Full Length Research Paper

Reproductive biology and some observation on the age, growth, and management of *Tilapia zilli* (Gerv, 1848) from Lake Timsah, Egypt

Waheed Farg-Alla Mahomoud[1], Amal Mohamed Mahmoud Amin[2], Kamal Fathey Elboray[1] Amal Mohamed Ramadan and Magdy Mostafa Kamal Osman EL-Halfawy[1]*

[1]Fish Reproduction and Induced spawning Laboratory, Aquaculture Division, National Institute of Oceanography and Fisheries, Suez, Egypt.
[2]Stock Assessment Laboratory, Fisheries Division, National Institute of Oceanography and Fisheries, Suez, Egypt.

In the present investigation, some biological aspects of *Tilapia zillii* from Lake Timsah were studied. This was carried out on 700 fish samples collected during the period from October, 2002 to September, 2003. Total length of females ranged from 7 to 16 cm and males from 8 to 21cm. Age determination based on length frequency distributions showed that the life span are two and four years for females and males, respectively. Estimates of growth parameters are widely used for detailed assessment and modeling of fish species and fisheries. The length-weight relationship, age at length zero (t_o), growth coefficient (K), asymptotic length (L∞) and rates of natural (M) and total mortality (Z) were estimated for *T. zillii* from Lake Timsah. Length-weight relationships were calculated from individual fish length and weight records collected from sampling using gill nets. Analyses were obtained by sampling direct from the fisher's catches. Data were analyzed using the FISAT software. *T. zillii*, the estimate of K was 0.320 and 0.680 year^{-1} for males and females, respectively, whilst L∞ was approximately 22.05 and 17.85 cm, for males and females, respectively. *T. zillii* (males) had the lowest value of K and the largest L∞ than females. Natural mortality was the lowest for *T. zillii* (females) (M=0.464 and 0.38 year^{-1}) and fishing mortality was highest for *T. zillii* (males) (F=2.656, 1.88 year^{-1}). In addition, exploitation rate was estimated at E=0.83 and length at first capture (L_c) was calculated at 11.30 cm for males while E=0.78 and (L_c) was estimated as 6.68 cm for females. The majority of fish caught of the main commercial species in the Lake Timsah fishery were from the first age group, at a size far below the optimal length at capture. This suggests growth overfishing for *T. zillii* in Lake Timsah.

Key words: Lake Timsah, *Tilapia zillii*, age and growth, mortality, gonadosomatic index, length at first maturity, population structure.

INTRODUCTION

Though fishes are the most divers among the major vertebrate groups (Moyle and Cech, 1996), they are faced with considerable threads which are generally associated with a combination factors summarized in acronym HIPO (habitat destruction, introduced species, pollution and over exploitation) (Getahun and Stiassny,

1998). Tilapia is the common name applied to three genera of family Cichlidae (*Sarotherodon; Oreochromis* and *Tilapia*) including about 70 species (Meyer, 2002).

Tilapia zillii is widely distributed and has a very wide common range. However, in Egypt, *T. zillii* is widely distributed, supports important commercial fisheries and it is indigenous to Lake Timsah. Many authors studied the reproduction of *T. zillii* (Dudzie and Wangila, 1980; 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; El-Sawy, 2006; Akel and Moharram, 2007; Negassa and Padanillay, 2008). *T zillii* is highly euryhaline that is, can tolerate a wide range of salinity (Bayoumi, 1969; El-Zarka et al., 1970; Fryer and Iles, 1972; Chervenski and Horing, 1973; Meyer, 2002). El-Sayed (2006) mentioned that *T.zillii; Oreochromis mosambicus* and *Oreochromis aureus* are the most salinity-tolerant tilapia species, while other tilapias are generally less euryhaline, and can grow, survive, and reproduce at 10 to 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).

Fishes belonging to family Cichlidae are moderate in size, living in shallow and vegetative areas (Eccles, 1992). *T. zilli* is one of the most valued fish in North Africa. It constitutes an important part of inland fish production especially in the brackish lagoons of Morocco, Senegal River, Egypt and Libya (Teugles and Thys van den Audenaerde, 1991). Age and growth determinations are important in studying longevity, age at first maturity, catchable size and other life history problems in fishes (Lagler, 1966; Ricker, 1971; Lagler et al., 1977). Hadi (2008), studied age and growth of *T. zillii* in Umhfein Lake (Libya). Age and growth determination of *T. zilli* from the Egyptian waters were studied by Botros (1968), El-Zarka et al. (1970), Khallaf and El-Nenaei (1987), Latif et al. (1989), Faltas (1995) and El-Kashef (2002), but in Nigerian waters which were studied by Basu and Kalu (1999), and from the French waters which were studied by Panfili and Tomas (2001). Due to its economic importance and its common presence at the sample site, *T, zilli* was selected for investigation. The purpose of this study is thus twofold: To assess the impact of the marine habitat in Lake Timsah on the reproductive biology of *T. zillii*. This study included the reproductive aspects (sex ratio, gonadosomatic index and gonad maturation) in addition to condition factor and it was carried out to determine the fundamental growth parameters required for assessing and managing *T. zillii* stock at Lake Timsah.

MATERIALS AND METHODS

Materials for this study were obtained from 700 individuals ranging in size from 7 to 21 cm. Monthly samples of *T. zillii* were collected during the period from October 2002 to September 2003 by the gill net from Lake Timsah which lies on Suez Canal (Figure 1).

Fish total lengths were measured to the nearest centimeter and weighed to the nearest gram. The sexes and maturity stage were determined on sub-samples by dissection (Legendre and Ecoutin, 1989). Gonads were weighed to the nearest milligram and the gonado-somatic indexes of both sexes separately were determined as:

GSI=GW·100/BW

where GW=gonad weight and BW=body weight (de Vlaming et al., 1982).

Methods to estimate the length-weight relationship of fishes are described by Pauly (1983). The length-weight relationship (LWR) was estimated by using the equation:

$$W = aL^b$$

where W = weight in grams, L = total length in centimeters, a is a scaling constant and b the allometric growth parameter.

