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# Population Biology and Dynamics of Fringelip Mullet *Crenimugil crenilabis*, Forsskål, 1775 from Southern Red Sea, Egypt

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## ABSTRACT

This study was conducted to assess the biological characteristics and growth pattern of *Crenimugil crenilabis* for the first attempt in the Egyptian Red Sea. *C. crenilabis* is a rewarding fish in the Red Sea small scale fishery. 350 samples were obtained seasonally during the period 2017 to 2018 from the commercial fishery operating in Shalatin, southern Egyptian Red Sea. Total length was varied from 24.0 to 49.4 cm (35.0 cm mean, SD: 4.75) and total weight ranged from 157.0 to 1265.0 g (476.58 g mean, SD: 214.47). The weight at length relationship showed an isometric growth pattern (b= 3.052). The von Bertalanffy growth constants K and $L\infty$ were estimated using ELEFAN I method. The growth parameters were found to be K= 0.36/year and $L\infty$=51.5 cm. The annual total mortality coefficient (Z), natural mortality (M) and fishing mortality (F) were estimated to be 1.26, 0.73 and 0.53/ year respectively. The length at first capture ($L_c$) was calculated at 35.65 cm, while the length at first maturity ($L_{m50}$) was found to be 32.7 for males and 33.3 cm for females. The exploitation rate of *C. crenilabis* was determined as 0.42, indicating the under- exploited level where the maximum exploitation level reported was 0.5. Thus the study recommended preserving the current level of exploitation rate to conserve the population stock of *C. crenilabis* from the breakdown.

## INTRODUCTION

The Fringelip mullet, *Crenimugil crenilabis*, locally known as Araby, it is a member of the family Muglidae, it is widely distributed throughout Indo-Pacific: Red Sea and East Africa to the Line and Tuamoto islands, north to southern Japan, south to Lord Howe Island (Lieske and Myers, 1994). *C. crenilabis* is marine, brackish, schooling and non-migratory species, lives at maximum depth 20 m at tropical; 32°N - 32°S, 32°E - 143°W (Bacchet *et. al*., 2006). *C. crenilabis* reported in coastal waters, over sandy or muddy areas of lagoons and associated to reef flats with maximum length of 60 cm TL, while the common length observed was 30 cm TL (Harrison and Senou, 1997).

Very minor knowledge is available on the biological traits of *C. crenilabis*, however (Al-Abdessalaam, 1995 and Randall, 1995), reported its maximum size and studied the feeding behavior in Oman, Arabian Sea. Helfrich and Allen (1975) concluded the reproduction and the spawning time in Micronesian waters. Al-Nahdi *et. al*., (2008) studied length-weight relationships, maturity, and reproductive time of *C. crenilabis* from Oman, Arabian Sea Coast.

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*C. crenilabis* is an abundant species in fish markets of the southern Red Sea from Hurghada to Shalateen with high demand. It is regarding to be commercial species in this region constituting 2% of the total Red Sea catch (GAFRD, 2016).

Despite the commercial importance of *C. crenilabis*, there was no literature had done in Egypt; this work represents the first attempt to study its population biology in the Egyptian Red Sea.

This context aimed to evaluate the present fishery status of the Red Sea mullet, by the study of size frequency distribution, length at first maturity, length at first capture and the exploitation rates, in order to conserve *C. crenilabis* stock in the Egyptian Red Sea.

## MATERIALS AND METHODS

### Data Collection and the study area

Samples of *Crenimugil crenilabis* were collected seasonally during 2016 to 2018 from the artisanal commercial boats adopted in El-Shalateen fishing port, southern Red Sea, Egypt. *C. crenilabis* mainly exploited by artisanal fishery using small fiberglass boats with outboard engines that using trammel and gillnets as well as hand and long line techniques.

Shalateen fishing port is located at 700 km south Hurghada and at 280 km southern to Marsa Alam, Egyptian Red Sea. It is located between latitude 23° 09\ 0\\ N and longitude 35° 36\ 51\\ E (Fig. 1). Shalateen Coastal area is very wide and shallow, with narrow beach composed of sand. The tidal flat is very wide, extends smoothly with very gentle slope seaward. The bottom of the bay floor is sandy and covered with algal flats and sea grass. Coral reefs are found seaward parallel to the shoreline. The long shore confronting the city is good for fishing industry.

