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Some Ecological Factors Influencing Egg Hatching, Incubation Period, Food Consumption and Aestivation of *Monacha cartusiana* Snails Under Laboratory Conditions

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ABSTRACT

This study was conducted on the land snail *Monacha cartusiana* to determine the influence of four different degrees of temperature (18, 20, 22 and 24 ^{0}C) treated with four levels of soil moisture (25,50,75 and 100% field capacity) on egg hatching and developmental period and to define the activity of snails during aestivation and food consumption under the effect of seven temperature degree ranges (5,10,15, 20, 25,30 and 35^{0}C) under laboratory conditions. The present data revealed that the optimum temperature (22^{0}C) for the highest percent of egg hatching was (78 and 76%) treated with 75 and 100% of soil field capacity and the shortest incubation and hatching period were 4.6 and 0.8 days at 24^{0}C with 75% soil moisture and at 20^{0}C with 50% soil moisture, respectively. Food intake by *M. cartusiana* on cabbage leaves was directly related to temperature and the land snail sizes. Feeding was maximal at 20 and 35 ^{0}C for juveniles (8-9, 10-11mm) and at 5 and 35 ^{0}C for all sizes of adults. All juveniles sizes showed higher food intake rate (general mean,31.14mg) than the adult sizes (general mean,30.20mg), as it increased by increasing only the shell size of all juveniles indicated by the general mean which could be arranged in an ascending order as follows, 29.03, 31.04 and 33.37 mg for the size of (8-9), (9-10) and (10-11 mm), respectively, during three days. When the aestivated snails were exposed to serial levels of temperature degrees (starting from 10 to 40^{0}C,15 to 40^{0}C, 20 to 40^{0}C, 25 to 40 ^{0}C and 30 to 40^{0}C), were more active (19.2, 50, 17.2, and 3.6%) at temperature 25 ^{0}C and became less active with increasing temperature (0.4, 6.4, 7.6, 5.6 and 4%) at 40 ^{0}C. By the end of the experiment, all the aestivated snails become epiphragmed and only died when exposed suddenly to a lower temperature, while it still alive when exposed to higher temperature.

Keywords: *Monacha cartusiana*, temperature, egg hatching, developmental period, food consumption, emergence from aestivation.

INTRODUCTION

The Gastropoda is the only class of mollusks which have successfully invaded land. They are one of the most diverse groups of animals, both in shape and habits. Among gastropods, land snails (subclass: Pulmonata) are harmful pests to many crops worldwide (Godan, 1983). Singled out-that, the glossy clover snail, *M. cartusiana* (Muller) which is the major species found in a wide range of crops in most localities of Egypt specially at Sharkia Governorate. Individuals of this species cause a heavy damages to economically important crops (Nakhla *et al.*, 1995; El-Massry, 1997;Mahrous *et al*., 2006; Lokma, 2007; Abdel-Aal, 2007 and Shahawy *et al*., 2008).

These snails have active dispersal capabilities which enable it to successfully expand its range to new areas, its success may be due to its environmental tolerances, high fecundity, and adaptability to the new habitats (El-Okda,1981).Temperature, the relative humidity, photoperiod, food supply and habitat characteristics are considered the most important factors influencing the occurrence/survival of land snails (Panigrahi and Raut, 1994; Millar and Waite, 2002; Mahrous *et al.,*2002; Metwally, *et al.,* 2002; Martin and Sommer 2004 and Ramzy, 2009).Temperature and humidity are the primary factors determining snail activity (Cook, 2001). Adequate knowledge of biology and ecology of pests should be acquired before application of management purpose to control these harmful animals.

The objectives of this research were to determine egg hatching, incubation period, hatching period and food consumption of *M. cartusiana* over-narrower ranges of temperature degrees and soil moisture under laboratory conditions. Moreover, effect of wide ranges of temperature degrees on aestivation of *M. cartusiana* was studied also.

