

Survey and Population Density of Land Snails under Different Conditions at Qalubia and Sharkia Governorates

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Abstract

The aim of this research is study the survey and effect soil components on population density and distribution of land snails in Kafr Al-Gammal and Kafer Hamza villages (Qalubia Governorate), and Sunhot and Adleya villages (Sharkia Governorate). Survey studies revealed that four species of land snails, *Monacha cartusiana*, *Eobaina vermiculata*, *Succinea putris* and *Cochlicella acuta* were found in the two governorates. All species were found in Adleya and Kafr Al- Gammal villages, while the two species, *M. cartusiana* and *S. Putris*, were found in Kafr Hamza village, whereas, *M. cartusiana* only was found in Sunhot village. These findings indicated that the population density of land snails differed from one locality to another. The highest population was recorded in Adleya village, while *M. cartusiana* was the most predominant species. On the other hand, soil analysis showed that the population density of land snails were high in loam soil, especially *M. cartusiana*, followed by sandy loam but the population density of *E. vermiculata* was high in sandy loam. In addition the low population density of land snails was in silty loam. On the other hand, the chemical analysis of soil showed that the number of snails increased with the increase of calcium, while decreased with high values of pH and EC (Electrical conductivity) in soil.

Key words: Land snails, survey, distribution, population density, analysis of soil.

Introduction

Snails represent one of the important groups of invertebrates in terrestrial ecosystems. Land snails belong to the second largest phylum, after arthropods, (Sandeepet *et al.* 2012). Land snails constitute around six percent of the total species on earth, (Clark and May, 2002). Terrestrial gastropods attack the leaves, roots, buds, flowers, and even the tree trunks, causing damage to the foliage and fruit of cultivated plants, (Awad *et al.* 2012). The feeding activities of gastropods, as well as their soiling of fruits and crops with their excreted feces and mucus materials, during movement, lower the quality and size of the harvest, and damage crops in fields and gardens, (Awad, 2014). As a result, undesirable smell is caused, which prevents both man and animals from feeding on these contaminated plants, (Shetaia *et al.* 2009). In addition, rotting agents, such as bacteria, and fungi, usually establish themselves at places where slugs or snails have fed, so fruits and vegetables, in storage, suffer further damage, (Shahawy *et al.* 2008). In Egypt, the destructiveness of gastropods is much greater today than it was in former times, (Mortada, 2002). To control this pest, it is necessary to understand and investigate the reaction between their population density, and the surrounding conditions, such as soil temperature, soil structure, host plants, etc. Moreover, the perception of climate and environmental changes on the performance and availability of

edible land snails was researched by (Giokas *et al.* 2007), and (Woogeng *et al.* 2013). In many studies on land snails, particular attention was paid to soil chemical parameters, as snails have high demand of calcium for shell formation. Calcium content of soil or litter, or PH value as another measure for calcium supply were concluded to be major factors determining snail species richness, and also snail density, (Millar and Waite, 2002).

The present work was carried out, to throw light on the survey and population density of land snails in certain fields, vegetable crops, and fruit trees at Sharkia and Qalubia Governorates

Materials and Methods

The present work was carried out in four locations: Sunhot and Adleya villages at Sharkia Governorate, Kafr Al- Gammal and Kafer Hamza villages, at Qalubia Governorate. Survey and population density of land snails were recorded on Egyptian clover (*Trifolium alexandrium*), wheat (*Triticum vulgare*), lettuce (*Lactuca sativa*), tomato (*Solanum copersicum*), eggplant (*Solanum melongena*) orange trees (*Citrus sinensis*) and guava (*Psidium guajava*), throughout seasons of 2014 to 2016.

Survey of land snails on different crops

Survey of land snails was conducted to study the definition and distribution of land snail species attacking numerous host plants, cultivated at Sharkia and Qalubia Governorates,

during the period from February 2014 to May 2015. The survey was undertaken on various host plant species. Samples were taken in the early morning using the quadrat sample size 0.25m², or a single tree (Eshra, 2013). Five random samples were taken from each crop in the surveyed localities. All snails found on plants or on soil surface in the quadrat were counted and transferred in muslin cloth bags to the laboratory (Asran, 2001), and classified according to Godan's Key of identification for Central European Best Gastropods. (1983). This procedure was done once monthly during the trial period.

