ISSN: 0067-2904
GIF: 0.851

Ecological observations on two species of Gastropoda (Family Hygromiidae) : *Monacha cantiana* and *Candidula gigaxii* In three central Iraq provinces

Eman H. Abd* and Emadudeen Almukhtar
College of Science for women / University of Baghdad, Baghdad, Iraq.

Abstract

This study was carried out on two species of the Hygromiidae family *Monacha cantiana* and *Candidula gigaxii* collected from six sites in three central Iraq provinces (Baghdad , Babylon and Karbala) . A total of 1318 individuals of *Monacha cantiana* and 173 of *Candidula gigaxii* have been examined during the study period from October 2013 to July 2014.The study included estimation of species relative abundance, population density and relationship with some physico- chemical properties of the soil; temperature, moisture and pH.

The *Monacha cantiana* was present at all sites but with varying numbers, while *Candidula gigaxii* was confined to only three sites: Aljadiriyah and Zafaraniya at Baghdad, and Hindiya dam at Babylon. Results showed that the highest relative abundance of *Monacha cantiana* was 60.8% in April 2014 at Al-Al-Hussainia, Karbala and the lowest was 12.6% in January 2014 at Zafaraniya, Baghdad. The highest value of relative abundance of *Candidula gigaxii* was 51.9 % in January 2014 at the Zafaraniya , Baghdad and the lowest value was 7.3 % in March 2014 at Hindiya dam , Babylon.

Population density of *Monacha cantiana* showed that highest value was 12.5 individual / m^2 in January 2014 at Al-Al-Hussainia, Karbala and the lowest value was 0.8 individual / m^2 in October 2013 at Aljadiriyah , Baghdad. Highest population density of *Candidula gigaxii* was 13.6 individual / m^2 in December 2013 at Zafaraniya, Baghdad, and the lowest was 0.4 individual / m^2 in October 2013 in Aljadiriyah, Baghdad.

Soil temperature varied between 7and 30 C° in January and July 2014 at Twereje, Karbala, and Aljadiriyah at Baghdad respectively. Moisture values were between 9 and 33% in July and January 2014 at Alexandria and Hindiya dam, Babylon, respectively. Values of pH varied from 7.31 to 7.96 in December 2013 and July 2014 at Alexandria, Babylon and Zafaraniya, Baghdad respectively. These results showed that ecological factors may have affected abundance and population density of the snails at all of the study sites .

Keywords: Land Snails , Hygromiidae Family , *Monacha cantiana*, *Candidula gigaxii*

ملاحظات بيئية لنوعين من صنف بطنية القدم Gastropoda (عائلة Hygromiidae) : *Monacha cantiana* و *Candidula gigaxii* في ثلاث محافظات وسط العراق

إيمان حسين عبد* و عماد الدين المختار
كلية العلوم للبنات ، جامعة بغداد ، بغداد ، العراق.

*Email: bable.Iraq@yahoo.com

الخلاصة

أجريت هذه الدراسة على النوعين *Monacha cantiana* و *Candidula gigaxii* من أفراد عائلة Hygromiidae في ستة مواقع في محافظات وسط العراق (بغداد وبابل وكربلاء). إذ تم جمع 1318 فرد من النوع *Monacha cantiana* و173 فرد من النوع *Candidula gigaxii* خلال فترة الدراسة من شهر تشرين الأول 2013 ولغاية شهر تموز 2014 ، وتضمنت الدراسة حساب الوفرة النسبية والكثافة السكانية للأنواع المدروسة والعلاقة مع بعض الخصائص الفيزيوكيميائية للتربة كدرجة الحرارة والرطوبة والأس الهيدروجيني.

