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Original Research Article

Some Biological Studies on *Terapon puta* (Cuvier, 1829) in the Lake Timsah, Egypt 1-Age, Growth and Mortality of *Terapon puta* (Spinycheek Grunter)

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Abstract

In the present study age, growth and mortality of *Terapon puta* was estimated for 380 specimens collected by monthly sampling. This study was carried out from June 2012 to May 2013 in the Lake Timsah, Egypt. The age of *Terapon puta* was estimated by scales' readings and it was found out that the maximum age was IV years. The main total length and total weight values were calculated as 12.8 ±1.34 cm to 38.14 ±5.16 g and the calculated length-weight relationships were $W = 0.016004\ L^{3.0240}$ (Both sexes). The von Bertalanffy growth parameters were $L\infty = 20.13$ cm $K = 0.13363$ $year^{-1}$ and $t_o = -1.10850$ year. The instantaneous rate of total mortality (Z) was 1.63251; the natural mortality (M) was 0.4304.and the fishing mortality (F) was estimated to be 1.202113. The exploitation rate (E) was calculated as 0.73 using value of M and F. Therefore, the population of *Terapon puta* off Lake Timsah was under the threat of overfishing.

Keywords: Age estimation, *Terapon puta*, Timsah Lake.

INTRODUCTION

The Suez Canal is stretching from Port Said in the north, and continues southward for 162.5 km, crossing Lake Timsah and the Bitter Lakes on its way to the Gulf of Suez. Terapontidae is a perciform family including 16 genera and about 48 fish species (Nelson, 2006 and Minos *et al.*,2012), which are frequent in the marine coastal, brackish and freshwater of the Indian and West Pacific oceans, including the Red Sea. *Terapon puta* belong to the family Teraponidae is a medium size food fish which inhabits the sea in Egyptian coasts. This fish has been popular as excellent sea food with a sensible market price. Though they are not commercially important, they constitute a regular fishery throughout the year. No information available regarding the growth studies of *Terapon puta* with the view of supplementing this, the present study was undertaken in the Lake Timsah, Egypt. On the other hand, little studies have been concerned of this species in India with sex ratio (Nandikeswari, *et al* 2014) and its reproductive biology (Nandikeswari and Anandan, 2013).

Length-weight relationship has the essential role in fishery resource management and also useful for comparing life history and morphological aspects of populations inhabiting different regions (Goncalves,*et al.,*1997, Kalayci, *et al*.,2007) . The correlation between fish length and weight are useful for converting length observations into weight estimations to provide some measure of biomass (Froese, 1998). In fish studies, the length of a fish is often more rapidly and easily measured than its mass, therefore it is opportune to be able to determine mass where only the length is known (Harrison, 2001). In this study, it is expected to determine the age, growth rate, length- weight relationship and age composition of *Terapon puta* with von Bertalanffy growth models. Additionally, the natural and fishing mortality and the level of exploitation of this fish species off Lake

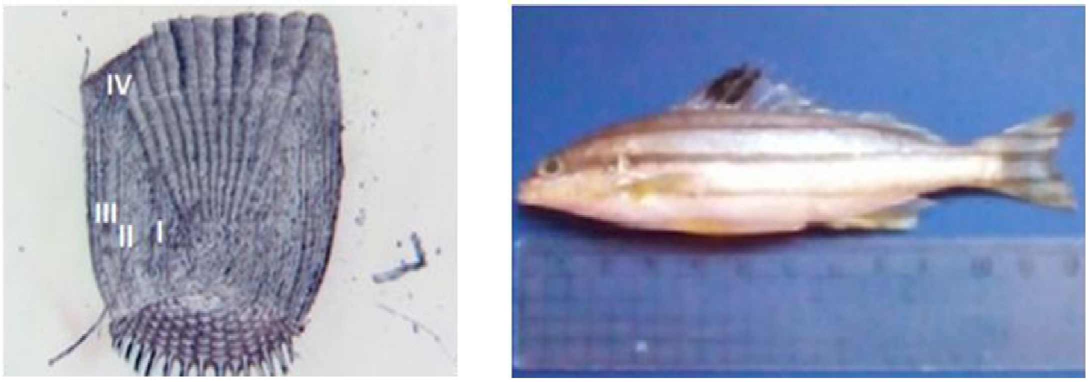

Figure 1. A- A scale from *Terapon puta* shows IV annual rings B- Female , *Terapon puta* (12cmT.L.)