MATERIALS AND METHODS

1- Collection of snails:

The required individuals of the terrestrial snail, *M. cartusiana* were collected in the early morning from heavily infested field cultivated with Egyptian clover (*Trifolium alexandrinum*), at El-Nakhas locality, Zagazig district, Sharkia Governorate during activity season in March 2015. The collected snails were classified to seven groups each of size class interval of one mm according to shell diameter using a vernier caliper accurate to 0.02mm. Snails with shell diameter 8,9,10 and 11 were considered as juveniles, while those of shell diameter 12,13,14,15 and 16 mm were classified as adults based on the presence of maturation lip around the shell opening as the main criterion to recognize maturity. Snails of each group were placed in rearing containers (50 × 30 × 30cm) and fed daily on fresh cabbage leaves for at least 10 days before experiment to acclimatize under laboratory conditions.

2- The effect of different temperatures degrees and soil moisture levels on egg hatching, incubation and hatching period of *M. cartusiana* :

To study hatching period (time elapsed between the date which the first egg hatched and the date which the last egg hatched) for *M. cartusiana*, newly deposited egg clutches were removed carefully from the laboratory culture and placed separately in small plastic pots of10cm diameter filled with sterilized clay soil to a depth of about 5 cm. Soil moistures was adjusted to 25, 50,75 and 100% of field capacity. The pots were placed in incubators at four temperature degrees 18, 20, 22 and 24 ^{0}C. Five replicates were used for each treatment. Egg masses were examined daily and the newly hatched juveniles were recorded and removed to avoid egg cannibalism (Baur, 1990). Examination was continued until the last eggs were hatched. Data were statistically analyzed using F test and least significant difference

(L.S.D.) were calculated using MUTST program version 4 (1986).

3- The effect of different temperatures on the food consumption of snails:

The effects of temperature on the food intake of the terrestrial snail, *M. cartusiana* were investigated using three size groups for juvenile ranged from 8 - 11mm and four size groups for adult ranged from 12-16 mm in shell diameter (SD). Five snails of each size group were assigned into plastic pot (10cm diameter) filled with clay soil. All of pots were exposed to a set of seven different temperature degrees (5, 10, 15, 20, 25, 30 and 35 ^{0}C) using refrigerator incubators. Two fresh cabbage discs with diameter 2 cm were weighed and offered to the snails daily, for three successive days. After 24 hours, the old food residues were weighed and replaced by fresh weighed food for each pot. This procedure was adopted for all snails groups concurrently and replicated five times for each temperature degree. The feeding activity was observed and the consumed amount of food was measured daily according to (Waldbaner, 1964).The obtained data were subjected to statistical analysis using least significant difference (L.S.D) as comparative mean.

4- The effect of temperatures on the activity of snails during aestivation:

This experiment was undertaken during August 2015, where the range of the soil surface temperature ranged from 30 to 35^{0}C and the epiphragm adult snails were found near damp habitats either under grasses or tunnels of irrigation canals and under the lowered portion of the tree trunks. A series of five experiments was conducted to determine the effect of exposure to gradual increase in temperature on aestivation. Five groups of ten epiphragm adult snails, of *M. cartusiana* (12-13mm SD) were introduced directly into pots (10 cm diameter) filled with dry clay soil to depth about 5 cm. All groups of epiphragm adult snails were subjected directly to different levels of temperature degrees without acclimatization, starting from (10- 15- 20- 25- 30- 35- 40 ^{0}C), (15- 20- 25- 30- 35- 40 ^{0}C), (20- 25- 30- 35- 40 ^{0}C), (25- 30- 35- 40 ^{0}C) and (30- 35- 40 ^{0}C) each per 5 days with added a new epiphragm adult snails for each test group of temperature degrees - over a period of 125 days. For each test temperature degree, five replicates were used. Pots were checked daily, at the end of each experiment; the percentage of non epiphragm snails was recorded and is taken as an indication of the activity. During the entire experiment, relative humidity was at or nearly at (65-70%), with free bottled water placed at the bottom of incubator.

