CATRINA (2017), 16 (1):33-42

Growth and Morphometric Characteristic of the Bivalve *Callista chione* Population in Timsah Lake, Suez Canal, Egypt

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ABSTRACT

This is the first attempt to study some biological aspects for the bivalve *Callista chione* in Egypt. The study of dimensional relationships assumes great importance in fishery biology researches. Studying the biological characteristics of *C. chione* is also essential for improving the state of current production and fishery management, as well as a base for introduction of its potential aquaculture. The growth of *C. chione* in Timsah Lake was studied in the period from June 2013 to August 2014 by the comparison of the rate of increase of one body parameter relative to that of the other parameter (allometry). The population characteristics of *C. chione* in Timsah Lake were studied depending on size frequency distribution to determine different age cohorts, growth parameters and mortality and exploitation rates. The results indicated that all morphometric relationships of *C. chione* showed a negative allometry. The length frequency analysis using FiSAT showed that *C. chione* population in the lake includes three age groups. The von Bertalanffy Growth Parameters; $L\infty$, k and to, were 6.25 cm, 0.530 and -0.68 y. The growth performance index was estimated as 1.316. The natural mortality, fishing mortality and total mortality were found to be 0.5, 1.91 and 2.41 year^{-1}. The estimated exploitation rate for C. chione from Timsah Lake was 0.792 year^{-1} which indicates that it is over exploited. The results of this study will help in better fisheries and management. Strategies for a sustainable exploitation of smooth clams in Timsah Lake.

Keywords: *C. chione* ,Timsah lake, biological aspects.

INTRODUCTION

Timsah Lake is adjacent to Ismailia City, near the middle section of Suez Canal at a point 80 km South of Port Said (Kaiser *et al*., 2009). Bivalves of family Veneridae is the most successful organisms in Timsah Lake. They are commercially important and successful group of bivalves in Timsah Lake (Fouda and Abou Zied, 1990 and Ghobashy *et al*., 1992) Many species of this family are commercially marketed and cultured as an essential source of protein in various parts of the world (Valli *et al*., 1981; Ketchen *et al*., 1983 and Bourne, 1986); therefore, it was the subject of some research works to investigate its biology. Among these clams is the smooth clam *Callista chione* (Linnaeus, 1758); the species of this study. There are no previous studies on *C. chione* in Egypt, and this is the first work to investigate biological aspects of *C. chione* in Timsah Lake. *C. chione* is a relatively large (up to 5.8 cm long) and edible bivalve. It is commercially fished in Timsah Lake. The catches are sold in the markets and the restaurants with low price. *C. chione* is a shallow-burrowing venerid bivalve. It inhabits sandy sediments in coastal waters from just offshore to a depth of about 130 m (Leontarakis and Richardson, 2005). It lives in fine and clean sand, from low tide down to 180 m (Tirado *et al.*, 2002). It is widely distributed in Mediterranean and Atlantic waters, from the British Isles to the Moroccan Coast. In the Mediterranean Sea, *C. chione* is among the most abundant bivalve species inhabiting shallow soft bottomed shores and in some areas, the most prominent suspension-feeding species in terms of biomass (Leontarakis and Richardson, 2005). It is clear that *C. chione* found in Timsah Lake is an Antilessepsian migrant.

It penetrated Timsah Lake through Suez Canal. Often growth is estimated by measuring shell dimensions or the volume of the animal (Hibbert, 1977; Bailey and Green, 1988) because they are simple, non- destructive methods that can be easily completed in the field. The study of length-weight relationship and dimensional relationships assumes great importance in fishery biology researches. Measuring shell dimensions allows comparisons of the rates of increase of one body parameter relative to that of the other parameters by establishing allometric relationships which are essential for generating useful information for managing resources and understanding changes in environmental cond-itions (Palmer, 1990). The knowledge of growth rates is also necessary for modelling population dynamics, which, in turn, is crucial to support exploitation and mana-gement (Peharda *et al*., 2007) and to propose effective measures for the protection of the species (Katsane-vakis, 2007). Geographic latitude has a profound effect on the growth rate and age of bivalves (Moura *et al*., 2009). For example bivalves occupying warmer waters tend to have

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faster growth rates compared with populations in cooler waters (Metaxatos, 2004). Certain techniques for estimation the age and growth of bivalve populations may be more appropriate for one species than other (Daniel and James, 2013). The loss of individuals in a population can be estimated in terms of percentage of individuals that die (mortality rate). For commercial and edible species, overfishing is a source of mortality. The instantaneous total mortality rate is the sum of the instantaneous rate of fishing mortality and the instantaneous rate of natural mortality (Gosling, 2003). In order to improve the state of current production and fishery management, as well as a base for introduction of its potential aquaculture, a detailed study and evaluation of the biological characteristics of *C. chione*, specifically regarding its growth and reproduction is needed. This is why this paper includes information on the population characteristics depending on size frequency distribution of *C. chione* in Timsah Lake to determine different age cohorts, growth parameters and mortality and exploitation rates.

