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Age, growth and mortality of the small scaled *Terapon puta* (Cuvier, 1829) in Bardawill lagoon, North Sinai, Egypt

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ABSTRACT

Age, growth, and mortality of *Terapon puta* were studied from a small scale fishery of Bardawill lagoon, (North Sinai, Egypt). 2777 specimens (6.9 to 17.5 cm total Length and 14.1 to 55.9 g total weight), were collected from April to December, 2016. The relationship between length and weight was $W = 0.0186L^{2.7809}$. Age was determined by otoliths and age groups 0 to 4 years were observed. Growths in length and weight at the end of each year were calculated. The growth parameters of von Bertalanffy equation were calculated as (L_∞ = 18.50, K = 0.3554 yr^{-1} and t_0 = -1.15 yr^{-1}). Growth performance index was calculated (φ = 2.08 for length and φ= 0.75 for weight). Mortality rates were 0.90 yr^{-1}, 0.35 $yr^{-1}$and 0.55yr^{-1} for total, natural and fishing mortality, respectively. The currently exploitation rate E = 0.61. The probability of capture (Lc_{50} = 12.7). The higher of fishing mortality verses natural mortality observed for *T. puta* indicates that its stock was overexploited in Bardawill lagoon.

Key words: Age, growth, mortality, *Terapon puta*, Bardawill lagoon.

INTRODUCTION

Bardawil lagoon is one of the most important fishing grounds in Egypt, since it is the largest and almost free of pollution lagoon (El-Bokhty and El-Aiatt, 2014; Fanos *et al.*, 1994; Mehanna *et al*., 2011). It is an important source of local and economic fishes in North Sinai, and it plays an essential role in the fish production in Egypt, where it produces very economically important species of fishes such as sea bass, sea bream, sole, grey mullet, eel, meager and white grouper (GAFRD, 2012). One of the species that requires the most urgent attention is Small-scaled terapon, *Terapon puta* (Family: Terapontidae), which despite being quite abundant in Bardawill lagoon fisheries, could be very deleterious to the local population densities.

The present work is the first attempt to assess the stock of *T. puta* in Bardawill lagoon and aims at developing an appropriate Management plan to maintain this valuable fish resource.

MATERIALS AND METHODS

The Bardawil lagoon (Fig. 1) covers an estimated area of 136,318 Feddan with a maximum length of 95 Km and a maximum width of 22 Km, the water depth ranges from 0.5 to 3 m (GAFRD, 2015). Three openings connect the lagoon with the sea; two artificial openings at the West side (Boughaz I and Boughaz II) and one natural opening at the East (El-Zaranik). The fishing in the lagoon is seasonal starting in April and extends to the end of December (Mehanna *et al.*, 2011).

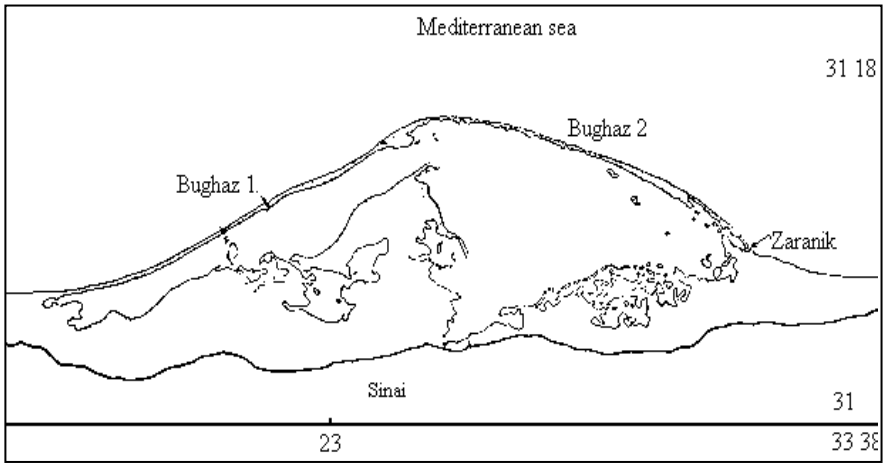

Fig. (1): Map of the study area Bardawil lagoon, Egypt.

Monthly, random samples (2777 fish ranging from 6.9 to 17.5 cm TL) of small scaled terapon (*Terapon puta*) were collected from well mixed catches during the fishing season 2010. The total length was measured to the nearest millimeter and total the total weight was measured to the nearest 0.1 g.