Condition factor was estimated according to the formula:

$$K = W * 100 / L^3$$

where W=gutted body weight (gm) and L=total length in (cm).

The FISAT software (Gayalino et al., 1997) was used with the length-frequency distributions (t_0) estimate von Bertalanffy growth parameters, (K) (growth coefficient) and (L_∞ (asymptotic length).

The growth performance index $\acute{O}$ described in Pauly and Munro (1984) was calculated using the relationship:

$$\acute{O}' = \log K + 2 \cdot \log 10 L_\infty.$$

Total mortality (Z) was estimated from length converted catch curves and natural mortality (M) which caused by all other factors except fishing, was estimated from the empirical relationship of Pauly (1980), as following:

$$\log 10 M = -0.065 - 0.287 \cdot \log 10 L_\infty + 0.604 \cdot \log 10 K + 0.513 \cdot \log T$$

using a mean annual environmental temperature of 25°C. The estimate of F was obtained by subtracting M from Z. then exploitation ratio was obtained as:

$$E = F/Z.$$

The length at first capture L_c was estimated by Pauly (1984a, b).

Relative yield per recruit (Y/R)´ and relative biomass per recruit (B/R)´ were estimated using Beverton and Holt's (1966) model as follows:

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

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

RESULTS AND DISCUSSION

Length- weight relationship

The length-weight relationship is helpful for estimating the weight of a fish of a given length and can be used in studies of gonad development, rate of feeding, metamorphosis, maturity and condition (Le Cren, 1951). The constants of the length weight relationship were determined separately for each sex and for combined sexes (Figure 2) the results were given by the following equation:

$$W = 0.0185 * L^{3.0055}$$

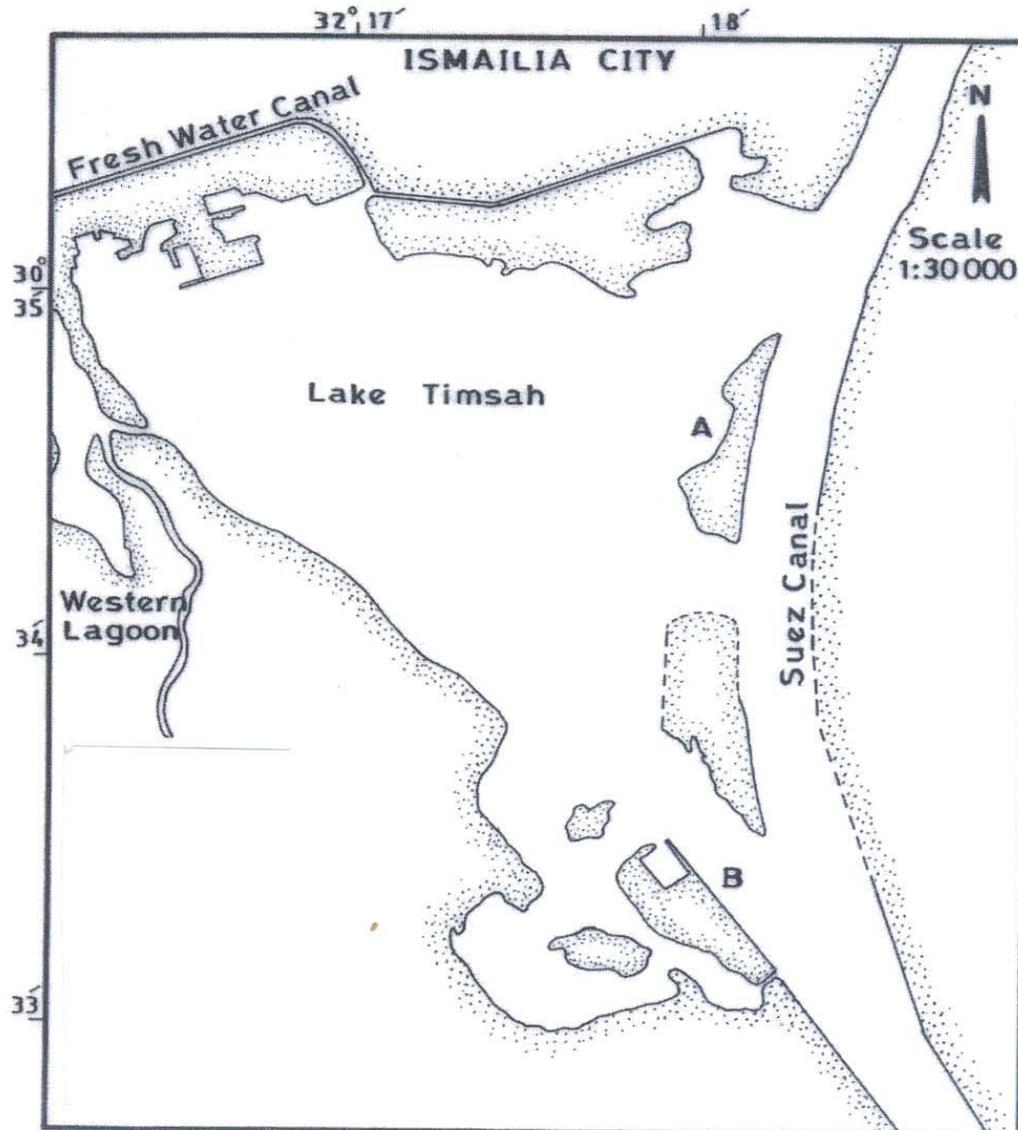($r^2 = 0.973$) (for males).

$$W = 0.0207 * L^{2..975}$$

Figure 1. Map of Lake Timsah.

