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POPULATION DYNAMICS OF Tilapia zillii (Gerv.) IN LAKE QARUN, EGYPT

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ABSTRACT

Population dynamics of **Tilapia zillii** *(Gerv.) in Lake Qarun was studied in the present work. Samples were taken from the trammel catch during 1991. Estimation of mortality coefficients and yield per recruit are based upon age composition and growth parameters. Total mortality, natural mortality and fishing mortality were 2.645, 0.908 and 1.737 respectively. Reducing the value of the present fishing mortality (Fishing effort) by 60% causes only a decrease of 10% in the yield in weight per recruit. The results proved that the trammel fishery of* **T. zillii** *was over-exploited in Lake Qarun.*

INTRODUCTION

Lake Qarun is a closed basin located South-west of Cairo at latitude 29° 28' N and longitude 28° 40' E. Its area is about 240 km^2 with average depth of 4 m.

Tilapia zillii (Gerv.) is an important contributor to the lake fisheries. It is mainly captured by trammel nets. Its fishery assessment is based on dynamics analysis using parameters of growth, recruitment and mortality rates (Ricker, 1975).

The population dynamics of this species was only studied in Lake Manzalah (Hosny, 1987) and Lake Edku (Khalil, 1994) in Egypt. The present study gives a useful guide in assessing the current status of ***T. zillii*** in Lake Qarun.

MATERIAL AND METHODS

Fishes were collected periodically from Lake Qarun during 1991. They were only sampled from trammel nets of mesh sizes ranging between 46 and 54 mm. A total of 484 individuals were taken measuring between 8 and 18.5 cm in total length. At laboratory, each specimen was measured and weighed. Age determination by scale reading to compute the growth was done on a sample of 151 fish. Growth studies were done by formula given by Lee (1920) for back calculation. Further specimens were taken only to obtain age composition from length frequency distribution. Length-weight relationship was determined according to Le Cren (1951). Theoretical growth was made using the von Bertalanffy equations developed by Beverton and Holt (1957). Their parameters ($L\infty$, $W\infty$, K and to) were calculated by Gulland's method (Gulland, 1965).

Total mortality (Z) was estimated by construction of the catch curve i.e. from the slope of decreasing trend of age composition (Ricker, 1975). Natural mortality (M) is computed according to Pauly (1980):

$$\text{Log } M = -0.0066 - 0.279 \text{ Log } L\infty + 0.6543 \text{ Log } K + 0.4634 \text{ Log } T$$

Where $L\infty$ and K are growth parameters and T is the annual mean water temperature°C. Fishing mortality (F) could then be obtained by subtracting M from Z (Beverton and Holt, 1957).

Yield per recruit (Y/R) was determined according to formula developed by Beverton and Holt (1957):

$$Y/R = F. \exp. [- M (t_c - t_r)]. W\infty \sum_{n=0}^{3} \frac{U_n \exp. [-nK (t_c - t_0)]}{F + M + nK}$$

Using the notation of Holt (1960), thus:

- **Y** is annual yield in weight.
- **R** is annual recruitment (at age t_r).
- t_c is age at first capture.
- **F** is fishing mortality coefficient.
- **M** is natural mortality coefficient.
- $W\infty$, K and t_0 are parameters of the von Bertalanffy growth equation.

U_n is summation variable taking the values 1, -3, +3 , -1 for n = 0, 1, 2, 3, respectively.

This formula can be simplified in the form :

$$Y/R = F.\ Q.\ W\infty \left[1/Z - \frac{3q}{Z+K} + \frac{3q}{Z+2K} - \frac{q}{Z+3K}\right]$$

where $Q = \exp.[-M(t_c - t_r)]$
$q = \exp.[-nK(t_c - t_o)]$

RESULTS

1- Growth

1.1- Scale radius and total length relationship

The relationship between scale radius (S) and total length (L) was found to be linear (Fig. 1) . The equation representing this relation, is the following :
$L = 1.2076 + 0.2133\ S$ ($r^2 = 0.9876$) .

