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Biological Parameters of the Conical Snail *Cochlicella acuta* (MÜLLER, 1774) (Gastropoda: Cochlicellidae) under Laboratory Conditions

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ABSTRACT

Biological parameters like as mating, pre-oviposition, oviposition, post-oviposition, and generation periods as well as growth rate of the pointed or conical snail *Cochlicella acuta* (Müller, 1774) **(**Gastropoda: Cochlicellidae**)**were studied in the Plant Protection Department, Faculty of Agriculture, Zagazig University under laboratory conditions. In 2017/2018,samples of pointed or conical snails of date palm were collected during its reproductive and activity season from highly infested palm tree orchards at Abo-Nagii farm, El-Kassassein, Ismailia governorate. The temperature and RH% values ranged from 19 to 28^{o}C and 48 to 61, respectively. Snails immediately transported back to the laboratory where they were identified to species and kept in 1000 cc boxes "plastic containers" with tight fitting perforated covers , provided with fresh lettuce leaves (*Lactuca sativa*) as a source of food reared and ovipostion site. Plastic containers were staked side by side with moist soil. The fresh lettuce leaves were checked daily and replaced with fresh one. The laboratory observations revealed that in spite of this species is hermaphrodite, the cross mating was essential for ovipostion as unmated ones did not lay any egg. Mating occurs when snail individuals reach their sexual maturity as calculated from adulthood until mating. Besides large adults produced more eggs than small ones over the whole breeding season; this period was 95 ± 28.4 days in average. Pre-oviposition period (from mating till laying first egg) lasted for an average of 17.3 ± 6.1 days. Oviposition period (from laying first egg till last one) averaged 84.3 ± 23.6 days during which snail individual deposited a total of 110 ± 59.5 eggs. Post-oviposition period (from last laid egg till mortality) was 140 ± 74.3 days. The generation period (from egg to egg) of this species extended to an average of 275.3 ± 32.1 day

Keywords: *Cochlicella acuta*- Sexual maturity – Oviposition – Generation period – Growth rates.

INTRODUCTION

Terrestrial gastropods play an important role in nutrient cycling within terrestrial ecosystems (Dallinger *et al.,* 2001) and these animals often serve as prey or host for a variety of animals (Scheifler *et al*., 2002).On the other hand, some gastropods, including conical snail *Cochlicella acuta* (Müller,1774) **(**Gastropoda: Cochlicellidae**)**, our study animal, is regarded as a pest of many crops (Barker, 2001).

The native of *Cochlicella acuta* is coastal areas of the Mediterranean and Western Europe (Lewis, 1977; Kerney and Cameron, 1979). But in 1986, Baker stated this species in south eastern and south Western Australia as agricultural pest, that species aestivate on ears and stalks of cereal plants. In addition, *C. acuta* contaminate grains during harvest. In the field, Baker, 1989 mentioned that *C. acuta* caused insignificant damage to these plants

Recently land snails had become one of economic serious pests in different governorates in Egypt. It is causing serious yield reduction of infested filed crops and fruits (Kassab and Daoud 1964 & Nakhla and Tadros, 1995). *C. acuta* snail is considered one of the most abundant mollusc pest causing damage to palm trees, citrus orchards and ornamental plants.

The biology of this pest has been little studied and restricted to non agricultural habitats. Therefore, the present study was intended to determine several biological aspects of the life history (e.g. mating, life cycle, oviposition as well as growth parameters) of *C. acuta* under laboratory conditions.

MATERIALS AND METHODS

Hundred adult individuals of *C. acuta* were hand picked from nurseries in Abo-Nagii farm, El-Kassassein, Ismailia Governorate, Egypt, during its active period in November 2017 on date palm trees.

The snails were kept in three 1000 cc (15 x 10 x 11 cm) boxes or containers filled with moist soil to eight centimeters deep and were fed on fresh lettuce leaves (*Lactuca sativa*) as a source of food reared and ovipostion site.

The plastic boxes were covered with muslin cloth fixed with rubber bands to prevent the individuals from escaping. Boxes were examined daily. Fresh lettuce leaves and moisture (drops of water) were supplied as required, and the soil was searched for egg clutches.