$(r^2 = 0.921)$ (for females).

$$W=0.0207* L^{2.9667}$$
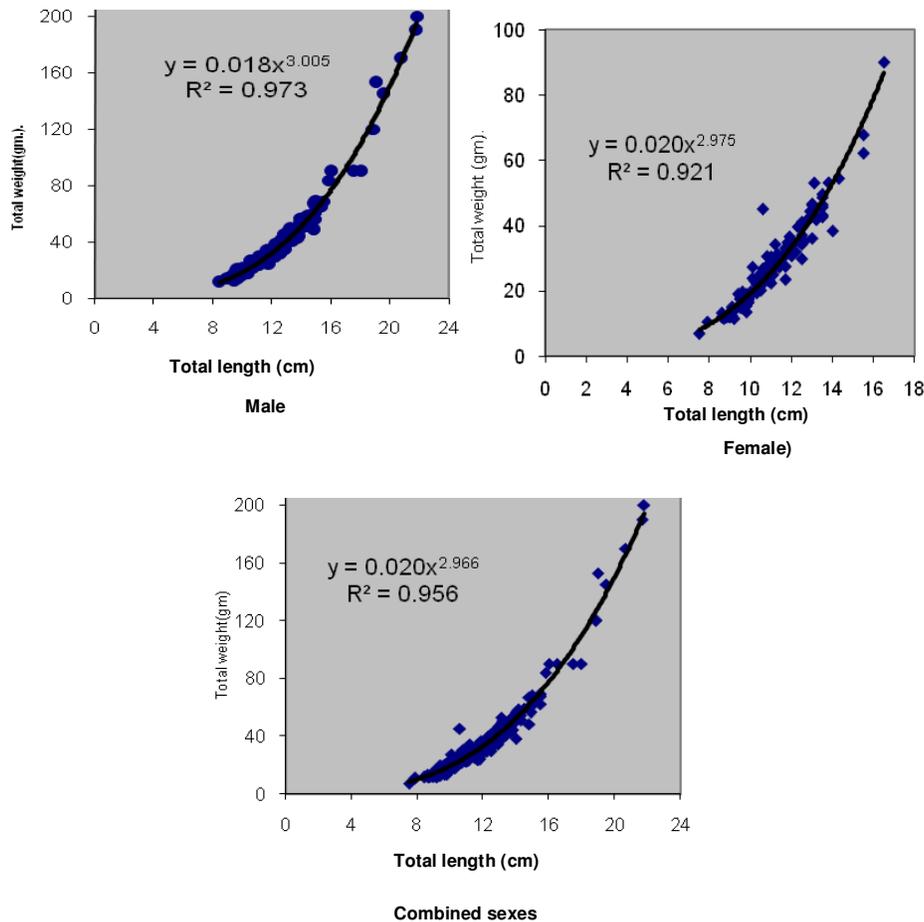
$(r^2= 0.956)$ (for combined sexes).

The previous data indicated high degree of correlation among both measures. A perusal of length-weight relationship, worked for *T. zillii* from, Lake Timsh showed the value of "b" for male and female and unsexed fish are very close to 3, that is, reflecting isometry, with highly significant values of the coefficient of determination (r^2). Our results are in agreement with Mehanna (2004) who recorded exponent (b) 3.088 of *T. zillii* in Wadi EL-Raiyan Lakes. The b value was 2.9 in Lake Qaurun recorded by Mosaad (1990). Abd-Allah et al. (2000) and Sholloof

(2009) recorded the same value of (b) =2.69 in Lake Qaurun and in Edko Lake. The differences in these values may be due to the difference in ecological condition.

The condition factor (k)

The value of the condition factor have been used to measure various ecological and biological factor such as degree of fatness, gonad development and the suitability of the environment with regard to the feeding condition (Mac Gregoer, 1959).

The mean values of condition factor for the total length between 8 and 21 for male and 7 to 16 for female of *T. zillii* ranged between 1.6603 to 2.0190 and 1.6354 to

$$y = 0.018x^{3.005}$$
$$R^2 = 0.973$$

Total weight(gm.)

Total length (cm)

Male

$$y = 0.020x^{2.975}$$
$$R^2 = 0.921$$

Total weight (gm).

Total length (cm)

Female)

$$y = 0.020x^{2.966}$$
$$R^2 = 0.956$$

Total weight(gm)

Total length (cm)

Combined sexes

Figure 2. Length–weight relationship of *T. zillii* from Lake Timsah.

2.1340 for males and females, respectively (Figure 3). It can be seen that the K values for males data increased at 16 cm (2.2019) then decreased gradually, followed by an increase up to 19 cm (2.0930). The values again declined at 21 cm, (1.894) while females recorded a higher value of (K) at 10 cm. (2.134) followed by decreased then increased at 16 cm (2.005). This may be attributed to sexual maturation and active spawning of the larger fish (El-Agami, 1988; Hadi, 2008; Shalloof 2009). Hadi (2008) estimated that (K) value of *T. zillii* in Umhfein Lake about (2.195), Anene (2005) found that K value was 4.3 in Imo State, while Shallof (2009) recorded K value 2.01 in Lake Qarun; this difference is due to the different ecological conditions.

Sex ratio

From Table 1, it appears that the over all sex- ratio (M / F) was 1:0.9 which 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). Also, it was more or less in agreement with Abu Qir Bay, 1:1.05 (Akel and Moharram, 2007). On the other hand, Fryer and Iles (1972) pointed out that in the African lakes, it is common in the cichlid populations that males dominate because they generally exhibited more growth than females.

Morphology of the gonad

Macroscopic structure of female and male gonads of *T. zillii* collected from Lake Timsah during the period (October, 2002 – December, 2003) is summarized as follow:

Stage I (Immature or virgin and resting adult)