Timsah were estimated. The main aim of the present study was to shed light on some biological and dynamic features of the *Terapon puta*. Using such information is essential for the management and the good precision of the fishing in the lake Timsah, Egypt.

MATERIALS AND METHODS

A total of 380 specimens of *Terapon puta* were collected by monthly sampling between June 2012 and May 2013. Age was determined by counting the annual rings on the scales using micrometer eye-piece. In order study the time of ring formation to establish its annular nature, the scales representing rings under formation (growth checks) at the outer margin in different months were examined (Figure 1A). To clarify further, the time of annulus formation, the distance from the last annulus to the margin of the scales were measured. A plot of monthly frequency of such scales which have marginal rings indicated the seasonal and established the annual nature.

Length–weight relationship was obtained since the total weight of each fish specimen was given with a digital balance to an accuracy of 0.01 g and total length was measured with a precision of 0.01 cm (Figure 1B). This relationship was determined according to the allometric equation given by Sparre *et al* (1989) as: $W = a\ L^b$

Where (W) is the total body weight in g, (L) is total length in cm; a and b are regression constants.

Growth in length and growth in weight were expressed in terms of the von Bertalanffy equation as follows:

$L_t = L\infty\ \ (1 - e^{-k(t - to)})$ & $L_t = W\infty\ \ (1 - e^{-k(t - to)})$

Whereas (L∞), (W∞) are the asymptotic total length, and total weight, respectively. (Lt) is the total length at age (t), (k) is the growth curvature parameter and (t_o) is the theoretical age when fish is at zero total length. These growth parameters were estimated by means of von Bertalanffy plot (Sparre and Venema, 1992). Total mortality rate (Z) was estimated which based on the length at first capture methods evaluating by Beverton and Holt (1957).

$$Z = K \times \left(\frac{L\infty - Lm}{Lm - Lc}\right)$$

Where: Lm = the average total length of the entire catch.
L**c** = the length at which 50% of the fish entering the gear are retained (Sparre *et al.,* 1989).

Instantaneous natural mortality rates (M) were estimated using the equation derived by Ursin (1967) which based on the mean total length where:

$$M = W^{-(1/b)}$$

W = mean total length, b = constant of length weight relationship.

Fishing mortality rates (F) were calculated as the difference between (Z), total mortality rates and (M), natural mortality rates as follows:

(Z = F + M) So, F = Z – M.

The value of the average annual exploitation rate (E) was obtained by E = F/Z (Sparre *et al.,* 1989).

RESULTS

A total of 380 specimens of *Terapon puta* were collected, ranging in size from 8.0-16.6 cm Total Length. The most common one was the 12 cm length group. Length frequency distribution, minimum, maximum, mean length and weight values of *Terapon puta* for each age group were illustrated in Table (1) and Figure (2). The age-groups of *Terapon puta* ranged from I to IV years and the most dominant age group occurred II off 35.8%. Total weight of the sampled individuals ranged from 14.95 to 70.92 grams. Overall mean total length and weight were calculated as 12.80± 1.34 cm and 38.14± 5.16 g, respectively.

Table 1. Length frequency distribution, of each age group of *Terapon puta* (Lake Timsah) Egypt.

Age group	Total Length(cm)				Total Weight(g)		
	Frequency	Min	Max	Mean ±SD	Min	Max	Mean±SD
I	129 (33.9%)	8.0	11.87	9.4±0.74	11.25	27.86	15.67±1.59
II	136 (35.8%)	10.5	13.9	12.3±0.91	21.78	48.10	31.15±5.08
III	82 (21.6%)	12.4	15.8	14.7±0.96	41.97	59.06	52.68±1.05
IV	33 (8.7%)	15.5	16.6	16.2±0.69	52.19	70.92	67.61±1.64
Total	380 (100%)	9.0	15.5	12.8±1.34	14.95	70.92	38.14±5.16