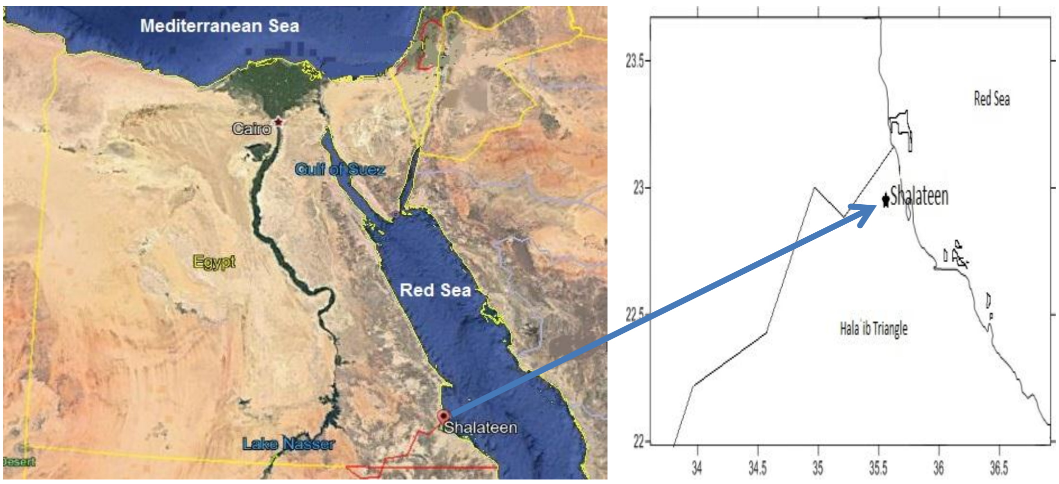

Fig. 1: Demonstrated Shalateen fishing sit, southern Egyptian Red Sea

### Data analysis

Fish total lengths (TL) to the nearest (mm) and fish total weight (TW) to the nearest (g) were measured for 350 fish samples. Samples of *C. crenilabis* were dissected and separated into males and females. Gonads were examined and their weights (GW) were recorded to the nearest 0.01 g.

Fig. 2: *Crenimugil crenilabis* dissected and separated at NIOF, fisheries biology Lab

**Length Frequency Distribution:**

The Total length measurement of 350 specimens of *C. crenilabis* was distributed into length classes of 2 cm interval. A bar chart was plotted to show the variation of length frequency distribution in males and females.

**Weight at length relationship** was computed according to (Ricker, 1975) exponential regression equation $TW = a\ TL^b$ where a (intercept), b (slope), TW (total fish weight) and TL (total fish length).

**Age and growth studies:**

Sagitta otoliths of 350 fish were cleaned, dried and conserved for the age determination. Otoliths annual rings were counted using stereomicroscope transmitted light. The length-frequency data were used to estimate the Von Bertalanffy, 1938 growth parameters, ($L\infty$) the total asymptotic length and (K), the growth coefficient by using the ELEFAN I incorporated in FiSAT II (FAO ICLARM Stock Assessment Tools) Software (Gayanilo *et al*., 2005).

**Mortality rate estimation:**

FiSAT II software package (Gayanilo *et al.*, 2005), ELEFAN I was used to estimate the total mortality Z/year using the length converted catch curve (Pualy, 1983). Z was calculated from the slope (-b) with sign changed of the descending right arm of the curve. The natural mortality rate M/year was calculated by Pauly, 1980 empirical equation: $\text{Ln } M = -0.0152 - 0.279 \text{ Ln } L\infty + 0.6543 \text{ Ln } K + 0.463 \text{ Ln } T$. This formula depends on (T) which is related to the annual mean water temperature of the southern Red Sea (24.0 $^0$C). Fishing mortality F was derived as $F = Z - M$ (Silvestre and Graces, 2004). The exploitation rate (E) was estimated according to (Gulland, 1969) $E = F/Z$.

**Probability of capture***:*

Probability of capture estimated from the length converted catch curve routine and determined the final $L_{25}$, $L_{50}$ and $L_{75}$ (Lengths related to 25, 50 and 75% of fish would be vulnerable to the gear) (Pauly, 1984).

**The size at maturity ($L_{m50}$)** was computed for both sexes by analyzing the maturation curve between mature and immature fish at 5 cm interval. The mean size at maturity was estimated as the size at which 50% of samples were mature and 50% were immature (Pitt, 1970).