Ovaries very small, thin, thread like pale in colour, occupying a small part of the body cavity. Testes is thin,
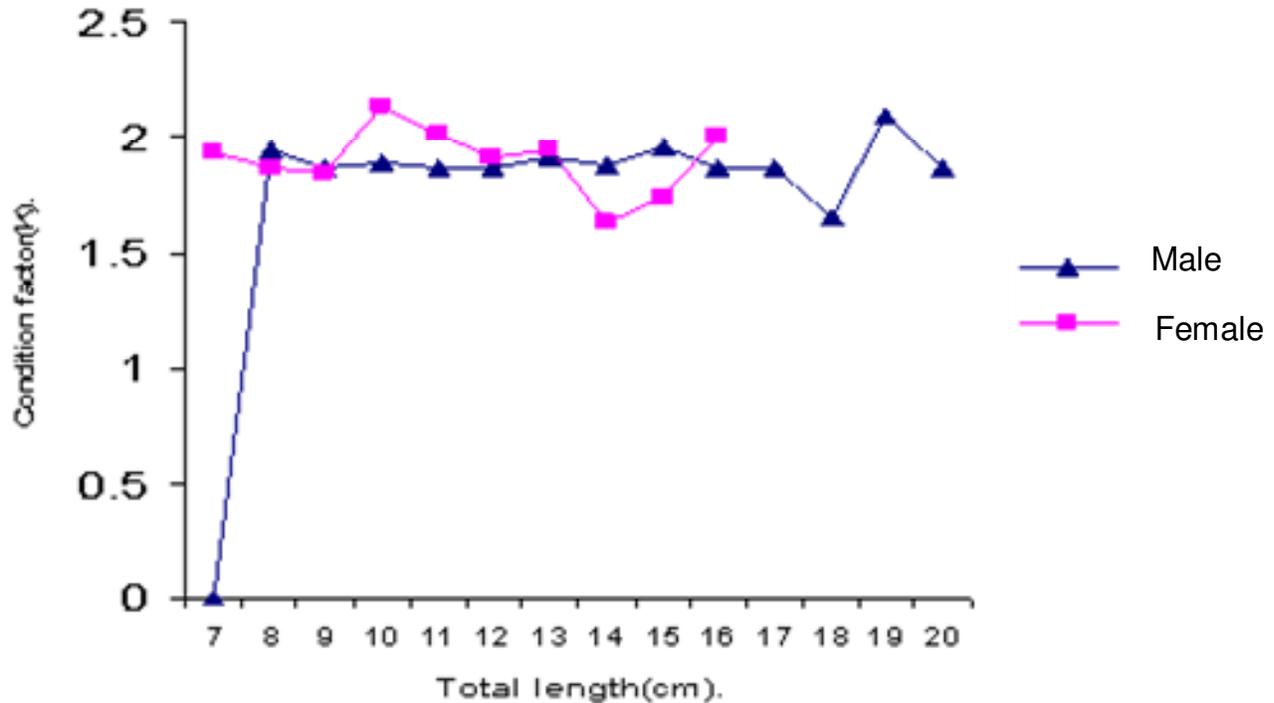
Figure 3. Condition factor (k) for males and females of *T. zilli* from Lake Timsah

Table 1. Seasonal variations in sex ratio of *T. zillii* from Lake Timsah.

Month	Male	%	Female	%	Ratio (M/F)
October-02	9	60	6	40	1:0.7
November	5	31.3	11	68.7	1:2.2
December	8	47.1	9	52.9	1:1.1
January-03	13	34.2	25	65.8	1:1.9
February	26	66.7	13	33.3	1:0.5
March	5	38.5	8	61.5	1:1.6
April	11	36.7	19	63.3	1:1.7
May	16	72.7	6	27.3	1:0.4
June	12	63.2	7	36.8	1:0.6
July	13	44.8	16	55.2	1:1.2
August	13	68.4	6	31.6	1:0.5
September	16	55.2	13	44.8	1:0.8
Total	147	51.3	139	48.7	1:0.9

slender translucent and pale in colour. Both gonads are invisible to the naked eye

Stage II (Early maturing)

Ovaries become slightly larger and increase in weight and volume with minute opaque whitish eggs occupied about half of the body cavity. Testes become enlarge, flat, increase in weight and volume, and creamy white in

colour. Both gonads are readily seen without any aid.

Stage III (Developing)

Ovaries distended occupied, about 2/3 of abdominal cavity with large pale yellow eggs. Testes enlarge, increase in weight and volume, light pinkish and thicker in size and look more vascular. Blood capillaries become conspicuous.
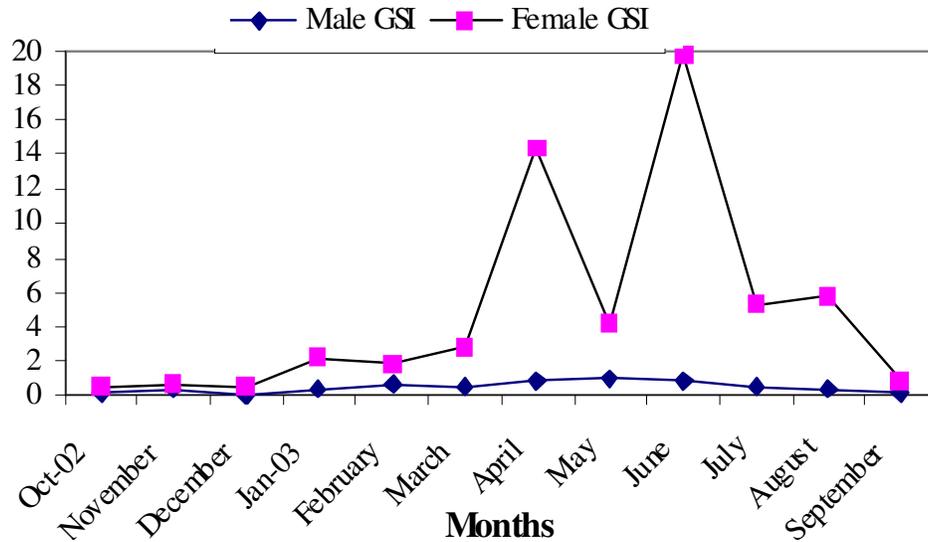
Figure 4. Monthly gonadosomatic index of *T. zillii* at Lake Timsah collected from October 2002 to December 2003.

Stage IV (Developed /pre spawning)

Ovary becomes more enlarged occupying almost entire body cavity, with large number of big, turgid, spherical, translucent, swollen green ripe ova. Testes become soft swollen milky white and increase in weight and volume. Blood capillaries are prominent. Roe to milt run with slight pressure.