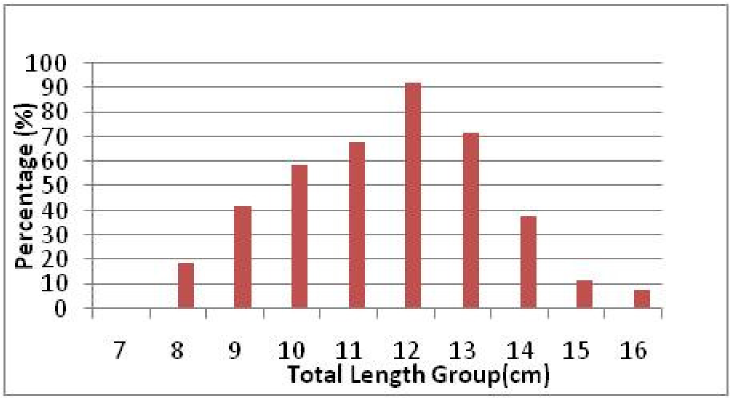

Figure 2. Length frequency distribution against length –groups for *Terapon puta* off Lake Timsah Egypt.

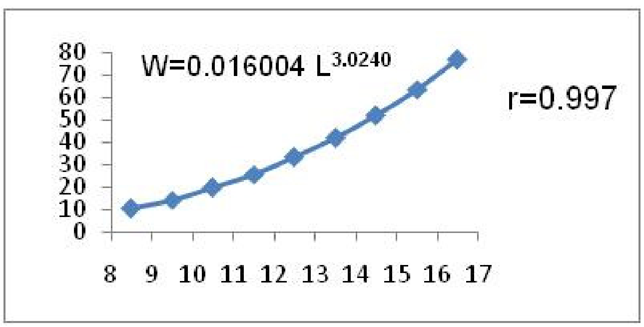

Figure 3. Length- weight relationship of *Terapon puta* off Lake Timsah in Egypt.

Length-weight relationship

The total length of *T. puta* varied from 8.0 to16.5 cm while the total weights ranged between 10.13 to 70.12 g. The equations were extracted for describing the relationship between weight and length as follows:

$W = 0.016004 \times L^{3.0240}$ (r = 0.99) or Log W = - 1.7958 + 3.0240 Log L

Where: W is the total weight (gm) in Y-axis, L is the total length (cm) in X-axis and r is the correlation coefficient. The high values of r^2 indicate a good measure for the strength of these equations and closeness of observed and calculated values of fish weight. The length and weight measurements of the analyzed specimens used to describe length-weight relationship are given in Figure (3).

The time of the annulus formation: Means the time at which a complete annulus is formed at the margin of the scale, this time is determined by using the marginal increment analysis or marginal growth which means the ratio between the distance from the last annulus to the margin and the total radius of the scale. The mean marginal growth for *Terapon puta* was calculated from scales for each month in order to establish the time of annulus formation which is shown in Table (2) and

Table 2. Monthly variations of marginal increment of the scales of *Terapon puta* from the Lake Timsah, Egypt.

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Number of fishes	10	12	9	10	9	10	7	9	11	13	10	10
Marginal Increment (mm)	0.036	0.030	0.032	0.015	0.020	0.037	0.043	0.056	0.050	0.046	0.040	0.036

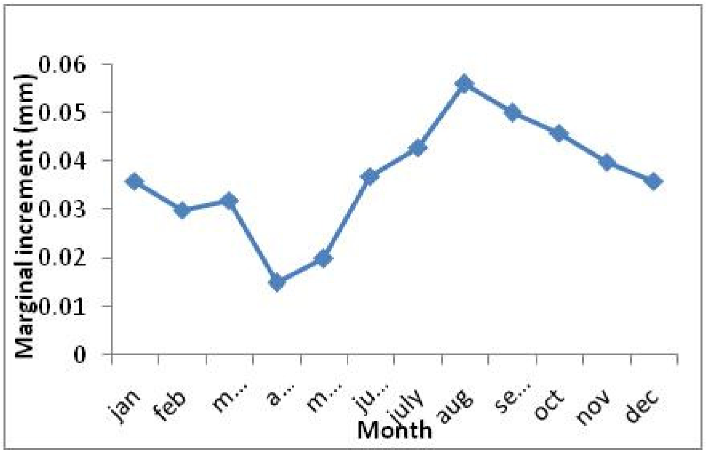

Figure 4. Monthly record of marginal growth for the scales of *Terapon puta* off Lake Timsah Egypt**.**

