Study on the biology of the small scaled terapon *Terapon puta* (Cuvier, 1829) from Bardawil Lagoon, North Sinai, Egypt

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**ABSTRACT**

This work aims to investigate some biological aspects as length-weight, age composition, sex ratio, Gonado-Somatic Index (GSI) and fecundity of the small- scaled *Terapon puta* (Cuvier, 1829) in Bardawil Lagoon, North Sinai, Egypt. The study was carried out during the period from May 2017 to January 2018. The results revealed that the total body weight relative to the total body length is positive isometric, $b = 3.0209$. The length at first capture was 11.9 cm, and the length groups 12-12.9 cm have predominated the fish population (17.8%). Four age groups were detected, and the age composition of *T. puta* indicated that individuals belonging to age group I dominate the fish population (38.6% of the total collected individuals). The overall sex ratio indicated that the females *T. puta* were dominant throughout all the months except in November. The lowest values of GSI of *T. puta* were recorded in November and December while its highest values recorded in June. The length at first mature ($L_{50}$) was determined as 13.2 and 13.7 cm for males and females respectively. The fecundity increase with increasing the total body length with correlation coefficient ($r^2 = 0.89$). To facilitate the management of modern fisheries of this species, the recommendation should be directed to equal length at first capture by the length at first mature and not less than 13.8 cm to give the females to spawn even once to keep stock of the fish in Bardawil Lagoon.

**INTRODUCTION**

Small- scaled terapon, *Terapon puta* (Cuvier,1829), is considered an important commercial fish in the Indo-West Pacific, North Indian Ocean and the Indo-Australian Archipelago. It is a Lessepsian migrant, and now is prevalent in the Mediterranean Sea (Golani et al., 2002). This species belongs to Order: Perciformes and Family: Terapontidae. This family includes 16 genera and about 48 fish species (Nelson, 2006). The species of this family are frequent in the marine coastal, brackish and fresh water. Ben-Tuvia (1976) mentioned that, *T. puta* found in Mediterranean recorded first in Bardawil Lagoon, northern Sinai, Egypt. Vari (1978) and Yoshida, et al., (2013) documented that the *T. puta* is found in inshore waters, sometimes entering brackish and fresh waters and mangrove areas. It is also found in Widespread in the Indo-Pacific from East Africa north of Zanzibar, Red Sea and Persian Gulf to New Guinea and Vanuatu, and north to the Philippines. Although the broad distribution of this species along the indo-pacific waters, modest information on its biological character has been reported by Ben-Tuvia (1986) in Bardawil Lagoon, Egypt; Paxton et al. (1989) in Australia studied the general biology of *T.*
Alwany and Hassan (2008) studied the relationship between otoliths size and the fish body size of *T. puta* from the Gulf of Suez, Egypt. Many scientists have studied the length-weight relationship of *Terapon puta* such as (Karna and Panda, 2012 in Chilika Lagoon, Odisha (India); Ahmed and Benzer, 2015 in Karachi Fish Harbour ; Nandikeswari, 2016 in Pondicherry coast, India ; Rizkalla *et al.*, 2016; Sabrah *et al.*, 2016 ; Abu El-Nasr and El-Drawany, 2017 in Lake Timsah Egypt and Kassem, 2017 in Bardawil Lagoon, Egypt).

The reproductive cycle of fishes is closely tied to the environmental changes particularly temperature, photoperiod and food supply (Bagenal, 1978). The length at first maturity and gonado somatic index and sex ratio of *Terapon puta* was estimated by many authors (Nandikeswari and Anandan, 2013; Nandikeswari *et al.*, 2013; Nandikeswari 2016, Sabrah *et al.*, 2016; Rizkalla *et al.*, 2016 and Kassem, 2017).

The objective of the present research is to shed light on some biological features of the *Terapon puta*. Using such information is essential for the management and the good accuracy of the fishing in Bardawil Lagoon.

**MATERIALS AND METHODS**

The study was carried out in the Bardawil Lagoon (Fig. 1). The lagoon is separated from the Mediterranean Sea by a sandy bar with two narrow inlets. It is considered as a natural depression with a depth of 1-3 m.

