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Size Distribution and Biometric Studies on the Rocky Snail *Thais carinifera* in Lake Timsah, Suez Canal

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ABSTRACT

This study investigates the population structure, size frequency distribution and the biometric studies of the rocky snail *Thais carinifera* in Lake Timsah, Suez Canal. The population was dominated by animals with shell length ranged from 5-5.5 to 5.6-6 cm, which represented 61.96 % of the total individuals. Significant correlations were found between shell length and most of the other parameters (shell width, aperture length, and body whorl), with negative allometric growth. The correlation co-efficient values between shell length and body weight were significant with isometric, positive and negative allometric growth along the study period (July 2006 - September 2007).
Key words: *Thais carinifera*, Lake Timsah, gastropods, imposex, Rockysnail.

INTRODUCTION

Suez Canal is considered as a stable system (Por, 1973). Recent increase of human impact, shipping activities, intensive dredging to clear and enlarge the main channel, drainage from irrigation canals and intensive tourist activities, especially along the western bank of the canal in and around the canal and its lakes may have affected this stability. The large number of vessels transiting the canal makes the waterway vulnerable to pollution. Since the early 1960, Tributyltin (TBT) and other organotin based compounds have been used successfully as effective biocides in antifouling marine paints for more than 2 decades (Hanafy, 1996). It was discovered that the organotin compounds have toxicological effects: imposex in prosobranch molluscs– the phenomenon whereby male sex characters are superimposed on females – has proved to be the most sensitive parameter to assess TBT pollution (Gibbs *et al.*, 1987; Alzieu *et al*., 1991).

The present study is focused on the edible gastropod *Thais carinifera* (Lamark, 1822) that being enormously found in Suez Canal in Lake Timsah. *Thais* is known as drill and sometimes dogwhelk (Stickle and Bayne, 1987).

Thais species live on rocky environments close to shore or in the intertidal zone. *Thais carinifera* are carnivorous gastropods, prey on live bivalves (Broom, 1982) and barnacles. It was recorded first from Jaffa, Israel in 1928 (Mienis, 1977); successively from Egypt (Moazzo, 1939) and Southern Turkey (Engl, 1995). It is widely distributed and has an economic importance since it is one of the most edible molluscs in the Suez Canal area (Hanafy, 1996). It is a very cheap food resource, due to its high abundance. It was also used as bioindicator pollution in the Suez Canal (Hanafy, 1996). Snails of the muricidae are also harvested to produce a dye called Tyrian purple (Tan and Peter, 1988). Among many drills "*Thais* sp." have a gland that secretes colorless mucus that turns purplish when exposed to air. This secretion is a neurotoxin when exposed to air also paralyses or kills other sea creatures and drill larvae, or result in deformities in adults. Human have used this mucus as a rare dye (Bourquin and Mayhew, 1999). The present work aims to study the population structure and biometric studies of *Thais carinifera.* No work was carried out on the length – weight and other allometric relationship of *Thais carinifera* in Lake Timsah and hence the present study was undertaken on fill full this gap.

MATERIALS AND METHODS

Thais carinifera species were collected monthly from El–Taawen area during the period "July 2006 – September 2007". *Thais carinifera* was only found on the barriers and rocks at the bottom of the investigated site (Fig. 1).

Collection of samples was carried out by two ways. The first way by net in which overlap of different net diameter was used and immersed in water overnight. A net with the small diameter inside the large one then, immersed them in the water overnight. When the animals move, it clinging up in the net and traped. A small amount was collected by this way. In the second way, a large amount of samples were collected directly by diving under the water and collecting the samples by hand.

Some hydrographical parameters (water temperature, salinity and hydrogen ion concentration) were monthly measured. Water temperature was measured in the site of collection, whereas water salinity and pH were measured in the laboratory.

A calibrated digital refractometer was used to measure salinity to 1.00‰ accuracy, and pH was measured by using a digital pH meter.

