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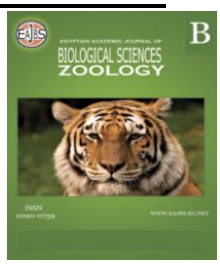

Field Observation on Biology and Ecology of Terrestrial Snails Infesting Field and Vegetable Crops at Gharbia Governorate

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ABSTRACT

Results of a survey carried out on land mollusks infesting field and vegetable crops in Gharbia Governorate during the period from February to April 2017 and 2018 revealed the occurrence of two land snail species. These species were the glassy clover snail, *Monacha cartusiana* (Muller), family: Hygromiidae and the amber snail, *Succinea putris* Linnaeus, family: Succineidae. The identified species varied in their incidence and level of infestation according to locality and host plant. *M. cartusiana* infested all inspected fields of Egyptian clover, wheat, Cabbage and lettuce in the nine surveyed localities (villages) with low, moderate and high levels of infestation. While, broad bean and potato were populated with the species in one and two localities, respectively with low infestation. On the other hand, *S. putris* was detected on Egyptian clover and wheat with low or moderate numbers.

The seasonal population behavior of the predominant species, *M. cartusiana* was monitored on Egyptian clover and wheat during two successive seasons (2016/2017) and (2017/2018). It was found that population density increased during the spring months as compared to low or moderate values during the autumn and winter months. The breeding season of *M. cartusiana* as recognized by the presence of egg clutches in the field lasted 3.5 months from mid-November to the beginning of March. The general mean of clutches laid by *M. cartusiana* was 1.58 clutches per 0.25m^2. On the other hand, the general mean clutch size was 19.8 eggs/clutch with a range of 11 to 24 eggs per clutch.

INTRODUCTION

In recent years, land snails are considered one of the most important pests attacking field and vegetable crops, fruit trees and ornamental plants. They are mostly vegetarian feed on leaves, roots and tubers of the infested plants. Movements of snails cause unfavorable smells which prevent man and animals from feeding on contaminated

plants (El-Okda, 1984). Crops infested by these animals lose their marketability and hence their export potential in many countries (Baker and Hawkle, 1990). In addition, many land snails are known to serve as intermediate hosts to human and livestock parasites of platyhelmenths and nematodes (Grewal *et al*., 2003). Moreover, they act as vectors of many plant pathogens (Alvarez *et al.,* 2009). On the other hand, the importance value of terrestrial snails is now becoming obvious with descending in the importance of insect pests due to the development of effective control strategies (Barker, 2002). Problems caused by gastropod pests on agricultural crops were detected in many countries of the world i.e., Australia (Baker, 1989), China (Chen, 1994), England (Garthwaite and Thomas, 1996), Pakistan (Ali, 1991), Spanish (Castielleio *et al.*, 1996) and Switzerland (Baur and Baur, 1993). In Egypt, up till the 1980s, it was established that land gastropod pests have been concentrated mostly in the northern Governorate of the Delta region such as Alexandria and Beheira. However, at present time they were determined in all Delta Governorates infesting field and vegetable crops as well as other fruit trees and ornamental plants. The most predominant species were, *Monacha* spp, *Eubania vermiculate, Helicella vestalies, Theba pisana , Cochlicella acuta, Succinea putris and Deroceras* spp (El-Deeb *et al.,* 1996, Mahrous *et el*., 2002, Rady *et al.,* 2014 and Mohamed, 2015). In Gharbia Governorate many land snail species were found infesting economic crops included field and vegetable crops. The most abundant species were *M. cartusiana* and *E. vermiculate* (Metwally *et al.,* 2002 and Abd El-Halem, 2007). Moreover, in Upper Egypt, land snails were settled on many economic crops in Fayoum, Mena, Assuit and Sohag Governorates (Ramzy, 2009 and Desoky *et al.,* 2015). In general, the destruction of these pests is far greater today than in former times, since limits for their dispersal have not existed as a result of denser and faster transport and traffic. Also, large snail populations can be built up mainly because parasites and predators which occurred in their original area do not exist in the newly established area (Godan, 1983). Generally, it is obviously known that effective control strategies of any pest are greatly dependent on available data concerning its biology and ecology. Therefore, the objectives of the present study are to survey land snails infesting certain field and vegetable crops at Gharbia Governorate and monitoring population dynamics as well as the breading season of the most abundant species.

