

Growth and Reproduction of Female Brushtooth Lizardfish *Saurida undosquamis* (Richardson) from the Gulf of Suez, Egypt

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Özet: Süveyş Körfezi'nde (Mısır) lokum balığı *Saurida undosquamis* (Richardson) dişi bireylerinin büyüme ve üremesi. Ekim 2004'ten Mayıs 2005'e kadar Süveyş Körfezinden trol ile yakalanan ve Attaka balıkçı limanından çıkarılan 434 Lokum balığının (*Saurida undosquamis*) ilk olgunluk boyu, yumurtlama dönemi, büyüme parametreleri ve yaş kompozisyonu ele alındı. Dişilerin total uzunluğu 13.2 ile 34 cm arasında değişim göstermiştir. Boy (L)-Ağırlık (W) arasındaki ilişki $W=0.0038 L^{3.1666}$ olarak tespit edildi. FISAT programı ile analizi yapılan boy frekanslarından elde edilen yaş verileri von Bertalanffy denkleminin (1938) büyüme parametrelerinin tahmininde kullanıldı. Tahmin edilen parametreler $L_{\infty}=35.56$ cm, $K=0.26$ ve $t_0=-1.059$ idi. *Saurida undosquamis* dişileri için maksimum yaş 6 olarak tespit edilmiştir. Yakalananlar içinde 3 yaş grubu dominant olarak gözlenmiştir. Ovaryum, gonadosomatik indeks ve oosit çapının makroskobik görüntülerinden *Saurida undosquamis*'in yumurtlama mevsiminin Aralık ve Mayıs'ta iki dönemlik artış göstermesiyle birlikte tüm yıl boyunca sürdüğü anlaşıldı. Gonadların, bakir, olgun bakir, gelişmekte olan, gelişmiş, yumurtlayan ve yumurtalarını dökmüş gibi dış görünüme dayanan yedi aşaması belirlendi. Dişilerin 18.1cm'lik total boyda olgunluğa ulaştığı tespit edilmiştir. Total, doğal ve avcılıktan kaynaklanan ölümlerinin yıllık değerleri sırasıyla 1.22, 0.99 ve 0.23 yıl⁻¹ olarak hesaplandı. Tüketim oranı (E) 0.81 olarak tahmin edildi. Her toplamadaki ilgili verim ve biomas analizleri Süveyş körfezindeki *Saurida undosquamis* dişi stoklarının tüketilmiş olduğu bulunmuştur. Bireylerin en azından %50'sinin toplanma ve yumurtlatma için korunmasını garantilemek amacıyla, şu anki kullanım oranının yaklaşık %53.1'e kadar azaltılması gerekmektedir.

Anahtar Kelimeler: Süveyş Körfezi, *Saurida undosquamis*, yaş, gelişim, ilk olgunluk boyu, üreme biyolojisi, tüketim oranı, verim.

Abstract: The age composition, growth parameters, spawning season, length at first sexual maturity of the common lizard fish *Saurida undosquamis* was described based on 434 specimen caught by trawls in Suez Gulf waters and landed in Attaka fishing port from October 2004 to May 2005. The total length of females ranged from 13.3 cm to 34 cm. The length (L) – weight (W) relationships were estimated as $W = 0.0038 L^{3.1666}$. The age data derived from the length frequency data analyzed using the FISAT software were used to estimate the growth parameters of the von Bertalanffy equation (1938). The estimated parameters were $L_{\infty} = 35.56$ cm, $K = 0.26$ and $t_0 = -1.059$. The maximum age was 6 for *Saurida undosquamis* females. The 3-year age group was dominant in the catch. Macroscopic appearance of the ovary, gonado somatic index and oocyte diameter frequency distribution suggested that the spawning season of *Saurida undosquamis* is prolonged season nearly all the year round with two peaks in December and May. Seven stages of maturity were determined based on external appearance as virgin, maturity virgin, developing, developed, spawning and spent. Females matured at a total length of 18.1 cm. The annual rates of total, natural and fishing mortality were calculated as 1.22, 0.99 and 0.23 year⁻¹ respectively. Exploitation rate E was estimated as 0.81. The relative yield per recruit and relative biomass per recruit analysis showed that the stock of *Saurida undosquamis* females in the Suez Gulf is overexploited. To insure that at least 50% of the individuals can be maintained for spawning and recruitment, the present level of exploitation rate should be reduced by about 53.1%.