RESULTS AND DISCUSSION

1-The effect of different temperature degrees and soil moisture levels on egg hatching, incubation and hatching period of *M. cartusiana*:

The influence of four temperature degrees (18,20,22, and 24^{0}C) and four soil moisture grades (25, 50,75 and 100% of field capacity) on egg hatching, incubation and hatching period of *M. cartusiana* snails were studies under laboratory conditions. Data in Table (1) indicated that at soil moisture level 25% none of the tested eggs were hatched under all tested temperature degrees (18,20,22, and 24^{0}C). The hatching percentage started to increase gradually from 26 to 34 % and from 10 to 42% as the soil moisture increased to 50% and 70% at 18^{0}C and 20^{0}C, respectively till reaching its maximum values averaging 78 and 76% at temperature of 22 ^{0}C with 75% and 100% of soil field capacity. As the temperature increased to 24 ^{0}C, the average percentage of hatchability was decreased to 28 and 60%, at 75 and 100% of field capacity, respectively. So, the optimal conditions for egg hatching are 22^{0}C and when the soil moisture reached 75-100% of field capacity. On the other hand, under the highest levels of both temperature (24^{0}C) and soil moisture (75 and 100% of field capacity) the incubation period was shorter (4.6 and 8.2 days) than the values that obtained at lowest level of 18^{0}C (12.2, 10.6 and 17.4 days), at 50, 75 and 100% of field capacity, respectively. In addition the shortest hatching period was recorded (0.8 days), at 20 ^{0}C with 50% of field capacity, and was longer (5.6 days) at lower temperature level 18 ^{0}C and 100% of field capacity Table (2). On the other hand,

Table 1. Effect of different temperatures and soil moisture levels on egg hatching of *M. cartusiana* under laboratory conditions.

Temperature (^{0}C)	Eggs hatching (%)				
	Soil moisture levels				
	50	75	100	L.S.D (0.05)	General mean
18	26±14.69	34±17.20	70±9.48	N.S	43.33
20	10±100	42±15.62	76±12.49	39.779*	42.66
22	00±00	78±13.54	76±10.29	30.295***	51.33
24	00±00	28±19.59	60±17.02	46.186*	29.33
General mean	9.00^{c}	45.50^{b}	70.50^{a}		41.66
L.S.D(0.05)	22.894***				N.S

*** Different letters indicated significant effect at P < 0.05**
*** Significant (P < 0.05)*** highly significant (P < 0.01) .**

Results of ANOVA tested (L.S.D.) clearly revealed that a highly significant difference (P < 0.01)= 22.894*** in egg hatching was found at all the different temperature degrees within all levels of different soil moisture levels Table (1). In Table (2) there was a variance between the different temperature degrees at all levels of different soil moisture ranged from significant to insignificant. At temperature 22^{0}C showed highly significant difference for incubation period (0.616***) and hatching period (0.941***) of *M. cartusiana* snails at all different soil moisture levels. This however was insignificant with the temperature 20^{0}C. The interaction between all the different temperature degrees and all the different soil moisture levels is also significant (8.528*) and (1.598**). Therefore, temperature and soil moisture are significant factors affecting snails vital activities.

Table 2. Impact of temperatures and soil moisture contents on incubation and hatching period of *M. cartusiana* under laboratory conditions.

Temperature	Incubation period(days)					Hatching period(days)				
(c)	50	75	100	L.S.D(0.05)	G. mean	50	75	100	L.S.D(0.05)	G. mean
18	12.2±50	10.6±4.42	17.4±0.50	N.S	13.40	1.0±0.54	2.4±1.02	5.6±0.50	2.264**	3.00
20	8.8±.80	11.6±2.97	12.4±0.24	N.S	10.93	0.8±0.80	3.6±1.46	3±0.44	N.S	2.46
22	00±00	11.6±0.24	11.6±0.24	0.616***	7.73	00±00	2.2±0.48	1.8±0.200	0.941***	1.33
24	00±00	4.6±2.82	8.2±2.05	6.213*	4.26	00±00	0.2±0.73	2.2±0.58	1.668**	0.80
G. mean	5.20^a	9.60^a	12.40^a	N.S	9.06	0.45^{ab}	2.10^{ab}	3.15^a	N.S	1.90
L.S.D.		8.528*			N.S			1.598**		N.S