Stage V (Spawning)

Ovary walls become thin almost transparent. Ripe eggs are visible through the ovarian wall and some ripe eggs are present in the oviduct. Testes become flabby, thin and dull white in colour.

Stage VI (Spent)

Shrunken gonad has loose walls. Ovaries are flaccid, sac like and reduced in volume. Ovary contains ripe unspawned darkened eggs and a large number of small ova. Testes become flaccid empty with evidence of hemorrhaging (bleeding).

Percentage of gonadal maturity stages were as follows: In females 15.5% of the total fish were in developing stage (III); 35% were in developed stage (IV) and 49.5% were in spawning stage (IV). Therefore, 84.5% of total fish were in the reproductive process. In males 22.4% of the total fish were in developing stage (III); 13.2% were in developed stage (IV) and 64.4% were in spawning stage (V). So, 77.6% of the total fish were in reproductive process.

Gonadosomatic Index (G.S.I.)

Monthly variations in G.S.I. revealed that both sexes followed nearly the same trend. In females, several peaks of G.S.I. values were observed during January, April, June and August (Figure 4). This means that females could breed more than once in the season and the period from January to August represented the spawning (breeding) period of *T. zillii* in this region. It is also clear that females acquired higher values of GSI than males. The present study agreement with Maclaren (1981) who mentioned that 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 activities 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). Also, Negasssa and Padanilly (2008) stated that Indeed, fish with well-developed gonads and mature eggs in both species were noted almost throughout the year. GSI values and percentages of mature fish indicated that breeding in both species was year-round with its peak during April to September for *T. zillii* and February to August for *O. niloticus.*

Length at first maturity

Length at first maturity (Lm50) is the length at which 50% of the fish have reached maturity. Table 2 summarized the previous study and the smallest mature male, and female observed in the sample. Data showed that

Table 2. Comparative results of length at first sexual maturity of *T. zillii* in different localities.

| Male (cm)	Female (cm)	locality	Author
7	7	Lake Borollus	El-Haweet (1991)
8.6	10.1	Lake Manzalah	El-Shalloof (1991)
9	8	Lake Edku	Phillips (1994)
8.7	9.6	Abu Qir Bay	Akel (2007)
8.4	7.5	Lake Temash	Present study

(Males)
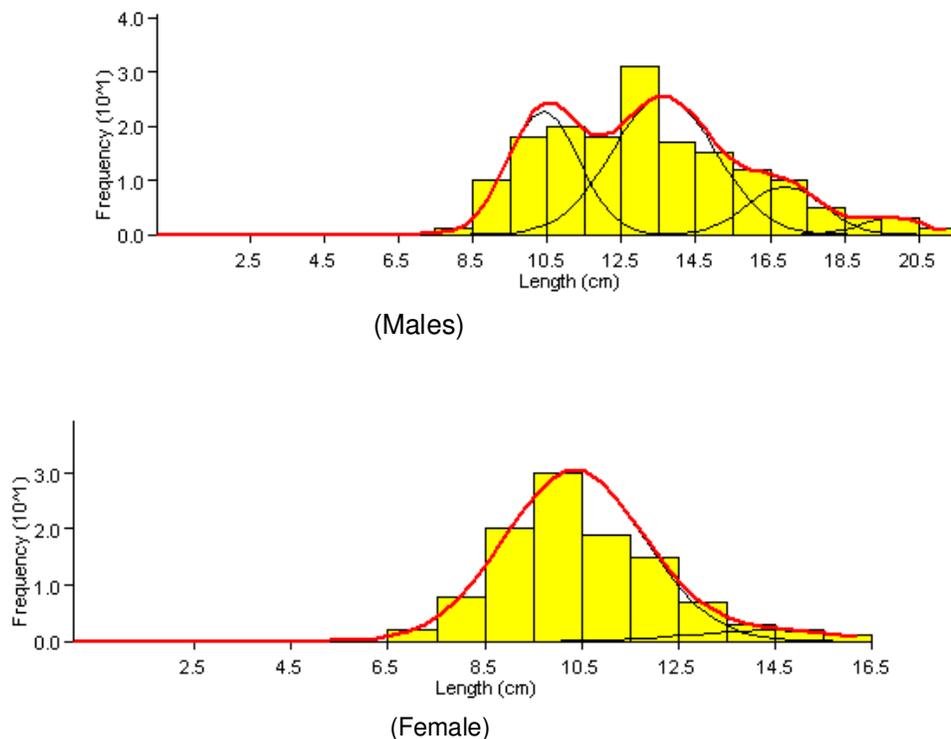
(Female)

Figure 5. Bhattacharya method for age determination of *T. zillii* from Lake Timsah.

smallest mature male observed during the present study was 8.4 cm total length whereas the smallest mature female was 7.5 cm total length.. This agrees with Akel and Moharram (2007) in Abu Qir Bay. This suggests that females reach their first sexual maturity before males (8.7 cm, females and 9.7 cm, males) 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 density and changes in temperature

and salinity (Bardackci and Tanyoloc, 1990; Unlo and Balci, 1993). From the aforementioned results, the length of males at which 50% of the fish have reached maturity was fluctuated between 7 to 9 cm) while the corresponding length for females fluctuated from 7 to 10.1 cm)