بينت النتائج تواجد النوع *Monacha cantiana* في جميع المواقع ولكن بأعداد مختلفة، بينما النوع *Candidula gigaxii* كان تواجده محددا فقط في ثلاث مواقع تضمنت الجادرية والزعفرانية (بغداد) وسدة الهندية (بابل). وقد أظهرت النتائج ان أعلى قيمة للوفرة النسبية للنوع *Monacha cantiana* كانت 60.8 % في شهر نيسان 2014 في الحسينية ، كربلاء وأوطأ قيمة 12.6 % في شهر كانون الثاني في الزعفرانية ، بغداد. بينما كانت أعلى قيمة للوفرة النسبية للنوع *Candidula gigaxii* 51.9 % في شهر كانون الثاني في الزعفرانية ، بغداد و،أوطأ قيمة كانت 7.3 % في شهر اذار في سدة الهندية ، بابل.

وكانت أعلى قيمة للكثافة النسبية قد سجلت للنوع *Monacha cantiana* 12.5 فرد/م^2 في شهر كانون الثاني في موقع الحسينية (كربلاء) وأوطأ قيمة كانت 0.8 فرد/م^2 في شرين الأول 2013 في موقع الجادرية (بغداد). بينما كانت أعلى للنوع *Candidula gigaxii* (13.6 فرد/م^2) في شهر كانون الأول 2013 في موقع الزعفرانية (بغداد)، أوطأ قيمة (0.4 فرد/م^2) في شهر تشرين الأول في موقع الجادرية (بغداد) . ،

وتراوحت قيم درجة حرارة التربة بين (7–30) م° في شهري كانون الثاني وتموز في الموقعين طويريج (كربلاء) والجادرية (بغداد) على التوالي، بينما تراوحت قيم الرطوبة بين (9–33) % في شهري تموز وكانون الثاني في الموقعين الأسكندرية (بابل) وسدة الهندية (بابل) على التوالي، بينما تراوحت قيم الأس الهيدروجيني بين (7.31–7.96) في شهري كانون الأول وتموز في الموقعين الأسكندرية (بابل) والزعفرانية (بغداد) على التوالي . وقد بينت النتائج أن العوامل البيئية قد تؤثر على الوفرة والكثافة السكانية للقواقع في جميع مواقع البحث.

Introduction

The family Hygromiidae belongs to the Kingdom: Animalia, Phylum: Mollusca, Class: Gastropoda sub class of Pulmonata order Stylommatophora super family Helicoidea [1] . It is characterized by small to medium shell size and the shell length is usually less than the width and varies in shape and number of coils, the direction and shape of aperture lip depending on the different genera and specimen [1, 2]. Hlaváć, and Peltanová, [2] pointed out that *Monacha cantiana* specie belongs to Hygromiidae family and have spread from the west of the Mediterranean Sea and the north west of Europe, Italy and southern France which considered to be their original habitat, but this specie spread out to the north of France, Belgium, the Netherlands, south Germany and Great Britain in the late Romanian period. Its spread was further extended mainly during the middle ages and continued to spread to Ireland.

The bodies of land snails are quickly affected by the climate changes, therefore they choose their habitats with appropriate ecological factors like temperature, moisture and pH. Perea, *et al.,* [3] assured that the land snails are characterized by their small size and slow movement, therefore their spread is determined by a number of biotic and abiotic components. Chatfield, [4] stated that the activity of *Monacha cantiana* is found under soil surface and it depends on the ambient temperature above the freezing point and elevation of relative moisture as it passes hibernation in winter. Soil moisture and pH are important ecological factors that affect the abundance and the presence of the snail [5]. A soil with a pH over 7 is favored throughout the year, also the soil with good drainage is preferred too, while in hot and dry weather they are found in wet lands .

Monacha cantiana was studied in Egypt by [6] in two sites, Khafir Al-Sheikh and Biala , and there study [7] refered to the fact that the snail become a problem for crops in the southern coast and the newly plowed-land along the Nile Delta. The effect of several ecological factors on phenotypic variations in *Monacha cantiana* within Baghdad city was assessed [8]. [9] listed *Monacha cantiana* and *Candidula gigaxii* species within the four specimen of snails that were collected from three sites in Baghdad city .

Candidula gigaxii is relatively less wide spread and there is no known environmental threat to it as stated by IUCN report for the year 2013 [10]. The present study is considered the first ecological account for these two species in selected sites of three central Iraq provinces.