1.2- Growth in length

Table (1) shows the back-calculated lengths for each year of life . The highest annual increment was found during the first year of life, thereafter it showed a tendency to decrease as fish grows older .

1.3- Length-weight relationship

The length-weight relationship was found to be represented by the equation:Log W = - 1.7580 + 2.9936 Log L ($r^2 = 0.9976$)

The observed values of lengths and weights were plotted and the calculated length-weight curve fitted the data (Fig. 2) .

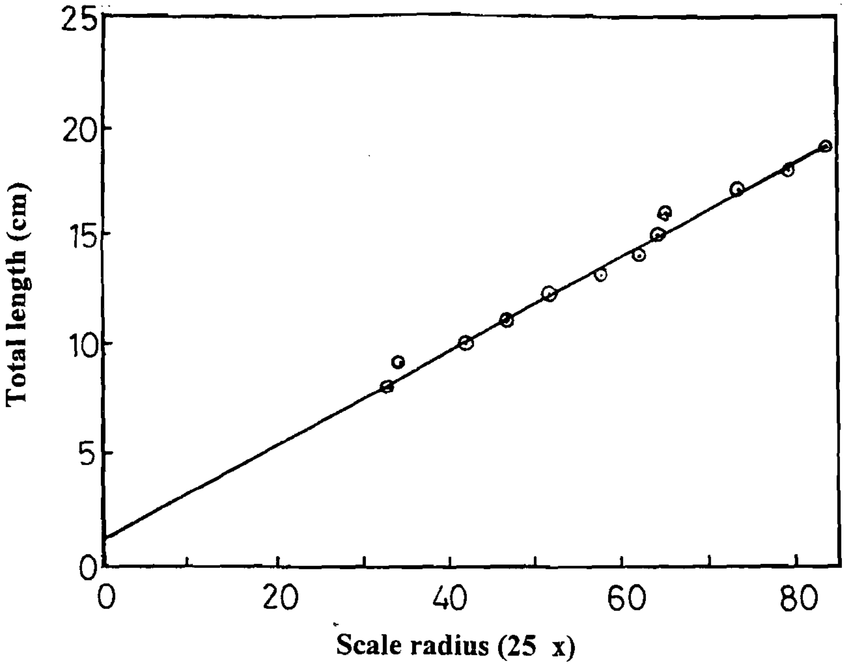

Fig. 1: Relationship between scale radius and total length of *T. zillii* in Lake Qarun.