MATERIALS AND METHODS

Study area

Timsah Lake has a surface area of about 8 km^2, an average depth of about 11 meters and a volume of about 90 million cubic meters of water (El-Sharkawy, 2012). The lake lies between latitude 30º 32' and 30º 36' N and longitude 32º 16' and 32º 21' E (Saad El-Din, 2014) (Fig. 1).

Sample collection

This study was carried out in the period from June 2013 to August 2014. *C. chione* is abundant in many sites in the lake but in lesser quantities than the other bivalve species. It is most concentrated in the eastern side of the lake which made it collected from different sites but mainly from North and South Islands, by local fishermen. Specimens of *C. chione* were collected monthly (Fig. 2), a total of 2436 specimens of *C. chione* were collected throughout the whole period of the study.

Morphometric measurements

Shell length (S.L.) and shell height (S.H.) were taken monthly for all specimens using a metal Vernier caliper (to the nearest 0.1 cm) to obtain the different body dimensions (Fig. 3). Total wet weight (T.wt.), flesh weight (F.wt.). And shell weight (S.wt.) was assumed using digital balance (to the nearest 0.01 gm) to obtain different weights.

Morphometric analysis

Morphometric relationships were carried out as the relations between shell length, shell height, shell weight, flesh weight and total weight were studied by testing each pair of variables using potential allometric equation, (Y=a + x b) or power regression method (Y= a x^b).

1-Length-length relationships were described by a linear regression:

$$\mathbf{Y = a + X\ b}$$

Where, Y is the dependent variable; X is the independent variable of the length (cm); a is a constant (the intercept of the regression line) and b is the slope regression coefficient that gives the rate at which the variable Y alter with the variable X.

2-Length-weight relationships were calculated using the equation:

$$\mathbf{Y = a\ X^b}$$

Where, Y is a weight variable (gm); X is the length variable (cm).

3-Weight-weight relationships were described by a linear regression:

$$\mathbf{Y = a + X\ b}$$

Where, Y is the dependent variable; X is the independent variable of the weight (gm).

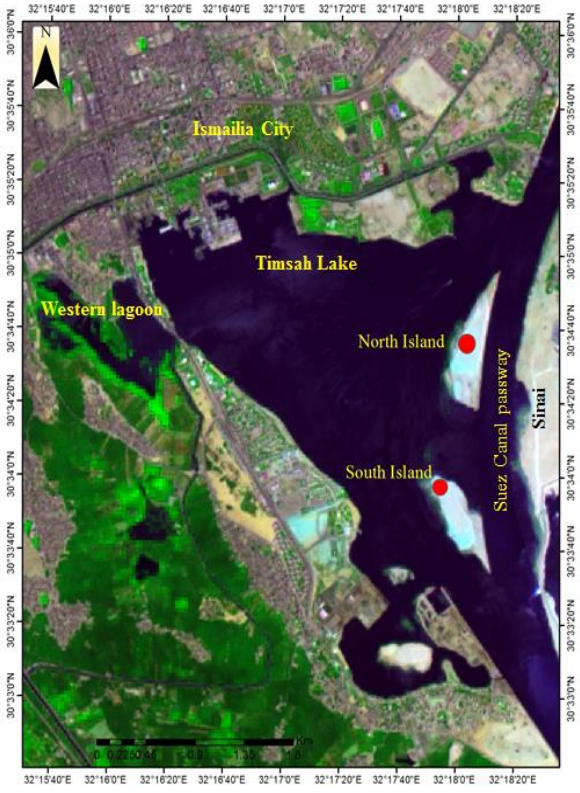

Figure (1): Location map of Timsah Lake, Suez Canal, Egypt.

Statistical analysis

The previously mentioned relationships between the morphometric parameters were carried out using linear regression in Microsoft Excel (2010).

Length frequency distribution

The shell length data obtained were grouped into shell length classes at 0.25 cm intervals and subsequently the frequency of each class was determined.

Figure (2): A photograph showing a sample of *Callista chione* in the laboratory after being sampled.

Figure (3): A Photograph of *C. chione* showing shell dimensions in frontal view as used in measurements.

Age determination

The length frequency distribution of *C. chione* was analyzed using routines in FAO-ICLARM Stock Assessment Tools (FISAT) II software package (Gayanilo *et al*., 2005). In order to identify the different age groups (cohorts) and the mean length of each group, Battacharya's method (Bhattacharya, 1967) incorporated in the FISAT II software was applied.