Age

A total of 700 *T. zillii* specimens were examined. Total length of females ranged from 7 to 16 cm and males from 8 to 21 cm. Age was determined based on length frequency studies using Bhattacharya's method (1967). Figure 5 showed that the life span is two and four years for females and males, respectively. These variation
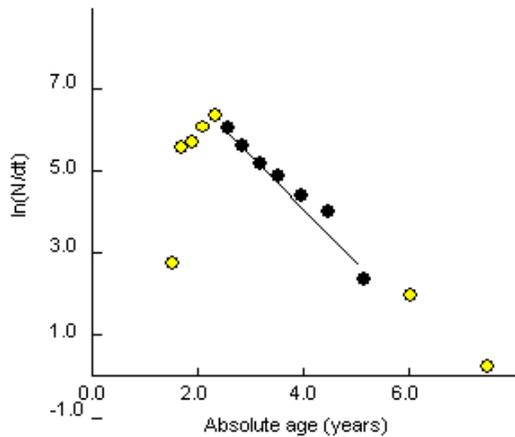
Figure 6. Length converted catch curve of *T. zillii* (males) from Lake Timsah.
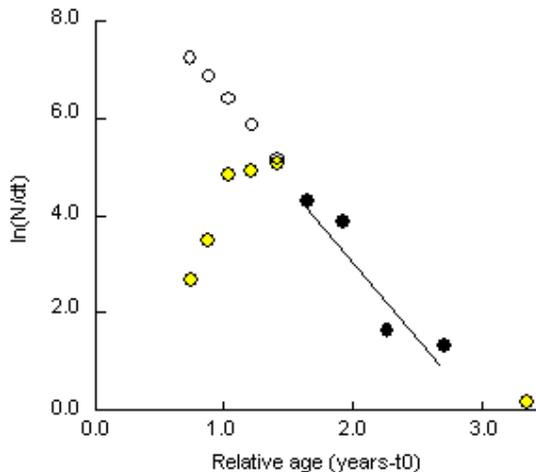
Figure 7. Length converted catch curve of *T. zillii* (females) from Lake Timsah.

between males and females due to the different recorded maximum length.

Growth

The growth in length of *T. zillii* is assumed to be best described by the von Bertalanffy Growth Formula (VBGF):

$$L_t = L_\infty (1-e^{-K \cdot (t-t_o)})$$

where, L_t is the mean total length (in cm) of the fish at age t; L_∞ is the mean asymptotic total length (cm); K is a growth constant (year^{-1}); t is the age of the fish; and t_0 is the theoretical "age" of the fish at zero length.

Theoretical growth in length

The von Bertalanffy growth equations for growth in length for *T. zillii* were estimated as follow:

$$L_t = 22.05 (1-e^{-0.320 (t+1.4128)}) \quad \text{for males}$$

$$L_t = 17.83 (1-e^{-0.680 (t+0.304)}) \quad \text{for females}$$

Theoretical growth in weight

The von Bertalanffy growth equations for growth in weight for *T. zillii* were predicated as follows:

$$W_t = 201.74 (1-e^{-0.320 (t+1.4128)})^{3.0055} \quad \text{for males}$$

$$W_t = 109.54 (1-e^{-0.680 (t+0.304)})^{2.975} \quad \text{for females}$$

Growth performance index (Ǿ)

Growth performance index (Ǿ) had been used since it is the best index for expressing the fish growth (Moreau et al., 1986).

It was found that the growth performance of *T. zillii* is 2.19 for males and 2.34 for females it was nearly the same for both sexes, indicating that differences in growth by sex are very small.

Mortality

Total mortality (Z) can often be estimated from a length converted catch curve The calculated (Z) = 2.656 for males is higher than females (Z) = 1.88 for *T. zillii* in Lake Timsah. Figures 6 and 7

The recorded natural mortality was 0.464 and 0.38 for males and females, respectively. This result may be due to the high levels of pollution in Lake Timsah (Elhalfawy et al., 2006). The corresponding estimates of the fishing mortality rate were 2.192 for males and 1.50 for females.

Exploitation rate

The exploited rate (E) was calculated as equal to the fraction of death caused by fishing (E=F/Z); the estimation values were (E=0.83) for males and 0.78 for females. According to Gulland (1971), the present estimated values of exploitation rate of *T. zillii* refer to an overexploitation in this species in the Lake Timsah. The high rates of exploitation indicate that this is due to high levels of fishing mortality. This agrees with the numbers and sizes of fish caught calculated for the lake fishery The initial indication is that there is a high mortality of the early year groups. The majority of the fish caught were
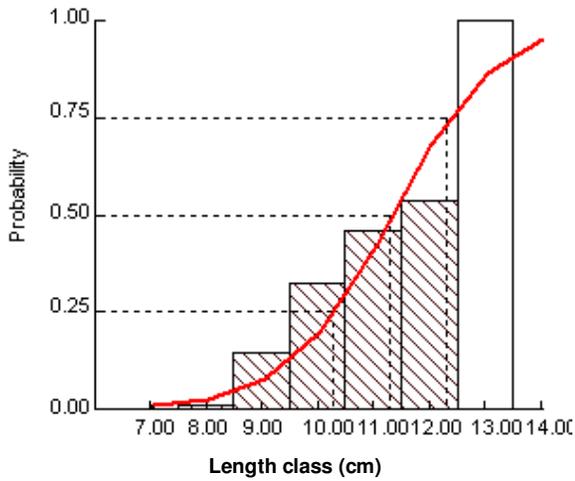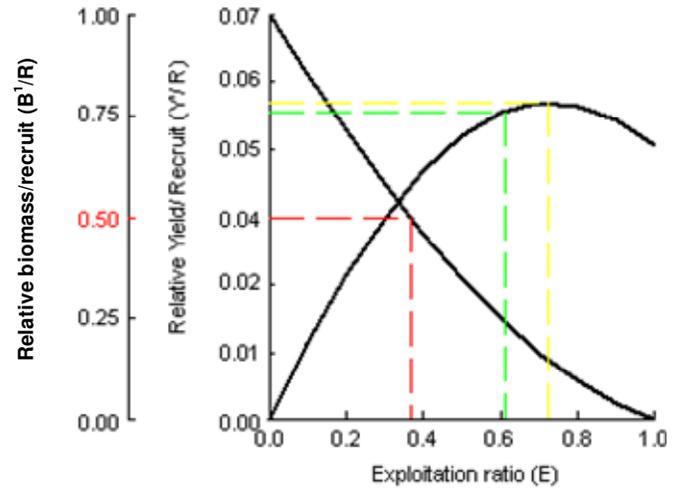
Figure 8. Length at first capture of male (11.30).