The study Area

Two sites were selected at random in each of the three provinces in central Iraq: which were Baghdad, Babylon and Karbala. These sites as follows (Figure -1):

- Baghdad: Aljadiriyah site was regularly irrigated with plenty of mostly citric trees shed; Zafaraniya site where plant cover mostly vegetables, palm trees and citric trees.
- Babylon: Alexandria site mainly a pomegranate plantation with some palm trees; Hindiya Dam site a mostly Clover field for livestock.
- Kerbala: Al-Hussainia, a vegetable crops planted together with Citric and Date Palm trees; Twereje site basically a Wheat and Barley field with some Date palm trees.

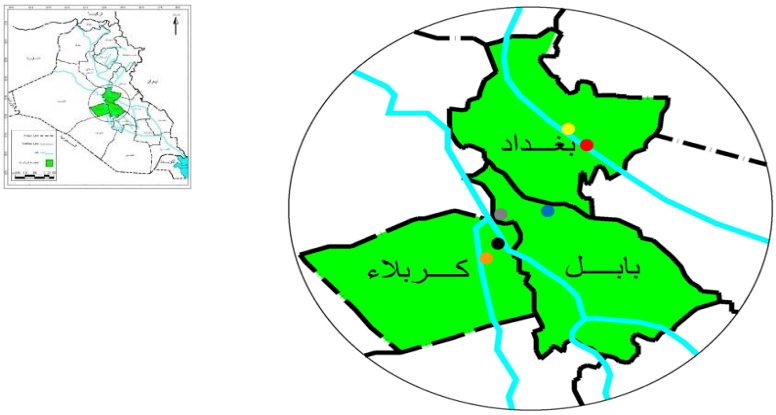

Figure 1– Map of Iraq, the central provinces and the study sites

Collection and Preservation of Specimens

The study was conducted for the period October 2013 to July 2014. Monthly snails samples (each sample composed of five replicates of one square meter each) were randomly collected by hand picking following [11,14]. Samples were kept in plastic container containing 70 % Alcohol [12]. Soil samples placed in plastic bags and brought to the laboratory for moisture and pH measurement. All samples were measured and examined following standard methods in [12] and [13].

Measurement of Soil Ecological Factors

Soil temperature was measured using simple mercury thermometer [15]. Soil pH was measured by the method of [16] using a portable pH meter. Moisture was measured according to the method of [16] by using the following equation:

$$\% \text{ moisture} = \frac{A - B}{A \times 100}$$

A = weight of the soil sample before drying.

B = weight of the soil sample after drying.

Examination and Identification of specimens:

Snail specimens were examined using a dissecting microscope. Both species were included in a list of other Gastropods identified and confirmed by the British Natural History Museum in 2009 [9]. However, the specimens of this study were identified using the identification keys presented by [1], [13]. The identification was carried mainly on the basis of shell characteristics: shape, size, color, shape and the direction of spire, and aperture lip [11].

Data Analysis:

Statistical analysis included the calculation of Least Significant Difference LSD, Chi-Square and the correlation coefficient between population densities and the soil temperature, moisture and pH following [17].

Results and Discussion

Physico-chemical properties of the soil

The lowest value of soil temperature (7 C°) recorded in the sampling sites of (Zafaraniya, Hindiya dam and Twereje) during January 2014, while the highest value was (30 C°) in Aljadiriyah and Al-Al-

Hussainia sites during July 2014 (Figure 1) . The decline of soil temperature values, especially in December-April during the winter and spring, and increase it in summer especially in July was regarded a significant field observations that may explain the increase in the presence of populations at low soil temperature and declined presence at high soil temperature. This is consistent with what referred to by [18] his study which explained that the snails cannot be active when temperatures are extremely low. Based on that, they often appear in hibernation periods in which they are not active, and the risk of drought increases with rising temperature of soil and air temperature in summer. This was confirmed by [19] when conducting a study to check the growth and the survival rate of two species of African snails at the end of dry seasons. It was concluded from his study that the percentage of the loss of both specimen was high at the end of the dry season, while the ratio of growth was low at the beginning of the rainy season. In the present study no significant differences between sites was detected except in December 2013 when significant differences were recorded.