Estimation of growth parameters

Von Bertalanffy (1938) growth function (VBGF) was used in the present study. This model is popular with fishery scientists and its parameter K (growth rate) can be used to relate environmental conditions and clam growth. The Von Bertalanffy growth function (VBGF) was applied to the size at age data:

$$L_t = L\infty\,(1 - e^{-K\,(t-t_0)})$$

Where L_t is the length at age t; $L\infty$ is the asymptotic length (theoretical maximum length of the clam); K is growth coefficient (it determines how fast the clam approaches its $L\infty$) and t_0 is the initial condition parameter (the theoretical age at length zero).

The three parameters ($L\infty$, K and t_0) need to be fitted by nonlinear regression. Powell-Wetherall method as modified by Pauly (1986), that is incorporated in the FISAT II software was employed in the estimation of the asymptotic Length ($L\infty$) of the Von Bertalanffy Growth Function (VBGF) and the ratio of the total mortality to growth coefficient (Z/K) from the linear relationship. Von Bertalanffy growth constant (K) was obtained using the "K- Scan" of ELEFAN-I model (Sparre and Venema, 1992) under the FiSAT II software. The initial condition parameter t_0 was estimated using the following equation:

$$t_0 = t + (1/K)\,\{\mathrm{Lin}\,(1-L_t/L\infty)\}$$ (Ricker, 1975)

Estimation of growth performance index

The growth performance index (Φ) (Munro and Pauly, 1983) was assumed. The estimated K and $L\infty$ were used in the calculation using the following equations:

$\Phi = \log K + 2 \log L\infty$

Where, Φ is the growth performance index; k is a growth coefficient and $L\infty$ is the asymptotic length.

Estimation of mortality rates

The total mortality (Z) was calculated directly from the previous obtained data of the growth parameters (Z/K and K), via multiplying the value of Z/K by the value of K.

Natural mortality (M) was obtained using the method described by Taylor (1960) for bivalves:

$$M = 2.996 / A_{0.95}$$

Where, $A_{0.95}$ is the 95 percentile of the asymptotic length ($L\infty$).

Fishing mortality (F) was obtained directly by subtracting the natural mortality from the total mortality, where;

$$Z = M + F \qquad \text{OR} \qquad F = Z - M$$

Exploitation rate (E)

The exploitation rate (E) is the portion of total mortality due to fisheries; it can be calculated according to Sparre and Venema (1992):

$$E = F / Z$$

RESULTS

Morphometric parameters

From the 2436 individuals of *Callista chione* that were collected from Timsah Lake during the period of study from June 2013 till July 2014, the mean shell length was 3.50 ± 0.58 cm with a maximum value of 5.78 cm that was recorded in May while a minimum value of 1.07 cm was recorded in December (Fig. 4). The mean shell height was 2.60 ± 0.44 cm with the highest value of 4.26 cm that was recorded in November and the lowest value of 0.70 cm was recorded in December. The mean total weight was 9.70 ± 5.00 gm with the greatest value of 33.96 gm that was recorded in May and the smallest value of 1.05 gm was recorded in December. The mean shell weight was 6.90 ± 3.90 gm with the topmost value of 21.70 gm that was recorded in May and a minimal value of 0.30 gm was recorded in December. The mean flesh weight was 2.40 ± 1.15 gm

with a maximum value of 7.90 gm that was recorded in May while the minimum value of 0.20 gm was recorded in December (Table 1).

Morphometric relationships

The results showed linear models for length-length and weight-weight relationships and power models for length-weight relationships. All the relationships showed a positive significant relationship ($P<0.001$). The correlation coefficient (R^2) showed a good fitted data and the exponent b value indicated a negative allometry (Fig.4 and Table 2).