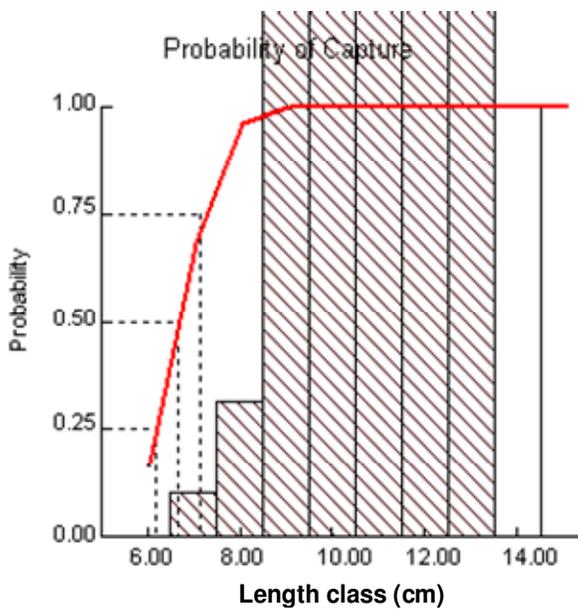**Figure 10.** Current yield per recruit analysis of *T. Zillii* from Lake Timsah for male at LC = 11.30.

Figure 9. Length at first capture of female (6.68 cm).
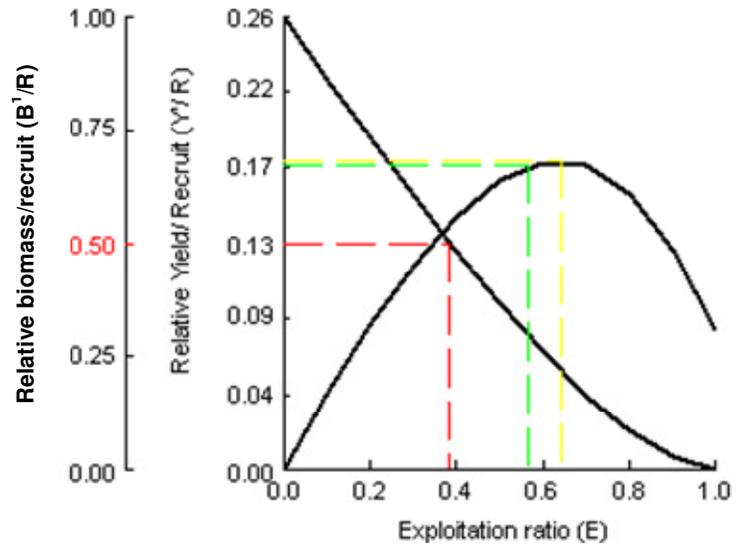

Figure 11. Current yield per recruit analysis of *T. Zillii* from Lake Timsah for female at LC = 6.68

below the optimal length at capture. This suggests growth overfishing. It must raise the length at first capture to management *T. zillii* in Lake Timsah. Figures 8 and 9

Relative yield-per-recruit, biomass-per-recruit and biological reference point

Y'/R and B'/R were determined as functions of $L_{50}/L\infty$ and M/K, respectively (Figure 10 and 11). It is clear that the relative yield per recruit increase with the increase in

exploitation rate. These results indicated that the current exploitation level of the *T. zillii* in Lake Timah (E=0.83 males and 0.78 for females) is higher than that associated with the optimum Y'/R which take place at an exploitation rate of ($E_{0.1}$ =0.616 for males and 0.513 for females) and it must be reduced by about 26 and 34% for males and females, respectively to achieve the optimum yield per recruit.

CONCLUSION

T. zillii must be protected in Lake Timsah till their third year of life, when they have a good marketable size, this

can be attained by:

1. Increase in the length at first capture by selecting the optimum mesh size which release small fish and allow each fish to produced eggs at least once in its life.

2. Reduce the fishing mortality by decreasing the number of boats and the number of fishing trap.

REFERENCES

Akel EH Kh, Moharram SG (2007). Reproductive biology of *Tilapia zillii* (Grev, 1848) from Abu qir Bay, Egypt. Egyptian J. Aquatic Res., 33. 1: 379–394.

Abd-Allah A, Talaat KM (2000). Growth and dynamics of Tilapias in Edku Lake, Egypt. Bulletin of National Institute of Oceanography and Fisheries World J. Fish Marine Sci., 1(1): 20-28

Anene A (2005), condition factors of four cichid of a man-made lake in IMO state, South east, Nigeria Turk> J. |Fish. Aquat. Sci., 5: 43-47.

Bardackci F, 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.

Basu M, Kalu M (1999). Study and comparison of length-weight relationship and condition factor of *Tilapia zillii* (Gervais) in Lake Alau and Monguno hatchery. The Borno State, Nigeria.Fourth Indian Fisheries Forum. Kochi. Kerala, pp. 357-360.

Bhattacharya CG (1967). A simple method of resolution of a distribution into Gaussian components Biometrics. 23:115-135.

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

Beverton RJH, Holt SJ (1966). Manual of Methods for Fish Stock Assessment. Part 2. Tables of Yield Functions. FAO Fish. Tech. Pap./ FAO Doc. (38) Rev., 1: 67 p.

Botros GA (1968). A comparative study on the fecundity of *Tilapia zillii* from Lake Mariut (Egypt). Ocean. Dep. Fac. Sci. Alex. Univ.

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

De Vlaming VG, Grossman, F. Chapman (1982). On the use of gonadosomatic index. Comp. Biochem. Physiol., 73: 31-39.

EL-Halfawy MMK, Mahmoud WF, Soliman YA, Ramadan AM (2006). Comparative study on the levels of heavy metals in Bitter lakes and lake Timsah, (Suez Canal) of fish *Sigauns rivulatus* in relation to reproductive cycle. Egyptian J. Aquatic Biol. Fisheries, 10(2): 179-193.

Eccles DH (1992). FAO species identification sheets for fishery purposes. Field guide to the freshwater fishes of Tanzania. Prepared and published with the support of the United Nations Development Programme (project URT/87/016). FAO. Rome, 145 p.

El–Agami AE (1988). Age determination and growth studies of *Gerres oyena* (Forskall 775) in the Arabian Gulf waters. Mahasagar. 21(1): 23-34.