Figure -2 shows values of soil moisture percentages and monthly variations values during the study period. Low value (9 %) in July 2014 at two sites Aljadiriyah and Alexandria, and higher value (33 %) in January 2014 in the Zafaraniya and Hindiya dam sites were recorded . The high moisture values during winter and spring months may be due to be highly frequent of rainfall, while the decrease during summer at almost all sites may probably due to high temperatures which cause increase in the evaporation rate.

It was noted that the snails gathered near the humid places with the dense vegetation cover, during snail samples collection. An increase in the abundance and presence extended in the agricultural fields while the limited presence of snails in areas far from water sources was also observed. Significant differences of moisture have been recorded during the study period , as reported by [20] which examined the increasing of the abundance of snails in soils covered with high trees. These soils allow to retain as much moisture by reducing solar radiation, unlike other environments with short herbs and grasses and vulnerable to solar radiation and wind so it does not prevent the loss of moisture, which in turn reduces soil moisture and lead to dryness and thus reduce the spread of land snails.

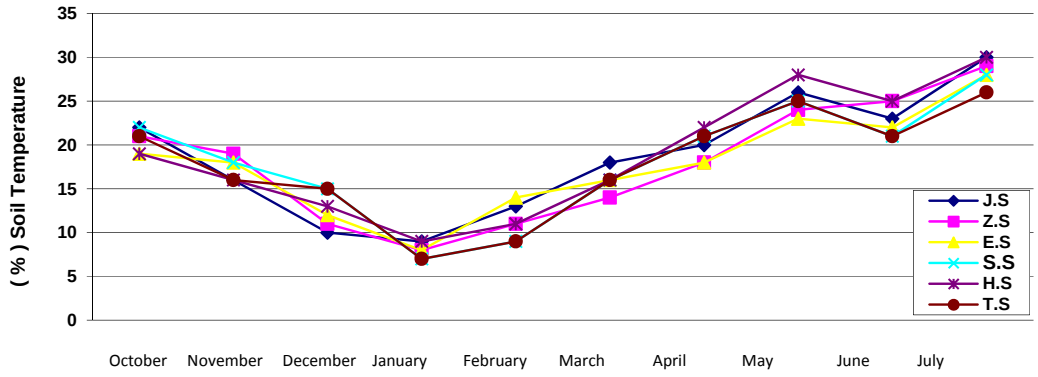

Figure 2- Soil temperature values recorded during the study period.

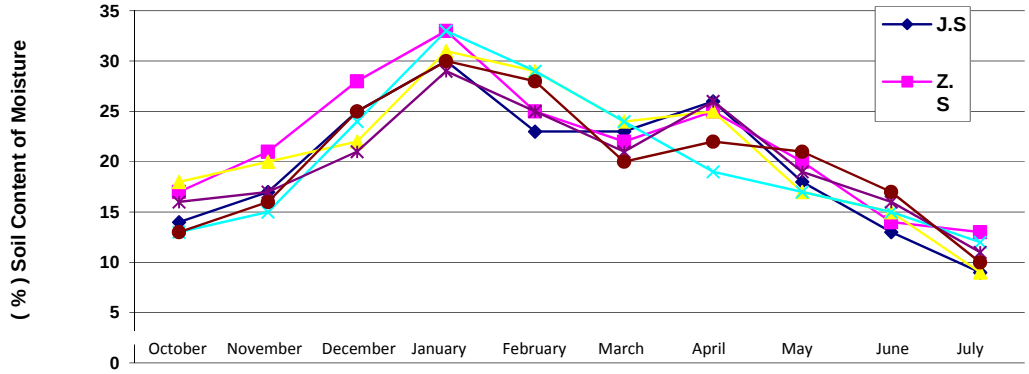

Figure 3- Moisture values recorded during the study period.