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Data of *Thais carinifera* was analyzed at 0.5 cm for size frequency histograms each month. The length of the snail was measured in cm from the curved larger end of the body whorl to the tip of the spiral apex, (shell length L) using a vernier caliper corrected to 0.1 mm. The other measurements, such as shell width (W), aperture length (AL), and body whorl length (BW) were also taken (Fig. 2). Total weight of live animal with shell (total weight W), weight of the flesh without shell (tissue weight TW), empty shell weight (SW), flesh dry weight (DW) and operculum weight (OW) were recorded.

The allometric relationship between two character was expressed by equation

$$Y = a + bx$$

where a is the intercept and b the slope of the line. Logarithmic calculation was as followed from the following way.

$$\text{Log } Y = \text{Log } a + b \text{ Log } x \quad \text{(Wilbur and Owen, 1964)}$$

Presently, the relationship between the shell length, and either of shell width, aperture length, aperture width, body whorl length, total weight, tissue weight, shell weight, dry weight and opercular weight) was studied in all possible combinations using the linear regression technique.

RESULTS

Hydrographical parameters

Recorded data showed that the maximum temperature 30˚C was recorded in July 2006. It gradually declined to reach its minimum value (18˚C) in January 2007. Salinity of shallow water was ranged from 40‰ (in August 2007) to 49‰ (in September 2006). Minimum value of hydrogen ion concentration (7.2) was recorded in November 2006. Whereas, the maximum value of pH (8.76) was recorded in September 2007.

Population structure

The dominance size class, recorded in this study was (5.6-6 cm). Figure (3) male occurred in higher percentage than female where they recorded 56.23% and 43.77% respectively. Numbers and percentages of males and females in each size group were given in Table (1). Males with size class intervals 5.1- 5.5 and 5.6-6 cm contributed 14.96% and 20.50% of the population. Whereas the percentages of females were 13.57% and 11.63% for class intervals 5.6-6 and 6.1-6.5 respectively. No females were recorded in the smallest size classes 3.5-4 cm and the largest sizes 8.5-9 cm in shell length. Whilst males were only recorded in these class intervals.

Size frequency distribution

Monthly shell length frequency distribution of *Thais carinifera* was represented in Figure (4). Size class (5.1 – 5.5 cm) was highly represented during summer 2006

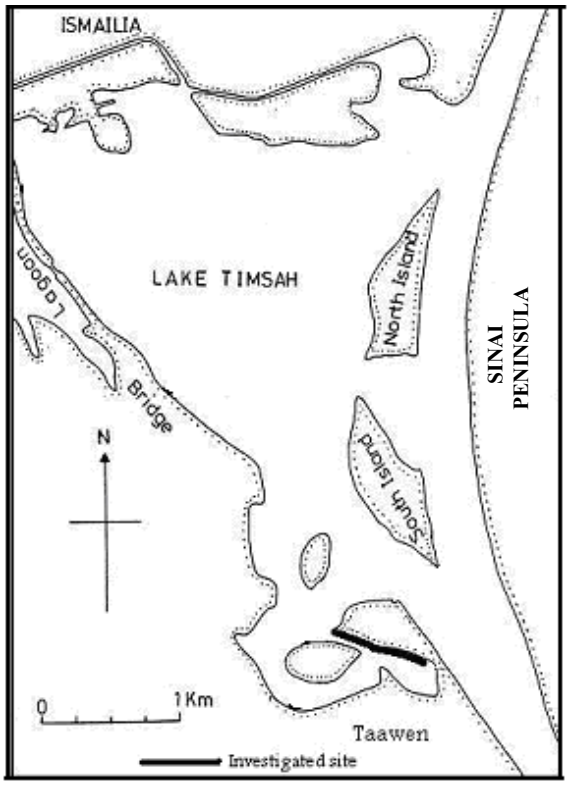

Figure (1): Map of Lake Timsah showing the investigated site.