Age determination:

For age determination, the otoliths were removed from 1209 specimens. In the laboratory, the otoliths were cleaned and stored dry in labeled vials. Annual rings on otoliths were counted using an optical system consisting of Nikon Zoom-Stereomicroscope focusing block, Heidenhain's electronic bi-directional read out system VRX 182, under transmitted light. The total radius of the otolith "S" and the distance between the focus of the otolith and the successive annuli were measured to the nearest 0.001 mm.

Lengths by age were back-calculated using (Lee's, 1920) equation:
Ln = (Sn/S) L, where: Ln = is length of fish at age "n ", Sn = is magnified otolith radius to "n "annulus, S = is magnified total otolith radius, L = is fish length at capture.

Length-weight relationship:

The relation between the total length (L) and total weight (W) was computed using the formula of Le Cren (1951) ($W = a L^b$, where: a and b are constants whose values were estimated by the least square method).

Von Bertalanffy growth parameters:

Theoretical growth in length and weight was obtained by fitting the von Bertalanffy growth model, using the Gulland and Holt (1959) method. Von Bertalanffy (1949) for theoretical growth in length can be written in the form :

$$L_t = L_\infty [(1 – e –k (t – t_0)]$$

$$W_t = W_\infty [(1 - e^{- K (t – t_0)}]^n$$

Where: L_t = the length at age t , $L\infty$ = the asymptotic length at $t\infty$, K = growth coefficient and t_0 = age at which the length is theoretically nil, W_∞= asymptotic weight, n=constant of length-weight relationship.

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Growth performance index (φ) :

The growth performance index (φ) was estimated as:

$\varphi = \log K + 2 \log L_\infty$

$\varphi = \log K + 2/3 \log W_\infty$

Where: K and L_∞ are parameters of von Bertalanffy) (Pauly and Munro, 1984).

Mortality coefficients:

The total mortality (Z):

It was calculated for *Terapon puta* fish with the following six methods:

1- Chapman and Robinson formula (1960) :

$S = T / (\sum N - 1) + T$ & $Z = -LN (S)$

Where:

$T = N1 + 2 N2 + 3 N3 + \ldots..x Nx$

$\sum N = No + N1 + N2 + \ldots\ldots Nx$

No is the number of fish in age – group I

N1 is the number of fish is age – group II

N2 is the number of fish is age – group III

Nx is the number of fish in age – group IV.

2- Modified Jackson (1939) Formula:

$S = (N_2 + N3 + \ldots\ldots N_x / \sum N)\ 1/2$

$Z = -Ln (S)$.

3- Heinke Formula (1913):

$S = (\sum N - N_o) / \sum N$ & $Z = -Ln (S)$.

4- Coded mean age:

$S = X` / 1 + X`$ & $Z = -Ln (S)$

Where $X` = T / \sum N$

5- The Powell- Wetherall method (Powell, 1979) discussed in (Wetherall *et al*., 1987):

$Z = 1 - k$.

6- Estimation of Z from a linearized catch curve based on age composition data

$Z = -b$.

Natural mortality coefficient (M):

It was calculated by three methods:

1- Ursin formula (1967) :

$M = W'^{(-1/3)}$

Where: W′: is average weight of fish in the catch.

2- Hoenig's method, 1983):

$M = 3/t_{max}$ & $t_{max} = 3/k$

3- Lorenzen formula (1996):

$M = 3W'^{(-.288)}$

Fishing mortality coefficient (F):

It' was calculated as F=Z-M

Exploitation rate (E):

The value of (E) was calculated after Gulland (1971) where E = F/Z.

RESULTS AND DISCUSSION

Age and growth:

In the present study the total length of combined sexes of the investigated specimens of *T. puta* varied from 6.9 to 17.5 cm with weights ranging between 4.1 and 55.9 g. It was used to estimate the Length – weight relationship (Fig. 2). The Length-weight equation was estimated as:$W = 0.0186\ L^{2.7809}$ ($r^2 = 0.9402$). The relationship equation showed a negative allometric in which b= 2.7809.These result agrees with that of Sabrah *et al.* (2016) who found that, the value of (b) equals 2.72 for *T. puta* in Great Bitter Lake. On other hand, the (b) value in this study was lower comparing with previous studies in Suez Bay ((b=3.14) and Lake Timsah (b= 3.0240) as recorded by Sabrah *et al.,* 2016) and Abu El-Nasr and El-Drawany (2017).While, these results were higher than that recorded for *T. puta* (b= 0.9328) by Ahmed and Benzer (2015) in Karachi Fish Harbour.

