11	11.75±3.99	3.00±2.20	-	-	-
	Feedimeen village-Sannoris District	-	-	-	-	-	-	-	-	-	-	10.4±7.5	5.12±5.51	3.00±2.67
October 2017 /May 2018	Forkous village-Tamiya District	206.75±211.73	18.25±19.84	9.75±9.22	9.25±5.95	2.75±1.58	2.38±2.19	3.25±1.04	-	-	-	-	-	-
	Dar Ramad site-Fayoum District	242±240.35	72.25±97.55	-	-	-	-	-	21.37±26.91	45.50±36.85	3.30±1.11	-	-	-
	Feedimeen village-Sannoris District	-	-	-	-	-	-	-	-	-	-	7.9±5.10	9.30±6.00	6.30±5.00

±symbol: It shows the range of the averaged value in the table of snails/host for mentioned season in each site

Table 2: Average number of *Monacha obstructa* on two field crops at Forkous village-Tamiya district and Dar Ramad site, Fayoum District, fayoum governorate during 2016/2017, showing the corresponding weather factors temperature (°C) and relative humidity (R.H.) (%)

Months	Average number of *Monacha obstructa*/50×50 cm²									
	Forkous village, Tamiya District				Dar Ramad site, Fayoum District					
	Egyptian clover		Wheat		Egyptian clover		Wheat			
Activity season	A.S.	A.P.	A.S.	A.P.	A.S.	A.P.	A.S.	A.P.	Temp. (°C)	R.H. (%)
1 October 2016	0	0	0	0	0	0	0	0	26.9	44
15 October 2016	0	0	0	0	0	0	0	0		
1 Nov. 2016	9.2±9.89 0-32	3.4±5.33 0-17	0	0	1.3±3.13 0-10	0	0	0	20.4	40
15 November 2016	5.2±4.77 0-13	2.8±2.52 0-8	0.5±0.53 0-1	0	1.8±4.02 0-13	0	0.5±0.53 0-1	0		
1 December 2016	4.1±5.95 0-18	1.9±1.96 0-6	2.9±2.51 0-5	0	0.1±0.32 0-1	0.1±0.32 0-1	0	0	12.5	40.5
15 December 2016	0.5±0.71 0-2	0.9±1.197 0-3	0	0	0	0	0	0		
1 January 2017	0.5±0.71 0-2	0.3±0.48 0-1	0	0	0	0	0	0	14.5	41.5
15 January 2017	0	0	0.1±0.32 0-1	0	0	0	0	0		
1 February 2017	0	0	0	0	0	0	0	0	20.9	35.5
15 February 2017	03±0.67 0-2	0.3±0.674 0-2	0	0	0	0	0	0		
1 March 2017	0	0	0	0	0	0	0	0	24.5	33.5
15 March 2017	5±2.94 1-9	7.2±5.1 1-18	0	0	0	0	0	0		
1 April 2017	27.8±25.4 1-9	10.9±9.36 3-35	0.1±0.32 0-1	0	41.7±5.29 30-49	11.8±2.78 9-15	3.10±2.47 0-7	0.4±0.52 0-1	27.3	33.5
15 April 2017	18±12.29 0-40	13.5±6.69 10-30	0	0	9.30±2.40 6-15	2.60±1.26 1-5	0	0		
1 May 2017	8.3±6.03 0-20	2.5±3.21 0-10	0	0	0	0	0	0	32.9	25
15 May 2017	0	0	0	0	0	0	0	0		
Total snail number/ activity period	789	437	36	0	542	145	36	4		
Total snail number	1226		36		687		40			

A. S.: Average of snail number that found on soil, A. P.: Average of snail number that found on plant and ±: It shows the range of the averaged value in the table of snails/quadrate on each crop for each month in each site

Table 3: Average number of *Monacha obstructa* on two field crops at Forkous village-Tamiya district and Dar Ramad site, Fayoum District, fayoum governorate during 2017/2018, showing the corresponding weather factors temperature (°C) and relative humidity (R.H.) (%)