**Relative yield-per-recruit and relative biomass-per-recruit:**

The Relative Yield per-Recruit (Y´/R) was computed using model of Beverton & Holt (1964) as modified by Pauly and Soriano (1986) and incorporated in the FiSAT software. $E_{max}$, $E_{0.1}$ and $E_{0.5}$ values were computed by using the program, where, $E_{max}$ is the maximum sustainable exploitation rate, $E_{0.1}$ is the exploitation rate at which the marginal increases of relative yield/recruit tend to be 1/10th and $E_{0.5}$ is the exploitation rate under which the stock has been reduced to 50% of its unexploited biomass. Relative biomass/recruit B´/R was estimated from the relationship B´/R = (Y´/R)/F.

## RESULTS AND DISCUSSION

**The length–frequency distribution**

350 samples of *Crenimugil crenilabis* were sorted with total length ranged from 24.0 to 49.0 cm. There were 226 females (64.6%) and 124 males (35.4%). Females TL ranged from 24.0 to 49.5 cm and males TL from 24.0 to 42.6 cm (Fig. 3). It is observed that females can grow longer than males and constituted about two third of the total samples. Data revealed that males were dominated in small lengths and exhibited approximately identical value with females at length groups from 24.0 to 33.9 cm. It is clear from (Fig. 3) that the length groups 32.0-35.9 cm were considered to be the most abundant length groups constituting about 38% of the total samples.

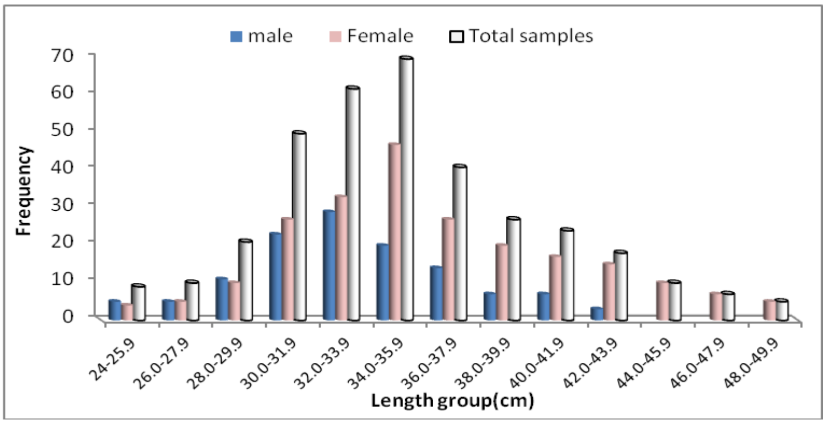


Fig. 3: Length frequency distribution of *C. crenilabis* from Shalateen, Southern Red Sea

There are no previous studies dealing the population length structure of *C. crenilabis* from Shalateen, Southern Red Sea, Egypt.

Availability of food, spawning rates, breeding grounds**,** current and depth of water have been suggested as major factors affecting the distribution and abundance of various fish families**.** Factors affecting fish distribution and abundance have been reported by Olatunde, (1977) and Lelek & El-Zarka, (1993). Allison *et al*., (1997), reported also that fish distribution and abundance may be varied with gear type used, time of capture and the seasonally condition. In the present study the observed results revealed that the fishing pressure depending on the lengths of 32.0 and 35.0 cm by about 38% of the total catch. Also it was noticed that adult fish exhibited small values (Fig. 3); this may be attributed to fishers targeting large sizes in order to maintain high production (Ama-Abasi *et al*., 2004). Al-Nahdi *et al*., (2008) concurrence with our results, where they concluded that females dominated samples of *C. crenilabis* than males in Oman, Arabian Sea.

**Weight at Length relationship**

The relationship between total weight and total length of *C. crenilabis* is presented in (Fig. 4). The analysis of variance (t-Test) revealed there is no significant difference between males and females (p>0.05). The minimum and maximum total length varied between 24.6 and 49.4 with an average of 35±4.75 cm, and those of weight from 157.0 to 1265.0 with a mean of 476.58±214.47 g. The Results showed that, the slope (b= 3.052) was not significantly different from 3.0 (t-Test, P > 0.05), indicating the isometric growth pattern of *C. crenilabis*.

These results exhibit differences when compared (a) and (b) values determined by other authors for the same species, where in Philippines water Gumanao *et al*., (2016) revealed that the length varied from 11.5 to 42.5 cm SL and a= 0.037, b= 2.86. In Oman, Al-Nahdi *et al*., (2008) concluded that the size varied between 12.0 and 54.5 cm TL with mean size of 32.4 cm and a=0.0225 & b= 2.769. The (b) value could be an indicator of the physiological condition of the fish and vary seasonally in response to seasonal variations in environmental condition and changes in the fish wellbeing (Biswas, 1993).