The (b) values in fish is species specific and varies with sex, age, seasons, physiological conditions, growth increment and nutritional status of fish, health, habitat, nutrition, environmental conditions (such as temperature and salinity), area, degree of stomach fullness, differences in the length range of the caught specimen, maturity stage and techniques of sampling fishing gear (Tesch, 1968; Le Cren, 1951; Bagenal and Tesch, 1978). In the present study, environmental or habitat factors were not analyzed, but the results indicated that, the environmental condition of Bardawil lagoon is suitable for *T. puta*.

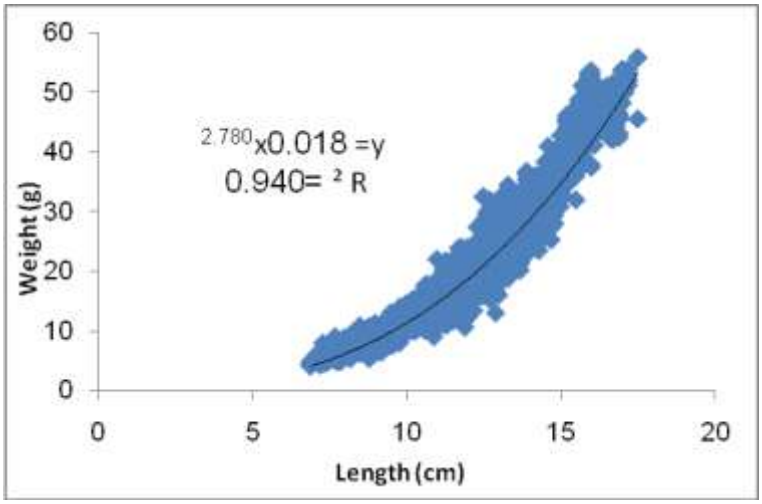

Fig. (2). Length- weight relationship of *T. puta* in Bardawill lagoon during fishing season 2016.

The age of *T. puta* was determined by the annual rings of otolith of 1029 specimens. Four age groups were observed. The average back-calculated lengths of small scaled terapon are given in Table (2) as were 9.89, 12.53, 14.23 and 15.58 cm for the 1st, 2nd, 3rd and 4th year of life, respectively. The highest annual increment occurred during the first year of life, while a noticeable decrease was observed in the second year, reaching to minimal value during the fourth year of life (Fig. 3).

Table (2): Back-calculation lengths at the end of different life years *T. puta* in Bardawil lagoon during season, 2016.

Age	No. of fish	observed length (cm)	observed weight (gm)	Average back calculated lengths at the end of each year (cm)			
0	39	8.37	7.03	I	II	III	IV
I	502	11.21	15.60	**9.89**			
II	430	13.36	25.11	10.51	**12.53**		
III	168	14.70	33.22	10.49	12.72	**14.23**	
IV	70	15.93	44.86	10.35	12.49	14.2	**15.58**
	1209		Increment	9.89	2.64	1.70	1.35

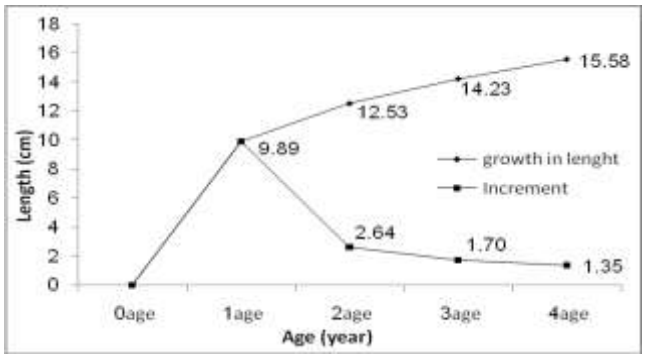

Fig**. (3). Growth and annual increment in length of *T. puta* during fishing season, 2016.**

Age reading indicated that attain their highest growth rate in length wasduring the first year of life, after which a gradual decreased in growth increment was observed with further increase in age. Table (3) summarized the lengths by age of *T. puta* in lake Timsah and Bardawil lagoon.

Table (3). Increment of length (cm) at age of life of *T. puta* in lake Timsah and Bardawil lagoon.