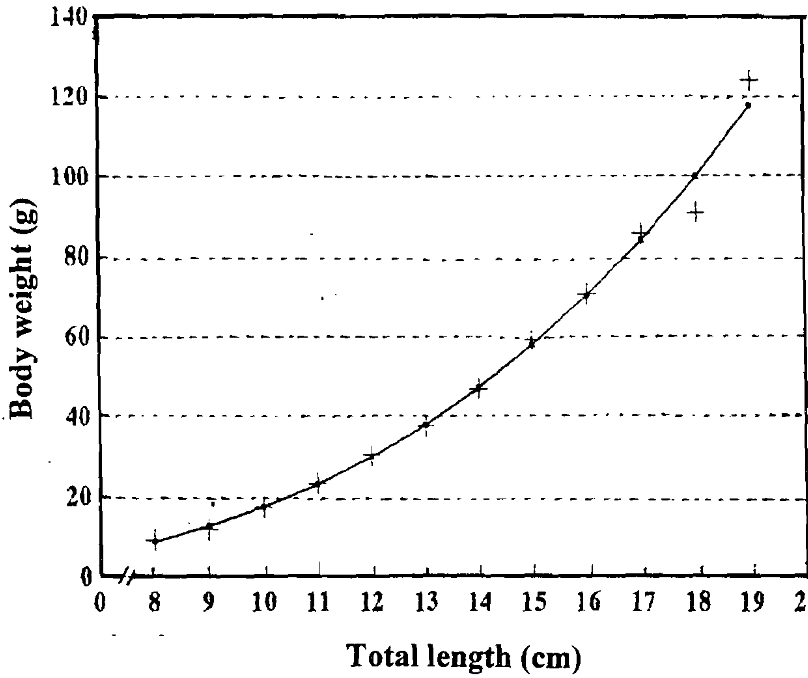

Fig. 2: Relationship between total length and body weight for *T. zillii* in Lake Qarun.

1.4- Growth in weight

The calculated growth in weight (Table 1) was obtained by using length-weight relationship. It appears that the annual weight increment increased until age 3 then slightly decreased for age 4 .

1.5- Theoretical growth rate

The mathematical expressions of growth in terms of von Bertalanffy equation were found to be as follows :

$$L_t = 20.96 \quad [1 - \exp. - 0.34989 (t + 0.17512)]$$

$$W_t = 157.89 [1 - \exp. - 0.34950 (t + 0.17628)]^{2.9936}$$

Fitting von Bertalanffy equation for length and weight (Table 1) showed negligible differences between the back-calculated lengths and weights and those predicted from above equations.

Table (1): Back-calculated lengths (cm) and weights (g) at different ages and those predicted from von Bertalanffy (v.B) equation for *T. zillii* in Lake Qarun .

Age	*1*	*2*	*3*	*4*
Number of fish	38	95	15	3
Mean length at capture (cm)	9.4	13.5	15.9	19.5
Back-calculated length (cm)	7.11	11.12	14.21	16.10
Increment of length (cm)	7.11	4.01	3.09	1.89
Lengths (cm) predicted from v.B	7.07	11.17	14.06	16.10
Back-calculated weight (g)	6.20	23.63	49.24	71.56
Increment of weight (g)	6.20	17.43	25.61	22.32
Weight (g) predicted from v.B	6.09	23.95	47.71	71.55

2- Mortality
2.1- Total mortality (Z)

Descending portion of the catch curve (Fig. 3) was used to calculate the total mortality of *T. zillii* . It was found to be 2.6454 .

2.2- Natural mortality (M) and Fishing mortality (F)

Natural mortality was found to be (0.9082) as obtained from Pauly (1980) equation using growth parameters ($L\infty$ = 20.96 cm and K = 0.34989) and water temperature (T) = 23.1°C (Dowidar and El-Nady, 1982) . By subtracting the value of M from the obtained value of Z, the value of fishing mortality was found to be 1.7372 .

2.3- Annual mortality (A)

It was computed from this formula A = 1-S, where S, survival rate [S ($=e^{-Z}$) = 0.0710] as 0.9290 .