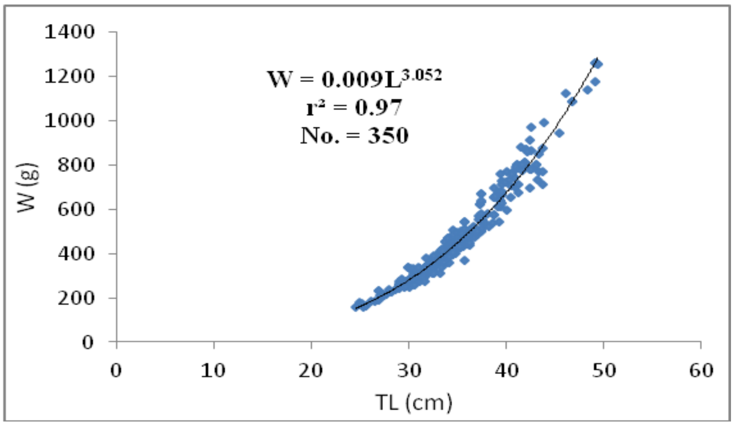


Fig. 4: Weight at Length relationship of *C. crenilabis* from Shalateen, Southern Red Sea

## Age determination

Age determination is considered to be one of the most important bases to study the fish stock assessment. Otoliths believe among the best hard fish structures used in the age determination.

350 otoliths were used for the age determination of *C. crenilabis* collected from Shalatin fishing port at the southern Egyptian Red Sea. Otoliths reading exhibited five age groups; the mean lengths at age were 26.7, 33.0, 39.7, 44.1 and 47.5 cm for age groups I, II, III, IV and V respectively (table 1). The results revealed that the maximum growth rates was detected at the first year of life, then a gradual decrease was observed as the fish increase in age. It is observed that age group III was the most frequent one constitutes 37.1%.

Table 1: Mean length at each age group, growth increment and age composition % of *C. crenilabis* from Shalateen, Southern Red Sea, Egypt.

| Age group (year) | Fish No. | Mean lengths (cm) at each age group | Increment (cm) | %of age composition |
|---|---|---|---|---|
| I | 45 | 26.7 | 26.7 | 12.9 |
| II | 75 | 33.0 | 6.3 | 21.4 |
| III | 130 | 39.7 | 5.7 | 37.1 |
| IV | 80 | 44.1 | 4.9 | 22.9 |
| V | 20 | 47.5 | 3.5 | 5.7 |

## Growth parameters

The von Bertalanffy growth parameters of *C. crenilabis* were estimated at $L\infty$ = 51.5 cm and K = 0.36 $yr^{-1}$. These values did not show much difference when compared to the $L\infty$ and K values estimated by the other authors for the same genus, where Venkatesha *et al*., (2003), studied the age and growth of *Crenimugil sahli* from India and concluded $L\infty$= 53.4 cm and K= 0.285/year.

Stergiou (2000) explained the importance of the proportion of fish maximum length ($L_{max}$) to the asymptotic length ($L\infty$) in the fish life history, as he reported that the value of $L_{max}/L\infty$ for marine fish ranged between 0.56 and 1.34. In the present work the maximum length observed to be $L_{max}$= 49.0 cm, so the value of $L_{max}/L\infty$ was found to be 0.95 which is very close to Stergiou (2000) suggestion for 383 marine fish.

**Annual Mortality and exploitation rates**

The estimated annual mortality rates Z, M and F were found to be 1.26/yr, 0.73/yr and 0.53/yr respectively. (Fig. 5) represents the catch curve apply the estimation of Z, M, F and E which corresponding to the exploitation rate (E=0.42), which is nearly in the optimum range according to Patterson (1992). According to Etim *et al*., 1999, who reported that if Z/K ratio≈2 in case Powell-Wetheral plot, that is indicate the overexploitation. In the present work, the Z/K ratio was found to be 0.75 which confirmed the under-exploitation ratio of *C. crenilabis*. According to Gulland (1971) suggestion who stated that the stock is optimized when F=M. The current study revealed that F<M by about 27%, so the stock is generally in the optimum exploited state.

