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# REPRODUCTIVE BIOLOGY OF *TILAPIA ZILLII* (GERV, 1848) FROM ABU QIR BAY, EGYPT.

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*Keywords: Reproductive aspects, condition factor, hepatosomatic index, Tilapia zillii, Abu Qir Bay.*

## ABSTRACT

Reproductive aspects in addition to condition factor and hepatosomatic index were analyzed for Cichlid: *Tilapia zillii* collected from the beach-seiners operating in Abu Qir Bay during the period from June 2000 to February 2001. The overall sex ratio (M/F) was 1: 1.05. Length at first sexual maturity was 8.7 cm for females and 9.7 cm for males. Gonadosomatic index revealed that spawning season lasted from June to September with peak in July. Macroscopic examination for the gonads of *T. zillii* indicated that adult females had 4 stages of gonadal development (matureII; vitellogenic stage III; ripe stage IV and spent V). The maturity stages of males were three (matureII, mature III, and ripe stage). The microscopic features of gonadal sections of both females and males showed that *T. zillii* gonads developed like other tilapian fishes inspite of their hyper saline habitat. Ripe females released in the average about 2138 eggs per cm of length and 2464 eggs per gm of gutted body weight. Condition factor showed similar trend between both sexes of increase and decrease. Hepatosomatic index in females attained higher values over males.

## 1. INTRODUCTION

Tilapia is the common name applied to three genera of family Cichlidae: (*Sarotherodon; Oreochromis* and *Tilapia*) including about 70 species (Meyer, 2002). Reproduction in *Tilapia zillii* was studied by many authors: (Maclaren, 1981; Latif *et al.,*1986; Khallaf *et al.*, 1986; El-Haweet, 1991; El-Shazly, 1993; Phillips, 1994; Coward and Bromage, 1999; Negassa and Getahun, 2003 and El-Sawy,2006). *T zillii* is highly euryhaline i.e. can tolerate a wide range of salinity (Bayoumi, 1969; El-Zarka *et al.,* 1970; Fryer and Iles, 1972; Chervenski and Horing, 1973 and Meyer, 2002). El-Sayed (2006), mentioned that *Tilapia zillii; Oreochromis mosambicus* and *O.aureus* are the most salinity-tolerant tilapia species, while other tilapias are generally less euryhaline, and can grow, survive, and reproduce at 10 – 30 ‰, depending on the species, size and sex. Optimum temperature tolerance of *T. zillii* was found to be between 28.8 and 31.4 °C (Phillip and Ruwet, 1982). Samaan and Mikhail, (1990) pointed out that Abu Qir Bay was highly fertile. *Tilapia zillii* is a new invader to Abu Qir Bay from Lake Edku and well established in the marine habitat contributing about half of the economic catch by weight of small beach–seine (Faltas and Akel, 2003). This species became a distinct population having different biometric characters from that of Lake Edku (Akel, 2005b).

The present study aimed to assess the impact of the marine habitat in Abu Qir Bay on the reproductive biology of *T. zillii*. This study included the reproductive aspects (sex ratio; length at first sexual maturity; gonadosomatic index; gonad maturation; histological examination of the gonads and fecundity) in addition to condition factor and hepatosomatic index.

## 2. MATERIAL AND METHODS

Abu Qir Bay lies between 30° 5′ to 30° 22′ E and 31° 16′ to 31° 21′ N in the Mediterranean Sea. lt is situated between Rosetta mouth on the River Nile and Abu Qir town. It is a shallow circular basin with an average depth of 12 m and salinity ranging from 34.8 and 38.7‰ (Zakaria, 2007 – in press- p.c.) (Fig. 1).

A total of 348 specimens of *T. zillii ranging from* 4 - 16 cm total length, were collected monthly from beach – seiners operating in Abu Qir Bay, during the period from June 2000 to February 2001. In the laboratory, total length and total weight were recorded to the nearest centimeter and gram respectively. Condition factor was calculated according to the formula:

$$K = W \times 100 / L^3,$$

Where W = gutted body weight in g, L = total length in cm. Fishes were dissected, sex and maturity stages were determined macroscopically. Gonads and liver were removed weighed at accuracy of 0.01 gram. Gonadosomatic and hepatosomatic indices were estimated as the percentage of ovaries and liver weights respectively to the gutted body weight. For fecundity estimates the ovaries of 44 full mature and ripe ovaries were preserved in 10% formalin. Determination of maturity stages followed Latif and Saady (1973). Absolute fecundity as the number of mature ova that was likely to be spawned using ripe ovaries of higher gonadosomatic index by the method of Batts (1972). Relative fecundity as the number of eggs per length unit (cm) or gutted body weight (g) was calculated. For histological examination small pieces of gonad were fixed in Bouin's fluid, followed by dehydration in gradual series of alcohol, clearing, embedding in paraffin wax and transverse sections from 3-7 µm were obtained. Histological examination of the mature and ripe gonads was carried out on sections stained by the hematoxylin and eosin method. Oocyte size measurements were made under binocular microscope by eye piece micrometer (± 1 µm). Statistical analysis: t–test and Chi-square analysis were made according to Snedecor and Cochran (1967).

## 3. RESULTS

### 3.1. Sex ratio

From Table (1) it appears that the over all sex- ratio (M / F) was 1: 1.05. Occurrence of males was relatively higher than females in autumn (52.7%) and winter (56.7%), while for females, sex ratio was found to occur in higher percentage in summer (54.5%). Chi-square test ($X^2$) showed insignificant seasonal differences between both sexes ($P< 0.05$).

### 3.2. Length at first sexual maturity

According to Pitt (1970), the length at which 50% of a fish population reaches sexual maturity ($L_{50}$) is considered to be the length of the onset of sexual maturity. From Fig. (2), it is also clear that $L_{50}$ for females and males of *T. zillii* was attained at total length of 8.7 cm and 9.7 cm respectively belonging to age group II ( Akel , 2005a ). Both sexes were all sexually mature above 15 cm total length.

### 3.3. Gonadosomatic index (GSI)

Monthly variations in GSI revealed that both sexes followed nearly the same pattern. GSI showed higher values during the period from June to September with a peak in July, while the lower ones occurred during the period from October to February (Fig. 3). So, the period from June – September may be representing the spawning season of *T. zillii*. From Fig. (3), it is clear that females acquired higher GSI over males.