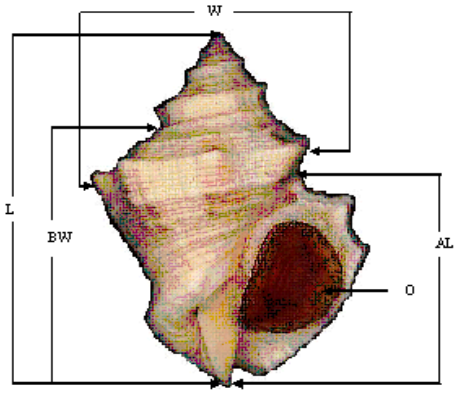

Figure (2): Calibration size of *Thais carinifera*.

Table (1): Numbers of males and females and percentages recorded in each size interval of *Thais carinifera* collected from Lake Timsah.

Size class (Cm)	Lake Timsah			
	Males	Percentages	Females	Percentages
3.5-4.0	2	0.55%	0	0
4.1-4.5	6	1.66%	5	1.39%
4.6-5.0	20	5.54%	14	3.88%
5.1-5.5	54	14.96%	32	8.86%
5.6-6.0	74	20.50%	49	13.57%
6.1-6.5	37	10.25%	42	11.63%
6.6-7.0	7	1.94%	14	3.88%
7.1-7.5	1	0.28%	2	0.55%
7.6-8.0	0	0.00%	0	0.00%
8.1-8.5	1	0.28%	0	0.00%
8.6-9.0	0	0.00%	0	0.00%
9.1-9.5	1	0.28%	0	0.00%

(July – September). This pattern was gradually shifted to a larger size class (5.6 – 6 cm), which predominated other groups from October 2006 to July 2007. Later it was shifted backward again to the size class (5.1 – 5.5 cm) during August – September 2007, after admission of individuals (3.5 – 4) in June 2007. The oldest size class (8.1-8.5) and (9.1-9.5) cm were recorded only in April 2007.

Biometric studies

The linear regression and the correlation coefficient for the various parameters of *Thais catinifera* were analyzed (Table 2). It was evident that the correlation co-efficient(r) for various combinations of shell characters was found to be highly significant ($P < 0.001$). Negative allometric growth ($b < 1$) was recorded in Shell length (L) × Shell width (W), Shell length (L) × Aperture length (AL) and Shell length (L) × Body whorl length (BW) relationships. The logarithmic linear regression between shell length and all body weight parameters were also significant ($P < 0.001$) with negative allometric growth ($b < 3$) in shell length (L) × total weight (W) and shell length (L) × tissue weight (TW). Positive allometric growth ($b > 3$) were found in shell length (L) × dry weight (DW) and shell length (L) × operculum weight (OW) relationships. Isometric growth (b=3) was only recorded in shell length (L) × shell weight (SW).

DISCUSSION

In Lake Timsah small individuals (3.5–4 cm shell length) and old animals (8.1–9.5 cm shell length) of *Thais carinifera* occurred at low percentage (0.55% – 0.56%) respectively. Meanwhile, the size group 5.1 – 6cm of *Thais carinifera* was the dominance. The present results are in a similar pattern with *Murex tribulas, which* is related to the same family. Hanafy (1993) stated that two size groups of 5-5.99 and 6-6.99 cm shell length represented 59.6% of the whole population .The smallest size group of *Murex tribulas* (2–2.99cm) and the largest one in Bardawil population (9.99cm shell length) was represented in whole population by 1.4% – 0.7% respectively of the whole population. The dominance of the small shell length in the present work may be attributed to the continuous pollution of Lake Timsah due to the dense shipping and dredging. In addition the effect of imposex phenomenon, caused by TBT pollution was affected the growth rate, which may increase the mortality of the old individuals. Differences in the gastropod shell size were also related to several physical conditions of the habitat including population density, shore height (Vermeij, 1972; Hobday, 1995; Giraldo *et al.*, 2002; Tanaka *et al*., 2002) wave intensity (Brown and Quinn, 1988; Denny, 1994; Giraldo-Lopez and Gomez-Schouben, 1999). Lake Timsah is characterized by calming waves.