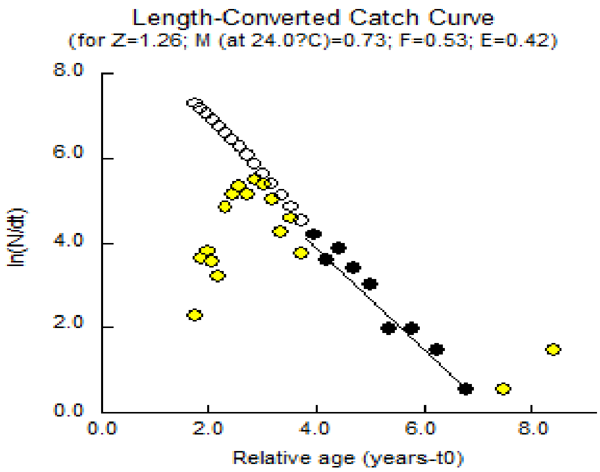


Fig. 5: Length converted catch curve of *C. crenilabis* from Shalateen, Southern Red Sea (indicating Z, M, F and E)

**Probability of capture and size at first maturity**

The estimated sizes for 25% ($L_{25}$), 50% ($L_{50}$) and 75% ($L_{75}$) probabilities of capture would be 32.65, 35.63 and 38.60 cm, respectively for *C. crenilabis* (Fig. 6). The length at first capture $L_{c50}$ was found to be 35.63 cm. It is well known that $L_c$ is related to the net mesh size. Fig. (7), shows the mean size at first sexual maturity $L_{m50}$ which estimated to be 32.7±1.55 cm for males and 33.3±1.65 cm for females. It is clear that length at maturity for *C. crenilabis* ($L_{m50}$≈33.0 cm) is smaller than the length at capture ($L_{c50}$ = 35.63), this means that, the present level of $L_c$ is suitable length at first capture for *C. crenilabis* from the coastal area of Shalateen.

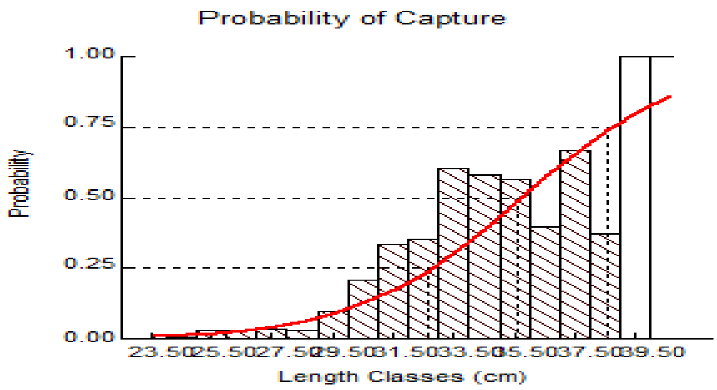


Fig. 6: Probability of capture of each length class of *C. crenilabis* ($L_{25}$ = 32.65 cm, $L_{50}$ = 35.63 cm, $L_{75}$ =38.60 cm)

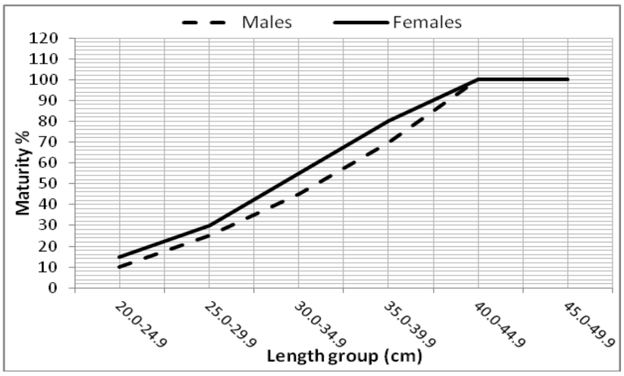


Fig. 7: Size at first maturity of *C. crenilabis* from Shalateen, Southern Red Sea

## Relative yield-per-recruit and relative biomass-per-recruit

Beverton and Holt (1964), relative yield per recruit estimated using the knife-edge method is given in Fig. 8, the optimum exploitation rates were estimated as; $E_{max}$ = 0.421, $E_{10}$ = 0.355 and $E_{50}$ =0.421. The computed exploitation ratio was 0.42, which is equal to the predicted maximum exploitation rate ($E_{max}$) of 0.421, which further lend credence to the fact that *C. crenilabis* is in the optimum fishing situation