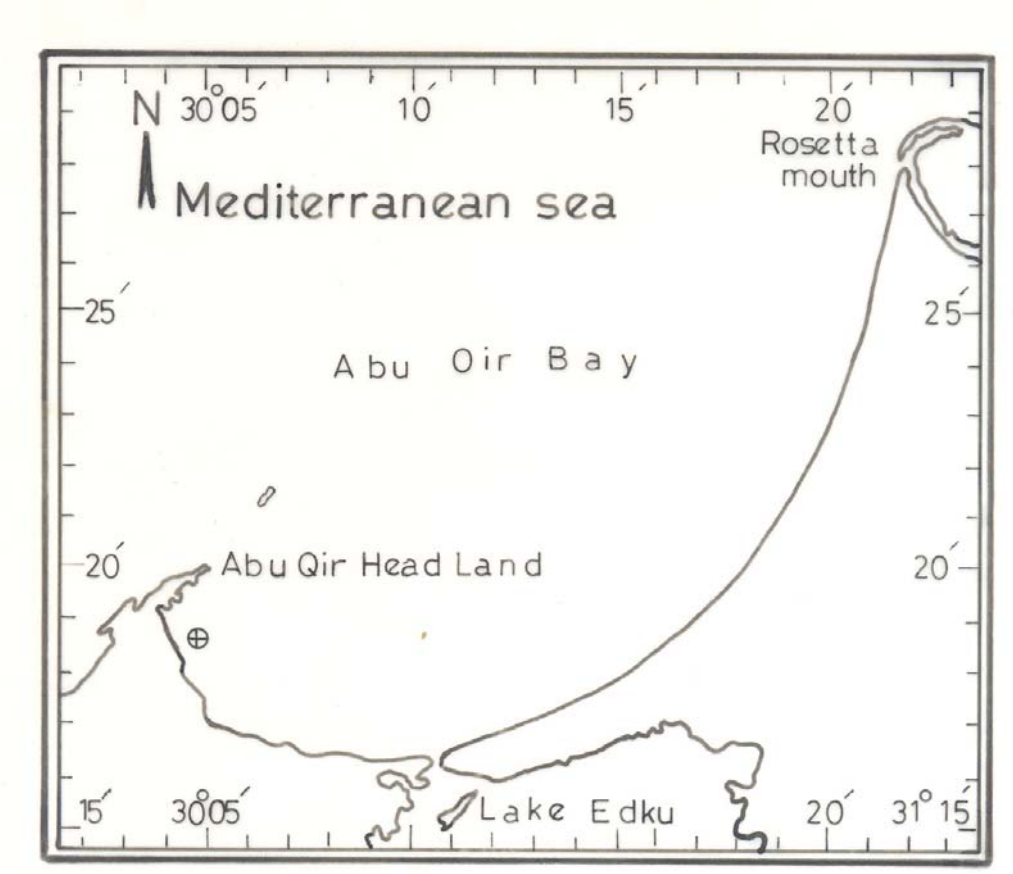


**Fig. (1): Study area showing the position of sampling.**

**Table (1): Seasonal variation in sex ratio for males and females of *T .zillii* from Abu Qir Bay.**

| Season | ♂ | | ♀ | | Chi-square | Sex-ratio |
|---|---|---|---|---|---|---|
| | No. | % | No. | % | $X^2$ | M / F |
| Summer | 61 | 45.5 | 73 | 54.5 | 1.075* | 1: 0.83 |
| Autumn | 58 | 52.7 | 52 | 47.3 | 0.327* | 1: 1.12 |
| Winter | 59 | 56.7 | 45 | 43.3 | 1.885* | 1: 1.31 |
| Total | 178 | 51.15 | 170 | 48.85 | 0.184* | 1: 1.05 |

* $X^2 = 0.184$ ($P < 0.05$)