Key Words: Gulf of Suez; *Saurida undosquamis*, age, growth, first sexual maturity, reproductive biology, exploitation rates, yield.

Introduction

The Lizard fishes are a group of fishes widely distributed assume a very important place in trawl fishery in the Gulf of Suez. Family Synodontidae are represented in the trawl catch of the south Egyptian Red Sea by five species, *Saurida tumbil*, *Saurida undosquamis*, *Saurida longimanus*, *Synodus hoshinonis* and *Trachinocephalus myops* catch according to the fishery statistics obtained from the fisheries office of the Ministry of Agriculture at Suez Governorate Among the various species of Brush tooth lizard fish in the Gulf of Suez, *Saurida tumbil* is the most widely distributed constitute about 65% of the Lizard fish, followed by *S. undosquamis* which contributes to 33% of the catch, while the other three species are the least abundant, appear occasionally in the catch (El-Ganainy 1997). The

biology and dynamics of *Saurida undosquamis* have been studied in different localities (El-Ganainy 1992, 1997 and 2002 and Ramadan 1995 in the Gulf of Suez, Golani 1993, Abdallah 2002 and EL-Gresiy 2005 in Mediterranean). Several studies of this species have been undertaken in localities other than Egypt: such as Siripakhavanich, 1990 in Gulf of Thailand; Boonwanich 1991, Erzini 1991, Sousa 1992, Federizon, 1993, Xu *et al.*, 1994, Pauly & Gayanilo 1996, Letourneur *et al.*, 1998, Ismen, 2003 in İskenderun Bay).

The present study deals with estimating the basic parameters required for assessing the status of female *Saurida undosquamis* from the Gulf of Suez in relation to ovarian development and this information would help in the proper management of the Gulf of Suez trawl fishery and in the achievement of its optimum sustainable yield.

Material and Methods

Monthly random samples (434 fish ranging from 13 - 34 cm TL) were collected from the Attaka harbour during the period from October 2004 to May 2005. The total length to the nearest millimeter, total weight to the nearest 0.1g, and sex were taken for each individual of *Saurida undosquamis* females.

Samples were measured to study the length frequency distribution which was divided into 1.0 cm length class. The relation between the total length (L) and total weight (W) was computed according to the FAO-ICLARM Stock Assessment Tools (FiSAT; Gayanilo et al., 1997) was used for all computation using the formula: $W = a L^b$ where a and b are constants whose values were estimated by the least square method.

Aging determined by Battacharya (1967) method which depends on analysis of length frequencies, the back-calculated lengths were applied according to Gulland and Holt (1959) plot incorporated in FiSAT software package to estimate the von Bertalanffy growth parameters (L_{∞} , K and t_0). The growth performance index (ϕ) was computed according to the formula of Pauly and Munro (1984) as

$$\phi = \text{Log } K + 2\text{Log } L_{\infty}$$

The sex and maturity stage of each specimen were determined morphologically. The stages of maturation were classified according to Ramadan 1995 scale.

Stage I (Virgin): The ovaries occupy less than a quarter of the body cavity. They are ribbon like bands and transparent in colour or having pale yellowish red colour.

Stage II (Maturing virgin): The ovaries become broader than the virgin stage one and long occupying third of the body cavity. The ovaries are light red or pink in color.

Stage III (Developing): The ovaries increase in size and occupies about half of the body cavity. They are red or reddish-brown in color.

Stage IV (Developed): The ovaries in this stage reach to their maximum development and nearly fill the body cavity. Ovary is pinkish-yellow with granular appearance and ripe ova could be easily extruded upon exerting a slight pressure on the belly.

Stage VI (Spawning): The ovaries are slightly shrunk and flaccid but not completely hollow due to discharge of ova during the spawning process. The ovaries are red or redish-yellow in colour with crumpled in shape.

Stage VII (Spent): The ovaries are flaccid in shape and sometimes contain large opaque-yellow residual eggs. The ovaries wall are filled with blood capillaries where they have deep red colour.