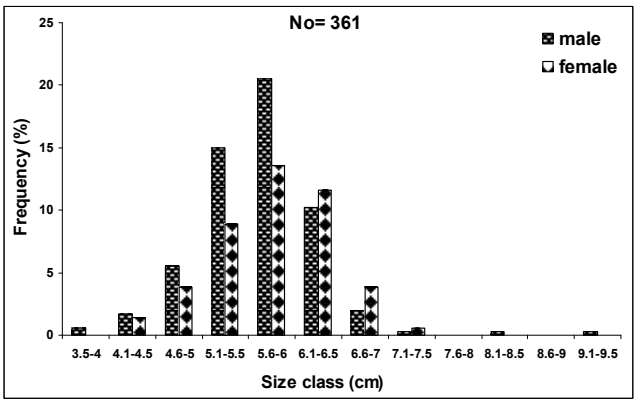

Figure (3): Size frequency of males and females of *Thais carinifera*.

Table (2): Values of regression equations describing the relative growth between shell length (cm) and body measurements of *Thais carinifera*.

Measurements	No of Specimen	a	SE	Lower 95% C.L of a	Upper 95% C.L of a	b	SE	Lower 95% C.L of b	Upper 95% C.L of b	P-value	R^2
Shell width (cm)	1797	-0.052	0.054	-0.158	0.055	0.689	0.01	0.670	0.707	P < 0.001	0.744
Aperture width (cm)	922	-0.286	0.059	-0.402	-0.169	0.464	0.010	0.444	0.484	P < 0.001	0.688
Aperture length (cm)	922	0.8605	0.066	0.731	0.990	0.507	0.011	0.484	0.529	P < 0.001	0.681
Total weight (g)	1692	-0.595	0.028	-0.650	-0.539	2.884	0.038	2.811	2.958	P < 0.001	0.910
shell weight (g)	921	-0.898	0.048	-0.991	-0.804	3.079	0.063	2.955	3.202	P < 0.001	0.778
Tissue weight (g)	919	-1.136	0.052	-1.239	-1.033	2.876	0.069	2.741	3.011	P < 0.001	0.722
Dry weight (g)	580	-1.804	0.117	-2.033	-1.574	3.505	0.155	3.201	3.808	P < 0.001	0.654
Operculum weight (g)	920	-3.286	0.062	-3.407	-3.164	3.372	0.082	3.212	3.533	P < 0.001	0.471
Body whorl (cm)	922	0.1199	0.049	0.0234	0.216	0.823	0.009	0.806	0.839	P < 0.001	0.649

No: number, **a**: intercept, **SE**: standard error, **b**: slope, **C.L**: confidence limits, **P-value**: level of significance, and $\mathbf{R^2}$: correlation coefficient.