*** Different letters indicated significant difference at P < 0.05.**
*** Significant (P < 0.05) *** highly significant (P < 0.01) .**

The best temperature for egg hatching in this study was 22 ^{0}C with 75-100% of field capacity. This conclusion is in close agreement with those reported by many authors (Mohamed, 1999, Al-Akra, 2001 and Mohamed,Ghada, 2004) who found that 20^0C gave the best hatching rate for *Eobania vermiculata*, *M. cartusiana* and *M. obstructa*. Also this finding is very similar to results reported by Baur and Baur, (1993) who reported that the hatching optima for *Cepaea nemoralis* were at 22 and 25^0C. The finding indicated that 20^0C temperature and soil moisture 50% of this experiment accelerate development rate and reduced the duration of the developmental stages is similar to findings of Clave, (1989) who reported that the length of incubation period for *Helix aspersa* was negatively correlated with temperature.

2-The effect of temperatures on food consumption of juvenile and adult stages of *M. cartusiana*:

Data concerning the daily food consumption of fresh cabbage leaves as a food by three sizes of juvenile and four sizes of adults of the land snail, *M. cartusiana* during three successive days of experimental period are presented in Table (3). As the temperature increased from 5 to 30 ^{0}C, there was no stability in the feeding rates for all sizes of both juvenile and adult snails.

The daily values were higher (41.46 mg) for juvenile (8-9 mm) at 20 ^{0}C than that obtained (35.86 and 37 mg) by juveniles (9-10 and 10-11 mm) at 10 and 15^0C, respectively. However the lower values were recorded (14.86, 15.90 and21.93 mg) for juveniles of 8-9, 10-11 mm at 30^0C and 9 -10 mm at 20 ^{0}C, respectively. At temperature 35 ^{0}C, the feeding rates reached a maximum values (80.80) for juvenile (10-11mm) followed by relatively lower values (37.10mg) for both juveniles sizes of 8-9 and 9-10 mm. Regarding adult snails, it was noticed that at low temperature 5^0C a remarkable increase in the consumption rate was attained (32.93, 52.13, 41.46 and 45.40 mg) for adult sizes 12-13, 13-14,14-15 and 15-16 mm, respectively and these values increased till reached to the maximum values by the end of experiment at high temperature (35^0C), became 44.66, 52.53, 60.06 and 61.10 for adult snails 12-13, 13-14,14-15 and 15-16 mm, respectively.

It can be noticed that the rate of food intake by all sizes of juveniles increased with increasing the shell size diameter. This was indicated by the general mean of food consumption which could be arranged in ascending order as follow, 29.03, 31.04 and 33.37 mg for juvenile size (8-9, 9-10 and 10-11 mm), respectively, while the size groups of adult snails (12-13, 13-14, 14-15 and 15-16 mm) showed unstable in feeding rate (25.62 ,33.07,30.33 and 31.70mg), respectively. Also the obtained data declared that the total mean food intake by all sizes of juveniles snails was fairly higher (31.14mg) than intake by all sizes of adults snails (30.18mg). As corroboration, all of individuals exhibited maximal feeding activity with the increasing the thermal conditions to overcome dehydration, to reach maturity and to enter a dormant state (aestivation). Moreover, for all size groups tested we found no significant difference P<0.05 in daily ration among the gradually exposure of different temperature degree within all size classes of adult and juvenile snails through the period of experiment (3 days).

Table 3. Effect of different temperature degrees on food consumption of juveniles and adults of *M. cartusiana* under laboratory conditions.