Months	Average number of *Monacha obstructa*/50×50 cm²									
	Forkous village, Tamiya District				Dar Ramad site, Fayoum District					
	Egyptian clover		Wheat		Egyptian clover		Wheat			
Activity season	A.S.	A.P.	A.S.	A.P.	A.S.	A.P.	A.S.	A.P.	Temp. (°C)	R.H. (%)
1 October 2017	0	0	0	0	0	0	0	0	25.5	38
15 October 2017	0	0	0	0	0	0	0	0		
1 November 2017	0.9±1.53	1.3±0.95	0	0		0	0	0	19.8	41
	0-5	0-3			0					
15 November 2017	0.5±1.58	1.1±0.99	0	0	0	0	0	0		
	0-5	0-2								
1 December 2017	2±2.83	0.9±0.57	0	0	0.4±0.52	1.7±1.34	0	0	18.2	43
	1-10	0-2			0-1	1-5				
15 December 2017	1.8±3.05	0.7±0.94	0.3±0.48	0	0.1±0.32	1.2±0.79	0	0.2±0.42		
	0-10	0-3	0-1		0-1	0-2		0-1		
1 January 2018	4.1±2.64	10.7±5.33	0	0	4.9±3.14	8.1±3.96	0	0	15.4	43
	1-9	4-20			2-13	2-16				
15 January 2018	6.5±5.78	10.5±6.17	0.5±0.53	0.1±0.32	5.8±4.03	10.4±6.38	0	0		
	1-21	4-23	0-1	0-1	1-5	2-20				
1 February 2018	4.8±0.63	13±4.83	4.4±1.89	2.5±1.08	1.8±1.87	8.5±5.29	0	0.1±0.32	16.6	41
	3-5	5-20	2-8	2-5	0-5	5-20		0-1		
15 February 2018	9.6±2.46	6.9±2.51	6.3±2.45	3.6±2.12	6±3.71	13.7±5.79	12.0±3.97	9.3±4.37		
	7-15	3-10	3-10	2-8	1-10	2-20	8-19	4-17		
1 March 2018	6±3.71	13.7±5.79	27.2±9.96	14.8±5.27	11.5±5.29	18.5±7.83	7.6±3.77	0	21.1	37
	2-20	2-20	10-40	9-25	5-20	5-20	3-15			
15 March 2018	19.4±5.81	14.4±3.43	1.5±0.85	2.2±1.14	8.3±3.59	9.1±3.84	4.5±2.95	0		
	10-30	10-20	1-3	1-4	3-15	2-15	1-10			
1 April 2018	19.0±7.77	19.2±6.67	3.5±1.51	1.5±1.08	17.8±6.18	18.9±6.10	2.9±1.91	1.2±0.79	15.2	27
	9-35	8-30	2-6	0-3	10-30	10-28	0-6	0-2		
15 April 2018	15.3±4.81	23.1±5.82	2.5±1.90	1.5±1.35	8.6±5.03	7.7±2.49	0	0		
	10-25	15-35	1-6	0-4	2-15	2-10				
1 May 2018	0	0	0	0	0	0	0	0	29.9	26
15 May 2018	0	0	0	0	0	0	0	0		
Total snail number/ activity period	899	1153	462	262	647	978	270	108		
Total snail number	2054		724		1625		378			

A.S.: Average of snail number that found on soil, A.P.: Average of snail number that found on plant and ±: It shows the range of the averaged value in the table of snails/quadrate on each crop for each month in each site

surface of Egyptian clover in April, 2017, while the highest average of snail/quadrate on plant was 11.8±2.78 snail/quadrate in the same month. The total number of snails was 687 snails during activity season.

The snail infestation was still weak on wheat during the same season whether on soil surface or plant, the total number of snails through the activity season was 40 snails Table 2.

Data in Table 3 revealed that in season 2017/2018, the highest average of snails was 17.8±6.18 snail/quadrate on soil surface and 18.9±6.10 snail/quadrate plant of Egyptian clover in April, 2018. The total number of snails recorded 1625 snails for the activity season, while on wheat on February, recorded the highest average.