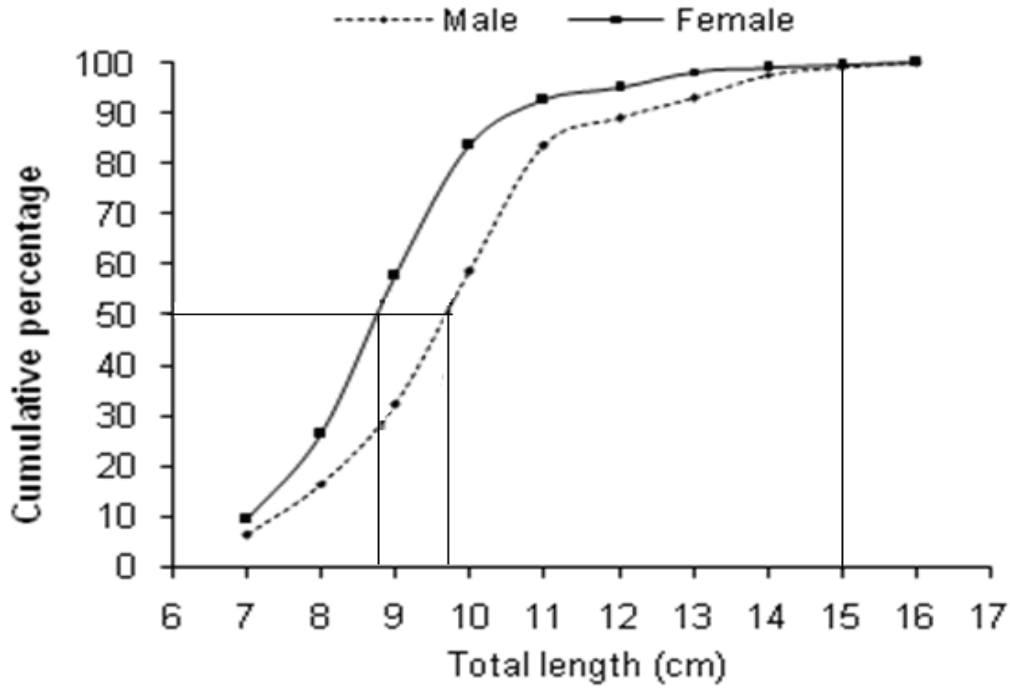


**Fig. (2): Length at first sexual maturity of *T. zilii* from Abu Qir Bay.**

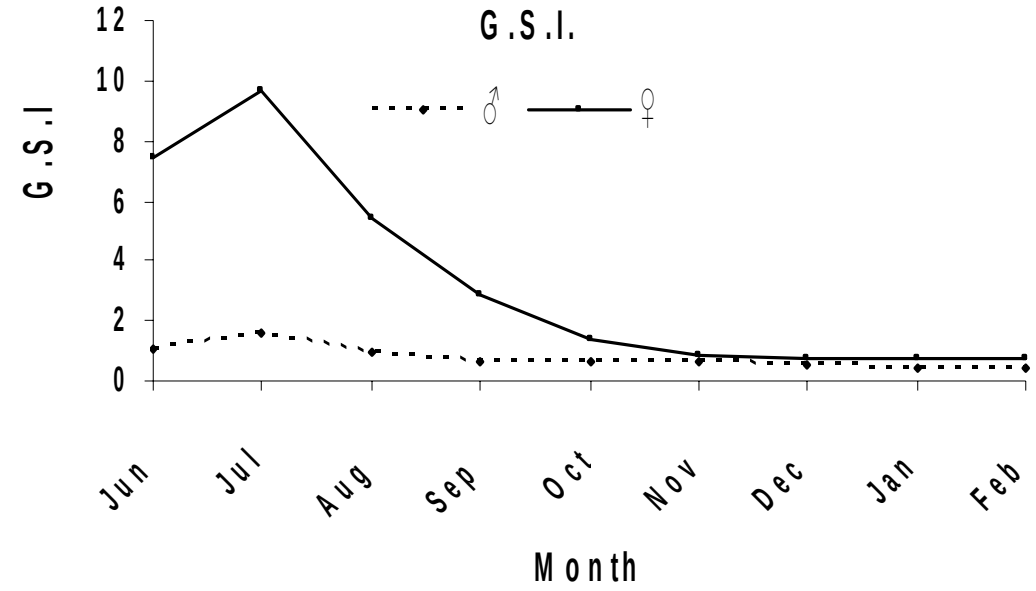


**Fig. (3): Monthly variations in gonadosomatic index (GSI) for males and females of *Tilapia zillii* from Abu Qir Bay.**

### 3.4. Gonad maturation

Macroscopic examination of the gonad of *T.zillii,*according to Latif and Saady (1973), showed that small immature males had translucent, thread – like testes while adult males out of spawning season had thread – like testes which were milky white in appearance with evidence of vascularization. The testes of mature males appeared swollen milky white and well vascularized and readily released milt under gentle pressure of the abdomen. Spent males had flaccid empty testes with evidence of hemorrhaging (bleeding).

Immature females had thread–like translucent ovaries. In maturing females (stage II) the ovaries were large occupying one to two third of the body cavity and were well vascularized with blood vessels. Ripe females (stage IV) had swollen green ovaries that occupied 2/3 of the body cavity. The spent ovaries appeared flaccid.

Percentage of gonadal maturity stages were as follows:

In females 32% of the total fish were in mature stage (II); 37% were in mature stage (III) and 31% were in ripe stage (IV). Therefore, 68% of total fish were in the reproductive process.

In males 35% of the total fish were in mature stage (II); 41% were in mature stage (III) and 24% were in ripe stage (IV). So, 65% of the total fish were in reproductive process.

Histological examinations were made for testicular & ovarian tissues of mature gonads:

#### *3.4.1. Females*

##### *3.4.1.1. Mature stage (II)*

The ovary in this stage contains oocytes in perinucleotic (PG) and previtellogenic (CA) stage. Perinucleotic oocytes were small in size measuring 15-120 µm and the nucleus was about 60% of the oocyte diameter with one or two nucleoli and intense basophilic cytoplasm. In previtellogenic oocytes (CA) the nucleus occupies about 2/3 of the cell and contains numerous nucleoli arranged under the nuclear membrane (Fig. 4).

##### *3.4.1.2 Vitellogenic stage (III)*

Oocytes at this stage measured 450 – 750 µm and contains yolk granules (protein yolk) and large vacuoles (fatty yolk). The nucleus was about 10–15% of the total oocyte diameter (Fig.5). The Zona Radiata ( Z R ) was visible just beneath the follicle having a diameter of 4 µm . The follicle consisted of two layers: an outer theca layer and inner glandular granulosa layer with 11 µm in thickness (Fig. 6 ).

##### *3.4.1.3. Ripe stage (IV)*

At this stage (I V ) the ovary was densely packed with vitellogenic oocytes and ova with hydrated yolk and could be seen through a thinly stretched ovarian tunica. The oocytes were rounded or ovoid and varied in diameter between 850 – 1550 µm. The nucleus disappeared due to heavy yolk accumulation (Fig. 7).

##### *3.4.1.4. Spent stage (V)*

In this stage a few small oocytes were present and was characteized by the presence of atresia of the remaining vitellogenic ova after spawning. Atretic oocytes characterized by breaking down of Z.R and proliferation of granulosa layer which invade the dead ova.and vacant spaces in the ovary (Fig. 8).

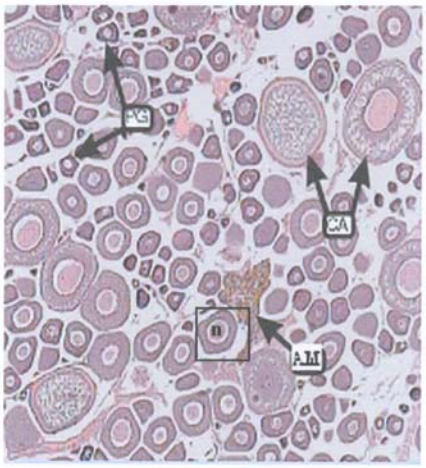


Fig.(4)- T.S. of the ovary of *Tilapia.*zillii stage (II) . X 250
PG = primary growth oocyte. CA = cortical alveoli oocyte n =nucleolus.
AM = Atretic macrophage.

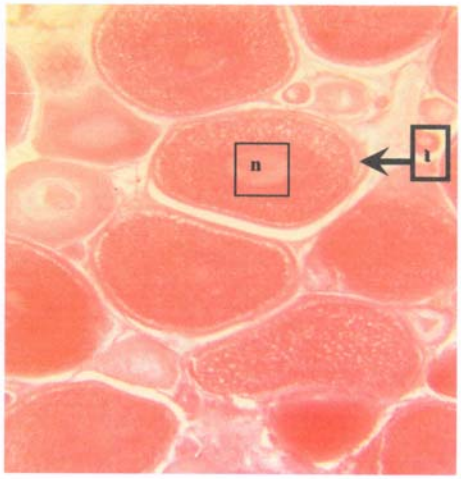


Fig.(5)- T.S. of the ovary of *Tilapia.*zillii showing the vitollogenic stage (III). X 250.
a – vacolised oocyte.
n - nucleolus.