MATERIALS AND METHODS

Survey of Terrestrial Snails Infesting Certain Field and Vegetable Crops at Gharbia Governorate:

A survey study was carried out at three districts (El- Santa, Kafr El- Zayat and Zefta) in Gharbia Governorate through two successive growing seasons during the activity period from February to April 2017 and 2018. At each district, three villages were chosen randomly. These villages were Gemeza, Kar Khazal and Al- Anbouten (El-Santa), El- Mansouria, Kafr El-Baja and Mansheat Soliman (Kafr El- Zayat), Shrushabah, Kafr Hussein and Sandadea (Zefta). The survey was undertaken on field crops as Egyptian clover, (*Trifolium alexandrium*), broad bean (*Vicia faba*) and wheat, (*Triticum aestivum*) and vegetable crops i.e. cabbage, (*Brassica oleracea*), lettuce, (*Lactuca sativa*) and potato (*Solanum tuberosum*). Samples were taken in the early morning before sunrise in absence of rains by using the quadrate sample size 50x50cm (Staikou *et al*., 1990). Snails found on plants or on the soil surface in the quadrate were counted and transferred in tightly closed polyethylene bags to the laboratory for identification using a key given by Godan, (1983). Levels of infestation were determined according to Shetaia *et al*., (2009) as follows: light infestation (less than 15

snail/0.25m^2), moderate infestation (16–30 snails/0.25 m^2) and high infestation (more than 30 snails/0.25 m^2).

Population Dynamics of *Monacha cartusiana* (Muller) on Two Field Crops:

The population dynamics of the glassy clover snail *Monacha cartusiana* (Muller) infesting two field crops namely Egyptian clover and wheat were studied during two successive growing seasons (2016/2017 and 2017/2018). In this respect, an area of about one feddan infested with *M. cartusiana* was selected for each crop at Gemeza village, El-Santa district, Gharbia Governorate. Five replicates of quadrate sample size (50x50cm) were randomly examined at biweekly intervals during the growing season of each crop (Staikou *et al*., 1988). The examination was undertaken in the early morning before sunrise in absence of rains. All snails found on plants or on soil surface in the quadrate were counted and left in their initial places (Baker, 1988). Data concerning temperature and relative humidity during the period of study were obtained from the Metrological Station of Gharbia Governorate.

Number of Clutches and Eggs Laid by *Monacha cartusiana* During The Breeding Season:

This experiment was conducted at Gemeza village, El-Santa district, Grarbia Governorate during the egg-laying period started from November 2017 to March 2018. Five replicates (50x50 cm) were examined at biweekly intervals in a selected field cultivated with Egyptian clover and infested with the land snail *M. cartusiana*. The numbers of clutches and eggs in each quadrant were counted. Clutch size (number of eggs per clutch) was detected also.

4- Statistical analysis :

Data were subjected to analysis of variance (ANOVA) using a software package, CoStat Statistical Software (2005), a product of Cohort Software, Monterey, California. Means were compared by estimated least significant differences at $P \leq 0.05$ level of probability. Correlation coefficients between snail populations and each of temperature and relative humidity was calculated also. The general mean ± S.E was calculated for the number of clutches, eggs and clutch size.

RESULTS AND DISCUSSION

Survey of Terrestrial Snails Infesting Certain Field And Vegetable Crops During 2017/2018 At Gharbia Governorate:

Results of a survey carried out on molluscs fauna infesting certain field and vegetable crops in nine villages representing three districts of Gharbia Governorate revealed the occurrence of two land snails species belonging to order: Pulmonata. These species were, the glassy clover snail *Monacha cartusiana* (Muller), family: Hygromiidae and the amber snail *Succinea putris* Linnaeus, family Succineidae. The identified species varied in their incidence and level of infestation according to locality and host plant (Table 1). In this respect, *M. cartusiana* snail has the upper hand, since it was detected in all surveyed localities, while *S. putris* was found in two localities in Zefta district. All examined crops were liable to be infested with *M. cartusiana* with different levels of infestation. Egyptian clover harbored the highest numbers since it was detected with high levels of infestation (more than 30 snails/0.25m^2) in all inspected localities of El-Santa and Zefta districts, compared to moderate numbers(16 – 30 snails/0.25 m^2) in localities of Kafr El-Zayat district. On the other hand, all examined fields of wheat and lettuce were contaminated with *M. cartusiana* snail at varying levels of infestation. Cabbage was found with moderate or high numbers in localities of El-Santa and Zefta districts, while broad bean and potato were populated with this species