All egg clutches were removed and placed in prepared pots (13x10 cm) with moist soil and then observed twice daily till hatching to determine the incubation period and hatchability. New hatched snails (juveniles) were placed solitary in plastic cups (15 x13cm) with moist soil and fresh lettuce leaves.

The cups were covered to avoid escaping of snails, and were examined daily, where fresh lettuce and moisture were added as required throughout the life span.

Pairs of similar weight and shell diameter of *C. acuta* snails were put in prepared pots (15 x 13cm) and observed several times daily till mating to determine the periods of sexual maturity and copulation.

After that, individuals of every pair were separated and each individual was placed singly in the similar pot to determine the pre-oviposition period, oviposition period, number of egg clutches per individual, clutch size and post-oviposition period.

Juveniles were weighed using a digital balance, and shell diameter was measured using a caliper. This was done monthly from hatching time (zero time) till maturity (according to lips growth). The shell volume was calculated following Baur and Raboud (1988):

$$\textbf{Shell volume} = (\textbf{width})^2 \times \textbf{height} / 2$$

The growth rate was calculated monthly according to the formula:

$$\text{Growth rate} = \frac{WF - WI}{WF} \times 100$$

Where

WI and WF are the initial and final weights of snails during a period of month.

Also, the rate of change in diameter was calculated using the formula:

$$\text{Rate of change in diameter} = \frac{DF - DI}{DF} \times 100$$

Where

DI and DF are the initial and final shell diameter of snails during a period of one month.

The rate of change in shell height was calculated as:

$$\text{Rate of change in height} = \frac{HF - HI}{HF} \times 100$$

Where

HI and HF are the initial and final shell height of snails during a period of month.

Also, the following formula was applied to calculate the rate of change in shell volume.

$$\text{Rate of change in volume} = \frac{VF - VI}{VF} \times 100$$

Where

VI and VF are the initial and final shell volume of snails for a period of month.

Data were subjected to analysis of variance (ANOVA) suing MSTAT VERISION 4(1987).

RESULTS AND DISCUSSION

1- Duration of different stages of *Cochlicella acuta* reared on lettuce under laboratory conditions:

Data in Table (1) showed the different stages of *Cochlicella acuta* under reared on lettuce under laboratory conditions. The optimum temperature and relative humidity, individuals reached their adulthood according to lip signs and mating.

In *C. acuta* mating occurred when individuals reached to sexual maturity in about 95.7 ±28.4 days (N= 14) after adulthood was achieved. Mating happened in day time between 9.20 am to 4.30 pm, during its reproductive season from November till the end of February and two days in beginning of March).

Cross mating is essential to lay eggs, and as expected, during copulation two individuals faced each other and attached together strongly from the fleshy parts with a thick layer of mucus for an average period of 112.5±31.2 minutes (N= 10 pairs) and separated within an average period of 13.0 ± 3.5 minutes.

Table 1. Duration of different stages of *Cochlicella acuta* reared on lettuce under laboratory conditions.

Type of Items	Period in Days of the Following Parameters								
	Incubation	Juveniles	Life cycle	Sexual maturity	Pre-oviposition	Oviposition	Post-oviposition	Life span	Generation
Average ± SD	12.7 ±1.7	245.9 ±26.5	258.6 ±28.2	95.7 ±28.4	16.9 ±6.8	84.3 ±23.6	123.7 ± 63.4	542.5 ±114.3	275.3 ±32.1
Temperature ºC	21.0 ±0.4	24.5 ±4.5	24.0 ±5.6	27.0 ±4.1	22.7 ±2.1	18.8 ±1.6	26.2 ±4.6	24.8 ±4.5	23.3 ±3.9
R.H.%	49.4 ± 6.8	60.1 ±6.9	60.0 ±5.8	57.0 ±7.7	61.5 ±7.6	60.4 ±6.5	60.6 ±6.1	60.5 ±5.8	59.1 ±7.1

***Each value is a mean of tested *Cochlicella acuta* snail pairs .**

Regarding the ovipostion period, the both mated individual of *C. acuta* or only one deposited eggs and pre-oviposition period averaging 16.9 ± 6.8 days before depositing eggs. Whereas, oviposition period averaged 84.3± 23.6 days and number of average deposited clutches per snail was 12.8 ± 5.4. In addition, the period between deposit two clutches and size of clutch were 6.2 ± 1.3days and 6.1, respectively. On the other hand, the white egg diameter ranged from 1.1 to 1.4mmwith smooth surface, spherical shape. Due to failure in copulation in some cases, both mated snails did not lay any eggs. Post-oviposition period was calculated from last egg deposited till individual death. This period averaged 123.7 ± 63.4 days for *C. acuta*.