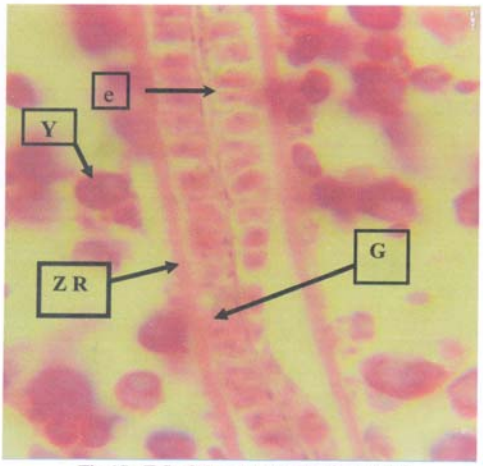


Fig.(6)- T.S.of the ovary of *Tilapia.*zillii showing the epithelial layer, granulosa and Zona-Radiata. X400.
e – epithelial follicle.
G – granulose.
Y – yolk globule.
Z R– zona radiata.

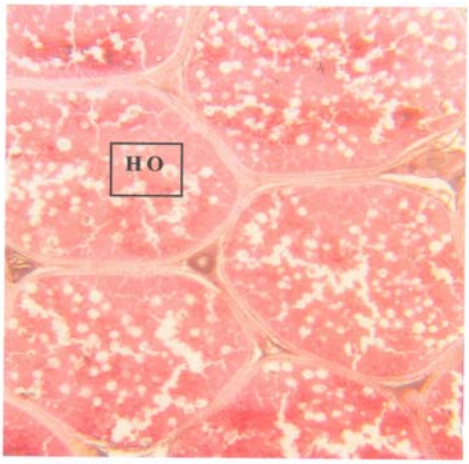


Fig.(7)- T.S.of the ripe ovary of *Tilapia.*zillii showing the ripe oocytes distended with yolk Globules
HO- Hydrated oocyte

### *3.4.2. Males*

Histological examination revealed that testis was divided into seminiferous lobules (SL) separated by interstitial tissue which contain interstitial (leyding) cells. SL of mature testes contain cysts of spermatogonia and developing germ cells (spermatocytes and spermatids). In ripe testis the lumen of the SL was full of spermtozoa and open into the central sperm duct which was also full of spermatozoa. Sections of the testes of mature males had spermatogonia and spermatocytes (Fig. 9) . In stage III the testes of *T. zillii* showed the presence of both spermatocytes and spermatozoa (Fig. 10). In a section taken from ripe males, the testes had lobules distended with spermatozoa ( Fig. 11).

## 3.5. Fecundity

Absolute and relative fecundity were calculated in relation to fish length and gutted weight.

### *3.5.1. Fecundity – total length relationship*

Table (2) shows the relationship between fecundity (absolute and relative) and total length for *T. zillii*. The relation was found to be curvilinear and represented by the following formulae:

Log Fa = 1.8618 + 1.3561 log L. (r = 0 .9775) (Fa = absolute fecundity).

Log Fr = 1.8602 + 0.3579 log L . (r = 0 .9715) (Fr = relative fecundity).

It was evident from table (2) that the calculated absolute fecundity for *T.zillii* ranged from 1220 and 3124 eggs with a mean 2139 ± 626 for fish of size range 8 to 16 cm total length .Also, it could be detected that the relative fecundity had the same trend of increase from 153 to 196 eggs per length unit with mean 176 ± 10.96.

### *3.5.2. Fecundity – gutted weight relationship*

The corresponding results concerning the relationship of absolute and relative fecundity to gutted weight of *T. zillii* were given in Table (3).The computed equations expressing these relations were as follows:

Log Fa = 2.46035 + 0.5981 log W. (r = 0.9519)

Log Fr = 2.1744 + 0.2250 log W. (r = 0.9603)

The calculated absolute fecundity ranged between 1144 and 366 eggs with mean 2464 ± 714.15 for fish with gutted weight ranging from 10 to 70 gram; while relative fecundity showed decreasing values from 89 to 58 eggs with mean 68 ± 8.21 as the fish increased in weight. Therefore, absolute fecundity increased as the fish increased in weight, while relative fecundity was higher in younger females than older ones.

## 3.6. Condition factor

Monthly variations in condition factor for males and females of *T. zillii* were shown in Fig. (12). It is obvious that for males higher values were detected in August (2.11) and November (1.99), meanwhile lower ones were found in September (1.61) and January (1.37). On the other hand, for females, higher values were found in August (2.01); and from October (1.81) to December (1.87) while the lowest value was noticed in September (1.48) (Fig. 12). From the figure, it was evident the conformity and nearly similarity between condition factor of both sexes i.e. they had more or less similar trend of increase and decrease. Statistical analysis (t- test), showed insignificant seasonal differences ($X^2 < 0.01$) between condition factor for males and females.

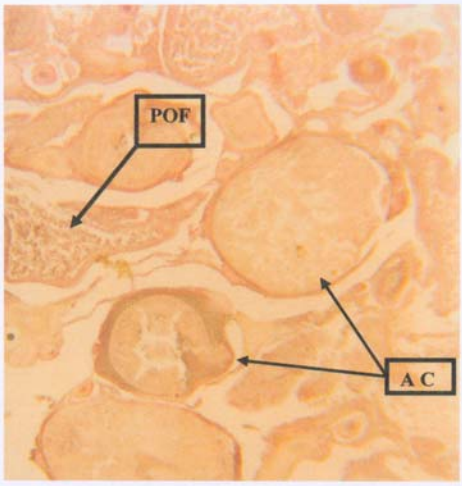


Fig.(8)- T.S.of the ovary of *Tilapia.*zillii stage (V) showing spent ovary with atretic oocytes.X250.
AC – atretic oocyte.
POF -postovulatory follicle

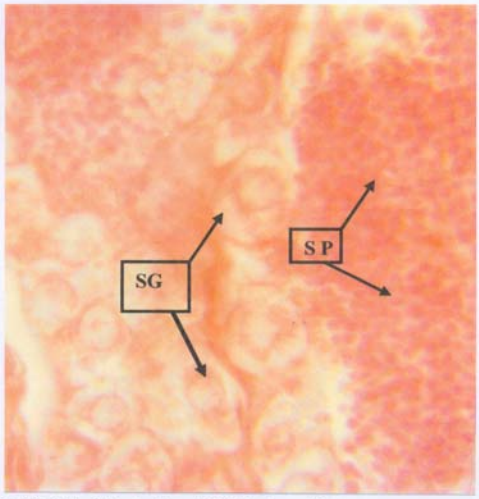


Fig.(9)- T.S. of the testis of *T.zillii* stage (II) showing the presence of spermatogonia and spermatocytes. X 400
SG - spermatogonia,
SP -- spermatocytes.

