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Fishery biology of *Terapon puta* (Cuvier, 1829) from east Egyptian Mediterranean waters

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ABSTRACT

This study aimed to investigate the fishery biology of *Terapon puta*, family Teraponidae, caught during 2016 with bottom trawlers from east Egyptian Mediterranean waters at Damietta and Port Said. The total number of fish studied at the present study was 506, ranged from 6-14 cm, total length. Length-weight relationship was determined for males (logw = -1.3122 + 2.333 log L), females (logw=-1.70195+2.7238 logL), immature (logW=-2. 10597+3.0806 log L) and for total fish (log w=-2.0763+3.0557 log L). Condition factor for females (k=1.023) was higher than that for males (k=0.997). Age was estimated from length frequency data by Bhattacharya's method (1967) Von Bertalanffy growth parameters were L_∞=15.9 cm, K=0.3614 y^{-1}, t_0=0.6313 y^{-1} and w_∞=39.27 gm. The individuals of this species live for about 3 years and the second age dominate the population. the growth performance index in length (φ_2=4.3643). Estimated total, natural, fishing mortality rates and exploitation rate were (z=1.0374 y^{-1}, M=0.9797 y^{-1}, F=0.0577 y^{-1} and E=0.3797 respectively).

INTRODUCTION

Terapon puta belongs to family Teraponidae that mainly lives in marine waters and reaf associated. They are found in shallow tropical seas around the coastlines of Indian Ocean, Red Sea (including the eastern Mediterranean Sea, off south Africa and off western India, in coastal waters down to a depth range of 65-68 m (Weitkamp and Sullivan, 2003). The striped piggy is caught mainly with bottom trawls and on hook and line (Carpenter *et al*., 1997).

Different aspects of biological parameters of *Terapon puta*, have been studied in different regions by different authors, sucj as those of Ben-Tuvia and Mckay (1984) in north-eastern Atlantic and Mediterranean; Fisher *et al*. (1990) in Mozambique; Pauly *et al*. (1998) in Philippineanes waters; Hashemi and Taghavimotlagh (2012) in northwest of Persian Gulf (Khuzestan Coastal Waters. Iran, Amtyaz; Safi *et al*. (2014) in Karachi coast, Pakistan and Abd El Azim; Mehanna and Belal (2014) in Bitter lakes, Egypt.

The objective of the present study is an attempt to understand various biological aspects: age, growth, mortality, exploitation rate, length and age at first capture and growth performance as an attempt toward management of the fishery of *Terapon puta* from Egyptian Mediterranean waters.

MATERIALS AND METHODS

A total of 506 fishes of (*Terapon puta*) between 5.8 to 14.4 cm (T.L) were collected by professional fishermen using trawler net from Port Said and Damietta at the eastern Egyptian Mediterranean waters during 2016. In the laboratory, total length (cm), total weight (gm) as well as sex of each fish were determined.

Length-weight relationship was calculated by the following equation:

$$\text{Log } w = \log a + b \log L$$

Where w: total weight (gm), L: total length (cm), b is the slope and log a is the intercept which can be determined by Lagler (1956) and Ricker (1975).

In order to verity if calculated b was significantly different from 3, the Student t test was employed (Zar, 1996).

The condition factor (k) was calculated according to the following equation (Ie Cren, 1951):

$$K = \frac{W\ x\ 100}{L^3}$$

Where (w) is observed body weight of fish (gm) and (L) is total fish length (cm).

Age was determined by Bhattacharya's method (1967) which depends on the analysis of length frequency data during the whole year (2016). The assigned age at length groups was used for estimation of the von-Bertalanffy growth parameters according to Ricker (1975). The maximum age $t_{max}=\frac{3}{k}+t_0$ (Beverton, 1963). The index of growth performance Q was determined according to Moreau *et al*. (1986) $Q=\log k+2 \log L_\infty$. Total mortality (z) was estimated from the slope of descending right limb of catch curve (Ricker, 1975). The annual mortality (A) was computed as A=l-s, where s is the survival rate which was calculated as $s=e^{-z}$ (Ricker, 1975). Natural mortality (M) was calculated using the general regression equation of pauly (1983):

$$\text{Log } M = -0.0066 - 0.279 \log L_\infty + 0.6543 \log k + 0.4634 \log t.$$

Where L_∞ and k are the von Bertalanffy parameters and T is the mean annual water temperature.