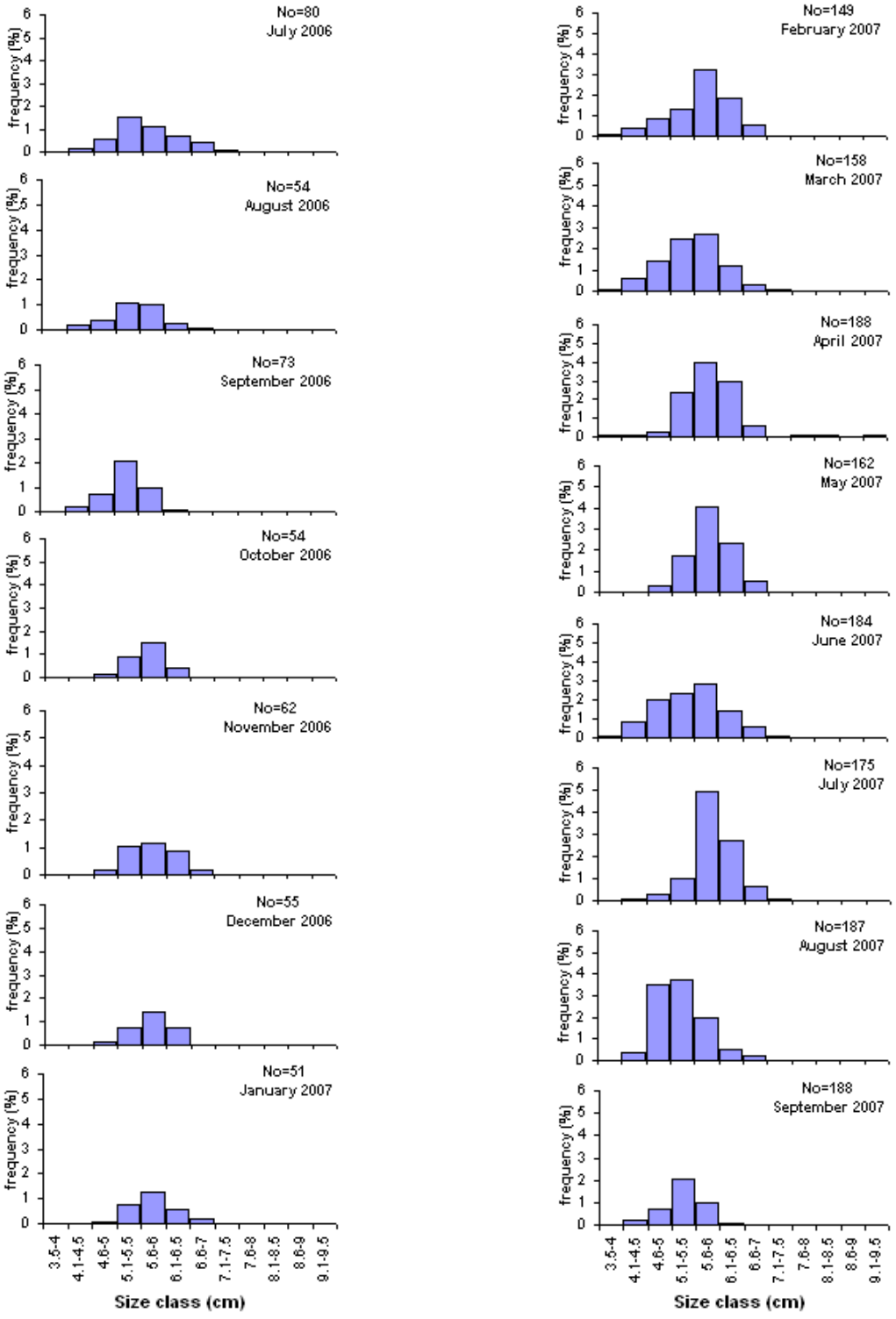

Figure (4): Monthly size frequency distribution of *Thais carinifera*.

In the present study sex ratio of male: female was 1.276:1. Males dominated females in most size groups except at the size intervals 6.6-7 & 7.1-7.5 where the reverse obtained. This was previously recorded in *Thais carinifera* by Hanafy (1996) who concluded that a trend of higher proportion of females than males in the largest size (7-7.9) was found in the Mediterranean Sea population, whilst it was noticed in the smaller size (5-5.9 cm) in Lake Timsah.This is evident that, dominance of females has been shifted from smaller 5-5.9 cm, previously, to the larger size 6-7.5 cm recently. In many prosobranchs, predominance of females in large size