Regions	Increment in length of Age (cm)				Authors
	I	II	III	IV	
Lake Timsah	9.43	2.67	2.55	1.32	Abu El-Nasr and El-Drawany, 2017
Bardawil Lagoon	9.89	2.64	1.70	1.35	The present study

Back-calculation weights at the end of each year of life of *T. puta* from Bardawill lagoon were estimated by applying the length-weight relationship. Table (4) indicates the calculated weight of *T. puta* at the end of each year of life. Figure (4) showed the growth and annual weight increment in fishing season 2016.

The results in these tables showed that the weight increased successively and reached its maximum at group IV up to 38.51 gm. Our results were disagreement with that results which obtained by (Abu El-Nasr and El-Drawany, 2017) of the same species in Lake Timsah, (Egypt) where the author found that the back calculated weight were 13.27, 32.41, 52.02 and

69.67 gm for ages 1st, 2nd, 3rd and 4th years respectively. The lower growth in this study may be related to the higher salinity during this work.

Table (4): Back-calculation weight at the end of different life years *T. puta* in Bardawil lagoon during season, 2016 .

Age	No of fish	Observed length (cm.)	Observed weight (g.)	Average back calculated lengths at the end of each year (cm)			
0	39	8.37	7.03	I	II	III	IV
I	502	11.21	15.60	**10.89**			
II	430	13.36	25.11	12.89	**21.02**		
III	168	14.70	33.22	12.82	21.93	**29.95**	
IV	70	15.93	44.86	12.34	20.85	29.78	**38.51**
	1209		Increment	10.89	10.13	8.94	8.56

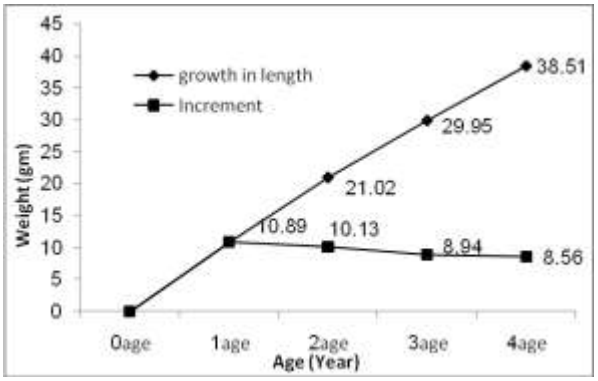

Fig. (4). Growth and annual increment in weight of *T. puta* during season, 2016.

The growth parameters of von Bertalanffy for small scaled terapon *T. puta* were as follow; $L_\infty = 18.50$, $K = 0.3554$ year^{-1} and $t_0 = -1.15$ year^{-1}.

The von Bertalanffy growth models for length and weight of *T. puta* were estimated to be as follow:

$L_t = 18.50\ (1 - e^{-0.3554\ (t + 1.1522)})$

$W_t = 62.11\ [(1 - e^{-0.3554\ (t + 1.1522)})]^{2.7809}$.

Mcllwain *et al.* (2005) mentioned that the differences in growth parameters were due to age, sex, maturity and sampling period for the same species.

Growth performance index (φ) of the same species reflects its adaptations to the environment factors. The obtained results indicated that the growth performance index of *T. puta* was 2.085 for length and 0.7380 for weight. Sabrah *et al*, (2016) estimated φ for the same species in Suez Bay, Great Bitter Lake and Lake Timsah to be 2.18, 2.26 and 2.22, respectively.

The φ in this study was higher than that estimated by Abu El-Nasr and El-Drawany, (2017) in Lake Timsah, (Egypt) where they found that, the φ for the same species equals 1.73.Thus, it could be reported that the environmental condition of Bardawil lagoon is better for the growth of *T. puta* under study. Such differences may be attributed partially from the different techniques used, but more likely reflect slight environmental differences such as food availability, Salinity and temperature (El -Ganainy and Ahmed, 2002).

Table (4): Growth parameters recorded in previous and present studies.

Locality	Growth parameters				Authors/year
	L_∞	K	T_0	Φ	
Suez Bay	13.1	0.88	-	2.18	Sabrah *et al.*, 2016
Great Bitter Lake	17.5	0.6	-	2.26	Sabrah *et al.*, 2016
Lake Timsah	15.5	0.7	-	2.22	Sabrah *et al.*, 2016
Lake Timsah	20.13	0.13	-1.11	1.73	El-Nasr and El-Drawany, 2017
Bardawill lagoon	18.5	0.36	-1.15	2.8	The present study

Mortalities and exploitation rate

The total mortality (Z) was calculated for *Terapon puta* fish with six methods and the average obtained (Z) was 0.71 for combined sexes in Bardawil lagoon during the fishing season 2016.