in one and two localities respectively with a low infestation (less than 15 snail / 0.25 m^2). On the other hand, *S. putris* was detected on Egyptian clover and wheat in two localities of Zefta district with low or moderate numbers. These results agree with those reported by Metwally *et al*., (2002) and Abd El-Halem, (2007) who surveyed land snails at Gharbia Governorate. They indicated that *M. cartusiana* was the most widely distributed species on field crops, especially Egyptian clover. On the other hand, many authors showed that the glassy clover snail occupies the first grade in incidence and high level of infestation on field and vegetable crops, compared to the amber snail which was recorded in few localities with low numbers (Mortada, 2002, Shetaia *et al*., 2009, Ismail *et al*., 2011 and Mohamed, 2017).

Table 1: Occurrence and population size of land snail species infesting certain field and vegetable crops during 2017/2018 in nine villages at Gharbia Governorate.

Localities city/ village	Snail species	Host plants and level of infestation
El-Santa		
El-Anbouten	*M. cartusiana*	Egyptian clover(+++),Wheat(+++), Lettuce(++)and Cabbage(+++)
Gemeza	*M. cartusiana*	Egyptian clover(+++),Wheat(++), Lettuce(++)and Cabbage(++)
Kafr Khazal	*M. cartusiana*	Egyptian clover(+++),Wheat(+++), Lettuce(++)and Cabbage(++)
Kafr-Elzayat		
El-Mansouria	*M. cartusiana*	Egyptian clover(++),Wheat(++), Lettuce(+)and poteto(+)
Kafr El Baja	*M. cartusiana*	Egyptian clover(++),Wheat(++), Lettuce(+)and poteto(+)
Mansheat Soliman	*M. cartusiana*	Egyptian clover(++),Wheat(++), Lettuce(++)and broad bean(+)
Zefta		
Kafr Hussein	*M. cartusiana*	Egyptian clover(+++),Wheat(+++), Lettuce(++)and Cabbage(++)
Sanadeet	*S.putris*	Egyptian clover(+) and Wheat(+)
Shrushabah	*M. cartusiana*	Egyptian clover(+++),Wheat(+++), Lettuce(++)and Cabbage(++)
	M. cartusiana	Egyptian clover(+++),Wheat(++), Lettuce(++)and Cabbage(++)
	S.putris	Egyptian clover(++) and Wheat(++)

(+) = Low infestation (less than 15 snails/ 0.25m^2)
(++)= Moderate infestation (between 16-30 snails / 0.25m^2) .
(+++) = High infestation (more than 30 snails / 0.25m^2)

Seasonal Population Dynamics of *M. cartusiana* on Egyptian Clover and Wheat in Gemeza Village, Al-Santa District, Gharbia Governorate:

Survey studies showed that *M. cartusiara* snail was the predominant species since it was detected in all surveyed localities, with moderate to high population density on most of the examined hosts. Therefore, the population dynamics of this snail were studied on Egyptian clover and wheat in Gemeza village, El-Santa district, Gharbia Governorate during two successive growing seasons 2016/2017 and 2017/2018. Data in (Table 2) showed that the initial infestation of *M. cartusiana* has appeared at the beginning of November on Egyptian clover with relatively low population densities of 0.2 and 0.4 snail per quadrate size of 50x50cm in the growing seasons 2016/2017 and 2017/2018, respectively. While on wheat the initial infestation was appeared later at the beginning of January with relatively low population densities of 0.6 and 1.2 snails per sample in the two successive seasons, respectively. Monitoring the population behavior of *M. cartusiana* after the initial infestation, it was clear that the snail numbers were slightly increased during December and January months. However, in February snail

numbers were noticeably increased to reach their peak in mid-April with values of 39.6 & 47.6 and 22.3 & 29.8 snails per sample on Egyptian clover and wheat for the two successive growing seasons, respectively. However, the population density of the snail was obviously decreased during May on Egyptian clover in the two seasons. The number of snails per sample at the end of the growing seasons on Egyptian clover was 10.6 and 11.8 snails, respectively. It is necessary to mention that, Egyptian clover harbored a relatively higher number of snails compared to wheat. Total numbers of counted snails on Egyptian clover and wheat were 188.2 & 224.6 and 94.8 &117.4 in the two successive growing seasons, respectively. While the parallel general means were 13.44 &16.04 and 8.62 &10.67, respectively. Moreover, it was noticed that values of *M. cartusiana* population density were higher in the second growing season (2017/2018) compared to those in the first one (2016/2017) on the two tested crops. Generally, it could be concluded that the population density of *M. cartusiana* increased during the spring months as compared to low or moderate values during the autumn and winter months.