Monthly random samples of *Terapon puta* were collected from the different landing sites of the Bardawil Lagoon, North Sinai. The sampling period occurred during the fishing season from May to December, 2017 and January 2018.

![Satellite image of Bardawil Lagoon](image)

**Length distribution and length at first capture:**

In the laboratory, total fish length and total weight for 1106 specimens were determined to the nearest 0.1 cm and 0.1 gm respectively. Estimated distribution length by length frequency for length groups and estimating length at first capture ($L_c$) was taken as corresponding to the cumulative length probability at 50% (Pauly, 1987).

**Length-weight relationship:**

The relationship between length and weight was described by the potential equation:
W = a L^b (Ricker, 1975), where W is the total weight (gm), and L is the total length (cm), a and b are constants. The condition factor was calculated monthly by formula:

\[ K = \frac{W \times 100}{L^3} \] (Hile, 1936), Where: K = condition factor, W = weight in gram and L = length in centimeter.

**Age determination:**

Most of the authors preferred to use scales for the age determination. In the present study, it was difficult to collect scales, since the scales of T. puta are small and loosely embedded structures with hardly visible annual marks. Therefore in the present study, otoliths were used for the age determination. Otoliths were cleaned by 8% HCl, and then dried. The otoliths were cleared in a mixture of 50% ethyl alcohol and 50% glycerin and they were examined using microscope. The opaque and transparent rings were counted from the nucleus to the margin along the longest axis of the otolith. One opaque zone together with one transparent zone was considered to be an annual increment. Each annual increment represents one year of the fish age (El-Ganainy, 1992). The number of fish in each age group was calculated, and then the proportion of the different age groups of the fish in the catch was used to calculate the age composition of T. puta.

**Reproduction:**

Length, weight, sex, stage of maturity and fecundity of individual fish samples were recorded. Ovaries were removed and preserved in 10% formalin for further studies. After the gonads had been extracted, the specimens were sexed with naked eye and by microscope in young specimens. The gonads (Fig. 2) after being removed were weighed to the nearest 0.01 gm. In order to determine the spawning season, the Gonado Somatic Indices (GSI) were calculated monthly by equation of Albertine-Berhaut (1973) as follows:

\[ GSI = \frac{Gonad Weight}{Body Weight} \times 100. \]

The length and age at first maturity (L_{m50}) was determined by examination of gonads to determine the sex and the stage of maturity, where 50% of fish reach their sexual maturity was estimated by fitting the maturation curve between the percentage maturities of fish corresponding to each length class interval.

**Fecundity:**

Absolute fecundity (F_{abs}) is defined as the number of mature eggs in the ovaries during the spawning season. 40 mature ovaries of adult females were used of length ranged from 11.5 to 18.9 cm. The gonads were removed, weighed to the nearest 0.01g and placed in glass bottle with 10% formalin. Then, the gonads were washed.
and dried. Subsamples were taken from different parts of the ovaries and weighted to obtain the net eggs weight. The subsamples weighted (1gm), and eggs were well mixed, and placed on slide which was divided into squares. The eggs in twenty squares were counted under the microscope. The mean number and the total number of eggs in the subsample were counted. Then, the total fecundity (F) was calculated as given by Yeldan and Avsar (2000):

\[ F = \text{Gonad Weight} \times \text{Egg Number in the Subsample} / \text{weight of subsample} \]

The relative fecundity (F_rel) was calculated as: \( F_{\text{rel}} = F_{\text{abs}} / (\text{Body length or body weight}) \). The relationship between the total length (L) and fecundity using the least square method was recorded.

**RESULTS**

**Length distribution:**

A total of 1106 specimens of *Terapon puta* were obtained from the Bardawil Lagoon from May to December, 2017 and January 2018. Total length ranged from 5.3 to 18.9 cm and the observed total weight from 2.5 to 68 g. Length frequency of *T. puta* (Figure 3) showed that the length group (12-12.9cm) was the most frequent, since it constitute 17.8% of the catch, whereas the length group (5-5.9 cm) were lowest since it represented 0.5% in the catch. Length at first capture (L_c) was 11.9cm as shown in Figure (4).