Fishing mortality (F) was calculated as F=Z-M. (Beverton and Holt, 1957). Exploiation rate $E=\frac{F}{Z}$ was calculated according to pauly (1983). The length at first capture (L_c) was estimated using the formula ($L_c=L^{/}-K(L_\infty- L^{/})/Z$) as given by Beverton and Holt (1957). The corresponding age (t_c) was obtained by converting L_c using the Von Bertalanffy growth equation:

$$T_c=\frac{-1}{K} \ln \left(1-\frac{Lc}{L\infty}\right)+t_0$$

RESULTS AND DISCUSSION

Size composition

Size composition of both sexes of *Terapon puta* obtained during the present study is represented in Table (1). It is clear that the majority of catch was immature (214 individuals) ranged between (6 to 11 cm) forming about 42.3% of the total catch. The males were 158 individuals constitute 31.23% of studied samples ranged from 10 to 14 cm with an average 10.92 cm, while the number of females was 134

individuals representing 26.48% of the samples studied ranged from 9 to 14 cm with an average length of 11.41 cm.

Length frequency distribution of males and females is represented in Fig. (1). This makes a sex ratio of 1.00 to 0.85 males to females.

Table 1: Length frequency distribution of *Terapon puta* from the eastern Egyptian Mediterranean waters.

Total length (cm)	Males		Females		Immature		Combound sexes	
	No.	%	No.	%	No.	%	No.	%
6					3	1.40	3	0.59
7					6	2.80	6	1.19
8					24	11.21	24	4.14
9			2	1.49	69	32.24	71	14.03
10	60	37.97	20	14.93	77	35.98	157	31.03
11	64	40.51	62	46.27	35	16.36	161	31.82
12	25	15.82	28	20.90			53	10.47
13	5	3.16	15	11.19			20	3.95
14	4	2.53	7	5.22			11	2.17
No.	158		134		214		506	
%		31.23		26.48		42.29		
Av.L±St.L	10.92±0.9441		11.41±1.0845		9.48±1.0689		10.43±1.3354	

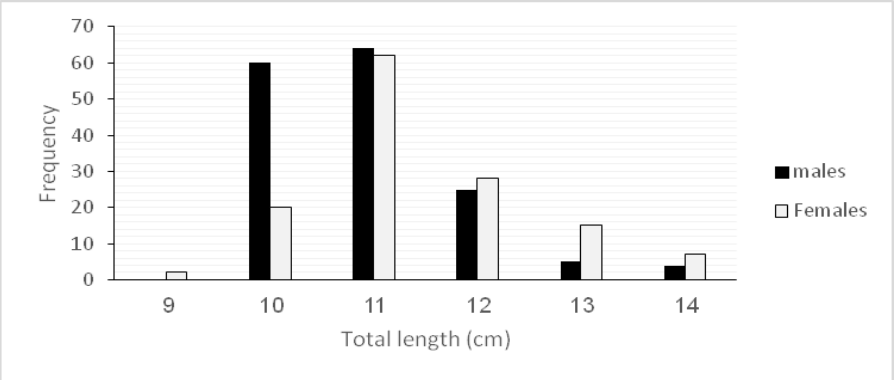

Fig. 1: Length frequency distribution of males and females *Terapon puta* from eastern Egyptian Mediterranean waters (2016).

Length-weight relationship

Data for length-weight relationship were based on 506 fish ranging in length from 6 to 14 cm, including 158 males, 134 females and 214 immature (Table 1), the following equations were obtained:

For males: log W=-1.31223+2.333 log L (R^2=0.9901)
For females: log W=-1.70195+2.7238 log L (R^2=0.9976)
For immature log W=-2.10597+3.0806 log L (R^2=0.98701)
For combined sexes log w=-2.0763+3.0551 log L (R^2=0.9974)

The average observed and calculated weights for males, females, immature and combined sexes (Table 2) shows that the calculated weight coincides with those of empirical ones.

By fitting non-linear regression to the data of length-weight relationship, it could be observed that the value of "t" for both males (-0.0314), females (-0.4534), immature (-0.0678) and combined sexes (-0.0444) were insignificant at 0.05 level indicating all isometric growth.

Table 2: Mean observed and calculated total weight (gm) per I cm total length of *Terapon puta* from eastern Egyptian Mediterranean waters, (2016).