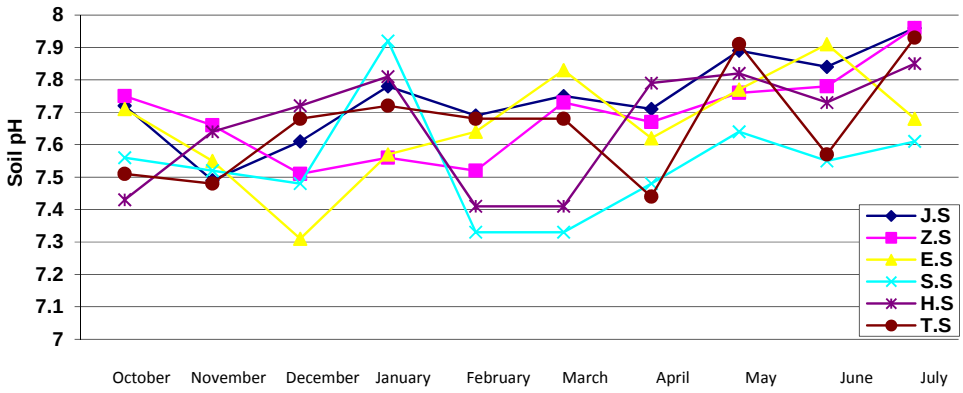

Figure 4- pH values recorded during the study period.

Results show significant differences in soil moisture among study sites, while Figure -3 shows monthly variations in pH during the study period. Where the lowest value of pH 7.31 was recorded in December 2013 in Alexandria (Babylon)and the highest value 7.96 in July 2014 in Aljadiriyah and Zafaraniya (Baghdad), These values indicated the tendency from neutral to Alkaline reaction making the soil favorable for snails and this is consistent with what referred to in [21] in a study on European forests.

The Biological Study:

Results of the biological study are given in Tables -1, -2, -3 and -4. The *Monacha cantiana* was recorded at all sites and all months. Its relative abundance varied between (12.5-35.2) % at Zafaraniya (Baghdad) to (43.9- 60.8) at Al-Al-Hussainia (Karbala). The lowest and highest abundance were recorded in December and April respectively.

Table 1 Relative abundance of *Monacha cantiana* and chi-square values for the study period. (** = P≤0.01)

Months	The Sites						Chi-square value
	Jadiriyah	Zafaraniya	Alexandria	Alhindia dam	Al-Hussainia	Twereje	
October 2013	16.6	17.8	38.8	30.0	60.0	35.4	10.07 **
November	24.2	15.8	34.4	17.1	54.05	41.8	10.64 **
December	12.5	27.7	31.9	23.5	60.3	43.6	9.79 **
January 2014	22.1	26.7	20.5	17.3	55.6	33.3	10.71 **
February	12.7	36.03	20.5	29.7	60.0	32.9	9.63 **
March	31.2	23.5	28.04	19.5	56.3	41.6	10.46 **
April	32.09	26.7	44.1	31.5	60.8	41.6	10.72 **
May	35.2	31.2	53.3	43.1	56.3	46.8	8.47 **
June	25.6	20.0	40.8	36.1	43.9	47.6	8.31 **
July	22.5	22.2	38.8	31.0	58.8	47.2	9.66 **
Chi-square value	8.52**	8.94**	9.61**	8.69**	7.25**	7.94 **	---

The *Candidula gigaxii* was confined to only three sites: Jadiriyah, Zafaraniya and Al- Hussainia. Its relative abundance varied between (8.3-16.04) percent at Aljadiriyah to (25.9-51.9) % at Zafaraniya. The lowest and highest abundance were recorded in March and January respectively.