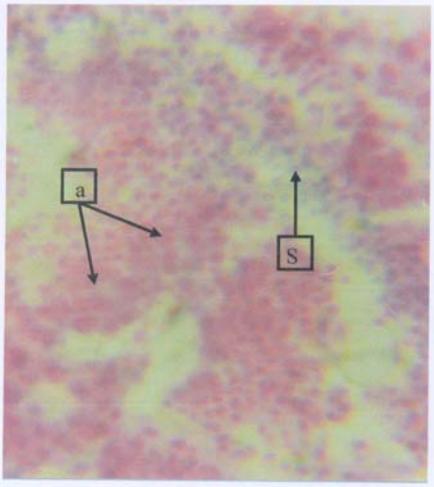


Fig.(10)- T.S. of the testis of *T.zillii* stage (III) showing the presence of spermatocytes and spermatozoa. X 400.
a – spermatocytes.
S - spermatozoa.

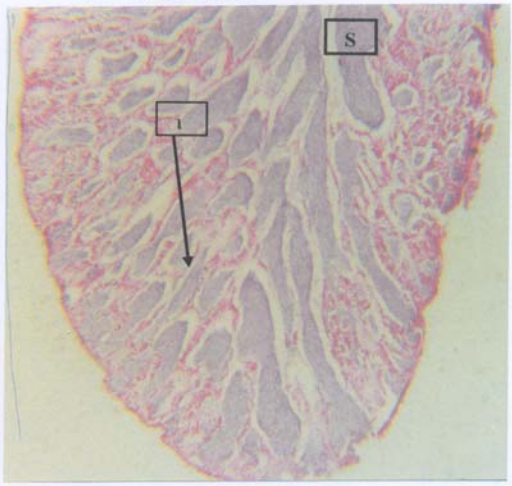


Fig.(11)- T.S. of ripe testis of male *T.zillii* showing the lobules destended with spermatozoa. X100.
a – lobules s- spermatozoa

**Table (2): Relationship between fecundity (absolute & relative) and total length of *T. zillii* from Abu Qir Bay.**

| Total length (cm.) | | Absolute fecundity | | Relative fecundity | |
|---|---|---|---|---|---|
| | No. | Obs. | Calc. | Obs. | Calc. |
| 8 | 2 | 1350 | 1220 | 169 | 153 |
| 9 | 3 | 1463 | 1432 | 163 | 159 |
| 10 | 5 | 1680 | 1652 | 168 | 165 |
| 11 | 6 | 1850 | 1880 | 168 | 171 |
| 12 | 9 | 1954 | 2115 | 163 | 176 |
| 13 | 8 | 2340 | 2357 | 180 | 182 |
| 14 | 5 | 2725 | 2607 | 195 | 186 |
| 15 | 4 | 2932 | 2862 | 196 | 191 |
| 16 | 2 | 3448 | 3124 | 216 | 196 |

**Table (3): Relationship between fecundity (absolute & relative) and gutted weight of *T. zillii* from Abu Qir Bay.**

| Gutted weight group (g) | No. | Absolute fecundity | | Relative fecundity | |
|---|---|---|---|---|---|
| | | Obs. | Calc. | Obs. | Calc |
| 10 | 3 | 1450 | 1144 | 145 | 89 |
| 20 | 9 | 1680 | 1732 | 84 | 76 |
| 30 | 10 | 1985 | 2207 | 66 | 70 |
| 40 | 8 | 2440 | 2622 | 60 | 65 |
| 50 | 5 | 3225 | 2996 | 65 | 62 |
| 60 | 5 | 3590 | 3341 | 60 | 60 |
| 70 | 4 | 4120 | 3664 | 59 | 58 |

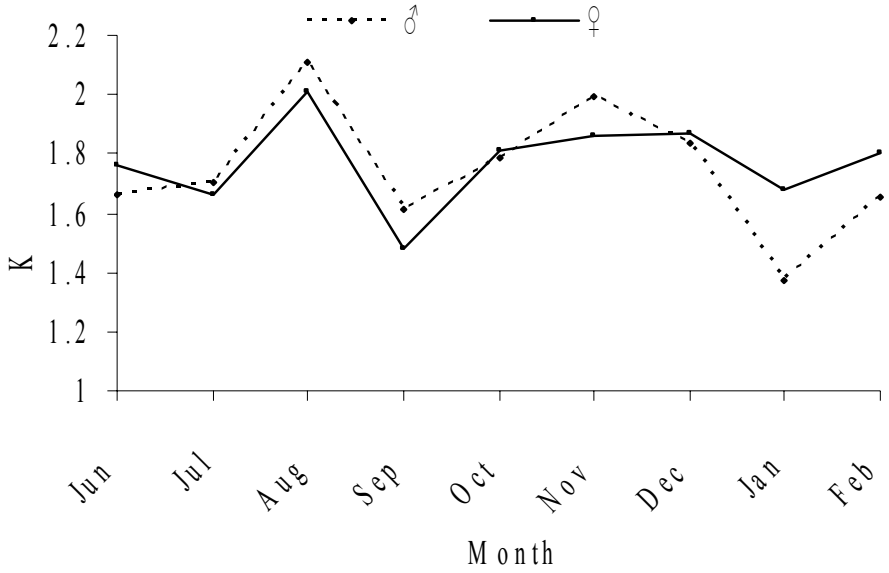


**Fig. (12): Monthly variation in condition factor (K) for males and females of *Tilapia zillii* from Abu Qir Bay.**

### 3.7. Hepatosomatic index (H S I)

Hepatosomatic index HSI of *T. zillii* is shown in Fig. (13). Generally, females had higher values from those of males particularly in December. However, indices of both sexes showed similar trend of increase in HSI after breeding season with marked increase in December for females. Lower values of HSI were recorded during spawning season for both sexes.

## 4. DISCUSSION

The present study in Abu Qir Bay, demonstrated that both sexes of *T.zillii* can survive and reproduce in hypersaline water. This observation conformed with the earlier investigators who reported that *T.zillii* can tolerate high salinity, survive and breed as well in the sea water (El-Zarka, 1956; Fishelson, 1966; Bayoumi, 1969 and El-Sayed, 2006).