Population density of land snails.

The population density of land snails were determined in the chosen fields cultivated with Egyptian clover, wheat, lettuce, tomato, eggplant and trees of orange and guava heavily infested with snails in Sunhot and Adleya villages, at Sharkia Governorate, and Kafr Al-Gammal and Kafr Hamza villages, at Qalubia Governorate, during two successive growing seasons from February to May 2015 and 2016. Half of feddan was selected for each crop. Five replicates consisting of five trees, or quadrat sample area of 0.25 m² were randomly examined once per month in the early morning. All snails, found on plants or soil surfaces in the quadrat or the single tree, were counted and left in their initial places (Baker, 1988). From the same site samples of the collected snails, soil samples (500 gm/sample) were taken at depth of 5 cm, then transferred in plastic bags for mechanical and chemical analysis. Absolute population density and relative population density of the individual's species were calculated as follows:

Absolute population density =

$$\frac{\text{Total number of individuals of species}}{\text{Number of samples containing this species}}$$

Relative population density =

$$\frac{\text{Number of individuals of species}}{\text{Sum of individuals of all this species}} \times 100$$

Results and Discussion

1- Survey and population density of the land snails at Qalubia and Sharkia Governorates.

Study of survey and population density of land snails species at Sharkia and Qalubia Governorates were showed in Table (1). Data indicated that Four land snails, *Monacha cartusiana*, *Eobania vermiculata*, *Succinea putris* and *Cochlicella acuta* are found in the two Governorates mentioned before. *M. cartusiana*, *E. vermiculata* and *C. acuta* belong to family Hellicidae, while *S. putris* belongs to family Succineidae. The land species *M. cartusiana* was the highest in total average of general population density (869.3 indiv. with 80.4%), while *C. acuta* was the lowest with (23.9 indiv. and 2.2%). For *M. cartusiana*, its population density in Qalubia Governorate was (482, 3 indiv. with 86%) higher than its population density in Sharkia Governorate (387 indiv. with 74.5%). However, the population density of *E. vermiculata* in Sharkia was highest with (86.9 indiv. and 16.7%). In addition, the recorded data cleared that *C. acuta* had the lowest population density for Sharkia and Qalubia Governorates both, meanwhile, *M. cartusiana* was the highest one.

Table 1. Survey and the mean number of population density of land snails at Qalubia and Sharkia Governorates.

Governorate	Mean number of snails per sample					
	Qalubia		Sharkia		Total average	
	Absolute	Relative	Absolute	Relative	Absolute	Relative
Land snails						
<i>Monacha cartusiana</i>	482.3	86%	387	74.5%	869.3	80.4%
<i>Eobania vermiculata</i>	42.2	7.5%	86.9	16.7%	129.1	12%
<i>Succinea putris</i>	27.1	4.8%	30.8	6%	57.9	5.4%
<i>Cochlicella acuta</i>	9.4	1.7%	14.5	2.8%	23.9	2.2%
Total average	561		519.2		1080.2	

2- The distribution and population density of land snails at Qalubia and Sharkia Governorates.

Data in Table (2) showed the distribution of different beneficence land snails in some villages of Qalubia and Sharkia Governorates. It is cleared that, at Sharkia Governorate, all identified species are found in Adleya village, and one specie *M. cartusiana* in Sunhot village. Adleya village was highly infested with the

land snail *M. cartusiana* (273.5 indiv. with 67.4%) in comparison with other land snails, followed by *E. vermiculata* (86.9 indiv. with 21.4%), *S. putris* (30.8 indiv. With 7.6%) and *C. acuta* (14.5 indiv. With 3.6%)

At Qalubia Governorate, results showed that, two land snails, *M. cartusiana* and *S. putris* were found in Kafr Hamza village, while four land snails species, *M. cartusiana*, *E.*

vermiculata, *S. putris* and *C. acuta* were found in Kafr El-Gammal village. *M. cartusiana* had the highest population density (328.3 indiv. with 84.4%), followed by *E. vermiculata* (42.2 indiv. and 10.8%). On the other hand, *C. acuta*

didn't found in each of Kafer-Hamza and Sunhot villages, while *S. putris* snail was found in all tested villages excepted for Sunhot village.