The gonado somatic index (GSI) was calculated monthly by the equation:

$$\text{GSI} = (\text{gonad weight/fish weight without gonad}) \times 100$$

The total mortality coefficient "Z" was estimated using the method of Pauly (1983a). The natural mortality coefficient "M" was estimated using the formula of Pauly (1983b). while the fishing mortality coefficient "F" was estimated as :

$$F = Z - M.$$

The exploitation rate "E" was calculated using the formula of Gulland(1971) as:

$$E = F/Z$$

The length at first capture " L_c " was estimated by the analysis of catch curve using the method of Pauly (1984 a&b). Relative yield per recruit (Y/R)' and relative biomass per recruit (B/R)' were estimated using the model of Beverton and Holt (1966) as modified by Pauly and Soriano (1986) and incorporated in the FiSAT software. This model is defined by:

$$Y/R)' = E U^{M/K} [1 - (3U/1+m) + (3U^2/1+2m) - (U^3/1+3m)]$$

$$(B/R)' = (Y/R)'/F$$

where (Y/R)' is the relative yield per recruit

(B/R)' is the relative biomass per recruit

$$m = (1-E)/(M/K) = (K/Z)$$

$$U = 1 - (L_c/L_{\infty})$$

M = the natural mortality coefficient

F = the fishing mortality coefficient

K = the growth parameter

E = the exploitation rate

Results

The obtained results revealed that the maximum life span of *Saurida undosquamis* females is six year at length 14.80, 19.81, 23.34, 25.92, 28.10 and 30.10 cm.(Table 1).

Length and weight measurements of 434 specimens were used to describe the length-weight relationship of *Saurida undosquamis* females in the Gulf of Suez (Figure 1). Their total lengths varied between 13.3 and 34 cm while the total weights ranged between 8 and 130.5 g. The obtained equation was as follow:

$$W = 0.0038 L^{3.1666}$$

The obtained equations were as follow:

$$\text{For growth in length } L_t = 35.56 (1 - e^{-0.3(t+1.3)})$$

$$\text{For growth in weight } W_t = 326.35 (1 - e^{-0.3(t+1.3)})^{3.1666}$$

The growth performance index (ϕ) of *Saurida undosquamis* females was computed as 2.602.

Table 1. Minimum, Maximum and average length of *Saurida undosquamis* collected from Gulf of Suez, during the period from October 2004 to May 2005

Age	Minimum length(cm)	Maximum length(cm)	Aver.
I	13.3	15.9	14.80
II	15	20.9	19.81
III	19	23.9	23.34
IV	22	26.9	25.92
V	27	30.9	28.10
VI	30	34	30.10

The results from figure (2) indicate that the total mortality coefficient "Z" was estimated as 1.22 year⁻¹. The value of natural mortality coefficient "M" was estimated as 0.23 year⁻¹, while fishing mortality coefficient "F" was estimated as 0.99 year.

Exploitation rate "E" of females was computed to be 0.81.

The length at first capture was obtained as $L_{50\%} = 18.89\text{cm}$ which corresponded to an age of 1.81 (Fig. 3).

The length at which 50% of fish population reaches sexual maturity (L_{50}) is considered to be the length at first sexual maturity according to Pitt (1970). The present study divided length of fish to different groups and classified them into two main categories Immature and mature individuals. Where fish of stages I & II are collected under immature but fish gonad of stages from III to VII are considered as mature. L_{50} value was found that female *S undosquamis* fish reach first sexual maturity at 18.1 cm. Figure (4) demonstrated that all females with total length less than 15 cm are immature, while other fish longer than 23 cm are mature.

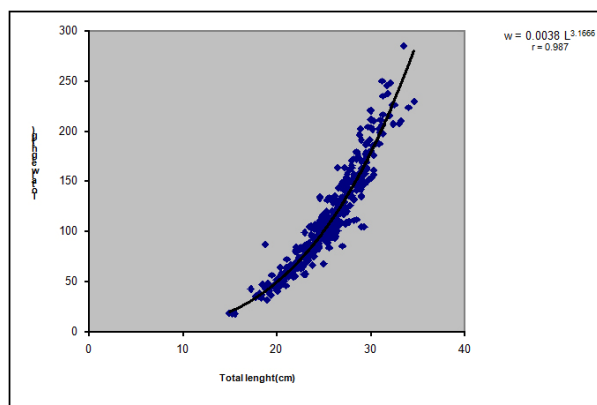


Figure 1. Length-weight relationship of *Saurida undosquamis* females from the Gulf of Suez.