Total length (cm)	Males			Females			Immature			Combined sexes		
	No.	Empir-weight	Calc-weight	No.	Empir-weight	Calc-weight	No.	Empir-weight	Calc-weight	No.	Empir-weight	Calc-weight
6							3	2.00	1.96	3	2.0	1.99
7							6	3.00	3.14	6	3.0	3.19
8							24	4.52	4.74	24	4.52	4.80
9				2	8.0	7.89	69	7.74	6.82	71	7.63	6.88
10	60	10.82	10.49	20	10.10	10.52	77	9.22	9.43	157	9.94	9.50
11	64	13.06	13.10	62	14.0	13.63	35	12.29	12.65	161	13.25	12.72
12	25	15.24	16.05	28	17.29	17.28				53	16.32	16.61
13	5	19.0	19.35	15	21.80	21.49				20	21.10	21.22
14	4	24.0	23.0	7	25.86	26.30				11	25.18	26.63
No.	158			134			214			506		

Condition factor

The values of the condition factor "K" of *Terapon puta* range from 0.865 to 1.082 for males, from 0.942 to 1.097 for females and from 0.883 to 1.062 for immature. Generally females have higher condition factor than males (Table 3).

Table 3: Mean condition factor (K) per total length (cm) for *Terapon puta* from eastern Egyptian Mediterranean Waters.

Total length (cm)	Males		Females		Immature		Total	
	No.	Av. K	No.	Av. K	No.	Av. K	No.	Av. K
6					3	0.926	3	0.926
7					6	0.875	6	0.875
8					24	0.883	24	0.883
9			2	1.097	69	1.062	71	1.063
10	60	1.082	20	1.010	77	0.922	157	0.994
11	64	0.981	62	1.051	35	0.923	161	0.995
12	25	0.882	28	1.001			53	0.945
13	5	0.865	15	0.992			20	0.960
14	4	0.875	7	0.942			11	0.918
No.	158		134		214		506	
Mean		0.997		1.023		0.962		0.989
SD		±0.0766		±0.0321		±0.0707		±0.0430

Age composition

The age composition of *Terapon puta* was analyzed by Bhattacharya's method (1967) is given in Table (4). It is clear that the population of *Terapon puta* in east Egyptian Mediterranean at Port Said and Damietta consist mainly of three age groups having length range 6-14 cm, with mean 11.7 cm comprised three age groups with total length of 8.56, 10.51 and 12.50 cm respectively. Age two dominated 62.85% of the total catch.

Table 4: Age composition of *Terapon puta* from East Egyptian Mediterranean Waters (2016).

Age groups	No.	% Frequency	Mean length (cm)	S.D.
I	104	20.55	8.56	±0.734
II	318	62.85	10.51	±0.501
III	84	16.60	12.50	±0.72

Total=506

SD= standard deviation

Growth parameters

The von Bertalanffy growth model is commonly used in fisheries research to describe growth (Misra, 1986, Maller and de Boer, 1988. Chen *et al*., 1992. In the present study, Von Bertalanffy growth parameters are given in Table (5), and the von Bertalanffy equations for length and weight are as follows:

$$L_t=15.9[1-e^{-0.3614(t-0.6313)}]$$

$$W_t=39[1-e^{0.3614(t-0.6313)}]^{3.0551}$$

Table 5: Growth parameters of *Terapon puta* from east Egyptian Mediterranean Waters (2016).

parameters	value
- Coefficient growth (k)	0.3614
- Hypothetical age at zero size (t_0)	0.6313
- Asymptotic length (L_∞)	15.9
- Mean length ($L^{\backslash}$)	11.72
- Minimum length in present sample (l'min)	6.2
- Maximum length in present sample (L'max)	14.3
- Intercept of length-weight relationship (a)	-2.0763
- Coefficient of length-weight relationship (b)	3.0551
- Asymptotic weight (W_∞)	39.27
- Growth performance of length (φ_L)	4.3643
- Growth performance of weight (φ_W)	2.4584
- Av-water temperature	22°C

Fishery parameters:

Table (6) shows that natural mortality rate (M=0.9797 y^{-1}) was higher than fishing mortality (f=0.3933 y^{-1}), and the exploitation ratio (E=03797) according to gull and (1971), the yield is considered optimum when the exploitation ratio E= 0.5, or when F= M. in the present study it was observed that both E and F were less than that mentioned values. These results indicate that the stock of *Terapon puta* in the east Egyptian Mediterranean waters is under exploited.