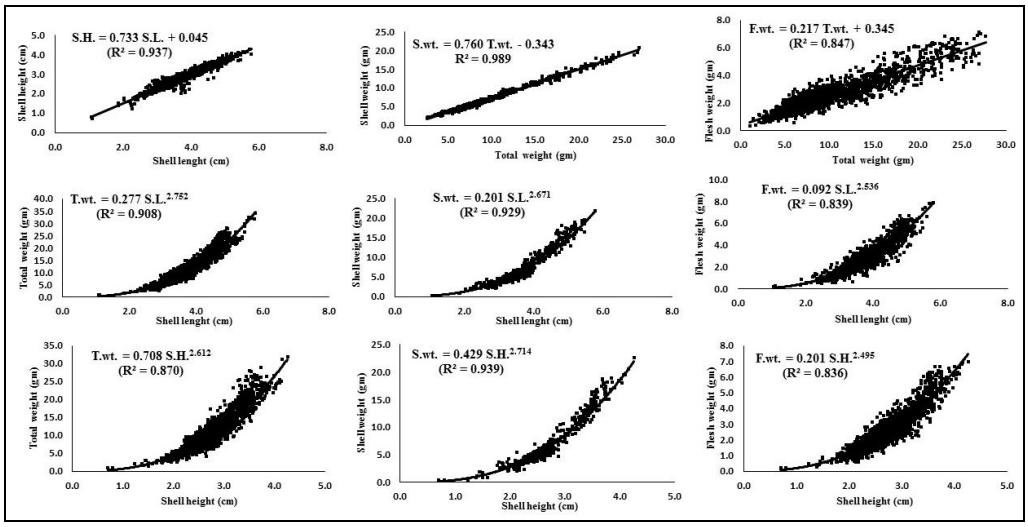

Figure (4): Morphometric relationships of *C. chione* collected from Timsah Lake in the period from June 2013 to July 2014.

Table (1): Mean, standard deviation (S.D.), minimum and maximum values of the morphometric parameters (S.L., S.H., T.wt., S.wt. and F.wt.) for *Callista chione* collected from Timsah Lake in the period from June 2013 to July 2014.

Morphometric parameter	Mean± S.D.	Maximum value	Minimum value
Shell length (cm)	3.50 ± 0.58	05.78	1.07
Shell height (cm)	2.60 ± 0.44	04.26	0.70
Total weight (gm)	9.70 ± 5.00	33.96	1.05
Shell weight (gm)	6.90 ± 3.90	21.70	0.30
Flesh weight (gm)	2.40 ± 1.15	07.90	0.20

S.D. = standard deviation of the mean.

Table (2): Linear regression results for the relationships between the morphometric parameters (S.L., S.H., T.wt., S.wt. and F.wt.) for *C. chione* collected from Timsah Lake in the period from June 2013 to July 2014.

Morphometric relationship	a	b	R^2	S.E.	P-Value	t-value	95% Confidence interval	
							Lower	Upper
Shell length–shell height	0.045	0.733	0.937	0.004	<0.001	189.6	0.0174	0.0719
Shell length-total weight	0.277	2.752	0.908	0.018	<0.001	155.4	0.2649	0.2892
Shell length-shell weight	0.201	2.671	0.929	0.028	<0.001	093.9	0.1868	0.2158
Shell length-flesh weight	0.092	2.536	0.839	0.023	<0.001	112.4	0.0867	0.0969
Shell height-total weight	0.708	2.612	0.870	0.020	<0.001	127.7	0.6809	0.7362
Shell height-shell weight	0.429	2.714	0.939	0.030	<0.001	089.5	0.4042	0.4561
Shell height-flesh weight	0.201	2.495	0.836	0.022	<0.001	111.5	0.1924	0.2095
Total weight-shell weight	-0.343	0.760	0.989	0.003	<0.001	248.1	-0.4092	-0.2763
Total weight-flesh weight	0.345	0.217	0.847	0.001	<0.001	116.1	0.3052	0.3845

S.E. = standard error of slope; all regressions significant at $P < 0.001$.

Length frequency distribution

The length frequency distribution of *C. chione* was graphically represented in figure (5). Less than 25% of the individuals were represented in class intervals from 1.25 to 2.75cm. About 50% of the individuals were represented in class intervals from 3 to 3.5 cm. More than 25% of the individuals were represented in class intervals from 3.75 to 5.75cm.

Age determination

Bhattacharya's analysis allowed the separation of three different cohorts in the population of *C. chione* in Timsah Lake (separation index > 2). The mean lengths of these cohorts were; 3.38 cm (the first age group), 4.66 cm (the second age group) and 5.50 cm (the third age group). The main bulk of the catch was represented in the first age group (Fig. 6).

Growth parameters

Powel-Wetherall method was represented in figure (7) where the following estimates were obtained. L∞ = 6.25 cm and Z/K = 3.689. Von Bertalanffy growth constant (K) was found to be 0.530 year^{-1}. The value of t_0 for *C. chione* was determined for the three age groups as -0.68 year.