The average was 12.0±3.97 snail/quadrate on soil surface and 9.3±4.37 snail/quadrate on plant. The total number of snails was 378 on wheat for the activity season, noticing that snails were in high density on soil surface more than on plant.

The field wild weeds were significantly more likely to be attacked by snails throughout the activity season with higher density starting from February-April, 2018 on soil or on plant.

DISCUSSION

Monacha obstructa is wide spread species in the agricultural fields of northern governorates of Delta[10], such as Alexandria, El-Beheira, Kafr El-Shikh, Ismailia, Sharkia, Monufia, Gharbia and Damietta[9,30,31] due to seedlings transportation and human activities[32], where optimum climate, moderate temperature, high humidity and dense plant cover[18,23] as they are all encouraging conditions for the snails spread to other regions and increase in populations on various crops[23].

The data in this study clarifies that the terrestrial snail species *Monacha obstructa* is the most prevalent species in Fayoum govern orate on many economic field crops and vegetables i.e. Egyptian cover, wheat, garlic, onion, cabbage, broad bean and eggplant.

Despite its high temperature, low relative humidity, drought periods and adverse climatic conditions, which is not the ideal climate for the snail's dispersal, the species has adapted to this climate gradually and spread in several areas and spots in the governorate.

During the two study seasons, Egyptian clover was the preferred host plant more than wheat to be infested by *M. obstructa* in the two sites under study Forkous village, Tamiya District and Dar Ramad site, Fayoum District. In addition, April was the optimum month as weather conditions to record the highest average of *M. obstruct* infestation.

It has also been observed that the snail prefers to be located on the soil surface more than the plant itself, where near to shade and moisture.

Commonly, snail's activity differs from species to another and influenced by external factors such as temperature, humidity, light intensity, photo period, soil conditions, food supply and micro climatic conditions in their habitat[33,34] resulting into spread in other regions in southern governorates of Upper Egypt i.e. Beni Suef, Minia, Assiut[21] and Sohag[35].

Land snails prefer Egyptian clover leaves and wheat[36], which are the same two crops that had been chosen for this study.

Seasonal population density of the snail *Monacha* sp. was studied on the Egyptian clover *Trifolium alexandrinum* L. as abundant species at fields in Sannoris district, Fayoum governorate[23].

The locations under study, the adults and juvenile individuals were accompanied together in the population, which indicated that it may invade a larger area could disturbed by human activities and seedlings transporting. *Monacha* sp. found on most field crops, especially Egyptian clover and other seedlings of fruits such as citrus and Mango and ornamental plants[23,36,10].

CONCLUSION

The highest population density of *Monacha obstructa* recorded on Egyptian clover at Forkous village, Tamiya District for the both seasons in this study.

Generally, *Monacha obstructa* recorded almost every month on Egyptian clover more than wheat during the two successive seasons, however the population density recorded less for the season 2016/2017 than the season 2017/2018 on Egyptian clover at Dar Ramad site-Fayoum District.

The seasonal population dynamics in this study give a clear image of the snail's behavior and dispersal that will led to good design of an effective integrated pest control program or strategy against the pest with fully understanding of the other climatic and environmental factors.

SIGNIFICANCE STATEMENTS

This current research is the first study to assess the population dynamic of the terrestrial snail species *Monacha obstructa* (Pfeiffer) on the two economic field crops, Egyptian clover *Trifolium alexandrinum* L. (Fabaceae) and wheat *Triticum aestivum* L. (Poaceae), through the activity season of

this pest species. In addition to predict the spread of this species in the coming crop cultivating seasons and estimating the economic damage in the future. This data will lead the researchers and malacologists to design a good pest control program or strategy depending on the pest prevalence in the agricultural fields. In the last decade, Fayoum governorate received the least attention of this type of research, where the latest population dynamic had been assessed in 2006 and 2007, since then there have been no further studies or recent updating data.

Thus a new study research had been accomplished to understand closely the population dynamic of the species *Monacha obstructa* correlated with climate and environmental factors.

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