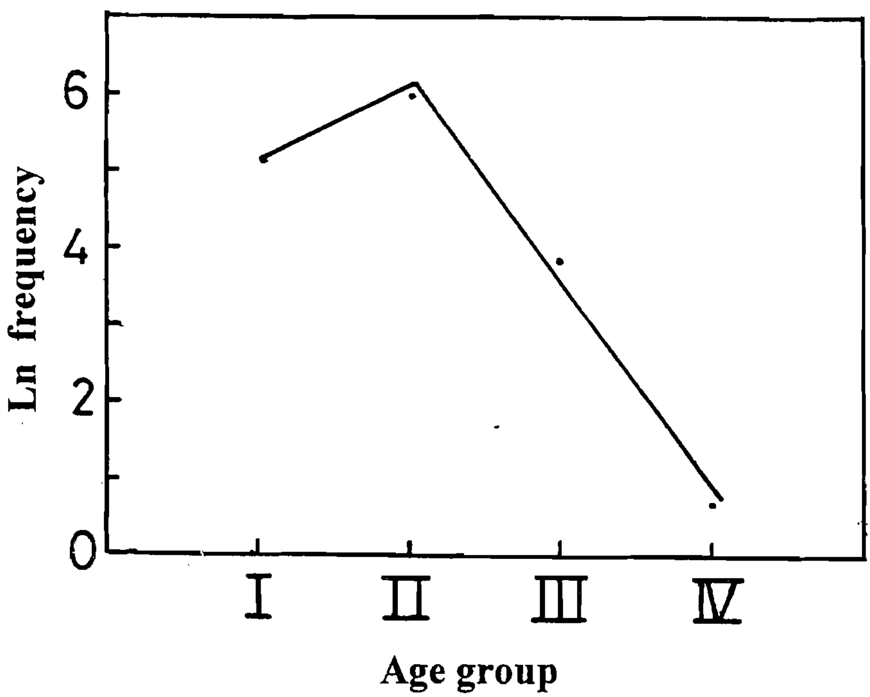

Fig. 3: Catch curve of *T. zillii* caught by trammel net in Lake Qarun.

3- Rate of exploitation (E)

It was calculated from equation E = FA / Z (Cushing, 1968) . It was found to be equal to 0.6101 .

4- Length and age at first capture

Length at first capture (L_c) of *T. zillii* was estimated using the formula given by Beverton and Holt (1957) :

$$L_c = \bar{L} - K (L\infty - \bar{L}) / Z$$

where

$\bar{L}$ is the mean length which was calculated from length frequency distribution as 11.78 cm .

The value of L_c was found to be 10.57 cm and its corresponding age (t_c) was 1.83 obtained by converting L_c using the von Bertalanffy growth constants.

5- Length and age of recruitment

Length at recruitment (L_r) was determined graphically from the plot of cumulative curve for the proportions of recruits against the corresponding lengths (Fig. 4) . It has been found that *T. zillii* is fully recruited at length of 8.8 cm . This length corresponds to an age t_r of 1.38 from von Bertalanffy equation.

6- Yield per recruit (Y/R)

The model of Beverton and Holt (1957) was used for determining the yield in weight per recruit of *T. zillii* where the input parameters were M=0.9082, $W\infty$ =157.89 gm, K=0.34989, t_o=0.17512, t_c=1.83 and t_r=1.38 .

Separate estimates of yield per recruit were calculated for different fishing mortalities (0.1-7.0) and graphically represented in Fig. (5) . The results show that the estimated yield per recruit increases continuously with the increase in fishing mortality coefficients reaching its climax at maximum sustainable yield (MSY) . Thereafter it remained more or less constant . The maximum sustainable yield was attained at fishing mortality F=4.8 reaching Y/R=13.5 gm, while at the level of fishing mortality operating (F=1.7), Y/R was 12.5 gm. The maximum sustainable yield is not preferable target in fisheries management but the profitable one is the optimum yield or maximum economic yield (MEY), which could be traced at fishing mortality 1.0 having Y/R=11.2 gm (Beverton and Holt, 1957).