The natural mortality coefficient (M) was calculated by three methods and the average obtained (M) was 0.33 for combined sexes in Bardawil lagoon in the fishing season 2016.

The calculated fishing mortality (F) of *Terapon puta* was 0.38 for combined sexes in Bardawil lagoon during the same fishing season 2016.

The present results disagree with the results obtained by (Abu El-Nasr and El-Drawany, 2017) (Z=1.63, M=0.43 and F= 1.20 $year^{-1}$) for the same species in the Lake Timsah, (Egypt). This difference can be explained by a very high fishing effort and a high natural mortality. Concerning mortality estimates, comparison is difficult because of scarcity of data and the total mortality coefficient is not a species-specific parameter, but an area specific parameter. These results could be explained by a high predation or other natural causes affecting fry and juveniles. Mortality parameters depend on both physiological factors (disease, old age, etc.), environmental factors (temperature, currents ...) (Christensen and Pauly, 1997).

Exploitation rate (E) was estimated as E=F/Z =0.53. (Gulland, 1971) suggested that the optimum exploitation rate for any fish stock is about 0.5 at F=M and more recent, (Pauly, 1987) proposed a lower optimum F that equal to 0.4 M, so the values of fishing mortality and exploitation rate were relatively high indicating a high level exploitation.

REFERENCE

Abu El-Nasr, T.M and El-Drawany, M.A. (2017). Some Biological Studies on *Terapon puta* (Cuvier, 1829) in the Lake Timsah, Egypt 1-Age, Growth and Mortality of *Terapon puta* (Spinycheek Grunter). Merit Res. J. Agric. Sci. and Soil Sci., 5(6): 108-114,.

Ahmed, Q. and Benzer, S. (2015). Length-Weight Relationship in *Terapon puta* (Cuvier, 1829) Collected from Karachi Fish Harbour. J. Appl. Environ. Biol. Sci., 5(10): 1-5.

Begenal, T.B. and Tesch, F.W. (1978). Age and growth In: T. Bagena, editor, methods for assessment of fish production in fresh waters. IBp handbook No.3 (3rded) Black well Scientific publications, Oxford. pp 101-136(chapter 5).

Chapman, D. G. and D. S. Robinson (1960). The analysis of a catch curve. Biomertics, 16: 354-368.

Christensen, V. and Pauly, D. (1997). Placing fisheries resources in their ecosystem context. EC fisheries Cooperation Bull., 10(2):9-11.

El-Bokhty, E.B. and El-Aiatt, M.O.A. (2014). Trends in artisanal fisheries of Bardawil lagoon with reference to shrimp bottom trawling (kalsa). Egypt. J. Aquat. Biol. & Fish., 18(4): 95-107.

El-Ganainy, A.A. and A.I. Ahmed (2002). Growth, mortality and yield -per- recruit of the rabbitfish, *Siganus rivulatus*, from the eastern side of the gulf of Suez, Sinai Coast, Red Sea. Egypt. J. Aquat. Biol. & Fish., 6 (1): 67-81.

Fanos, A.; A. Khafayg; M. Anwar and M. Naffaa (1994). Assessment and recommendations for the enhancement of the Bardawil Lagoon outlets. Coastal Dynamics, 189-204.

GAFRD (2012). Report of General Authority for Fish Resources Development on Bardawil lagoon.

GAFRD (2015). Report of General Authority for Fish Resources Development on Bardawil lagoon.

Gulland, J. A. and S. L. Holt (1959). Estimation of growth parameters for data at unequal time intervals. J. Cons. Perm. Int. Explor. Mer., 25(1): 47 – 49.

Gulland, J.A. (1971). The fish resources of the Oceans. Fishing News Books Ltd., England. 255p.

Heinke, F. (1913). Investigation on the plaice. General report 1. The plaice fishery and protective measures. Preliminary brief summary of the most important points of the report, Rapp. P. V. Cons. Int. Explor. Mer., 16 : 1 – 67.

Hoenig, J. M., 1983. Empirical Use of Longevity Data to Estimate Mortality Rates. Fishery Bulletin 82:898-903.

Jackson, C.H.N., 1939. The analysis of animal population. J. Anim. Ecol., 8: 238 – 264.

Le Cren, E.D. (1951). The length-weight relationship and seasonal cycle in gonad weight and condition in the Perch (*Perca fluviatilis*). J. Anim. Ecol., 20: 201-219.