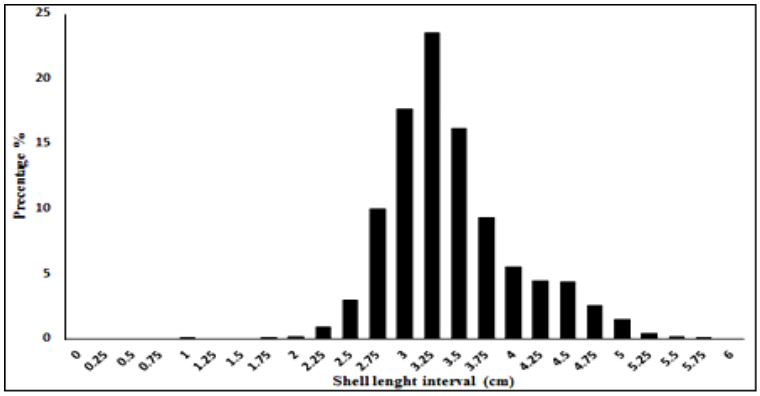

Figure (5): The length frequency distribution histogram for all samples of *C. chione* collected from Timsah Lake in the period from June 2013 to July 2014.

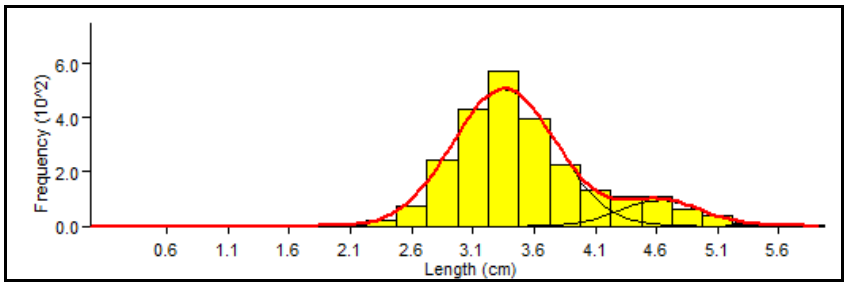

Figure (6): Age groups determination by length frequency distribution for the population of *C. chione* collected from Timsah Lake in the period from June 2013 to July 2014.

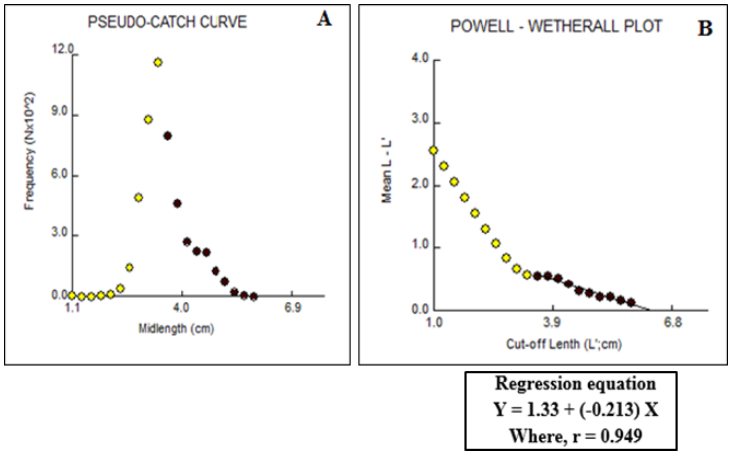

Figure (7): A, Pseudo-catch curve identifying the age group fully recruited to the fishery and **B,** Powell–Wertherall plot to estimate L∞ and Z/K.

Growth performance index

The growth performance index was calculated using the parameters of Von Bertalanffy growth equation; L∞ = 6.25 cm and K= 0.530 year^{-1}.

$\Phi = \log_{10} 0.530 + 2 \log_{10} 6.25$

$\Phi = 1.316$

Mortality rates

The total mortality coefficient of *C. chione* in Timsah Lake was obtained; Z = 2.41 year^{-1}. The natural mortality coefficient was; M = 0.5 year^{-1} and the instantaneous fishing mortality coefficient was; F = 1.91 year^{-1}.

Exploitation rate (E)

The exploitation rate of *C. chione* population in Timsah Lake was found to be; E = 0.792 year^{-1}. These results show that the fisheries of *C. chione* in Timsah Lake are highly exploited (E > 0.5).

DISCUSSION

The growth of *C. chione* was firstly studied by the comparison of the rate of increase of one body parameter relative to that of the other parameter (allometry). The term "allometry" was introduced by Huxley and Teissier (1936) and then it has been applied to many bivalves including several species of clams as *C. chione* (Gaspar *et al*., 2001 and 2002; Leontarakis and Richardson, 2005 and Damianidis *et al*., 2010). The present study revealed that, all morphometric relationships of *C. chione* showed a negative allometry which coincides with Valli *et al*. (1983) who also stated its negative allometry. It is in apparent contradiction with some studies in other geographical areas. Gasper *et al*. (2001 and 2002) and Damianidis *et al*. (2010) confirmed its isometric growth while Leontarakis and Richardson (2005) pointed to its positive allometry. Negative allometry indicates that the dimension X is increasing relatively faster than Y (Gould, 1966). The estimated values of a, b and R2 of the present morphometric relationships were compared to those estimated in other areas (Table 3).