Table 2. The distribution and population density of land snails in some villages of Qalubia and Sharkia Governorates.

Village	Mean number of snails per sample							
	Qalubia				Sharkia			
	Kafr Hamza		Kafr EL-Gammal		Adleya		Sunhot	
	Absolute	Relative	Absolute	Relative	Absolute	Relative	Absolute	Relative
<i>Monacha cartusiana</i>	154	94.3	328.3	84.4	273.5	67.4	113.5	100
<i>Eobania vermiculata</i>	0	0	42.2	10.8	86.9	21.4	0	0
<i>Sccinia putris</i>	17.9	5.7	9.2	2.4	30.8	7.6	0	0
<i>Cochlicella acuta</i>	0	0	9.4	2.4	14.5	3.6	0	0
Total average	171.9		389.1		405.7		113.5	

3- The distribution and population density of land snails on some host plants.

Data in Table (3) revealed that *M. cartusiana* land snail was found on all host plants with total number of 434.4 indiv./samples. The highest average number was 176.1 indiv. on clover, and the lowest one was 10.2 indiv. on guava trees. In addition *E. vermiculata* was found on all host plants except for guava trees, whereas, the orange trees were the most affected by this snail 54.8 indiv., for *S. putris* land snail was found on clover, wheat, lettuce, guava trees, and orange trees with 10.8, 6.3, 3, 3.6 and 5.6 indiv., respectively. However, it was not found on eggplant or tomato crops. *C. acuta* was appeared only on orange trees. Generally the highest number of land snails was found on clover with 190.3 indiv., followed by wheat 124.9 indiv. and orange trees 117.8 indiv., while the lowest number of snails was observed on eggplant 19.1 indiv.. The previous results proved that *M. cartusiana* was the most abundant than other snail species. In addition, both clover and wheat crops were more infested by this snail than other crops. The orange trees were more infested by *E. vermiculata* than by other snail species. Through the results, we concluded that

agricultural crops with dense vegetation cover are more suitable host for land snails, and protected them against weather and natural enemies.

In general, results revealed that *Monacha cartusiana* land snail was the predominant species in the two governorates, while Sunhot village (Sharkia Governorate) was the least infested with the land snail species.

These results are in agreement with those reported by **Rady, et al. (2014)**, who stated that stating that *Monacha cartusiana* land snail was the predominant species on fields of vegetable crops in Ismailia and Sharkia governorates. On the other hand, population density of land snails differed from host plant to another. **Mohamed.(2015)** reported that ten land snails species, *Eobania vermiculata* (Muller), *Theba pisana* (Müller), *Helicella vestalis* (Pfeiffer), *Cochlicella acuta* (Müller), *Monacha cartusiana* (Müller), *Monacha obstructa* (Ferussac), *Succinea putris* (Linnaeus), *Succinea oblonga* (Draparnaud), *Achatinidae* (Linnaeus) and *Oxychilus alliarius* (Miller) were recorded on different vegetation, vegetable, fruit, ornamental plants in north East of Delta.

Table3. Population density and distribution of land snails on some host plants.

Land snails	Host plants							
	Clover	Wheat	Lettuce	Tomato	Eggplant	Guava	Orange	Total
<i>Monacha cartusiana</i>	176.1	115.9	47.5	21	18.3	10.2	45.4	434.4
<i>Eobania vermiculata</i>	3.4	2.7	1.7	1.4	0.8	0	54.8	64.8
<i>Sccinia putris</i>	10.8	6.3	3	0	0	3.6	5.6	29.3
<i>Cochlicella acuta</i>	0	0	0	0	0	0	12	12
Total	190.3	124.9	52.2	22.4	19.1	13.8	117.8	

4- Effect of soil type on the distribution and population density of land snails.

4-1- Effect of mechanical structure of soil.