Shell diameter(mm)		Temperature degree(^{0}C)							L.S.D (0.05)	General mean
		5	10	15	20	25	30	35		
juveniles	(8-9)	37.53	30.73	24.60	41.46	16.93	14.86	37.10		29.03
	(9-10)	34.40	35.86	34.20	21.93	30.86	22.93	37.10		31.04
	(10-11)	20.93	23.66	37.00	30.93	24.40	15.90	80.80		33.37
General mean		30.95	30.08	31.93	31.44	24.06	17.89	51.66		31.14
L.S.D(0.05)					N.S					
adults	(12-13)	32.93	22.93	17.86	25.80	25.60	9.60	44.66	N.S	25.62
	(13-14)	52.13	32.66	25.46	33.06	16.93	18.73	52.53		33.07
	(14-15)	41.46	19.40	25.13	39.06	14.73	12.53	60.06		30.33
	(15-16)	45.40	25.93	20.46	18.73	35.33	15.06	61.10		31.70
General mean		42.98	25.23	22.22	29.16	23.14	13.98	54.58		30.18
L.S.D(0.05)					N.S					

The change of temperature have a profound effect on the ability of these snails to acquire their food from the environment. High consumption rates were achieved at 10, 15, 20 and 35 ^{0}C for certain sizes of juvenile and at 5 and 35^{0}C for all sizes of adult snails. This result is in agreement partially with Osunkeye, *et al.*(2006) who assured that ambient temperature (29.4 ^{0}C) and moistening the soil with 65 ml of water on daily basis increase feed intake and reduced the mortality rate of the giant African land snails, thereby increasing their survivability. Also Abed,(2017) found that the highest food consumption was occurred at 25 and 30^{0}C for juveniles of *M. cartusiana* and *Eobania vermiculata*, respectively and at 15^{0}C for adult stages of both snail species. While this finding is in contrary with Lokma, (2013) who found that the maximum food intake rate of cabbage for both juveniles and adults of *M. cartusiana*, occurred at 30^{0}C after 7 days

The finding that feeding activities of juvenile individuals were higher than adult individuals, as it increased with increasing their shell size, in response to increasing temperature over a range of 5 to 35^{0}C, were similar to those previously found by Lokma, (2013) who reported that juveniles of *M. cartusiana* registered the higher food consumption rate of cabbage (31.85mg) than adult snails (23.14mg) at 10^{0}C during 7 days.

Generally, it could be concluded that the food consumption rates were dependent on the land snails size and temperature degrees.

3-The effect of temperatures on the emergence *M. cartusiana* from aestivation:

Percentage of emerged adult snails from aestivation due to exposure to gradual increase of temperature levels (10- 15- 20- 25- 30- 35- 40 ^{0}C), (15- 20 -25- 30- 35- 40 ^{0}C), (20- 25- 30- 35- 40 ^{0}C), (25- 30- 35- 40 ^{0}C) and (30- 35- 40 ^{0}C) after 5days is shown in Table (4:groups1,2,3,4,5) .Data in all the first three groups levels, (groups 1,2,3) starting from10-15- 20- 25- 30- 35- 40 ^{0}C to15- 20- 25- 30- 35- 40 ^{0}C and 20- 25- 30- 35- 40^{0}C) indicated that the exposure to 25 ^{0}C showed the highest rate of emerged adult snails (19.2, 50 and17.2 %) while those at the highest level (40 ^{0}C) showed the lowest rate of non-epiphragm adult snails (0.4,6.4and7.6%). Although the initiation with low temperature degrees favored the activity of the snails, the snails withdrawn into their shell and closed on itself with epiphragm and died by the end of the experiment, this may be due to that the aestivated snails are unable to accommodate metabolically when exposed suddenly to lower temperature levels (can not avoid low heat shock). However, in natural situations, temperatures usually change gradually enough to adjust its metabolic rates in an orderly manner (Ackefors, *et al.*1994).