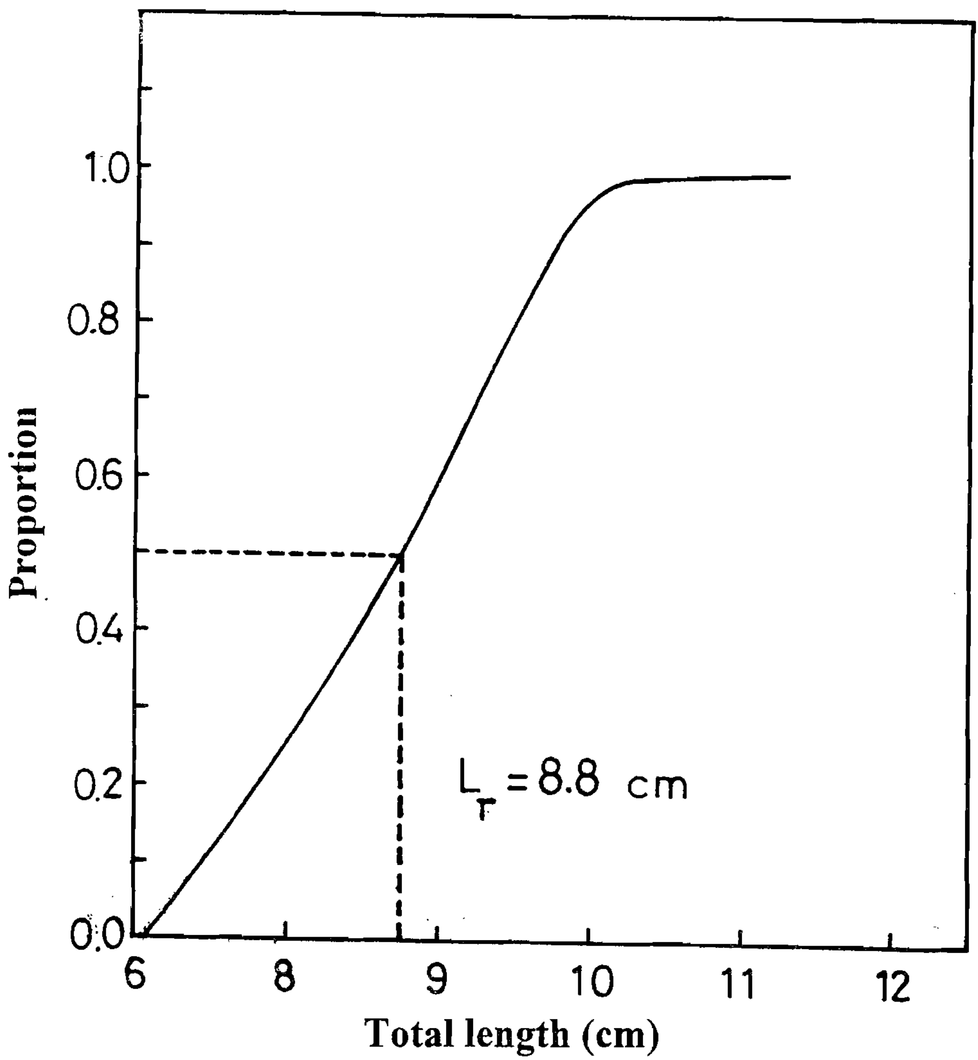

Fig. 4: Cumulative curve of recruit proportions at different lengths for ***T. zillii*** caught by trammel nets in Lake Qarun.