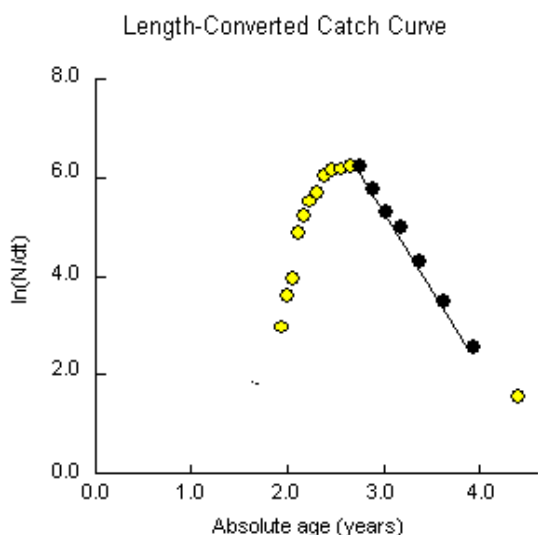


Figure 2. Estimation of Z of *Saurida undosquamis* females from the Gulf of Suez.

Monthly changes of GSI of female *S. undosquamis* as shown in Figure (5) demonstrated that mean GSI values range between minimum value 3.25 in January and maximum value 11.41 in May. In December the value of GSI elevate to record 7.76 between two lower values.

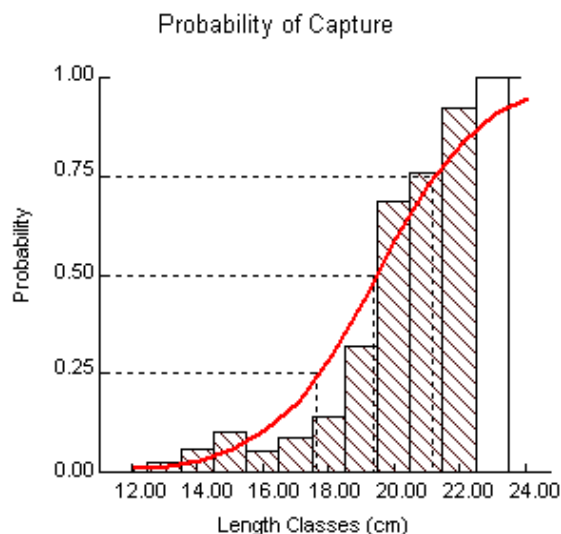


Figure 3. Length at first capture L_c of *Saurida undosquamis* females from the Gulf of Suez.

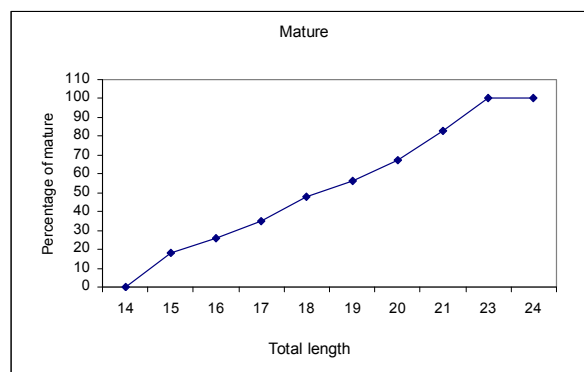


Figure 4. Length at first sexual maturity for female *Saurida undosquamis* collected from from gulf of Suez, during the period from October 2004 to June 2005.

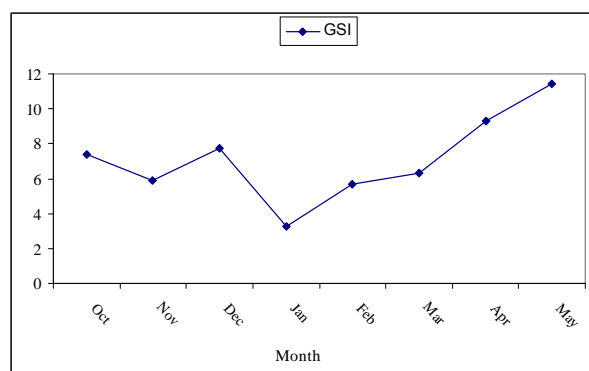


Figure 5. Monthly variaton of the average Gonado-Somatic Index of female *Saurida undosquamis* from gulf of Suez, during the period from October 2004 to May 2005.

The ova of *S. undosquamis* are differentiating microscopically into four groups. The first group of ova ranging between >0.1 mm to 0.3 mm. This group called transparent group where eggs are small and immature. The second group ranging between 0.3 mm and 0.6 mm. They characterized by the occurrence of a small amount of yolk. The third type of ova ranging from 0.6 mm to 0.8 mm in diameter. The ova have full deposition of yolk. The fourth group includes the highly developed ripe ova ranging from 0.9 mm to 1.0 mm in diameter where represented in the anterior part of ovary near to the genital opening during the process of spawning.