Table 2: Population dynamics of *M. cartusiana* infesting Egyptian clover and wheat in Gemeza village, El-Santa, Gharbia governorate during 2016/2017 and 2017/2018 growing seasons in relation to temperature and relative humidity.

Date of examination	Mean number of snails/sample				Temp. (˚C.)		R.H. (%)	
	Egyptian clover		Wheat					
	2016/ 2017	2017/ 2018	2016/ 2017	2017/ 2018	2016/ 2017	2017/ 2018	2016/ 2017	2017/ 2018
Nov.1	0.2	0.4	-	-	21.99	22.84	67.81	49.59
Nov.16	0.6	0.4	0	0	19.79	19.93	45.31	52.03
Dec.1	1.0	1.2	0	0	17.86	17.79	50.31	52.77
Dec.16	0.6	1.0	0	0	15.71	17.41	55.41	55.13
Jun.1	2.6	2.8	0.6	1.2	13.14	15.69	52.91	53.84
Jun.16	6.0	7.4	2.4	3.6	12.23	15.88	49.37	50.26
Feb.1	9.8	9.4	4.4	6.6	12.68	13.40	56.84	54.40
Feb.16	17.6	14.8	11	11.8	13.26	16.77	48.5	52.9
Mar.1	19.2	27.4	13.4	16.8	13.93	16.81	54.73	50.33
Mar.16	29.2	37.4	19.6	20.4	16.34	19.47	50.6	46.36
Apr.1	33.6	41.4	21.1	27.2	16.83	20.16	50.16	50.12
Apr.16	39.6	47.6	22.3	29.8	17.87	20.38	48.87	48.18
May.1	17.6	21.6	-	-	19.34	22.79	44.27	44.53
May.16	10.6	11.8	-	-	23.44	24.5	46.5	47.16
Total	188.6	224.6	94.8	117.4				
Mean	13.44	16.04	8.62	10.67				
L.S.D (0.05)	4.612	4.881	31.78	39.269				

This conclusion is in agreement with the findings of Mahrous *et al.,* (2002) and Ismail *et al*., (2011) who found that the population density of *M. cartusiana* was obviously increased during spring months (March, April, and May) as compared to low or moderate values during winter and autumn months at Sharkia Governorate. The infestation did not appear during the summer months. Moreover, Mohamed, (2017) showed that Egyptian clover harbored the highest number of *M. cartusiana* followed by

wheat and population density was obviously increased during February, March and April months as compared to the other months.

The correlations between some climatic factors i.e., temperature or relative humidity and population density of *M. cartusiana*. were subjected to statistical analysis. Data presented in (Table 3) revealed that temperature showed an insignificant negative effect on the numbers of *M. cartusiana* during the two successive seasons on Egyptian clover and wheat. Regarding the effect of relative humidity on the population density of such snail, it was found that a significant negative effect was detected on wheat with correlation coefficient values of -0.237 and -0.646 during the two seasons, respectively. However, on Egyptian clover, an inconstant result was obtained, since during the first season relative humidity and population density were insignificantly negatively correlated (-0.432) while in the second season they were highly significantly negatively correlated (-0.615). The obtained results agree to a certain extent with those reported by Mohamed, (2017) who revealed that temperature showed an insignificant effect on numbers of *M. cartusiana* during two successive seasons on Egyptian and wheat. On the other hand, the effect of relative humidity on population density showed an insignificant or significant negative effect on the numbers of *M. cartusiana* during two successive seasons on the two crops.

Table 3: Simple correlation coefficient (r) values between temperature and relative humidity and population size of *M. cartusiana* infesting Egyptian clover and wheat during two successive seasons in Gharabia governorate.

Host plants	Temperature (˚C.)		Relative humidity (%)	
	2016/2017	2017/2018	2016/2017	2017/2018
Egyptian clover	- 0.033 $^{n.s}$	- 0.370$^{n.s}$	- 0.432 $^{n.s}$	- 0.615**
Wheat	- 0.149 $^{n.s}$	- 0.423 $^{n.s}$	- 0.237*	- 0.646*

- Each value represent correlation coefficient.
n.s = not significant
*= Significant at 0.05 level.
**= Highly significant at 0.01 level.