In shell length–total weight relationship, length was increasing faster than weight. The findings are corroborated by Wilbur and Owen (1964), who stated that, the values of equilibrium constant (b) lies between 2.4 and 4.5 in most of the bivalves. When b value is < 3, this means that the large specimens have changed their body shape to become more elongated or small specimens were in better nutritional condition at the time of sampling (Froese, 2006). Leontarakis and Richardson (2005) findings contradict with the present study in the (b) values while R^2 values of the relationships are nearly the same. Damianidis *et al*. (2010) studied the seasonal shell length-total weight relationships in Agean Sea where the average value of (b) of the relationships does not coincide our results. Kilada (2010) studied the different morphometric relationships for two species belong to the same family of the studied species; *Ruditapes decussatus* and *Gafrarium pectinatum* that collected from the same area of study (Timsah Lake) where the (b) values are in agreement with the present findings.

This may confirm that, the allometry coefficient (b) differs according to the different hydrological and sedimentological features in various geographical areas (Gaspar *et al*., 2002).Variations in allometry of bivalves are linked to species, physiological characteristics, and habitat conditions (Gosling, 2003). In consequence, the results of the present study concerning the relationships between different shell dimensions and body weights are specific and might be an indication for specific environmental factors in the lake. In the present study, the age determination of *C. chione* depends on length-frequency distribution analysis of specimens collected from Timsah Lake. Three different cohorts in the population of *C. chione* in Timsah Lake were identified. The mean lengths of these cohorts were; 3.38 cm (the first age group), 4.66 cm (the second age group) and 5.50 cm (the third age group). The main bulk of the catch is belonging to the age group I. Despite not having estimated growth parameters for the same species in Egypt, most of the previous age determination studies conducted on *C. chione* in other regions in Mediterranean and Atlantic show no similar results. In the Maresme coast (North-western Mediterranean Sea), Baeta *et al*. (2014) found that 90% of the population corresponds to ages below 4 years which is closely similar to the present findings.

The older individuals in this area; represent a small portion of the population. In contrast with the maximally reached age of *C. chione* in other regions in the Mediterranean and Atlantic. Hall *et al*. (1974) estimated the maximum age of the species to be 18 years in the Adriatic Sea. Forster (1981) mentioned it as a long-lived bivalve that can live for 40 years in coastal waters of the U.K. In the Aegean Sea, Metaxatos (2004) observed that most of the smooth clam's *C. chione* were between 5 and 8 years old. In Thracian Sea, Northeastern Mediterranean, Leontarkis and Richardson (2005) found that the longevity of smooth clam *C. chione* ranged between 12 to 16 years and *C. chione* of 6 to 9 years old represent more than the 10% of the population. In Portugal, Moura *et al*. (2009) reported that it had reached 17 years. In the Adriatic Sea, Ezgeta-Balic *et al*. (2011) found that a high proportion (32%) of the population located in places with none or low fishing pressure were older than 15 years. In the present study, the shell length of *C. chione* ranged between 1.1 to 5.8 cm and the mean shell length was 3.5 cm. In the Maresme coast (North-western Mediterranean Sea), Baeta *et al*. (2014) carried out his studies on the *C. chione* population by year 2004 and 2010 with mean shell length 3.1 and 2.8 cm respectively, which are close to the mean shell length of *C. chione* in this study and this may elucidate the similarity of most of his findings to the present one.

The range of shell length in the present study is relatively smaller than that of *C. chione* investigated in the previous works in different areas. This may be due to that, most of these areas lie in higher latitude (lower temperature) so, the individuals there grow slower and reach higher shell length than in temperate area and consequently has higher maximum reached age.

Table (3): Morphometric relationship parameters for *C. chione* collected from different locations.

Author	Location	Studied species	a	b	R^2	Relatioship
Leontarakis and			0.660000	1.0300±(0.006)	0.956	Shell height-shell length
Richardson (2005)	Greece	*C. chione*	0.000087	3.0800±(0.033)	0.941	Shell length -shell weight
			0.000015	3.3000±(0.043)	0.859	Shell length-flesh weight
Damianidis *et al*. (2010)	Portgul	*C. chione*	0.000200	3.0063±(0.280)	0.840	Shell length-total weight
Kilada *et al.* (2010)	Timsah Lake, Egypt	*R. decussatus*	5.040000	1.9000±(0.066)	0.860	Shell height-shell length
			0.000100	2.8300±(0.080)	0.890	Shell length-total weight
		G. pectinatum	5.640000	2.2500±(0.060)	0.870	Shell height -shell length
			0.001000	2.5300±(0.057)	0.900	Shell length-total weight
Present study	Timsah Lake, Egypt	*C. chione*	0.045000	0.7330±(0.004)	0.937	Shell length-shell height
			0.277000	2.7520±(0.018)	0.908	Shell length-total weight
			0.201000	2.6710±(0.028)	0.929	Shell length-shell weight
			0.092000	2.5360±(0.023)	0.839	Shell length-flesh weight
			0.708000	2.6120±(0.020)	0.870	Shell height-total weight
			0.429000	2.7140±(0.030)	0.939	Shell height-shell weight
			0.201000	2.4950±(0.022)	0.836	Shell height-flesh weight