For development of conical snail *C. acuta* snails, data in Table 1 reveal that the averaged incubation period of eggs were 12.7 ± 1.7 days under laboratory conditions at temperature of 21.0 ± 0.4ºC and 49.4 ± 6.8 % relative humidity with a mean hatchability of 64.8 ± 34.8 % (N = 22). Newly hatching snails (juveniles) are similar to adults but smaller in size and weight. Their average measurements were 1.8 ± 0.3 mm for height and 1.4 ± 0.2 mm for width at zero time (N = 30). They developed slowly in a week activity and reached adulthood after eleven months. At that time their average maximum shell dimensions reached 9.5 ± 1.4 mm for height, 4.3 ± 0.6 mm for width and weighted 0.06 ± 0.012 g (N = 30).

Data in Table 2 assessed the life span of *C. acuta* during actively season. The duration of *C. acuta* life cycle from egg to adulthood (incubation period plusjuveniles) averaged 258.6 ± 28.2 days. Mating influenced life span of this species (from egg till mortality). As shown in the Table 2, unmated *C. acuta* snails have long life span as compared to mated ones. For non-mated, it was 522.3 ± 120.4 days, while it was 557.4 ± 103.2 formatted ones. On the other hand, this period decreased to half in non-laying snails

Table 2. Average life span period of *Cochlicella acuta* life span in in mated and unmated snails.

Type of Items	Average life span period in days		
	Mated snails		Unmated
	Laid	Non laid	
Average ± SD	557.4 ± 103.2	262.6 ± 190.5	522.3 ± 120.4
Range	456 - 689	245 - 436	320 - 720
N	8	6	14

2- Changes in weight, width, height, and volume of the land snail *C.acuta* shell during the life span.

Data in Tables 3 clearly showed an increase in land snails *C. acuta* shell during at first five months and decreased gradually at elven months. The growth rate of

snail shell indicated that in the first and second months, weight increased with highly significant to reach 0.02 ± 0.01 and 0.04 ± 0.02, respectively, then declined significantly by a rate of 9.12 % each month. Also, appositive correlation between the change in snail weight and variable changes in width, height and volume. Shell width steadily increased over age and reached 4.39 mm by the ninth month of age and remained constant during the 10^{th} and 11^{th} months of age. Shell height was also gradually increased with age to 9.47 mm at nine month of age. Shell volume was increased from 1.62 mm^3 at hatch to 91.51 mm3 at nine months of age.

Table 3. Weight, width, height, and volume (Average ± SD) of the land snail *Cochlicella acuta* shell during the life span.

Age	Average of the Following Parameters ± SD			
	Weight	Width	Height	Volume
Hatch time	0	1.3 ± 0.2	1.7 ± 0.2	1.62 ± 0.8
1st month	0.02 ± 0.01	1.88 ± 0.3	2.23 ± 0.5	3.99 ± 1.3
2nd month	0.04 ± 0.02	3.1 ± 0.6	4.8 ± 1.3	23.3 ± 10.8
5th month	0.09 ± 0.02	3.9 ± 0.8	7.9 ± 1.9	65.4 ± 32.1
8th month	0.07 ± 0.01	4.4 ± 0.6	9.47 ± 1.7	89.3 ± 35.8
11th month	0.06 ± 0.01	4.4 ± 0.5	9.5 ± 1.4	91.51 ± 33.5

Discussion

Snails and slugs belong to the class Gastropoda (Phylum Mollusca) is the third most important animal group after the arthropods and vertebrates (South, 1992). The terrestrial snails and slugs are destructive agricultural pests causing economic damage to a wide variety of plants including horticulture, field crops, and forestry (Kaya, 2000) and a lot of studies conducted on land snails in Lower Egypt but Upper Egypt to describe their heavy damage to seed of oilplants and leaves of ornamental plants. As well as, citrus, peach, palm and vegetable, i.e. cabbage, carrot and bean (El-Deeb *et al*., 1999; El-Okda, 1981; Ismail *et al*., 2003; Lokma, 2007; Abd El-Aal, 2001& 2007).