![Fig. 3: Length frequency distribution of *T. puta* from Bardawil Lagoon during 2017-2018.](image1)

![Fig. 4: Length at first capture of *T. puta* from Bardawil Lagoon during 2017-2018.](image2)

**Length-weight relationship:**

The length – weight relationship was described by the power equation as:

\[ W = 0.0117 \times L^{2.9472} \ (R^2 = 0.9369),\ W = 0.0062 \times L^{3.1886} \ (R^2 = 0.9712) \text{ and } W = 0.0097 \times L^{3.0209} \ (R^2 = 0.959) \text{ for males, females and combined sexes respectively (Figs.5, 6 and 7).} \]
Biological studies on Terapon puta from Bardawil Lagoon

Fig. 5: L - Wt relationship of males for *T. puta* in Bardawil Lagoon during 2017-2018.

Fig. 6: L - Wt relationship of females for *T. puta* in Bardawil Lagoon during 2017-2018.

Fig. 7: L - Wt. relationship of combined sexes for *T. puta* in Bardawil Lagoon during 2017-2018.

**Condition Factor:**

The mean condition factors of males, females and combined sexes of *Terapon puta* were nearly similar to each other. Condition Factor varied from 0.98 to 1.46 in all individuals. Lower condition factor values (K) were recorded in August for males and combined sexes while in September for the females. The highest values were recorded in December for males and females, while the highest value of combined sexes were recorded in November (Fig. 8).

Fig. 8: Monthly variation in condition factor (K) of combined sexes, females and males of *T. puta* in Bardawil Lagoon during 2017-2018.
Age composition:
The results show that, four age groups were recorded. The age composition of *T. puta* from Bardawil Lagoon reveals the predominance of age group (I) in the catch, since it compose 38.3%, followed by the age group II (23.1). Age group IV was the least frequent, since it composes 7.3 % of the total age groups, Figure (9).

![Fig. 9: Age composition of *T. puta* from Bardawil Lagoon during 2017- 2018.](image)

Sex ratio:
The sex ratio of *T. puta* collected in this study was 1: 1.7(313 males to 518 females). It was observed that the two sexes did not distribute in the same proportion during different months. Females predominated during all months except in November, since it constitutes more than 60 % of the collected sample during the period of study (Table 1).

<table>
<thead>
<tr>
<th>Month</th>
<th>Females</th>
<th>Males</th>
<th>sex ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>May 2017</td>
<td>76</td>
<td>40</td>
<td>1:1.9</td>
</tr>
<tr>
<td>June</td>
<td>151</td>
<td>73</td>
<td>1:2.1</td>
</tr>
<tr>
<td>July</td>
<td>44</td>
<td>19</td>
<td>1:2.3</td>
</tr>
<tr>
<td>August</td>
<td>52</td>
<td>38</td>
<td>1:1.4</td>
</tr>
<tr>
<td>September</td>
<td>31</td>
<td>21</td>
<td>1:1.5</td>
</tr>
<tr>
<td>October</td>
<td>35</td>
<td>29</td>
<td>1:1.2</td>
</tr>
<tr>
<td>November</td>
<td>34</td>
<td>39</td>
<td>1:0.9</td>
</tr>
<tr>
<td>December</td>
<td>26</td>
<td>17</td>
<td>1:1.5</td>
</tr>
<tr>
<td>January 2018</td>
<td>69</td>
<td>37</td>
<td>1:1.9</td>
</tr>
<tr>
<td></td>
<td>518</td>
<td>313</td>
<td>1:1.7</td>
</tr>
</tbody>
</table>

It was noticed that females were outnumbered males for all length groups except length group (11-11.9) (Fig. 10).

![Fig. 10: Sex ratio according to different length groups of *T. puta* in Bardawil Lagoon during 2017-2018.](image)

Gonado-Somatic Index (GSI):
The monthly changes in males and females GSI of *T. puta* were represented in Fig. 11. GSI of males of *T. puta* was lower than females. The lowest value of GSI of males (1.0) was recorded in December, then increase slightly in January. The
maximum value of GSI of male was recorded in June GSI (4.3). GSI of females showed a similar pattern as males. It attained the lowest value (1.0) in November and reached the highest value in June (7.6). This means that the reproduction season of *T. puta* in Bardawil Lagoon is from May to July (summer spawner).