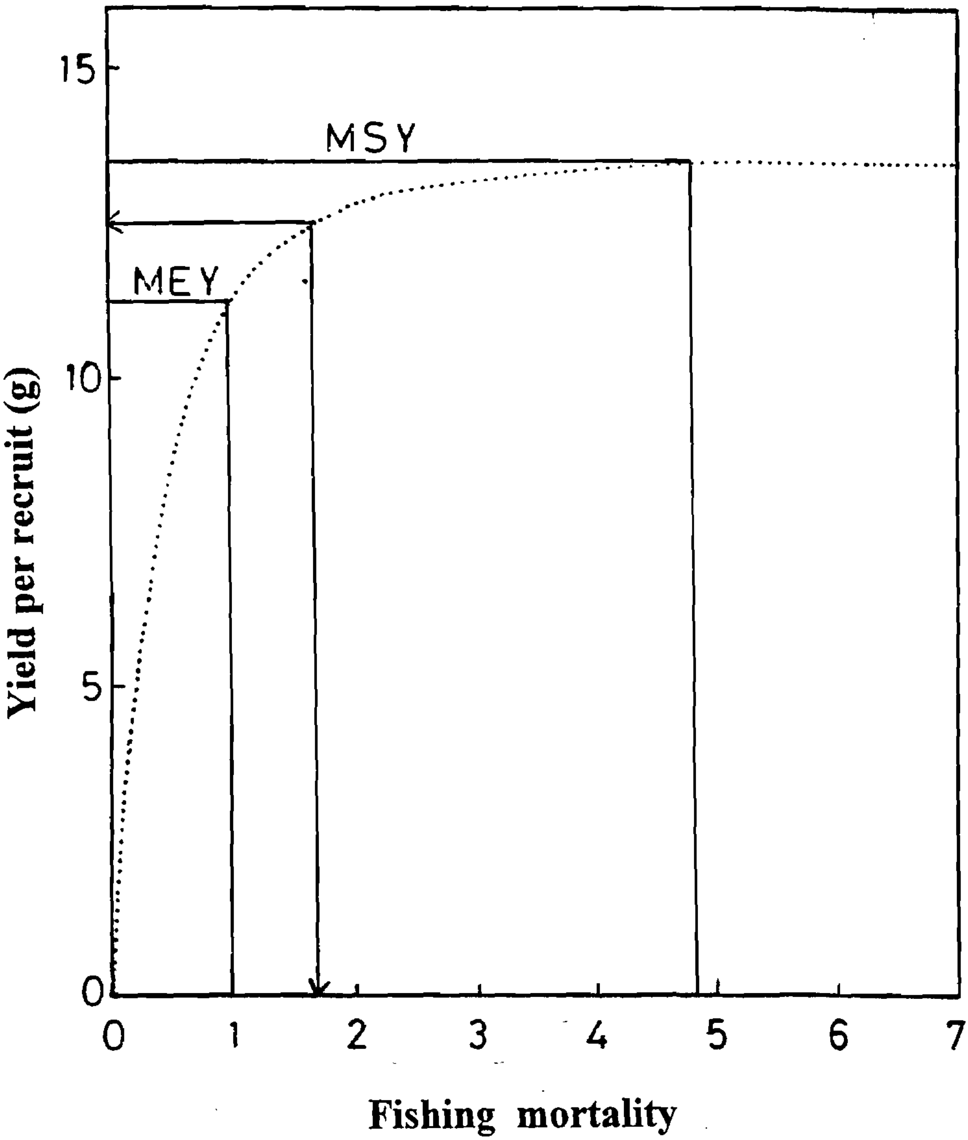

Fig. 5: Relationship between yield per recruit and fishing mortality for *T. zillii* in Lake Qarun. (arrows show the current state).

DISCUSSION

The result obtained by applying Beverton and Holt (1957) for estimating the yield per recruit for *T. zillii* provides a useful indication that its stock in Lake Qarun is over-exploited by trammel nets used . This coincides with the values of exploitation rates which amounted 61% for the current state but it was 45% for maximum economic yield and 84% for maximum sustainable yield . Only exploitation rate at maximum economic yield is moderate for stable fishery proposed by Gulland (1971) and Pauly (1983) . At maximum sustainable yield, 2.8 times of the present value of the fishing mortality (1.7) will give only 8% increase in yield per recruit . While, reducing the value of the present fishing mortality by about 60% which occurs at maximum economic yield causes a decrease of 10% in the yield per recruit . This is in agreement with Khalil (1994) who showed that the optimum yield of *T. zillii* from Lake Edku would be attained by decreasing fishing mortality by 60% . But the reverse is the case for *T. zillii* in Lake Manzalah, it was under-exploited and the best yield corresponds to fishing mortality of 0.8 which is double the actual fishing mortality (Hosny, 1987) .

From the present study of trammel net fishery of *T. zillii* , the fishing effort should be decreased . However, it is not practical to apply that to trammel nets exploiting multispecies . In fact *T. zillii* is one of three species exploited simultaneously by this gear which poses a difficult problem from the standpoint of management as it is impossible to determine the optimum fishing without reference to other species . Hence similar studies must be done to other related species to set the optimum fishing effort .

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