El-Haweet AA (1991). Biological studies of some *Cichlid* species in Lake Borollus. M.Sc. Fac. Sci. Alex. Univ. Egypt.

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

El-Kashef MA (2002). Fishery biology of some Nile fishes. Ph.D.Thesis, Fac. Sci., Zagazig Univ.

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-Sayed AFM (2006). Tilapia culture. CABI Publishing, Wallingford OX 108 DE. UK. 273 p.

El-Sawy WMT (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-Zarka SA, Koura R, ShaheenA H (1970). Selectivity of wire basket traps for tilapias (*T. nilotica T. galilae* and *T. zillii*) J. Cons. Int. Explor. Mer., pp. 282-291.

Faltas SN (1995). Population dynamics of *Tilapia zilli* (Gervais) in Lake Qarun,Egypt.Bull. Natl. Inst. Oceanogr. Fish. 21: 517-527.

Fryer G, Iles TD (1972). The Cichlid Fishes of the Great Lakes of Africa: Their Biology and Evolution. Oliver and Boyd. Edinburgh, Scotland. 641 p.

Gayalino Jr, Sparre FCP, Pauly D (1997). The FAO-ICLARM Stock Assessment Tools (FiSAT). FAO Computerized Information Series (Fisheries). No.8. Rome, FAO.

Gulland JA (1971). The Fish Resources of the Ocean. West Byfleet Surrey. Fishing News (Books), Ltd. for FAO: 255 p.

Getahun A, Stiassny MLJ (1998). The fresh water biodiversity crisis: the case of Ethiopian fish funa, SINET: Ethiop. J. Sci., 21: 207-230.

Hadi AA (2008) Some observation on the age and growth of *Tilapia zillii* (GERVAIS, 1848) in Umhfein Lake (Libya).J. Sci. Appl., 2: 12-21.

Khallaf EA, Latif AFA, Al ne nae AA (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.

Khallaf EA, El-Nenaei AA (1987). Feeding ecology of *Oreochromis niloticus* (Linnaeus) and *Tilapia zillii* (Gervias) in a Nile canal. Hydrobiologia. 146: 57-62.

Lagler KF (1966). Fresh water fishery biology. W.M.C. Brown Company Dubuque Iowa.

Lagler KF, Bardach GE, Miller RR, Passino AA (1977). Ichthyology. Second edition. John Wiley and Sons. Inc.

Latif AA, Khallaf EA, Alne – nae AA (1986). Reproduction of *Tilapia*s in a Nile Canal and its interaction with the environment. M. Sc.Thesis Fac. of Sci., Almonofya Univ. Egypt.

Latif AA, Khallaf ESA, El-Nenaei AA (1989). Effect of selectivity of trammel nets upon growth and mortality of two Tilapia species. Bull. Natl .Inst. Oceanogr.Fish. 2: 253-260.

Le Cren ED (1951). The length-weight relationship and seasonal cycle in gonad weight and conditions in perch *Perca fluviatilis*, J. Anim. Ecol., 20(2): 201-219.

Mac Gregoer JS (1959). Relation between fish condition and population size in the sardine (*sardinops cacrulea*) US. Fish. Wild. Fish , Bull, 166: 60.

Maclaren JF (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. 12.

Mehanna SF (2004). Population dynamic of two cichlids, *Oreochromis aureus* and *Tilapia zillii*, from Wadi El-Raiyan Lakes Egypt. Agric. Marine Sci.. 9: 9-16

Meyer DE (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].

Mosaad MNM (1990). Biological studies on five fish species from Lake Qarun, Egypt.1. Length –weight releationship and condition factor. Proceeding of the Zoological Society .A .R. Egypt. 21: 331-344.

Moyle PB, Cech JJ (1996). Fishes: An Introduction to Ichthyology. 3 rd Edn. Prentice Hall, New York.

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

Negassa A, Padanillay CP (2008). Abundance, food habits, and breeding season of exotic *Tilapia zillii* and native *Oreochromis niloticus* L. fish species in Lake Zwai, Ethiopia *Mj. Int. J. Sci. Tech* (2) 345-359.

Panfili J, Tomas J (2001). Validation of age estimation and back-calculation of fish length based on otolith microstructures in tilapias (Pisces, Cichlidae). Fishery Bull., 99(1): 139-150.Pauly D (1980). On the interrelationship between natural mortality growth parameters and mean environmental temperature in 175 stocks. J. Con. CIEM., 39(2): 175-192.

Pauly D (1983). Length-converted catch curves. A powerful tool for fisheries research in the tropics. Part 1. ICLARM Fishbyte, 1(2): 9-13.

Pauly D (1984a). Length-converted catch curves. A powerful tool for fisheries research in the tropics. (part II). ICLARM Fishbyte, 2(1): 17-19.

Pauly D (1984b). Length-converted catch curves. A powerful tool for

fisheries research in the tropics. (III: conclusion). ICLARM Fishbyte, 2(3): 9-10.

Pauly D, Munro JL (1984). Once more on the comparison of growth in fish and invertebrates. ICLARM Fishbyte, 2(1): 21

Phillips AE (1994). Studies on the biology of two *Tilapia* species in Lake Edku. M.Sc. Thesis. Fac. Sci. Alex. Univ. Egypt.

Phillip JCL, Ruwet JCL (1982). Ecology and distribution of Tilapias ICLARM. Conf. *Proc*. Manila,Phillipines*,* (7): 15 - 59.

Ricker WR (1971). Methods for assessment of fish production in fresh waters. I.B.P. Blackwell Scientific Publishers.

Shalloof KA, Sh (2009). Some Observations on Fisheries Biology of *Tilapia zillii* (Gervais, 1848) and *Solea vulgaris* (Quensel, 1806) in Lake Qarun, Egypt .World J. Fish Marine Sci., 1(1): 20-28, ISSN 1992-0083.

Shalloof KA Sh, Salama HMM (2008). Investigations on Some Aspects of Reproductive Biology in *Oreochromis niloticus* (Linnaeus, 1757) Inhabited Abu-zabal Lake, Egypt. Global Veterinaria, 2(6): 351-359.