Table 2- Relative abundance of *Candidula gigaxii* and chi-square values for the study period. (** = P≤0.01)

Months				
	Jadiriyah	Zafaraniyah	Alhindia Dam	Chi-square value
October 2013	8.3	46.4	15.0	10.37 **
November	15.1	32.2	20.0	8.96 **
December	9.3	31.4	17.6	8.67 **
January 2014	9.3	51.9	11.3	10.83 **
February	10.0	27.02	15.9	7.91 **
March	17.7	34.1	7.3	8.59 **
April	16.04	29.5	13.6	8.24 **
May	19.1	26.5	10.3	7.93 **
June	10.2	28.8	17.02	8.05 **
July	9.6	25.9	25.0	8.37 **
Chi-square Value	4.79*	8.52**	7.33**	----

Monthly averages for *Monacha cantiana* show that lowest population density at Al-Hussainia was 1 (individual / m^2) in October 2013, while the highest value at Twereje was 12.5 (individual / m^2) in January 2014 at Al-Hussainia. Results show that there are significant differences at (P≤0.05) in population density of *Monacha cantiana* for all sites during the study period. The highest value for the population density of the *Monacha cantiana* was recorded at Al-Hussainia and this may be due to the falling of large amount of plant leaves and this is consistent with what indicated by [23] that there is an increase in the abundance and diversity of snails in the deciduous forests. Monthly averages for *Candidula gigaxii* show that lowest population density at Jadiriyah was 0.4 individual / m^2 in October 2013, while the highest value at Zafaraniya 13.6 individual / m^2 in January.

Table 3- Monthly averages, standard deviation and LSD for population density of *Monacha cantiana* for the study period.

Months	Locations						LSD
	Aljadiriyah	Zafaraniyah	Alexandria	Alhindia Dam	Al-Hussainia	Twereje	
October2013	0.447 ± 0.8	0 ± 1.0	0.547 ± 1.4	0.447 ± 1.2	1.673 ± 2.4	1.303 ± 2.2	2.02 *
November	0.894 ± 1.6	0.894 ± 1.6	0.707 ± 2	0.447 ± 1.2	3.535 ± 4.0	1.816 ± 3.6	1.94 *
December	0.894 ± 1.6	1.581 ± 3.0	1.816 ± 4.6	1.673 ± 2.4	5.385 ± 7.0	2.167 ± 4.8	2.58 *
anuary2014	3.209 ± 6.6	2.345 ± 7.0	2.302 ± 4.4	3.5354.0	5.585 ± 12.5	3.872 ± 8.0	4.73 *
February	1.303 ± 2.8	3.872 ± 8.0	4.159 ± 6.4	2.073 ± 5.6	6.324 ± 12.0	2. 387 ± 6.2	3.52 *
March	3.535 ± 6.0	1.581 ± 4.0	1.816 ± 4.6	1.816 ± 3.6	3.346 ± 9.8	3.5356.0	2.95 *
April	2.949 ± 5.2	1.643 ± 3.8	5.630 ± 6.8	1.816 ± 4.6	4.505 ± 8.4	1. 581 ± 5.0	2.73 *
May	1.303 ± 4.8	1.581 ± 4.0	3.872 ± 8.0	1.581 ± 5.0	2.387 ± 6.2	2.302 ± 4.4	2.47 *
June	0.707 ± 2.0	0.836 ± 1.8	1.581 ± 4.0	1.516 ± 3.4	1.816 ± 3.6	1.581 ± 4	2.14 *
July	0.547 ± 1.4	0.447 ± 1.2	1.303 ± 2.8	0.707 ± 2.0	1.581 ± 4.0	1.516 ± 3.4	2.05 *
LSD	2.63*	2.75 *	2.41*	2.63 *	2.94 *	2.51 *	- -

Table -4 Monthly averages, standard deviation and LSD for population density of *Candidula gigaxii* for the study period.