Data in Table (4) explain the relationship between the distribution and population density of land snails

and mechanical structure of soil in the studied areas. The results revealed that the highest percentage of *M. cartusiana* was in Kafr Al-Gammal village, which has soil loam and consists of 39.68% sand, 46.7 % silt, and 13.5% clay. In Adleya village, the average of snails was higher than the other villages. It had the highest percentage of *E. vermiculata*, *S. putris* and *C. acuta*(67.2, 53.2, 60.4%) respectively, as its soil is sandy loam, and consists of 76.5% sand, 12.5% silt, and 10.96% clay. this may be due to the ease of drilling to lay eggs in light soil. The lowest percentage of snails was generally in Sunhot, which is characterized by silty loam soil, and consists of 23.96

% sand, 61.55% silt, and 13.03% clay. This may be due to the difficulty of drilling to lay eggs, because of the soil granules strength of cohesion, along with the difficulty of movement during drought or increase the water rate. The table indicates that numbers of both *E. vermiculata* and *C. acuta* are higher in sandy soil than in loam soil, whereas the numbers of *M. cartusiana* are higher in loam soil.

Statistical analysis showed that the average general population density of snails is positively correlated with the proportion of sand, but negatively correlated with the percentage of both silt and clay in soil structure.

Table 4. Effect of Mechanical analysis of soil on the distribution and population density of land snails.

Land snail Village	Population density per sample					Total	Sand%	Silt%	Clay%	Soil texture
	<i>M.cartusiana</i>	<i>E.vermiculata</i>	<i>S.putris</i>	<i>C.acuta</i>						
Sunhot	113.5	0	0	0	113.5	23.96	61.55	13.03	Silty Loam	
%	13	0	0	0	10.5					
Adleya	273.5	86.9	30.8	14.5	405.7	76.5	12.5	10.96	Sandy loam	
%	31.4	67.2	53.2	60.4	37.6					
K.Hamza	154	0	17.9	0	171.9	28.2	36.5	35.3	Silty loam	
%	17.7	0	30.9	0	15.9					
K.gmmal	328.3	42.2	9.2	9.4	389.2	39.68	46.7	13.5	Loam	
%	37.8	32.7	15.9	39.5	36					
Total	869.3	129.1	57.9	23.9	1080.2					
Correlation						+0.803	-0.687	-0.402		

4-2- Effect of chemical structure of soil.

The results in Table (5) explains the relationship between the distribution and population density of the snails, and the chemical analysis of soil in the studied localities. It was revealed that the total average population density of snails (405.7 and 37.6%) in Adleya village was higher than in other villages. Moreover, Adleya had the highest concentration of calcium in the soil (14425) ppm. The general average population density of snails in Sunhot was (113.5 and 10.5%), which was the lowest one compared to other villages, but the value of pH (8.23) and E.C (1.45)

ds/m increased in its soil. In addition, Sunhot village was the lowest in concentration of calcium (2530) ppm. The results of the chemical analysis of the soil in Kafr Al-Gammal are similar to the results of the soil of the Adleya village, in both E.C (0.903 and 1.04 ds/m) and pH value (7.77 and 7.65),but differ in calcium concentration (3500 and 14425 ppm), respectively. Kafr Hamza soil was the lowest in E.C (0.34) ds/m, although it ranked third after both Adlya and Kafr Al-Gammal in the population of snails (15.9%).

Table 5. Effect of chemical analysis of soil on the distribution and population density of land snails.

Land snail Village	Population density per sample				Total	Chemical analysis		
	<i>M.cartusiana</i>	<i>E.vermiculata</i>	<i>S.putris</i>	<i>C.acuta</i>		E.C(ds/m)	pH	Ca (ppm)
Sunhot	113.5	0	0	0	113.5	1.45	8.23	2530
%	13	0	0	0	10.5			
Adleya	273.5	86.9	30.8	14.5	405.7	1.04	7.65	14425
%	31.4	67.2	53.2	60.4	37.6			
K.Hamza	154	0	17.9	0	171.9	0.34	7.51	2710
%	17.7	0	30.9	0	15.9			
K.gmmal	328.3	42.2	9.2	9.5	389.2	0.903	7.77	3500
%	37.8	32.7%	15.9	39.5	36			
Total	869	129.1	57.9	23.9	1080.2			
Correlation						-0.63	-0.52	+ 0.66

EC: Electrical conductivity

Statistical analysis showed that the average general population density of snails is positively correlated with concentration of calcium, but negatively correlated with value of both E.C and pH

value in soil. **Idohouet al.** (2013) mentioned that the most parsimonious GLM model showed that the abundance of *A. fulicawas* positively associated to fine sands, fine silts and pH, while the interactions were negatively associated with the abundance of the

species. The abundance of *L. flammea* was negatively associated with fine sands, fine silts and pH, while the interactions were positively associated with the *A. Marginata*. The abundance was negatively associated with fine silts, pH and litter, while the interactions were positively associated with the abundance of the species. The abundance pattern of forest molluscs is likely to be affected by different processes.