Number of Clutches And Eggs Laid by *Monacha cartusiana* During The Breeding Season :

Data in Table (4) showed that snails of *M. cartusiana* laid their eggs for about 3.5 months started from mid-November 2017 to early March 2018. Clutches were laid in humid shady places in small holes dug by the parent snails in the soil. General means of clutches and eggs in 50 X50 cm were 1.58 and 31.45 respectively. While general mean of clutch size was 19.08 eggs/clutch with a range of 11 to 24 eggs per clutch. On the other hand, the number of clutches and eggs were changed during the breeding season. At the beginning of the egg laying, the period number of clutches and eggs were 0.67 and 11.33 per .25 m^2, respectively. As the time elapsed these values were gradually increased to reach their peak with values of 2.67 clutches and 59 eggs per sample at the beginning of February. Thereafter, the number of clutches and eggs was decreased to the end of the breeding season with values of 0.67 clutches and 10.33 eggs in early May. Clutch size was changed during the breeding season. The highest value (22.33 eggs/clutch) was detected in mid-January. These results are confirmed with those reported by many authors who determined the breeding season of *M. cartusiana* in Egypt Ismail, (1997), Mahrous *et al*., (2002) and Lokma, (2007). However, in Greece Staukou and Lazaridou-Dimitriadou, (1990) reported that the reproductive period of *M.*

cartusiana started between August and November depending on the year. On the other hand, the general mean of clutch size was 22.5 eggs /clutch with a range of 5 to 57 Ismail, (1997), 26.12 eggs /clutch with a range of 6 to 51 Mahrous *et* al., (2002) and 22.31 eggs /clutch with a range of 8 to 41 Lokma,(2007).

Table 4: Numbers of clutches and eggs deposited by the land snail *M. cartusiana* per 50 x 50 cm quadrate, during the period from mid-November 2017 to early March 2018 under field conditions in Gharbia governorate.

Variables	Sampling dates								General mean ± S.E	L.S.D (0.05)
	15.Nov	1.Dec	15.Dec	1.Jan	15.Jan	1.Feb	15.Feb	1.Mar		
Number of clutches	0.67	1.33	1.33	1.67	1.67	2.67	2.67	0.67	1.58± 0.292	0.522
Number of eggs/clutch	11.33	22.67	25.33	33.33	37.0	59.0	52.67	10.33	31.45± 5.064	9.905
Clutch sizel (cm)	16.91	17.66	19.5	20.33	22.33	22.16	18.31	15.5	19.08± 1.205	8.996

* Each value is an average of three replicates.
* F test for each variable during the experimental period was significant at (0.05 %).

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ARABIC SUMMARY

ملاحظات حقلية على بيولوجية وبيئة القواقع الأرضية التي تصيب محاصيل الحقل والخضر بمحافظة الغربية

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تم حصر الرخويات الأرضية التي تصيب محاصيل الحقل والخضر بمحافظة الغربية خلال الفترة من فبراير حتى ابريل لعام 2017 و 2018. أوضحت النتائج وجود نوعين من القواقع الأرضية هما قوقع البرسيم الزجاجي(*Monacha cartusiana* (The glassyclover snail والقوقع العنبرى (The amber snail *Succinea putris* L) اختلفت الأنواع التى تم تعريفها وفقا لمكان تواجدها والعائل النباتي حيث يصيب قوقع البرسيم الزجاجى حقول البرسيم والقمح والخس والكرنب بمستويات اصابة تراوحت بين العالى والمتوسط والمنخفض فى تسع قرى تتبع ثلاث مراكز بمحافظة الغربية بينما ظهر بمستوى إصابة منخفض على نباتات البطاطس والفول وسجل قوقع *Succinea putris* بأعداء متوسطة أو منخفضة.

بالنسبة للتعداد الموسمي للأنواع السائدة تم مراقبة قوقع البرسيم الزجاجي على البرسيم والقمح خلال موسمى 2016/2017 و 2017/2018 وجد إن حجم عشيرة القوقع تزداد خلال أشهر الربيع مقارنة بقيم متوسطة أو منخفضة خلال أشهر الخريف والشتاء.

يستمر قوقع البرسيم الزجاجي فى وضع كتل البيض لمدة 3.5 شهرا من منتصف نوفمبر حتى بداية مارس . بلغ المتوسط العام لكتل البيض 1.58 بيضه لكل مربع (50x50 سم) وبلغ المتوسط العام لحجم الكتله 19.8 بيضه / كتلة وتراوح المدى بين 11: 24 بيضه / كتلة.