Months	Locations			
	Aljadiriyah	Zafaraniyah	Alhindia Dam	LSD
October 2013	0.547 ± 0.4	1.140 ± 2.6	0.547 ± 0.6	0.73*
November	0 ± 1.0	0.707 ± 2	0.547 ± 1.4	0.65*
December	0.447 ± 1.2	1.516 ± 3.4	.836 ± 1.8	0.92 *
January 2014	1.303 ± 2.8	4.393 ± 13.6	1.140 ± 2.6	3.28 *
February	1.303 ± 2.2	3.535 ± 6.0	1.581 ± 3.0	2.04 *

March	1.516 ± 3.4	3.563 ± 5.8	1.581 ± 3.0	1.58 *
April	1.140 ± 2.6	2.588 ± 4.2	0.707 ± 2.0	1.37 *
May	1.140 ± 2.6	1.516 ± 3.4	.447 ± 1.2	1.07 *
June	0.447 ± 0.8	1.140 ± 2.6	0.894 ± 1.6	0.93 *
July	0.547 ± 0.6	0.547 ± 1.4	.894 ± 1.6	0.85 *
LSD	1.27*	1.48 *	1.09 *	- -

South in 1980 pointed out that the population density of the gastropods tend to increase an environment where the plant leaves increase. An increase in the population density has been observed for both species during winter and spring for the period of December 2013 to April 2014. This confirms what was reported by [24] about land snails become active during rainfall, thus increasing its activity and feed on new plants and the soil moist, while the population density was recorded in low numbers during summer, especially in June and July 2014. The reason may be due to the increase in temperature, low moisture and decrease of the plant cover in summer. The open spaces may not protect the snails from high temperatures and cause direct exposure to sunlight, in addition to the absence of natural plant and the removal of the plant remains by landlords, this is consistent with what referred to by [21] that the removal of the plant cover of the soil will affect presence because they are exposed to sunlight directly.

Table -5 shows values of the correlation coefficient between the population densities and physico-chemical soil properties. Highly significant negative correlation for soil temperature between the population density of both *Monacha cantiana* and *Candidula gigaxii*, while for soil moisture a highly positive significant correlation between the population density of both *Monacha cantiana* and *Candidula gigaxii* was detected respectively. Finally the soil pH showed highly positive significant correlation with *Monacha cantiana* densities and lower significant with *Candidula gigaxii*.

Table -5 The correlation coefficients between the population densities of *Monacha cantiana and Candidula gigaxii* and the physico-chemical soil proprieties. (** = P≤0.01 highly significant, NS = non-significant)

Soil properties	**correlation coefficient**	
	Candidula gigaxii	*Monacha cantiana*
Temperature	0.64**	0.75**
Moisture	0.52**	0.44**
pH	0.17 NS	0.39**

References:

1. Price,T. **2010**. *New pest response guidelines*, Temperate terrestrial gastropods, United States Department of Agriculture, 1st ed., Michalak, P.S. edi,U.S.A.,pp:2-5,3-7.
2. Hlaváč,J.C. and Peltanová,A. **2010**. First occurrence of the Kentish Snail *Monacha cantiana* (Mollusca: Gastropoda: Hygromiidae) in the Czech Republic, *Malacologica Bohemoslovaca*, 9, pp: 11–15.
3. Perea, J.;Garcia, A.; Gómez,G.; Acero, R. ;Peña, F. and. Gómez, S. **2007**. Effect of light and Substratum Structural Complexity on Microhabitat Selection By The Snail *Helix aspersa* Müller. *Journal of Molluscan Studies* ,73,pp: 39–43.
4. Chatfield, J. E. **1968**. The life history of the helicid snail *Monacha cantiana* (Montagu), With Reference also to *Monacha cartusiana* (Müller). *Journal of Molluscan Studies*, 38, pp: 233-245.
5. Chatfield, J. E. **1972**. Observations on the ecology of *Monacha cantiana* (Montagu) and associated molluscan fauna. *Pro Candidula Malacologica*, Society Lord,40,pp:59-69.
6. AL-Khodary, A. S.; Helal, R. R. ;Sharshir, F. A. and Sha-Hawy, W. A. **2000**. Ecological studies on *Monacha cantiana* (Montagu) snails at Kafr El-Sheikh, Egypt.in Abstracts Communication & Advancing Ecology, The Ecological Society of America 85th Annual Meeting,pp: 270.
7. Genena,M.A.M. and Mostafa, F.A.M. **2008**. Molluscicidal activity of six pesticidae against the two land snails, *Monacha cantiana* and *Eobania vermiculata* (Gastropoda: Helicidae) under laboratory conditions. *Journal Agriculture Science Mansoura University*, 33(7),pp:5307-5315.
8. Salih,N.F.K. **2012**. Effects of some environmental variables on morphological variations in the land snail *Monacha cantiana* (Montagu, 1803) within Baghdad city. M.S. Thesis, College of science for women, Baghdad University.