In U.K., Forster (1981) stated that the length of *C. chione* in his study ranged from 7.3 to 9.4 cm. In Thracian Sea, Northeastern Mediterranean, Leontarakis and Richardson (2005) investigated *C. chione* of shell length ranged between 1.6 and 7.2 cm. In Portugal, Moura *et al*. (2009) made his studies on *C. chione* of shell length ranging between 2.27 and 9.25 cm. In Aegean Sea, Damianidis *et al*. (2010) made his studies on seasonal collected samples from two different sites in Thermaikos Gulf, where their shell length ranged from 4.7 to 7.5 cm in Platamonas and from 2.95 to 7.30 cm in Sani. In the Eastern Adraiatic Sea, Ezgeta-Balic *et al*. (2011) made his studies on *C. chione* of shell length ranged between 3 and 8.8 cm. In the present study, it was observed that *C. chione* grows quickly during the first year (1.28 cm/year) and then the growth rate decreases during the second year (0.84 cm/year). Hall *et al*. (1974) stated that *C. chione* grew twice fast (0.93 cm) during the third year of their life than during their seventh or any later year (0.47 cm). Keller *et al*. (2002) confirmed that the growth rate of *C. chione* was relatively fast during the first three or four years of life and an apparent decrease in growth rate occurred after the fourth year. Damianidis *et al*. (2010) confirmed that this species has the fastest growth rate in its first years of life which was then reduced and Ezgeta-Balic *et al*. (2011) confirmed that *C. chione* growth rate is reduced with increasing age, as he found that *C. chione* grew rapidly during the first five years with a subsequent decrease in growth rate with increasing the age.

It was noticed that *C. chione* in Timsah Lake, grows in a similar fashion and it does not exceed the three age groups. The lowest reached age group compared with the same species in most of the comparative areas may be due to distinct environmental conditions prevailing in these areas. In the present study, asymptotic shell length ($L\infty$) that was calculated to be 6.25 cm is similar to the result obtained from the Thracian Sea, Northeastern Mediterranean by Leontarakis and Richardson (2005) as 6.2 cm. It is much smaller than that estimated by Forster (1981), Metaxatos (2004), Moura *et al*. (2009), Damianidis *et al*. (2010), Ezgeta-Balic *et al*. (2011) and Baeta *et al*. (2014). *C. chione* in the Mediterranean had a growth rate (K) of 0.24 $year^{-1}$ compared with a similar population in the Atlantic Ocean with growth rates between 0.15 and 0.18 $year^{-1}$ (Moura *et al*., 2009). In the present study the growth rate (K) was calculated to be 0.53 $year^{-1}$ which is higher than all other compared areas except that recorded in Thermaikos Gulf (In Sani) by Damianidis *et al*. (2010) as 0.66 $year^{-1}$.

The obtained K value for *C chione* in the present study indicates a relatively high growth rate. This means that *C. chione* reaches its maximum length faster. This could be attributed mainly to the temperature in Timsah Lake. The growth performance index that was estimated in Timsah Lake as 1.316 is similar to that in Spain but lower than that estimated in U.K., Greece, Portugal and Adriatic Sea. (3). As *C. chione* that found in Timsah Lake undergoes an Anti-lessepsian migration, where the Mediterranean species migrate from colder areas through the Suez Canal in the Red Sea direction, this may reveal the reason of the lower value of growth performance index. This means that the authentic environment is more appropriate and suitable for the growth of *C. chione* than Timsah Lake. The mortality and exploittation rates are important parameters in population dynamics. In the present study, the natural mortality (M) which is defined as the mortality caused by all possible causes of death except fishing (Osman, 2016) was found to be 0.5 $year^{-1}$. Fishing mortality (F) which is the death caused by fishing was found to be 1.91 $year^{-1}$. Both (M) and (F) is giving the total mortality (Z), it was estimated to be 2.41 $year^{-1}$. The exploitation rate is used to assess whether a stock is overexploited or not. This is based on the assumption that a stock is optimally exploited at E = 0.5 when (F) equals (M) (Gulland, 1971). The estimated exploitation rates for *C. chione* from Timsah Lake were 0.792 $year^{-1}$ which indicates that it is over exploited. It is observed that *C. chione* in the present study has suffered an intensive fishing