![Graph](image)

**Fig. 11:** Monthly changes in Gonado Somatic Index (GSI) of males (M) and females (F) of *T. puta* in Bardawil Lagoon during 2017-2018.

**Length at first sexual maturity:**

The immature and mature fish for each length group was analyzed to determine the length at first mature (L_m). All males and females with a total length higher than 12 cm are mature. The length at first mature (L_50) was determined as 13.2 and 13.7 cm for males and females respectively (Fig. 12).

![Graph](image)

**Fig. 12:** Length at first maturity (L_m) of males and females of *T. puta* in Bardawil Lagoon during 2017-2018.

**Fecundity:**

The relation between fecundity (absolute and relative) and total length and body weight of *T. puta* were illustrated in Table (2). The number of eggs gradually increased by increasing fish length, since fish of 11.5 cm produces about 89571.4 eggs, reaching maximum number of about 202761 eggs for a fish length 18.9 cm.

<table>
<thead>
<tr>
<th>L. groups(cm)</th>
<th>No</th>
<th>Ave. L</th>
<th>Absolute fecundity</th>
<th>Relative Fecundity</th>
</tr>
</thead>
<tbody>
<tr>
<td>11-11.9</td>
<td>1</td>
<td>11.5</td>
<td>89571.4</td>
<td>99111.17</td>
</tr>
<tr>
<td>12-12.9</td>
<td>5</td>
<td>12.8</td>
<td>110628.6</td>
<td>117030.8</td>
</tr>
<tr>
<td>13-13.9</td>
<td>10</td>
<td>13.3</td>
<td>128004.8</td>
<td>123477.1</td>
</tr>
<tr>
<td>14-14.9</td>
<td>5</td>
<td>14.4</td>
<td>143276.2</td>
<td>140803.7</td>
</tr>
<tr>
<td>15-15.9</td>
<td>11</td>
<td>15.4</td>
<td>158019.5</td>
<td>156214.6</td>
</tr>
<tr>
<td>16-16.9</td>
<td>3</td>
<td>16.3</td>
<td>171791.7</td>
<td>169755.9</td>
</tr>
<tr>
<td>17-17.9</td>
<td>1</td>
<td>17.9</td>
<td>188125.0</td>
<td>196928.7</td>
</tr>
<tr>
<td>18-18.9</td>
<td>4</td>
<td>18.6</td>
<td>202761.9</td>
<td>208571.7</td>
</tr>
</tbody>
</table>

The relative fecundity gradually increased from 7788.8 to 10915 eggs per cm. The relation between fecundity and size & weight was illustrated in Figs. 13 and 14.
absolute fecundity was increased with a total length and described by power equation
\[ F = a L^b \]
as: \[ F = 2239.4 L^{1.5518}, \quad (R^2 = 0.8873). \]

![Graph showing the relationship between total length and absolute fecundity of T. puta from Bardawil Lagoon during 2017-2018.](image)

**Fig. 13:** Relationship between total length and absolute fecundity of *T. puta* from Bardawil Lagoon during 2017-2018.

![Graph showing the relationship between body weight (g) and absolute fecundity of T. puta from Bardawil Lagoon during 2017-2018.](image)

**Fig. 14:** Relationship between body weight (g) and absolute fecundity of *T. puta* from Bardawil Lagoon during 2017-2018.

## DISCUSSION

This study presents some biological aspects on the small scaled terapon *Terapon puta* (Cuvier, 1829) from Bardawil Lagoon, North Sinai, Egypt. In the present study, the total body length of *T. puta* ranged between 5.3 to 18.9 cm and the total body weight varied from 2.5 to 68.0 gm. Vari (2001) reported that the maximum length of *T. puta*, from the western central Pacific was 15 cm, while Edelist (2012) stated that the total body length of *T. puta*, from the southeastern Mediterranean Sea ranges from 7.3-14 cm and the maximum total body weight is 28.5 gm. On the other hand, Nandikeswari and Anandan (2013) pointed out that the total body length of *T. puta* from Nallavadu Coast ranges from 13.4-21.9 cm and the total body weight varies from 30-78 gm. Also, Rizkalla et al., (2016) stated that the total body length of *T. puta*, from Lake Timsah Egypt ranged from 5.6 to 15.2 cm and the total body weight varied from 5.08 to 41.65 gm. This variability may be due to the difference in the environmental conditions such as: habitat, food abundance and temperature, or the differences in mesh size of the fishing gears.