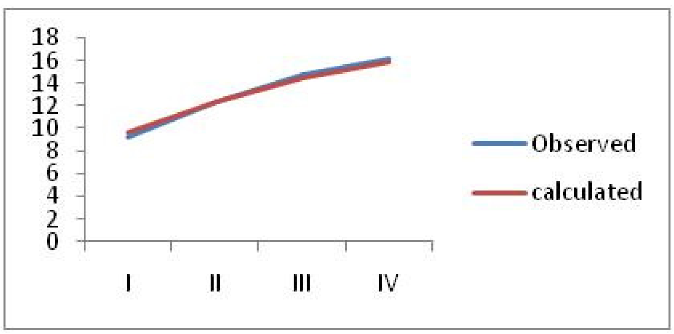

Figure 5. The von Bertalanffy growth curve of *Terapon puta* in the lake Timsah, Egypt.

represented graphically in Figure (4). Thus, it is indicated that the annulus formation occur in the month of April and this means that the annual rings were formed in the period of spring.

The age composition and growth

The age distribution of samples ranged from I to IV years for *Terapon puta*, based on the results of scales reading. The age group II (35.8%) was dominant followed by age groups I (33.9%), III (21.6%) and finally IV (8.7%).

The growth of the studied fish was described by the von Bertalanffy model (von Bertalanffy, 1938) based on the back-calculated length at age data (Figure 5). The estimated growth function was: $L_t = 20.13$ cm $(1 - e^{-0.13363\,(t+1.1085)})$.

The growth constant (K) was estimated at 0.13363. However, the maximum theoretical length ($L\infty$) and (t_0) describes the theoretical age where (L_t) is zero were 20.13 cm and -1.1085, respectively.

Growth in Length

The result of a plot of scale radius against total length is revealed that a linear relationship exists between the radius of the scale and the body length and can be

Table 3. Average back-calculated lengths (cm) of *Terapon puta* from the Lake Timsah, Egypt.

Age group	Fish number	Observed length(cm)	Back calculated lengths (cm) (Year) 1	2	3	4
I	129	9.4	9.23			
II	136	12.3	9.57	12.4		
III	82	14.7	9.42	12.0	14.5	
I V	33	16.2	9.48	11.9	14. 8	15.97
Grand Average calculated length (cm)	380		9.43	12.10	14.65	15.97
Annual Increment of length (cm)			9.43	2.67	2.55	1.32

Table 4. Calculated weights (g) of *Terapon puta* from the Lake Timsah, Egypt.

Age group	Fish number	Observed Weight(g)	Back calculated weights in (g) (Year) 1	2	3	4
I	129	15.67	13.27			
II	136	31.15	14.81	32.41		
III	82	52.68	14.12	29.35	52.02	
I V	33	67.61	14.39	28.62	55.35	69.67
Grand Average calculated weight (g)	380		14.15	30.13	53.69	69.67
Annual Increment of weigh (g)			14.15	15.98	23.56	15.98

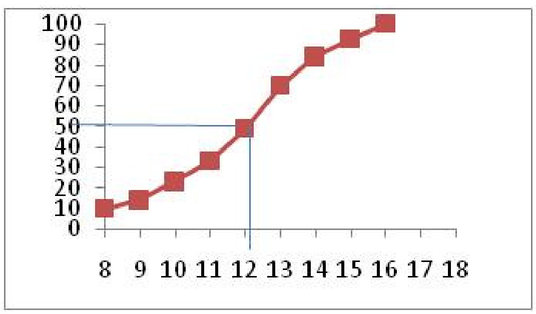

Figure 6. Cumulative curve from which length at first capture was determined.

expressed as follows:

$L = 3.19644 + 1.48960\ S$ $(r = 0.996)$

Where L is the total length in cm and S is the scale radius in mm.

Back-Calculations

The following formula for *T.puta* was derived to obtain the back calculated total length at the end of each year of life.

$$L_n = (L - 3.19644)\ S_n / S + 3.19644$$

Where: L_n is the length at the end of n^{th} year, S_n is the radius of the scale to n^{th} annulus, S is the total radius of the scale and L is the total length at capture. From the data given in Table (3), it is obvious that, *T. puta* attains its highest growth rate in the first year of life, after which a gradual decrease in growth increments was noticed with further increase in age.

Growth in Weight

The calculated weights at the end of each year of life of *T. puta* were estimated by applying the corresponding length-weight equation to the back calculated lengths. The resulting values are given in Table (4).