pressure and therefore there is a high exploitation rate. This may be a reason for the decrease in the mean size of the population compared with the same population in many other areas. This interpretation corresponds to the situation of *C. chione* population in the Maresme coast (Northwestern Mediterranean Sea), where the population had suffered an intensive fishing pressure for decades. This fishing pressure led to progressive decrease in the mean size of the population which was followed by the collapse of the population there as mentioned by Dr. Marc Baeta (Postdoctoral Researcher) (ETC-ULS SGR-Interfase, Department de Geografia, Autonomous University of Barcelona, Edifici B 08193 Bellaterra, Cerdanyola del valles) (personal communication).

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النمو والخصائص المورفولوجية لعشائر *Callista chione* في بحيرة التمساح بقناة السويس، مصر

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الملخص العربي

يعد المحار من الرخويات ثنائية المصراعين ويعتبر أكثر الحيوانات إنتشاراً من بين الكائنات الحية في بحيرة التمساح بقناة السويس، من حيث النوع والعدد. تركز هذه الدراسة على محار كالستا كيون والتي تعد المحاولة الأولى لدراسة بعض الجوانب البيولوجية لهذا النوع.

اهتمت الدراسة بدراسة الصفات البيولوجية للنوع إعتماداً علي توزيع التكرار الطولي لمحار كالستا كيون ببحيرة التمساح وذلك لتحديد المجاميع العمرية المختلفة ومعاملات النمو والنفوق ومعدلات الإستغلال، كما اهتمت بالتحقق من النسبة بين الجنسين والطول عند بداية النمو الجنسي وتحديد مراحل النضج الجنسي للمناسل وتحديد موسم التكاثر بواسطة إجراء فحص مجهرى لقطاعات نسيجية تم تحضيرها للمناسل.

أجريت هذه الدراسة فى الفترة ما بين يونيو ٢٠١٣ إلى أغسطس ٢٠١٤ حيث تم جمع العينات شهرياً للدراسات البيولوجية من بحيرة التمساح. بلغ عدد العينات التي تم جمعها خلال فترة الدراسة ٢٤٣٦ عينة. تم تحديد بعض العلاقات المورفومترية (المظهرية) لمحار كالستا كيون والتى بدورها لها أهمية فى الأبحاث البيولوجية السمكية و أظهرت جميع العلاقات المورفومترية وجود علاقة تنامى سلبية مشيرة إلى أن الدالة (س) أسرع في النمو نسبياً من الدالة (ص). تم إستخدام برنامج (FISATII) لحساب المجاميع العمرية ومعاملات النمو والنفوق ومعدلات الإستغلالحيث استخدمت الصيغ المتوفرة بالبرنامج لتحليل بيانات التكرار الطولي لمحار كالستا كيون التي تم رصدها خلال فترة الدراسة. استخدمت طريقة تحليل التطورالشكلي (Battacharya's method) لإستنباط المجاميع العمرية ومعرفة متوسط الطول لكل مجموعة. تم تحديد ثلاث فئات عمرية، متوسط الطول للثلاث فئات (٣.٣٨، ٤.٦٦، ٥.٥٠ سم علي التوالي). ولوحظ أن محار كالستا كيون في هذه الدراسة ينمو بسرعة خلال السنة الأولى ثم ينخفض معدل النمو خلال السنة الثانية. تم تعيين قيمة الطول الكلي اللانهائي ($L\infty$) عن طريق (Powell-Wetherall plot) لتكون ٦.٢٥ سم، وأيضاً حساب معامل النمو(K) عن طريق Electronic Length Frequency Analysis model (ELEFAN-I)حيث وجد أنه ٠.٥٣ عام-١. كما تم حساب الطول الإفتراضي للمحار عند العمر صفر (t_0) بإستخدام ($L\infty$) و (K) و وجد أنه - ٠.٦٨عام-١. تم حساب مؤشر أداء النمو (Φ) للكائن محل الدراسة بإستخدام معادلة خاصة (Munro and Pauly equation) و وجد أن قيمته ١.٣١٦. وبحساب معدل النفوق الكلي (Z) والطبيعي (M) والناتج عن الصيد (F) بإستخدام المعادلات المناسبة تم الحصول علي هذه القيم (٢.٤١، ١.٩١،٠.٥ عام-١ علي التوالي). من النتائج التى تم التوصل إليها لمعاملات النفوق أمكن استنتاج معدل الإستغلال(E) عند مقدار ٠.٧٩٢ عام-١. ستساعد نتائج هذه الدراسة في تحسينن الإنتاج الحالى وإدارة المصيد ووضع قاعدة وأساس للتربية.