groups is well known (Abbott, 1960; Paine, 1969; Feare, 1970; Fotheringham, 1971; Hanafy, 1993). It may be proposed that females could withstand environmental hazards than males in a restricted size, and this size was changed from year to another. Accordingly, the non-representation of female individuals in the smallest and largest size intervals may be attributed to the sensitivity of females to water pollution than males in the smallest size. Females suffer from spawning in the largest size that exhausted it and led to mortality. Bryan *et al*. (1986) stated that the percentage of females in a population of *Nucella lapillus* tends to fall with an increasing degree of imposex. Recruitments less than 4 cm shell length appeared in February, March, April and June 2007. This might indicate that the spawning begins in winter. This was in agreement with William (1973) who stated that the aggregation of *Thais lamellose* occurred after November and mating was observed by the author between aggregated animals in December.

The effect of latitude on the spawning time is elucidated from Mediterranean Sea and Lake Timsah. Hanafy (1996) stated that the recruitment of *Thais carinifera* that collected from the Mediterranean Sea is evident by occurrence of specimens within the smallest size categories (less than 4 cm shell lengths). He also added that specimens of *Thais carinifera* that collected from two sites in Suez Canal, one of them was Lake Timsah had no recruitment suggesting that reproduction was inhibited without any recruitment. The present study was in contrast to this opinion because of the dominance of the smallest size in the population.

The maximum shell lengths (8.1–9.5cm) was appeared only in April 2007. The absence of the oldest year classes of *Thais carinifera* during the period of investigation may be due to the overfishing or the mortality. The mortality was a weak reason because the irregular margin of the shell is well adapted to the irregular microtopography of the rocky substratum. So the water trapped inside during the low tide periods prevent desiccation at high temperature, giving oxygen supply for metabolism (Carrillo *et al.*, 2004).

The relationship between shell length and the other measurements (shell width, shell aperture length and shell body whorl length), showed a significant correlation with a negative allometric growth. Most mollusks have a slope between 2.5 and 4.5 when logarithm of the body weight is plotted as a function of the logarithm of the shell length (Wilbur and Owen, 1964). In the present study, *Thais carinifera* had a slope ranged between 2.03 and 3.50. All measurements and weights exhibited significant correlation with shell length except dry weight. This result does not agree with Hanafy (1993) who stated that the regression relationships of *Murex tribulas* between animal shell length and animal wet weight, tissue wet weight, tissue dry weight, and shell weight were in strong correlation coefficients. Positive allometric growth appeared between shell length with dry weight and operculum weight. Negative allometric growth appeared between shell length with total weight and tissue-wet weight. Isometric growth was only recorded in the relation between shell length and shell weight. The similarity and difference in shell morphometry can be attributed to habitat nature and the influence of the environmental conditions on their growth and shell properties (Wilbur and Owen, 1964; Saad, 1997, Shu-Chuan Lee and Shyh-Min Chao, 2003, 2004; Gaur *et al*., 2005).

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التوزيع الحجمى ودراسات قياسية على القوقع الصخرى ثايس كارنيفيرا فى بحيرة التمساح, قناة السويس

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الملخص العربى

الدراسه الحاليه تلقى الضوء على القوقع الصخرى ثايس كارنيفيرا حيث يعتبر من بين البطنقدميات السائده فى بحيرة التمساح. اظهرت الدراسه سيادة المجتمع بحيوانات يتراوح طول الصدفه فيها من 5.5-5.6 الى 5.6-6 سنتيمتر والتى تمثل 61.96% من العدد الكلى للأفراد. وقد وجد ان الذكور زادت عن الاناث حيث كانت معدل نسبة الذكور: للاناث 1:1.276. العلاقه بين طول الصدفه وقياسات اخرى مثل (عرض الصدفه- طول فتحة الصدفه-طول لفة الصدفه) كانت سالبه الاللومتريه وذات معامل ارتباط جيد. وبالنسبه للعلاقه بين طول الصدفه ووزن الجسم فقد اظهرت اللومتريه متماثله وموجبه وسالبه خلال فترة الدراسه من يوليو 2006 وحتى سبتمبر 2007.