On the other hand, non-epiphragm adult snails percentage (active snails) were greatly affected by increasing the levels of temperature degrees which represented in the four and five group, (25- 30- 35 and 40^{0}C) and (30- 35and 40^{0}C). Reduced activities was recorded at all the temperature degrees whereas the average percentage rate did not exceed of 5.6% at 40^{0}C (group4)and at 30^{0}C (group5) and declined to a minimum rate of 2% at 30and 35^{0}C (group 4) and 4% at 35and 40^{0}C (group 5). It was noteworthy that although the initiated temperature degrees slightly elevated outside the optimum ranges of snails activation, also all snails for both (4) and (5) groups closed on itself with epiphragm but remaining alive this mean that aestivated snails has capability to regulate their internal temperature as increasing the risk of dehydration with high temperature levels by tendency to ceased its activity and enter in the dormant state (aestivation) (Akinnusi, 2014) to overcome high temperature and dehydration through numerous behavioral, biochemical and physiological adaptations which support long term aestivation (Storey, 2002, Kingsolver and Huey 2008 and Ajayi *et al.*, 2012) that aid reduction of water loss (Ansart *et al.*,2002 and Omoyahki *et al.*, 2008).

It is appear from our results that the emergence of the aestivated snails is strongly influenced by the changes of temperature (aestivated snails were more active at temperature 25 ^{0}C and became less active with increasing temperature), that trigger the genetic process and induce aestivation in snails (Rahman and Raut, 2010).This finding is in accordance with that obtained by Ali and Suleman,(1992) who assured that in Pakistan both the adult and immature stages snails of *M.obstructa* were more active during wet days of spring months where the prevailing temperatures were around 25^{0}C and become inactive during the summer months and they either died or aestivated, as large numbers of empty shells and dormant snails were observed.

Tolerance to high temperature levels, 30- 35 and 40 ^{0}C supported finding by many authors. Riddle (1983) reported that the most stylommatophora snails are able to aestivate over periods of unfavorable conditions, with the retracted gastropod into the shell and the shell aperture sealed with one or more epiphragm. Raut and Ghose (1984) found that *Achatina Fulica* adapt well to temperature range of 0- 45 ^{0}C, but for population built up at temperature range of 22- 32^{0}C is required. Kempster and Charwat (2003) indicated that the adult snails of *Theba pisana* were incapable of surviving when incubated at 55 ^{0}C, and died after 3hrs while *Cernuella virgata* and *Cochlicella acuta* survived longer, with 100% mortality only after two successive 6 hrs exposure at 55^{0}C.

Generally, knowledge of the activity of the aestivated snails and its ability to tolerate elevated temperature levels in turn can be used both for predicting snail diversity and abundance in new un-surveyed areas and for projecting the effectiveness of control programmes.

Table 4. (groups1,2,3,4,5): Effect of different temperature degrees on the emergence of aestivated *M. cartusiana* snails during five days period.

Group (1)

Temp. degree	No.of snails	%Emerged snails after indicated days					Total mean
		1	2	3	4	5	
10	50	0	4	4	2	6	3.2
15	50	4	4	6	6	8	5.6
20	50	4	10	14	16	16	12
25	50	18	20	20	18	20	19.2
30	50	18	18	18	20	14	17.6
35	50	14	14	10	10	10	11.6
40	50	2	0	0	0	0	0.4

Group (2)

Temp. degree	No.of snails	%Emerged snails after indicated days					Total mean
		1	2	3	4	5	
15	50	0	14	16	16	18	12.8
20	50	20	34	34	36	42	33.2
25	50	52	54	48	48	48	50
30	50	46	44	42	40	24	39.2
35	50	36	36	36	32	30	34
40	50	14	12	6	0	0	6.4

Group(3)

Temp. degree	No.of snails	%Emerged snails after indicated days					Total mean
		1	2	3	4	5	
20	50	4	6	10	12	12	8.8
25	50	16	18	16	18	18	17.2
30	50	16	16	16	16	16	16
35	50	16	16	16	14	14	15.2
40	50	12	12	14	0	0	7.6

Group (4)

Temp. degree	No.of snails	%Emerged snails after indicated days					Total mean
		1	2	3	4	5	
25	50	4	2	4	4	4	3.6
30	50	2	2	2	2	2	2
35	50	2	2	2	2	2	2
40	50	4	6	6	6	6	5.6