The diameter of eggs varying from month to another (Table 2). The first two groups of ova diameter are represented allover females collected during the period of study. Third group which called full deposition yolk demonstrated during period of study except in January. Also, in November and February ova with diameter 0.7 mm occurred only. The fourth group of ova diameter showed separately in October and December. While this group of eggs showed continuously from March to may where the last two month represented the highest percentage of ova diameter.

Table 2. Monthly frequency of egg diameter of *Saurida undosquamis* collected from Gulf of Suez, during the period from October 2004 to May 2005

Month	No.	Egg diameter (mm)										
		>0.1	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
October	12	6	7	11	10	16	22	9	15	2	2	-
November	21	5	7	6	10	19	35	3	5	-	-	-
December	19	4	2	3	7	10	16	12	25	3	8	-
January	14	2	5	18	25	30	14	6	-	-	-	-
February	15	6	4	7	8	27	36	8	4	-	-	-
March	16	4	8	10	19	14	18	12	4	6	5	-
April	10	2	5	8	6	11	22	23	11	8	4	-
May	15	3	2	4	5	3	6	18	22	10	12	15

The relative yield per recruit (Y/R)' and relative biomass per recruit (B/R)'of *Saurida undosquamis* females in Gulf of Suez were calculated (Fig. 6). The maximum (Y/R)' was obtained at $E_{Max}= 0.68$ as the exploitation rate increases beyond this value, relative yield per recruit decreases. Both of $E_{0.1}$ (the level of exploitation at which the marginal increase in yield per recruit reaches 1/10 of the marginal increase computed at a very low value of E and $E_{0.5}$ (the exploitation level which will result in a reduction of the unexploited biomass by 50%) were estimated. The obtained values of $E_{0.1}$ and $E_{0.5}$ were 0.606 and 0.377 respectively. The results indicated that the present levels of E and F were higher than those which give the maximum (Y/R)'. Also the present level of exploitation rate (E = 0.81) is higher than the exploitation rate ($E_{0.5=0.377}$) which maintains 53.46% of the stock biomass (Fig. 7). For management purposes, the exploitation rate of *Saurida undosquamis* females to be reduced from 0.81 to 0.37 (53.46%) to maintain a sufficient spawning biomass.

Discussion

The study of age and the growth of fishes are of vital importance in the field of fisheries management. Information on age and growth parameters are used for evaluation of the population structure and yield per recruit of an exploited fish stock.

In the present work the longevity was about six years using Bhattacharya (1967) method, this agree with the finding of EL-Ganainy (2004). It is noticed that males of *Saurida undosquamis* reach their highest growth in length at the end of the first year of life about (14.80).While a minimum values were computed at the end of the last year of life (2) at the sixth year of life.

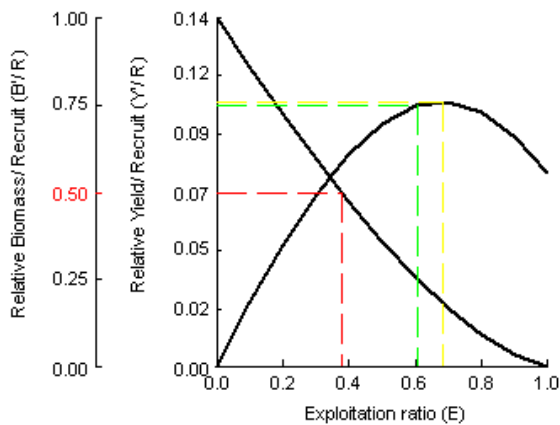


Figure 6. Yield of biomass per recruit of *Saurida undosquamis* females from the Gulf of Suez (Lc=18.89)

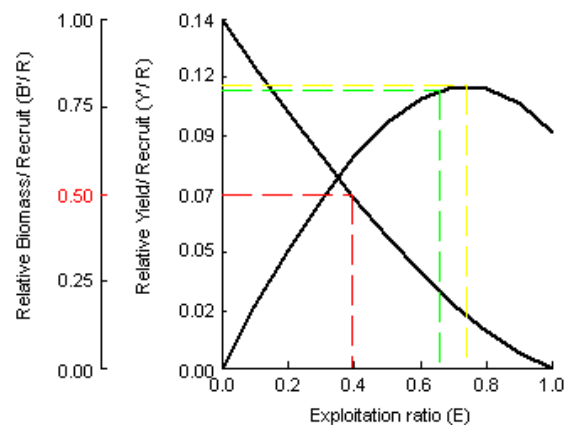


Figure 7. Yield of biomass per recruit of *Saurida undosquamis* females from the Gulf of Suez (Lc=21).