The length-weight relationship is very crucial in estimating the standing stock biomass and discusses the development history of fish population from various regions (Petrakis and Stergiou, 1995). It is an important fishery management tool and it is very beneficial for cultivators and fisheries managers to determine the growth of the species (Nandikeswari et al., 2014). The data obtained from the length-weight relationship equation showed an isometric growth in which \( b = 3.0209 \). This means...
that any increase in size of the studied fish accompanied by increasing in its weight. Olurin and Aderibigbe (2006) mentioned that fish are said to exhibit isometric growth when length increases in equal proportions with body weight for constant specific gravity. The regression co-efficient for isometric growth is ‘3’ and values greater or lesser than ‘3’ indicate allometric growth. The power “b” in this study is nearly agreement with previous studies in the Lake Timsah, (Egypt), since b = 3.0240; Abu El-Nasr and El-Drawany, (2017). On the other hand, these results were higher that recorded by Sabrah et al., (2016) and Kassem( 2017), since they found that, the values of (b) equals 2.72 and 2.775 for T. puta in Great Bitter Lake and Bardawil Lagoon respectively. Length-weight relationship differs for the same species in different localities according to the environmental conditions, such as temperature and abundance of food (Tesch ,1968). Condition Factor of the studied species varied from 0.98 to 1.46 in all individuals. Ahmed and Benzer (2015) reported that condition factor of Terapon puta in Karachi Fish Harbour, Turkey varied from 1.57 to 2.97 in all individual. Nandikeswari et. al., (2017) reported that condition factor of males and females T. puta from Puducherry waters, India ranged from 0.739-1.640 and 0.742-1.432 respectively. These differences may be attributed to the difference in ecological conditions.

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, since this paper showed that the maximum age of Terapon puta was IV years. Sabra et al., (2016) mentioned that 3, 1 and 2 years old recorded for Terapon puta in Bitter Lake, Suze Bay and Lake Timsah, Egypt respectively.

In the present study, the sex ratio of males to females of T. puta 1:1.7 .These results agree with Rizkalla, et al. (2016) in Lake Timsah, Egypt (1:1.2), Miu et al., (1990) from Tamshui River (1:1.8) and Kassem (2017) from Brdawil Lagoon (1:1.57). The predominance of females may be attributed to the male fertilizing efficiency as recorded by Salama (1996) or to the fact that females consume more energy for environmental adaptation than males for the reproduction( Liang et al., 2005) or males may not commonly inhabit the depth zone, where the majority of fishing efforts for this species is concentrated( Abaszadeh et al., 2013).

The most suitable method of determining the reproductive cycle of fishes is to observe the seasonal changes in their gonads( Karlou-Riga and Economidis ,1997). The present study revealed that the reproduction season of T. puta in Bardawil Lagoon extends from May to July (summer spawner). Niamaimandi et al., (2016) reported that the Spawning period of Terapon puta in in Bushehr coastal waters (Persian Gulf) occurred from late of summer to autumn.

The knowledge on length at maturity and spawning season detects when and at which length the fish should be protected and therefore it is important for the proper management and conservation of fish stocks(Hunter et al., 1992). In the present study, the length at first maturity (Lm) of Terapon puta was 13.2 and 13.7 cm for male and female respectively. Lm50 is an important trait of life history necessary for success of fishery management, fundamental to establishment of the means that avoid exploitation of young specimens and consequential reduction of spawning stock (Penha and Mateus ,2007). It seems that there is also differentiation in maturity between the two sexes. Most of the male reached maturity smaller and younger than female which explains the greater duration of life of the female that mature later (Nikolsky, 1969). Nandikeswari et al., (2014 a) reported that the gonad weight is considered the best indicator of the fecundity of the aforementioned fish species, while the total body length occupies the subsequent rank. Moreover, Bagenal (1967)
concluded that in some teleost fishes, explained the higher engagement of the absolute fecundity with the total body length than with the total body weight, to the stability of the fish length and the variability of its weight.