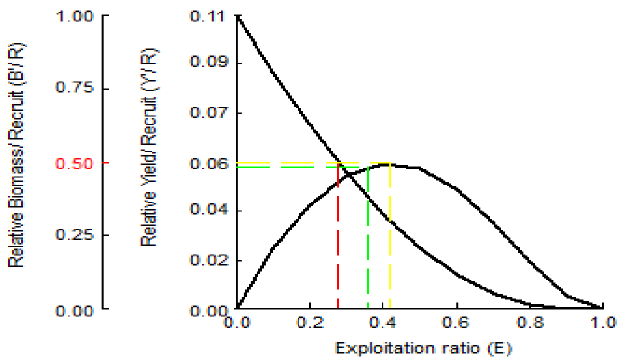


Fig. 8: Relative yield-per-recruit and relative biomass-per recruit of *C. crenilabis* using the knife-edge method ($E_{0.1}$ = 0.355, $E_{0.5}$ = 0.278 and $E_{max}$ =0.421).

The yield contours predict the response of relative yield-per-recruit of the fish to changes in $L_c$ (length at first capture) and E (exploitation rate); $Lc/L\infty$ = 0.05. $Lc/L\infty$ values represent different scenarios equivalent to changes in mesh size. E corresponds to changing levels of $F/Z$.

## CONCLUSION

In conclusion, evidence abound that *C. crenilabis* is in the optimum exploitation rate in the Southern Red Sea, Egypt and the current fishing level is in the suitable manner. Urgent caution needs to fix the current fishing effort to conserve the optimum yield and protect the fish stock through the concerted communities and government agencies.

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## ARABIC SUMMARY

### بيولوجيه وديناميكيه عشائر أسماك البورى (*Crenimugil crenilabis*) من جنوب البحر الأحمر، مصر

**منال مصطفى صبره ، وعزة عبد الحميد الجنايني، رشا على حنيش**
المعهد القومى لعلوم البحار والمصايد، مصر

تهدف هذه الدراسة الى تقييم الخصائص البيولوجية ونمط نمو أسماك البورى (*Crenimugil crenilabis*) لأول مره في البحر الأحمر بمصر. يتم صيد هذا النوع من أسماك البورى في البحر الأحمر عن طريق حرف الصيد الصغيره بأستخدام (الشباك الخيشومية و ثلاثية الطبقات). تم تجميع ٣٥٠ عينة بشكل موسمي خلال الفترة من٢٠١٦ إلى ٢٠١٨ من المصايد التجارية في الشلاتين جنوب البحر الأحمر. يتراوح الطول الكلى للعينات من ٢٤.٠ إلى ٤٩.٤ سم (بمتوسط طول=٣٥.٠ سم ، ومعامل انحراف=٤.٧٥ فى حين تراوح الوزن الكلى من ١٥٧.٠ إلى ١٢٦٥.٠ جم (بمتوسط وزن ٤٧٦.٥٨ جم ، بمعامل انحراف = ٢١٤.٤٧). وبدراسه العلاقة بين الطول والوزن باستخدام الأطوال والأوزان الكليه للأسماك التى تم تجميعها وجد أن هذا النوع من الأسماك يزيد فى الطول والوزن بنفس المعدل (isometric growth pattern). وقد تم حساب ثوابت النمو (Von Bertalanffy growth constants) باستخدام نموذج ELEFAN I فكان قيمه أقصى طول افتراضى يمكن أن يصل له هذا النوع من الأسماك "L∞= 51.5cm "، ومعدل النموالنظرى"K= 0.36/yr". وقدرمعدل النفوق الكلى "Z" و معدل النفوق الطبيعى "M "، و معدل النفوق الناتج عن عمليات الصيد "F" بنحو ( ١.٢٦ ؛ ٠.٧٣ ؛ ٠.٥٣ سنة-١، على التوالى). تم حساب الطول عند اول المصيد فكان (Lc= 35.65 cm)، بينما وجد أن الطول الذى يكون عنده ٥٠% من الاسماك قد وصلت لمرحله النضوج الجنسى او الطول عند اول النضوج فكان ($Lm_{50}$= 32.7 and 33.3 cm) للإناث وللذكور على التوالى. وقد تم تحدد معدل الاستغلال"E" فكان يساوى (٠.٤٢) ، مما يدل على أن المصيد يقع تحت معدل أستغلال أقل من النسبه القياسيه التى تساوى ٠.٥. ولذلك فان هذه الدراسه توصى بالأستمرار على هذا المعدل من الاستغلال الحالي و عدم محاولة زيادة مجهود الصيد الحالى للحفاظ على مخزون مصيد أسماك البورى من الانهيار.