9. Abdulla,D.K. **2009.** An ecological study of the Brown Garden snail *Cornu aspersum* (Müller, 1774) from selected habitats in South Baghdad vicinity. M.S. Thesis,College of science for women,Baghdad university.

10. Neubert, E. **2013**. *Candidula gigaxii* The IUCN Red List of Threatened Species.

11. Hossain, M.Md. and Abdul Baki. **2014**. A preliminary survey of freshwater mollusca (gastropoda and bivalva) and distribution in the river Brahmaputra, Mymensingh, Bangladesh . *The Journal of Zoology Studies*. 1(3), pp: 19-22.

12. Zhang, J. and Zhang, S. **2014**, A New specimen of *Nassarius* (Gastropoda: Nassariidae) from the China seas. *Raffles Bulletin of Zoology*, 62, pp: 610-614.

13. Daw,A. and Ivison,T. **2010**. Key to snails of the Bristol Region .Bristol Regional Environmental Records Centre, pp2-20.

14. Valovirta, I. and Halkka, O. **1976**. Colour polymorphism in northern peripheral populations of *Cepaea hortensis*. *Hereditus*,83,pp:123- I26.

15. Alsaadi,H.A.;Mouloud,B.K. and Al-Adhami,H.A.S.**1990**. practical environment and pollution. House of wisdon,Baghdad university,The ministry of higher education and scientific research,Iraq.

16. Rhine,J.;Stephen,J. and Rashid,A. **2003**. Soil and plant analysis laboratory antrz .*International agricultural research in the dry areas guide* (ICARDA),25-90.SAS. **2012**. *Statistical Analysis System, User's Guide. Statistical*.Version 9.1th ed. SAS. Institute InCandidula Cary. North Carolina USA .

17. Bailey, S.E.R. **1983**. The photoperiodic control of hibernation and reproduction in the land snail *Helix aspersa* Müller. *Journal of Molluscan Studies*. 12A, S2-S5.

18. Ogunjinmi,A.A.;Osunsina,I.O.O.and Onyeagocha,N. **2009**. The survival and growth performances of giant african land snails *Achatina Achatina* and *Archachatina Marginata* in the late dry early rainy seasons in northern guinea savanna ,Nigeria –publication of faculty of Agriculture,Nasarawa state University,*Keffi*.5(1),pp:172-180.

19. Perrot, J. K.; Levin, I. I. and Hyde, E. A. **2007**. Morphology, distribution and desiccation in the brown garden snail (*Cantareus aspersus*) in northern New Zealand. *New Zealand Journal of Ecology*. 31(1),pp: 60-67.

20. Martin,K. and Sommer,M. **2004**. Effects of soil properties and land management on the structure of grassland snail assemblages in SW Germany. *Pedobiologia*.48,pp:193-203.

21. Chang,H.W. and Emlen,J.M. **1993**. Seasonal variation of microhabitat distribution of the polymorphic land snail *Cepaea nemoralis*. *Oecologia*. 93(4),pp:501-507.

22. Abele, S.E. **2010**. Gastropod diversity in the boreal mixed wood forest of northern Alberta – variation among forest types and response to partial harvesting. M.S. Thesis. Edmonton, Alberta: University of Alberta. Canada , pp: 107.

23. South, A. **1980**. A technique for the assessment of predation by birds and mammals on the slug *Deroceras reticulatum* (Müller) (Pulmonata: Limacidae). *Journal of Conchology*. 30,pp: 229-234.

24. Schmidt-Nielsen,K.;Taylor,G.R. and Shkolnik,A. **1971**. Desert snails:problems of heat ,water and food. *Journal of Experimental Biology*.55,pp:385-398.