Table 6: Fishery parameters of *Terapon puta* as obtained in the present study.

Fishery parameters	value
- Total mortality (Z)	1.0374
- Survival rates (S)	0.3544
- Annual mortality (A)	0.6441
- Natural mortality (M)	0.9797
- Fishing mortality (F)	0.3933
- Exploitation rate (E)	0.3797
- Length at first capture (L_c)	10.26
- Age at first capture (T_c)	3.5

DISCUSSION

The length-weight relationship in fish is of great importance in fishery assessments (Haimovic and Velasco, 2000). Length and weight relationship in conjunction with age data can give information on the stock composite, age at maturity, life span, growth and production. The relative robustness or degree of well-being of a fish expressed as the coefficient of condition (condition factor) is an important tool for the study of fish biology, mainly when the species lies at the base of higher food web (Diaz *et al*. 2000).

In the present study, b value of females (2.7238) was heavier than that of males (2.333) of the same length groups. The variation in length weight relationship (Table 7) and fishery parameters (Table 8) in different region could be due to seasonal

fluctations in environmental parameters, physiological conditions of the fish at the time of collection, sex, gonad environment and nutritive conditions in the environment of fish (king, 2007).

Table 7: Length-weight relationship of *Terapon puta* in different geographical areas.

Authors	Regions	sex	Log a	b	r^2
1- Pauly *et al*. (1998)	Philippines	♂-♀	0.011	3.00	
2- Hashemi & Taghavimothlagh (2012)	Persian Gulf, Iran	♂	-4.097	2.66	0.89
		♀	-4.523	2.96	0.90
		♂-♀	-5.045	3.04	0.80
3-Abu El Nasr & El Drawany, (2012)	Lake Timsah	♂-♀	0.016004	3.0240	
4- Amtyaz Safi *et al*. (2014)	Karachi Coast, Pakistan	♂	-4.25	2.73	
		♀	-4.46	2.82	
5- Ahmed and Benzer (2015)	Karachi coast Pakistan	♂-♀	-0.1168	0.9328	
6- Hoveizavi *et al*. (2016)	Khuzestan	♂-♀	0.037	2.62	0.78
7- Nandikeswari (2016)	Puducherry (India)	♂	-0.9182	2.0246	
		♀	-1.0754	2.2074	
8- Present study	East Egyptian Mediterranean Waters	♂	-1.312	2.333	0.9901
		♀	-1.702	2.724	0.9976
		♂-♀	-2.106	3.081	0.9870

a= intercept b= slope r^2= Coefficient of determination
FB= test of slope F_M=test of adjusted mean size at first maturity and maturity stages of *Terapon puta* 12 cm index

Table 8: Growth parameters of *Terapon puta* in different regions by different authour.

Authors	Study area	sex	K	L_∞	t_0	Φ_L
Hashemi & Taghavimotlagh (2012)	Persian Gulf (Iran)	♂-♀	0.7	26	-0.65	2.82
Abu El-Nasr & Drawany (2012)	lake Timsah	♂-♀	0.13363	20.13	-1.1055	
Sajjad Karim *et al*. (2016)	North part of Persian Gulf	♀	0.14	24.54	-4.41	4.45
		♂	0.18	21.91	3.68	4.43
El Drawany (2017)	Bitter lakes Egypt	♀	0.26128	20.4	-1.3256	
		♂	0.26189	20.7	-1.3165	
Present study	Eastern Egyptian Mediterranean Waters	♂-♀	0.3614	15.9	0.6313	4.364

The differences in growth parameters between the present study and other authors in different regions were compered using Pauly's growth performance index (φ) (Moreau *et al*, 1986) because the growth performance K and L_∞ strongly correlated with each other (Sparre *et al*., 1989).Table (8) shows the estimated K, L_∞, t_∞ and φ_l from different regions. It's observed that the growth performance in the present study is nearly close to that given by Sajjad Karim *et al*. (2016).

The length at first capture L_c in the present study was estimated as 10.26 cm, which corresponds to the second year of life. At the same time, it was smaller than the length at first maturity as recorded by El Drawany (2017) where it was 11.5 cm i.e the major of the fishes in the present study are captured befors their first spawning period.

So, we can say that *Terapon puta* fish must be caught at least 12 cm total length to get the chance to spawn even once.

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