Fecundity and spawning habits are among the important aspects of the biology of fishes which must be understood to clarify the fluctuation of the level of population as well as to make efforts to increase the amount of fish harvest (Das et al., 1989) and also determination of fecundity and the development of sexual maturity is a essential to fishery science (Brown et al. 2003). In the present study, it was noted that, the values of the absolute fecundity of T. puta increase proportionally with the fish total body length and total body weight. These observations coincide with those reported by Nandikeswari and Anandan (2013) for T. puta from Nallavudu coast. The absolute fecundity of T. puta in the present study were between 89571 to 202761 eggs in fish ranged between 11.5 to 18.9 cm total body length and 15.7 to 68 gm total body weight. These results were lowest than results obtained for the same species studied by Nandikeswari and Anandan (2013), in which the fecundity ranges from 20002 to 123042 eggs in fish between 13.4 to 21.9 cm total body length and 30 to 78 g total body weight in Nallavudu coast, India. Kassem (2017) reported that, the absolute fecundity of T. puta ranged from 94133 to 300000 eggs in fish between 11.6 to 17.3 cm total body length and 20 to 54 g total body weight in Bardwil Lagoon Egypt. Latif and Shenouda (1973) found that the fecundity varies not only in the different species, but also in the same species in the different years or different environmental conditions.

**CONCLUSION**

The length – weight relationship of *Terapon puta* in Bardawil Lagoon exhibits an isometric growth. Condition Factor varied from 0.98 to 1.46 in all individuals. Females predominated during all months, since it constitutes more than 60 % of the collected sample during the period of study. *Terapon puta* in Bardawil Lagoon is a summer spawner, and the female attains its maturity at 13.7 cm of total length. Regulations should also be directed to equal length at first capture by the length at first mature and not less than 13.8 cm to give the females to spawn even once to keep stock of the fish in Bardawil Lagoon.

**REFERENCES**


ARABIC SUMMARY

دراسة بيولوجية على أسماك الشخرم (Terapon puta (Cuvier, 1829) في بحيرة البردويل شمال سيناء - مصر

عطبى على عمر العياط ، و كريمان أحمد شوقى شلوف

المعهد القومي لعلوم البحار والمصائد

يهدف هذا البحث إلى استكشاف بعض الجوانب البيولوجية لأسماك الشخرم (Terapon puta (Cuvier, 1829) في بحيرة البردويل شمال سيناء - مصر. تم إجراء الدراسة خلال الفترة من مايو 2017 حتى يناير 2018. أظهرت النتائج أن نمو إجمالي وزن الجسم بالنسبة لطول الجسم الكلي متماثل حيث = 0.0209. كان الطول عند بداية الصيد 11 سم وقد ساد المجتمع المجموعة الطولية (12-16 سم) بنسبة 71.8%. %، في هذه الدراسة تم تسجيل أربع فترات عمرية، وبينت التركيبة العمرية لأسماك الشخرم أن الأفراد الذين ينتمون إلى الفئة العمرية الأولى قد سادوا بنسبة 38.2% من مجموع الأفراد الذين تم جمعهم. وأشارت النسبة الإجمالية بين الجنسين إلى أن الإناث كانت مهيمنة طوال جميع الشهور باستثناء شهر نوفمبر من العام. كانت القيم المتوسطة لدئل المنوال صغرى في نوفمبر وديسمبر، في حين أنها ارتفعت تدريجياً تصل إلى أعلى القيم في يوليو. كشفت دراسة الخصوبة لأسماك الشخرم أن الخصوبة الطبيعية الملاحظة تزيد مع زيادة طول الجسم مع معدل الارتباط (0.89 = 0.3 stepper)، وبالتالي كان طول الجسم الكلي أفضل مؤشر على خصوبة أسماك الشخرم. نقوم بزيادة الطول عند بداية الصيد ليسى بالفن لزيادة الصيد، ولكن مع قدوم الطول عند بداية التصق الحيوي ولا يتقل عن 13 سم لإعطاء الإناث فرصة للتكاثر. وفي مرة واحدة للحفاظ على مخزون الأسماك في بحيرة البردويل.