In addition, during movement snails cause an undesirable smell which prevents men and even animals from feeding on these contaminated plants (El-Okda, 1984; Kassab and Daoud, 1964), contaminated crops by snail slime lose their marketability and hence their export potential in many countries (Baker and Hawke, 1990; Ittah and Zisman, 1992). Land snails cause also a heavy damage to seed of oilplants and leaves of ornamental plants, as well as, citrus, peach, palm and vegetable, i.e. cabbage, carrot and bean.

In concerning of biological parameters of the conical snail *cochlicellaacuta* (Müller, 1774), a few of studies were conducted. As a fact, the conical snail *C. acuta*is hermaphroditic, self-fertilization does not occur, so cross mating is essential for laying eggs, and unmated snails did not lay eggs. Our results is agreement with many authors. Bride and Gomot, 1991and Bride *et al*., 1991indicated that in several species of gastropods egg production is estimated by snails mating. Abd El-Aal, (2001, 2007) and Mahrous *et al.* , 2002 mentioned that these observation are in harmony with land snails *Monacha cartusiana* (Müller), *Eobania vermiculata* (Müller) and *C. acuta* under laboratory conditions. Current study stated that highly growth rate of the conical snail *C. acuta* in early 3 months of life span and decreased gradually after five months. In conclusion, there is a correlation between the growth of snail shell and changes in weight and volume but not contributed with width and height.

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القياسات البيولوجية لقوقع النخيل معمليا

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تمت دراسة القياسات البيولوجية مثل التزاوج وفترة ما قبل وضع البيض ووضع البيض وما بعد وضع البيض ومده الجيل ومعدل النمو لقوقع النخيل الحلزوني (Gastropoda: Cochlicellidae)(Müller, 1774) *Cochlicella acuta* في قسم وقاية النبات ـ كليه الزراعة ـ جامعه الزقازيق تحت ظروف المعمل. خلال عام 2018/2017 وأثناء فترة نشاط قوقع النخيل أخذت العينات من جذوع أشجار النخيل بمزرعة ابوناجى بالقصاصين محافظه الإسماعيلية. وتراوحت درجات الحرارة والرطوبة النسبية ما بين 19-28 م، 48- 61 % على الترتيب. نقلت عينات القواقع مباشرة الى المعمل في صناديق أو أقفاص بلاستيكية سعتها 1000 جرام ومزودة بأغطية مثقبة محكمة الغلق زودت يوميا بورق نبات الخس كمصدر للغذاء ومكان لوضع البيض ورصت أقفاص البلاستيك متجاورة وبها تربة رطبة مع استبدال أوراق الخس يوميا بأخرى طازجة. أسفرت الدراسات المعملية أنه بالرغم من كون قوقع النخيل خنثى فانه لابد من حدوث أخصاب خلطي لوضع البيض لأنه بدون التزاوج لا يضع أفراد هذا النوع أي بيض. كما يتم التزاوج بين أفراد هذا القوقع عندما تصل الى النضج الجنسي وتحسب من مرحلة البلوغ حتى التزاوج. كما أن الأفراد البالغة الكبيرة الحجم تضع بيضا أكثر من الأفراد البالغة صغيرة الحجم خلال موسم تربية القوقع والتي امتد هذه الفترة 95.7 ± 28.4 يوما في المتوسط. واستمرت فترة ما قبل وضع البيض (من التزاوج حتى وضع أول بيضه) بمعدل 16.9± 6.8 يومًا. وبلغ متوسط فترة وضع البيض (من وضع أول بيضه حتى آخر بيضه)84.3 ± 23.6 يومًا، مجموع البيض الذى يضعه القوقع الواحد 110 ± 59.5 بيضة. وكانت فترة ما بعد وضع البيض (من آخر بيضة وضعت حتى الموت) 123.7± 63.4 يومًا، امتد متوسط فترة الجيل (من البيض إلى البيض) لهذه الانواع بمعدل 258.6 ± 28.2يومًا.