The obtained results indicated that the growth rate in weight was slow during the first year of life. Then the annual growth increment in weight increased with further increase in age until it reached its maximum value at the end of the third year of life, after which a decrease in the growth increment was observed.

Mortality Rates

By using the cumulative curve of *Terapon puta* (Figure 6) illustrating length at first capture at 50 % and applying the method of Sparre *et al.*(1989), the total mortality coefficient (Z) was estimated. This coefficient was found to be 1.63251 year-1. But the Natural mortality coefficient "M" which obtained from the mean total length was 0.4304 year -1. Using the estimated (M) and (Z) the fishing mortality (F) was obtained (1.202113 year-1), where Z = M + F.

Exploitation Rate (E): The current exploitation rate "E" was estimated at 0.73. Length at First Capture (Lc): As in Figure (6), the length at first capture L50% (the length" X axis" at which 50% "Y axis" of the fish are first exposed to capture) was estimated as a component of the length converted catch curve analysis (FiSAT) and was found to be 12.2 cm which corresponds to an age of two years.

DISCUSSION

In this study, the power equations for describing the relationship between weight and length were extracted the isometric growth of *Terapon puta* in Lake Temsah, Egypt. Small specimens were in better nutritional condition at the time of sampling. This stated that there was no significant difference in the weights and lengths of *Terapon puta* as a result of sampling period during different seasons of the year 2012 from Karachi Coasts, Pakistan by Ahmed and Benzer (2015) and Ahmed *et al*., (2015). The length-weight relationships can be used for forecasting both the potential yield and determining the most favorable size of capture to obtain optimum yield; these management parameters are directly related to the weight of the fish (Suresh *et al.* 2006 and Shakman *et al*. 2008). Actually, when the b = 3 the relationship is isometric, positive allometric (b>3) or negative allometric (b<3) (Spiegel 1991). The equations of this study of Length-Weight relationships ($W=0.016004\ L^{3.0240}$) are coincided well with that by Nandikeswari (2014) and different from that of Indian specimens ($W= 0.76416090L^{0.9328}$) by

Nandikeswari and Anandan (2013) .They stated that the monthly changes of GSI of *Terapon puta* from Bengal estuary showing a protracting spawning period beginning from March to October. This is coincided well with this study where the annulus formation occurs in April. In addition, the power of driving population fluctuations was recruitment variability year by year (Saetre, *et al*., 2002).

Age is one parameter necessary to assess population dynamics and the state of exploited resources (Allain and Lorance 2000). The small scaled fish is not long lived; this paper showed that the maximum age of *Terapon puta* was IV years.

From back-calculated growth, the annual rings on the scales revealed increase in length rapidly during the first year and slowly thereafter. This study showed that the mean annual growth rate for 1 to 4 years old fish ranged between 9.43 and 1.32 cm, respectively (Table 3). The largest individual caught and the calculated maximum length in the Lake Timsah, were 16.5 cm and 20.13 cm, respectively. There is no accurate data for the annual catch of *Terapon puta* because the catches of all small scale fish of without separation to the species level are recorded in Egyptian Fisheries Statistics Striking increased within the past a few years. The absence of a 0 age group in the samples was probably due to the selectivity of the cod-end used in the trawl nets. However, the low levels of the older age groups after the age of 2 cannot be related to selectivity, and are more likely to be the outcome of extremely intensive fishing activities. While, the maximum absolute age for *Terapon puta* established here (4 years) was double to the maximum age of 2 years estimated for the same species in the Suez canal , which was aged using otoliths (Manal *et al*., (2016).

The larvae and juveniles of *Terapon jarbua* occurs along the coast of Taiwan enter estuaries in great abundance during May and November for feeding, are a popular game fish caught mainly for food. (Miu *et a*l. 1990), and it means that this supported to this study in formation of the annual rings on scales which formed in the period of spring.

According to Gulland (1971) which suggested that the optimum exploitation rate in an exploited stock should equal approximately 0.50. In this study, the high value of the current exploitation rate (0.73) indicates that the stock of *Terapon puta* (Lake Timsah), in Egypt is subjected to overfishing

For future management and conservation purposes of *Terapon jarbua* in Taiwanese Waters, the growth rate, age at maturity, or fecundity or other biological parameters are not sufficient to examine the single-stock assumption unless the reexamination which based on genetic stock information to eliminate the effect of mixing stocks (Vanson Liu, *et al*., 2015).

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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