It is worthy to mention that this species was clearly missing fom the beach seine catch during spring time and this finding may be related to two factors: **A**- A phenomenon took place in accordance with blooming in huge amount of the green algae (Caulerpa) and gastropods (Nudibranchia and jellyfish medusae). This flourishing and blooming in this season change the water quality and clogg the fishing nets. Moller, (1983) mentioned comments from many scientists indicating that jellyfish , under certain conditions of blooming and swarming , may interfere significantly with the development of young fish populations. As a result *T. zillii* was missing from the coastal fishing ground where the beach–seiners used to operate**. B**- This species in summer time approaches to the shoreside (as substratum spawner) to dig nests in the substratum to spawn and guard their progeny thereafter (Lowe-McConnel,1982). Futhermore,the next spring sampling during the present study , confirmed the same finding, where *Tilapia zillii* was markedly decreased from 50 % of the total catch in winter to only three specimens in spring time. So, the present study was confined to the period from June 2000 to February 2001.

The present study showed that the sex ratio (M / F) of *T. zillii* in Abu Qir Bay 1 : 1.05 was more or less in agreement with other localities: in Lake Mariut 1 : 0.91 ( El-Shazly,1993) ; in Lake Edku 1 : 0.91 (Phillips, 1994) and 1: 0.97 ( El-Sawy, 2006). Analysis of length at first sexual maturity for *T.zillii* from different localities was presented in Table (4). From the table , it is noticed that females reach their first sexual maturity before males : 8.7 cm (females) and 9.7 cm (males) in Abu Qir Bay ( present study) and this is in agreement with Lake Manzalah 8.6 cm (females) and 10.1 cm (males) (El–Shalloof, 1991). Both sexes reached first sexual maturity at the same length 7 cm in Lake Borollus (El–Haweet, 1991). In contrast to these findings, males reached first sexual maturity at smaller lengths than females: at 9 cm TL for females and 8 cm TL for males in lake Edku (Phillips,1994). These differences in length at first sexual maturity may be attributed to differences in genetical and environmental conditions such as food supply, population denisty and changes in temperature and salinity (Bardackci and Tanyoloc, 1990; Unlo and Balci, 1993). The present study revealed that, in Abu Qir Bay, *T. zillii* breeds with maximum activity during June and July. According to Maclaren (1981), cichlids exhibited prolonged spawning season in Lake Manzalah extended from April to September. Negassa and Getahun,(2003) declared that *T. zillii* in lake Zwai ( in Ethiopia) breeds all the year round with peak activites between April and September. This observation was more or less similar to those in other localities: in Lake Borollus ( El-Haweet, 1991); Lake Mariut (El-Shazly, 1993) and Lake Edku (Phillips, 1994). Gonadosomatic index of females was found remarkably higher in values over males.

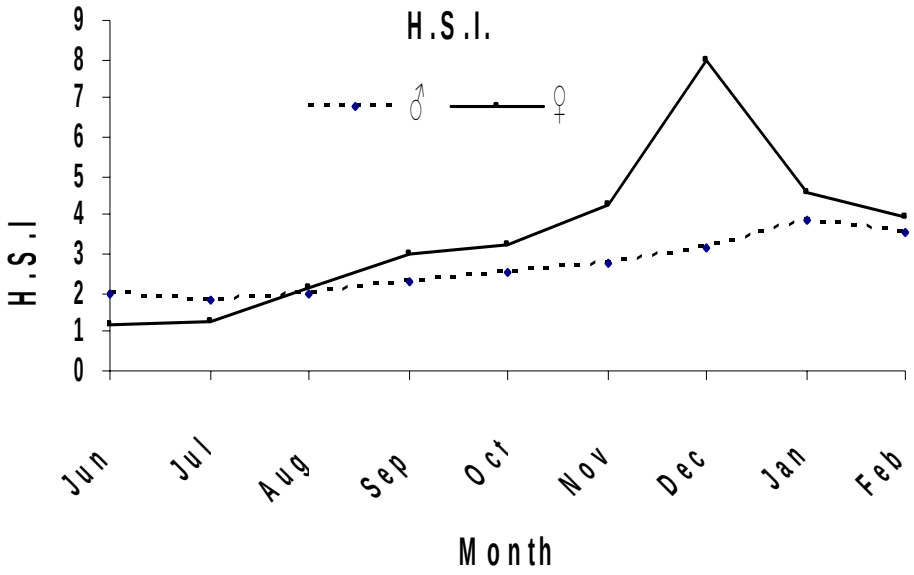


**Fig. (13): Monthly variation in hepatosomatic index (H.S.I) for males and females of *Tilapia zillii* from Abu Qir Bay.**

**Table (4): Comparative results of length at first sexual maturity of *T. zillii* in different localities.**

| Author | Locality | ♂ | ♀ |
|---|---|---|---|
| El-Haweet , ( 1991) | Lake Borollus | 7 cm | 7 cm |
| El-Shalloof , ( 1991 ) | Lake Manzalah | 10.1 cm | 8.6 cm |
| Phillips, (1994) | Lake Edku | 8 cm | 9cm |
| Present Study | Abu Qir Bay | 9.7 cm | 8.7 cm |

Normal oogenesis and spermatogenesis in the gonads of *T. zillii* during reproductive cycle were indicated by histological examination and were in accordance with Msiska and Costa-Pierce (1999) for the same species. Results of the present study demonstrated that the wall of vitellogenic ova consisted of three layers (zona radiata , granulosa and theca layer) as indicated by Coward and Bromage (1999)and Assem and El-Zaeem (2005) for *T. zillii.*

Cross sections of testes of *T.zillii* showed all stages of spermatogenesis . Ripe testes were composed mainly of lobules destended with spermatozoa. These findings were in agreement with those of Assem and El-Zaeem (2005).

Observations of fecundity give an indication of the state of the habitat and of the stock (Horwood, 1990). Lowe – McConnel (1982 ) mentioned that *Tilapia zillii* released six batches of adhesive eggs during its spawning period (6000–40000 egg per year).