Lee, R. (1920). A review of the methods of age and growth determination in fishes by means of scales. Fishery investigations, Series 2, Marine fisheries, Greet Britain Ministry of Agriculture, Fisheries and Food 4 (2).

Lorenzen, K. (1996). The relationship between body weight and natural mortality in juvenile and adult fish: a comparison of natural ecosystems and aquaculture. J. Fish Biol., 49:627-647.

Mcllwain, J.L.; M.R. Claereboudt; H.S. AL-Oufi; S. Zaki and G.S. Goddard (2005). Spatial variation in age and growth of the Kingfish (Scomberomorus commerson) in the coastal waters of the Sultanate of Oman. Fish. Res., 73: 283 – 298.

Mehanna, S.; A. El-Aiatt and Salem, M. (2011). An investigation of the impacts of shrimp bottom trawling on the Bardawil lagoon fisheries, Egypt. Egypt. J. Aquat. Biol. & Fish., 15(3). 407-416.

Pauly, D. (1987). A review of the ELEFAN system for analysis of length-frequency data in fish and aquatic invertebrate. ICLARM Conf. Proa, 13:7-34.

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

Powell, D.G. (1979). Estimation of mortality and growth parameters from the length frequency of a catch. Rapp.P.V.Réun.CIEM, 175:167-169.

Sabrah, M.M.; Mohamedein, L.I.; El-Sawy, M.A and Abou El-Naga, E.H. (2016). Biological Characteristics in Approaching to Biochemical and Heavy Metals of Edible Fish *Terapon puta*, Cuvier, 1829 from Different Fishing Sites along the Suez Canal, Egypt. J. Fish. & Aquat. Sci. 11 (2): 147-162.

Age, growth and mortality of the small scaled *Terapon puta* (Cuvier, 1829) in Bardawill lagoon, North Sinai, Egypt

Tesch, F.W. (1968). Age and Growth in Methods for Assessment of Fishes Production. In: W.E. Ricer (Ed.), in methods for assessment of fish production in Freshwater, IBP Handbook, Blackwell Science Publication, London: 93-123.

Ursin, E. (1967). A mathematical model of some aspects of fish growth, respiration and mortality. J. Fish. Res. Bd. Can., 24: 2355-2453.

Von Bertalanffy, L. (1949). Problems of organic growth. Nature, 163: 156 – 158.

Wetherall, J.A.; J.J. Polovina and S. Ralston (1987). Estimating growth and mortality in steady-state fish stocks from length-frequency data. In: Length-based References 131 methods in fisheries research (eds D. Pauly and G.R. Morgan). ICLARM Conf. Proc., 13: 53-74.

العمر، النمووالنفوق لأسماك الشخرم فى بحيرة البردويل، شمال سيناء

جابر دسوقى[1] ، أشرف عبد الرحمن[2] ، محمد سالم[1] ، عطيه عمر[3]، سماح أحمد[2]

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المستخلص

اجري هذا البحث لدراسة العمر، النمو والنفوق لاسماك الشخرم بمنخفض البردويل. تم تجميع 2777عينة فى الفترة من ابريل حتى ديسمبر خلال موسم صيد 2016. تم قياس أطوال العينات فكانت تتراوح من 6.9 الى 17.5 سم مقابل الأوزان من 4.1 الى 55.9 جم. أوضحت الدراسة أن هناك 4 مجموعات عمرية بالمنخفض تم تحديدها عن طريق قراءة حصاة الاذن وحسبت معدلات النمو في الأطوال المقابلة للمجموعات العمرية المختلفة بطريقة الحساب العكسي على النحو التالي9.89، 12.53، 14.23و 15.58 عند نهاية السنة الأولى ، الثانية، الثالثة والرابعه على الترتيب. قيم معاملات النمو لفون بيرتلانفى كانت كالتالي: الطول عند مالانهاية = 18,50 سم، معامل النمو = 0,3554 /سنة والعمر الصفري = -1.15 سنة. كفاءة النمو = 2.08 للطول و 0.75 للوزن. كما أمكن حساب معدلات النفوق على النحو التالي: النفوق الكلى = 0,90،النفوق الطبيعي = 0,35 . النفوق بالصيد = 0,55 /سنة و معدل الاستغلال = 0,61. الطول عند أول صيد حوالي12.7 سم وارتفاع معدلات الوفيات في الصيد مقارنة بالوفيات الطبيعية التي لوحظت في *T.puta* تشيرإلى ان المخزون يعانى من زيادة الصيد الجائر له فى بحيرةالبردويل.