Group (5)

Temp. degree	No.of snails	%Emerged snails after indicated days					Total mean
		1	2	3	4	5	
30	50	4	8	6	6	4	5.6
35	50	4	4	4	4	4	4
40	50	4	4	0	4	8	4

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تأثير بعض العوامل البيئية على نسبة الفقس ومدة الحضانة والاستهلاك الغذائى والبيات الصيفى لقوقع البرسيم الزجاجى تحت الظروف المعملية

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تم إجراء هذه الدراسة بغرض معرفة مدى تأثير درجات الحرارة المختلفة (١٨, ٢٠, ٢٢, ٢٤ درجة مئويه) مع مستويات الرطوبة المختلفه (٢٥, ٥٠, ٧٥. ١٠٠%من السعه الحقليه) على معدل الفقس وفترة الحضانة ومعرفة نشاط القواقع اثناء البيات الصيفى وكذلك معدل الاستهلاك الغذائى تحت تأثير سبعه درجات حرارة مختلفة (٥, ١٠, ١٥, ٢٠, ٢٥, ٣٠, ٣٥ درجة مئويه) تحت الظروف المعملية. وأوضحت النتائج أن أعلى نسبه للفقس ٧٨ , ٧٦% كانت عند درجة ٢٢ درجة مئويه مع نسبة رطوبة للتربه٧٥, ١٠٠% من السعه الحقليه على التوالى وكانت أقل فترة للحضانة٤,٦ يوم عند درجة حرارة ٢٤ درجه مئويه بمستوى رطوبة للتربه ٧٥% من السعه الحقليه اما بالنسبه لفتره الفقس فكانت ٠,٨ يوم عند درجة حرارة ٢٠ درجة مئويه عند مستوى ٥٠% من السعه الحقليه. ومن ناحية اخرى وجد أن أعلى معدل للاستهلاك الغذائى للافراد الغير بالغة عند درجة حرارة ٣٥،٢٠درجةمئويه وللافراد البالغة عند ٥ , ٣٥ درجة. ودل المتوسط العام بأن معدل الاستهلاك للافراد الغير بالغه (٣١,١٤) كان اعلى نسبيا من الافراد البالغه(٣٠,٢٠) وكذلك زاد بزيادة اقطار الافرادالغير البالغة وكان كالاتى ٢٩,٥ , ٣١,٠٤, ٣٣,٣٧مليجرام لكل من الاحجام ذات الاقطار ٨-٩،٩-١٠،١٠-١١, اما الافراد البالغة فشهدت استهلاك يومى غير ثابت بمتوسط ٢٥,٦٢ , ٣٣,٠٧, ٣٠,٣٣, ٣١,٧٠ لذات الاقطار ١٢-١٣, ١٣-١٤, ١٤-١٥, ١٥-١٦ على التوالى خلال ثلاثة ايام. بالاضافه الى انه عند تعرض القواقع وهى فى حاله البيات الصيفى(فتحه الصدفه مغلقه) الى سلسله من خمسه مستويات من تاثير درجات الحراره المختلفه والتى تبدا من ١٠ م° الى ٤٠ م° والثانيه من ١٥ م° الى٤٠ م° والثالثه من٢٠ م° الى ٤٠ م° والرابعه من٢٥ م° الى ٤٠ م°وا لخامسه من٣٠ م° الى ٤٠ م° كلا على حده سجلت القواقع اكثر نشاطا عند درجه حراره ٢٥ م° بقيم ١٩,٢ , ٥٠, ١٧,٢ % وكانت اقل نشاط عند درجه حراره٤٠ م° بقيم ٠,٤, ٦,٤, ٧,٦, ٥,٦, ٤% .وبنهايه التجربه وجد ان كل القواقع اغلقت على نفسها وماتت فقط عند تعرضها الى درجات الحراره المنخفضه بينما ظلت حيه عند تعرضها الى درجات الحراره المرتفعه.