The values of the absolute fecundity of *T.zillii* of the length ranging from (8–16 cm) from different lecalities were presented in Table (5) while the equations representing the relationship between absolute fecundity and total length and gutted weight were found to be as follows as given by various authors :

| | |
|---|---|
| Lake Borollus El-Haweet, 1991 | Log Fa = 1.881+ 1.388 Log L. (r = 0.963) |
| | Log Fa = 2.512+ 0.549 Log W. (r = 0.977) |
| Lake Edku Phillips , 1994 | Log Fa = 1.5744 + 1.660 Log L. (r = 0. 98561) |
| | Log Fa = 2.5931+ 0.5325 Log W. (r = 0. 975) |
| Abu Qir Bay Present Study | Log Fa = 1.8618 + 1.3561 log L. (r = 0 .9775) |
| | Log Fa = 2.46035 + 0.5981 log W. (r = 0.9519) |

The absolute fecundity of *T.zillii,* according to the present study, attained lower values in Abu Qir Bay 2139 ± 652, than in other areas studied . The highest values were found in fresh water- Bhar Shbeen Canal (4514 ± 2270) ( Latif *et al.* , 1986 ) followed by: Lake Borollus (2451±782) (ElHaweet, 1991); and Lake Edku (2367 ± 903) (Phillips, 1994). Applying t-test analysis, between Abu Qir Bay and Lake Edku, the difference was insignificant at ($P< 0.05$) while it was significant between Abu Qir Bay and Lake Borollus. So , it can be stated that though *T.zillii* in Abu Qir Bay became well established in the marine environment but still resemble the same population in brackish water (Lake Edku). Rogers (1989), and Wootton (1990), stated that the variation of fecundity within wide limits of fishes of the same length may be due to ecological conditions, genetic factors or total amount of energy given to the ovary during gonad maturation.

Table (6) shows that *T.zillii* in Abu Qir Bay (Present study) attained values of condition factor (1.74 ± 0.1826) for males and (1.81 ± 0.1086) for females. In Lake Borollus, values of condition factor for this species were (1.6 ± 0.1296) for males and (1.63 ± 0.1311) for females (El-Haweet,1991); in Lake Edku males acquired (1.74 ± 0.027) and females (1.7 ± 0.048) (Phillips,1994). Using the t-test analysis,the difference between Abu Qir Bay and Lake Borollus was signficant at ($P>0.05$) while the difference between Abu Qir Bay and Lake Edku was insignificant at ($P<0.05$) and this confirmed that though *T.zillii* population established itself in the marine habitat of Abu Qir Bay but still looks like the same species in the adjacent Lake Edku as mentioned before.

Hepatosomatic index for females of *T. zillii* was generally higher than that for males. Brown (1957), mentioned that the accumulation and storage of fat and protein take place in the liver prior to the spawning in many fishes. Roberts (1978) showed that fermales HSI increase may be due to the increase in the hormones of the sexual activities. He also mentioned that the feeding activity increases after spawning to increase lipids, proteins and water contents of the liver

to meet the requirements of yolk deposition in the developing oocytes for the next season. Ellis *et al.* (1978) declared that the enlargement of the liver resulted from the physiological changes occurred during the prespawning period.

**Table (5): Absolute fecundity of *T. zillii* in different localities.**

| TL (cm) | Bahr Shbeen Canal Latif *et al* , (1986) | L. Borollus El - Haweet , (1991) | L.Edku Phillips, (1994) | Abu Qir Bay Present Study |
|---|---|---|---|---|
| **8** | 1638 | 1332 | 1048 | 1220 |
| **9** | 2155 | 1572 | 1441 | 1432 |
| **10** | 2754 | 1824 | 1716 | 1652 |
| **11** | 3439 | 2086 | 2010 | 1880 |
| **12** | 4212 | 2858 | 2323 | 2115 |
| **13** | 5076 | 2639 | 2653 | 2357 |
| **14** | 6032 | 2929 | 3000 | 2607 |
| **15** | 7084 | 3228 | 3364 | 2862 |
| **16** | 8233 | 3595 | 3745 | 3124 |
| **Mean** | 4514± 2270 | 2451±782 | 2367±903 | 2139± 626 |

**Table (6): Comparative results of condition factor K for *T. zillii* in different localities.**

| Author | Locality | Mean ± S.D. | |
|---|---|---|---|
| | | ♂ | ♀ |
| El-Haweet , (1991) | Lake Borollus | 1.6 ± 0.1296 | 1.63 ± 0.1311 |
| Phillips, (1994) | Lake Edku | 1.74 ± 0.027 | 1.7 ± 0.048 |
| Present Study | Abu Qir Bay | 1.74 ± 0.1806 | 1.81 ± 0.1086 |

## REFERENCES


Akel, E. H. Kh.: 2005, a. Growth, Mortalities And Yield Per Recruit Of *Tilapia zillii* (Gervais) (Pisces, Fam. Cichlidae) From Abu Qir Bay – Eastern Alexandria, Egypt. *J. Egypt. Acad. Soc. Environ. Develop. (D- Environmental Studies),* **6 (3)**: 17 – 31.

Akel, E. H. Kh.: 2005, b. Biometric Characteristics of *Tilapia zillii as* a new invader in Abu Qir Bay, Egypt *J. Egypt.Acad.Soc. Environ. Develop. , (Environmental Studies)*, **6 (3)**: 33 – 43.

Assem, S. S. and El-Zaeem, Sy.: 2005, Application of biotechnology in fish breeding .II Production of highly immune genetically modified redbelly tilapia,*Tilapia zillii J. Biotech.,* **4(5)** : 449-459.

Bardackci , F . and Tanyolac, J.: 1990, Effect of temperature on the biological characteristics of *Cyprinion macrostomus* Heckel, 1843 (Teleostie: *Cyprinidae*) *10 th Turkish Biol. Congress* , **4** : 243 – 256 .

Batts, B. S.: 1972, Sexual maturity, fecundity and sex ratio of the skipjack tuna ,*Katsuwonus pelamis* (Linn.) in North Carolina waters . *Trans. Amer. Fish. Soc.,* **101 (4):** 626 – 637.

Bayoumi, A.R.: 1969, Notes on the occurrence of Tilapia zillii (in Suez Bay). *J.Marine Biology.* **104(3):** 55-259.

Brown, M. E.: 1957, The physiology of fishes (1) : Metabolism. Academic Press Inc., Publisher,
New York. 447 pp.

Chervinski, J. and Horing, E.: 1973, *Tilapia zillii* (Gerv.) (Pisces, Cichlidae) and its adaptability to various saline conditions. *Aquaculture*, **2 (1)**: 23- 29.

Coward, K. and Bromage, N. R.: 1999, Spawning frequency, fecundity, egg size and ovarian histology in groups of *T. zillii* maintained upon two distinct food ration sizes from first feeding to sexual maturity. *Aquatic Living Resources.* **12** (1999): 11-22

El-Haweet, A. A.: 1991, Biological studies of some *Cichlid* species in Lake Borollus. M.Sc., Fac. Sci. , Alex. Univ. Egypt.

Ellis, A. E., Roberts, R. J. and Tyler, P.: 1978, The anatomy and physiology of teleosts. IN: Fish
Pathology (Ed.:Roberts, R.J. ). Baillier Tindall, London: 13-54.