Conclusion

Results from this study showed that *Monacha cartusiana* land snail was the highest in density in the tested governorates. Statistical analysis showed that the average general population density of snails was positively correlated with the proportion of sand and calcium in the soil, while negatively associated with silt, clay, pH and E.C.

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دراسة الحصر والكثافة العددية للقواقع الارضية فى محافظتى الشرقية والقلوبية تحت الظروف المختلفة.

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أجريت هذه الدراسة في أربع قرى وهي سنهوت وعدليه بمحافظة أشرقية وكفر الجمال وكفر حمزة بمحافظة القليوبية في الفترة من 2014 إلى 2016 حيث تم حصر أنواع القواقع الأرضية بالأربع قرى، وتقدير تعدادها في محاصيل البرسيم والقمح والخس والطماطم والباذنجان والبرنقال والجوافة في الفترة من فبراير إلى مايو عامي 2015 و 2016. تم حصر خمس أنواع من القواقع الأرضية في القرى التي شملها البحث وهي: *Monacha cartusiana* (Müller), *Succinea putris* (Linnaeus), *Eobania vermiculata* (Muller), *Cochlicella acuta* (Muller).

اختلفت الكثافة العددية لها وتوزيعها بين المحافظات وداخل القرى نفسها ومن محصول إلى آخر حيث سجلت محافظة القليوبية اجمالى تعداد 561.1 قوقع / العينات بينما سجلت محافظة الشرقية 519.2 قوقع/العينات وكانت *M. cartusiana* أعلى نسبة تعداد فى كلتا المحافظتين 86% فى القليوبية و 74.5% فى الشرقية وكانت اقل نسبة اعداد للقوقع *C. acuta* حيث سجلت 1.6% و 2.8% فى المحافظتين على التوالي كما اختلفت الاعداد والأنواع داخل القرى فالعدليه فى محافظة الشرقية وكفر الجمال فى محافظة القليوبية تواجدت الاربعة انواع وكان الأكثر سيادة وهو *M. cartusiana* بينما فى قرية سنهوت بمحافظة الشرقية تواجد فقط قوقع *M. cartusiana* وفى قرية كفر حمزة التابعة لمحافظة القليوبية تواجد نوعين فقط هما *M. cartusiana* و *S. putris*.

اختلفت الكثافة العددية والأنواع تبعاً لنوع المحصول فالبرسيم كان أكثر الأنواع كثافة عددية للقواقع 190.3/ العينات وكان *M. cartusiana* أعلى الأنواع تعداد 176.1 يليه *S. putris* 10.8 قوقع / العينات وكانت أشجار الجوافة الأقل إصابة بالقواقع 13.8 قوقع / العينات وكانت أشجار البرنقال الأعلى إصابة بقوقع *E. vermiculata*.

اظهر التحليل الميكانيكي والكيميائي لعناصر التربة فى القرى المختلفة أن التربة الطمييه والتربة الرملية والتي تتميز بها كلا من قرية كفر الجمال فى محافظة القليوبية والعدليه فى محافظة الشرقية على التوالي هى الأكثر كثافة عددية للقواقع بينما التربة الطمييه السلتية والتي تتميز بها قرية سنهوت الأقل كثافة عدديه واثبت التحليل الكيميائي أن الأعداد ترتفع بزيادة نسبة الكالسيوم فى التربة وانخفاضها بزيادة التوصيل الكهري والأس الهيدروجيني

التحليل الاحصائى لدراسة الارتباط بين مكونات التربة الميكانيكية والكيميائية أشار إلى وجود علاقة ايجابية بين نسبة الرمل فى التربة والكثافة العددية وعلاقة سلبية بينها وبين نسبة السلت والطين وأيضاً ارتباط ايجابي مع نسبة الكالسيوم فى التربة وسلي مع قيمة كلا من التوصيل الكهري والأس الهيدروجيني .