The value of the constant (b) of the length –weight relationship of *Saurida undosquamis* obtained from the

present study is similar to what mentioned from EL-Ganainy (1992, 2004), this due to the same of condition factors.

The mathematical growth models permit the description and comparison of growth of different species at different times and localities. The constant obtained from the fitting of the observed growth data in mathematical models is used in yield equation and fishery management.

The von Bertalanffy growth model was used to describe the theoretical growth of *Saurida undosquamis* females. ($K = 0.26$ and $L_{\infty} = 35.56$) the values indicated that high longevity and less growth rate. This similar to that obtained by EL-Ganainy (1992, 2004) were $K = 0.11$, 0.17 and $L_{\infty} = 55.65$ and 11.72 respectively.

Knowledge of the mortality rate is very important in expressing the dynamics of fish population. The instantaneous mortality coefficient is integrated in yield per recruit model. In the present study, the low value of M were correlated with the low K value of *Saurida undosquamis* females in the Gulf of Suez.

Gulland (1971) suggested that the optimum exploitation rate is about 0.5, so the high value of the present exploitation rate indicates that the stock of *Saurida undosquamis* females is overexploited.

Length at first capture (L_c) is the length at which 50% of the fish at that size are vulnerable to capture) was estimated as a component of the length converted catch curve analysis (Pauly, 1984a&b). The value obtained was $L_{50\%} = 18.89$ cm which corresponded to an age of 1.81 (Fig. 4).

Maturity stages of female *S. undosquamis* showed seven stages Stage I (virgin), stage II (maturing virgin), stage III (developing), stage IV (developed), stage V (gravid), and stage VI (spawning) and stage VII (spent stage). This result coincides with (Latife and Shenoda 1973, Ramadan 1995 and EL-Greisy, 2005)

The length at first sexual maturity " L_{50} " of female *S. undosquamis* demonstrated that fish at length under 15 cm have immature gonads but at this length gonad begin maturation process and developing in maturity stages. L_{50} female determine at length 18.1 cm was corresponding to an age of two years While female at length 22 cm represented 100 mature The smallest length recorded in the catch was 13.3 cm, which was smaller than the L_{50} and also the length at first capture was nearest to L_{50} this means that the exploited *Saurida undosquamis* females must be protected in order to share at least once in the spawning.

Faltas (1993) recorded a range of (16-22 cm) for the same species. Latife and Shenoda (1973) recorded (16 – 18 cm) in the Gulf of Suez where the variation of the present study demonstrates the changes of condition factors which play an important role in the maturation of gonads. This was indicated through studies which were taken in other regions in the same species such as Budnichenko & Dimitrova, 1979 recorded (17 – 18 cm) in the Arabian sea. Rao (1983) recorded (14-26 cm) total length in the Indian waters. These different data from different regions means that length at first sexual maturity are related to the environmental conditions.

Gonado somatic index is a main item to give a background about the spawning season of *S. undosquamis*. Monthly distribution of GSI values demonstrated that the main maximum GSI is in May. Then it decreases gradually in the following months. GSI values allover the fishing period demonstrated that the spawning season of *S. undosquamis* is long. This results agreement with Ramadan, 1995 who indicated that the main GSI occurs in December and May although the spawning stages found all the year around.

The range of egg diameter values ranging from less 0.1 to 1.0 mm. According to Ramadan, (1995) found the same range of egg diameter but EL-Gereisy (2005) found the range extend from 0.8 to 0.12 mm.

The present study indicates that the spawning activity of *Saurida undosquamis* extends nearly all the year round with two main peaks of spawning at December and May.

Gulland (1971) reported that the optimum exploitation rate of any exploited stock is about 0.5, according to the results of Beverton and Holt (1959) analysis, It could be concluded that the *Saurida undosquamis* stock in the Gulf of Suez is overexploitation ($E = 0.81$) and to maintain this valuable fish resource, the exploitation rate should be reduced below the optimum value as well as increasing the length at first capture to be about 21cm.

Sanders et al. (1984) came to the same conclusion. They stated that the stock of *Saurida undosquamis* in the Gulf of Suez is fully exploited and any addition in the fishing effort will be associated with a decrease in the catch.

The previous studies recommended that the closing season of fishing for *S. undosquamis* in Gulf of Suez must extended from April to October and the mesh sizes used should be increased to catch fish at least 21 cm length.

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