El-Sayed, A. F. M.: 2006, Tilapia culture. CABI Publishing, Wallingford OX 108 DE, UK. 273 pp.

El-Sawy, W. M. T.: 2006, Some biological aspects of dominant fish population in Lake Edku in relation to prevailing environmental conditions, M. SC. Fac. Sci., Zagazig Univ., Egypt.

El-Shalloof, K.: 1991, Biological studies on tilapia species in the middle region of Lake
Manzalah.M.Sc.Fac.Sci.,MansuraUniv.Egypt.

El – Shazly, A.: 1993, Biological Studies On Four Cichlid Fishes *(Tilapia nilotica, Tilapia galilae, Tilapia zillii, Tilapia aurea)*. Thesis M.Sc. Fac. Sci. Zagazig Univ. Egypt.

El-Zarka, S.: 1956, Breeding behaviour of the Egyptian Cichlid Fish *Tilapia zillii.* Copia (1956).

El-Zarka, S. A.; Koura, R. and Shaheen,A. H.: 1970, Selectivity of wire basket traps for tilapias (*T.nilotica, T,galilae*,, and *T. zillii*) *J. Cons. Int. Explor. Mer.,* 282-291.

Faltas, S. N. and Akel, E. H. Kh.: 2003, Investigation of beach seine catch of Abu Qir Bay (Egypt) .*Bull. Nat. Inst. Oceanogr. & Fish. , A.R.E.,* **29**: 117- 135.

Fishelson, L.: 1966, Cichlidae of genus Tilapia in Israel .*Bamidgeh* , **8 (3)** : 67-80.

Fryer, G. and Iles, T. D.: 1972, the Cichlid Fishes of Great Lakes of Africa: Their Biology and Evolution. Oliver and Boyed, Edinburgh, 641 pp.

Horwood, J. W.: 1990, Fecundity and maturity of plaice *(Pleuronectes platessa*)

From Cardigan Bay. *J. Mar. Biol. Ass. U. K.,* **70**: 515 - 529.

Khallaf, E. A.; Latif A. F. A. and Al ne – nae, A. A.: 1986, Reproduction of *Tilapia nilotica* (Linn.) And *Tilapia zillii* (Gerv.) in a Nile Canal and its interaction with the environment , *Delta J. of Sci* . **10, (2)** 724 – 747.

Latif, A. A., and Saady, B.E.: 1973, Reproduction in the Nile Bolti, *Tilapia nilotica*. *Bull.Inst.Ocean. Fish.,* **3**:120-142.

Latif, A. A., and Saady, B.E.: 1973, Oogenesis in the Nile Bolti, *Tilapia nilotica*. *Bull. Inst. Ocean Fish.* **3**: 183 - 202.

Latif , A . A.; Khallaf E. A. and Alne – nae, A. A.: 1986, Reproduction of *Tilapia*s in a Nile Canal and its interaction with the environment, M. Sc. Thesis Fac. of Sci., Almonofya Univ. Egypt.

Lowe-McConnel, R. H.: 1982, the biology and culture of *Tilapias*. Conf. Proc.7, Inter. Cent.For Living Aquatic Resor. Manag. Manila, Phillipines, 432pp.

Maclaren, J. F.: 1981, Lake Manzalah Study Report to the A. R. E., Ministry of Development and New Communities and U N D P office for projects excusions . vol. **12**.

Meyer, D.E.: 2002, Technology for successful small-scale tilapia culture (CRSP Research Report 02-179). CRSP (Aquaculture Collaborative Research Support Program). [Abstract from original paper published in: D. Meyer (Ed). 6to Simposio oamericano de Acuacultura Proceedings: Tilapia Sessions, 22-24 August 2001. Tegucigalpa, Honduras, pp. 97-106].

Moller, H.: 1983, Effects of Jellyfish predation on fishes. Workshop on Jellyfish Blooms in Mediterranean Sea (Athens, 31 October – 4 Nov. 1983). Long–term Program for Pollution Monitoring and Research in the Mediterranean Sea) MED POL – PHASE II ). : 45 – 59.

Msiska,O.V. and Costa Pierce, B.A.: 1999, Maturity and gonads changes of *Oreochromis karonga* raised in fish ponds in Malawi. *J. Appl. Icth.* **15(3)**: 97-103.

Negassa, A. and Getahun, A.: 2003, Breeding season, length-weight relationship and condition f introduced fish, *Tilapia zillii* Gerv.1848 (Pisces: Cichlidae) Lake Zwai, Ethiopia. SINET: *Ethiopian Journal of Science*, **26(2)**: 115 - 122.

Phillip, J. C. L. and Ruwet, J. C. L.: 1982, Ecology and distribution of Tilapias ICLARM, Conf. *Proc. Manila, Phillipines.* **7**: 15 - 59.

Phillips, A. E.: 1994, Studies on the biology of two *Tilapia* species in Lake Edku. M.Sc. Thesis, Fac. Sci. Alex. Univ. Egypt.

Pitt, T. K.: 1970, Distribution, abundance and spawning of yellowtail flounder, *Limanda ferruginea*, in the New Foundland area of the North West Atlantic.l *J. Fish. Res. Bd. Canada,* **27(12)**:2261-2271.

Roberts, R. J.: 1978, the pathophysiology of teleosts. IN: Fish pathology (Ed.:Roberts, R. J.). Baillier Tindall, London: 55-91. Rogers, S. I., 1989. Seasonal variations in fecundity and egg size of the common goby, Pomatoschistus microps. *J. Mar. Biol. Ass. UK.* **69**: 535-543.

Samaan, A. A. and Mikhail, S. K.: 1990, Distribution of phytoplankton in Abu Qir Bay. (Egypt). *Bull. Nat. Inst. Oceanogr. & Fish, A. R. E.,* **16(1)**: 65-72.

Snedecor, G.W. and Cochran, W. G.: 1967, Statistical Methods. Iowa State Univ., Ames, J. O. U. S. A., 341pp. Unlo, E. and K. Balci, 1993. Observation on the reproduction of *Leucicus cephelus orientalis ( Cyprinidae )* in Savur Stream ( Turkey ) . *Cybium* **17(13)**: 241 – 250.

Wootton, R. J.: 1990, Ecology of Teleost Fishes. Chapman & Hall Ltd. (Fish & Fisheries Series: I), 404pp.

Zakaria, H. Y.: 2007, Distribution of zooplankton assembledges in Abu Qir Bay, Alexandria, Egypt. Egypt. J. of Aqua. Res. 33 (1): 238-256