Population Dynamics of the Thinlip Grey Mullet (*Liza ramada*, Risso, 1827) in Bardawil Lagoon, North Sinai, Egypt

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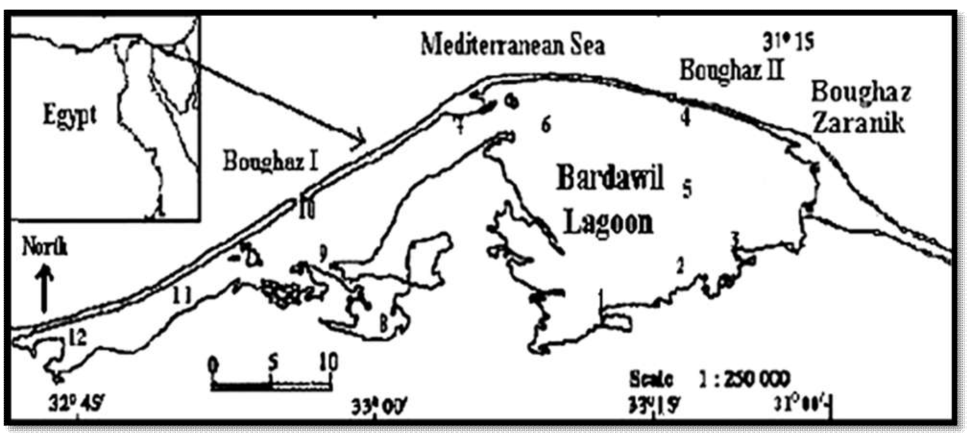
Abstract: The fisheries of Bardwell lagoon are one of the unique Egyptian northern fisheries that are characterized by its fish production. A total of 1200samplesof the thin lipgrey mullet (*Liza ramada*) fishes were taken from Bardawil lagoon, North Sinai Egypt, during fishing season from April to December2017. Some biological parameters such as length – scale radius and length – weight relationships, composite condition factor and reproduction biological aspects were studied. *L. ramada* shows isometric growth in the lagoon. The G.S.I. that means the spawning season of *L. ramada* was at its peak in October and December of each year.

Keywords: *Liza ramada*, Bardawil lagoon, fisheries, biology

INTRODUCTION

Bardawil lagoon is a man – made hyper saline lagoon. Separated from the Mediterranean Sea by a narrow sandy strip it spreads from 32. 40 to 33.30 E longitude and from 31.03 to 31.14 N latitude. The Area 165 thousand feddans.

The length of the lagoon measures 90 km. and the maximum width is 20 km the lagoon is sustained by one natural strait and tow artificial sea inlets. Those inlets, locally called bugaz, are silting up considerably: keeping them open is essential to keep lagoon salinities down and for fish recruitment from the sea A salt plant has recently been established at Zaranik with extensive evaporation ponds for salt harvesting.



Map of Bardwell lagoon-North Sinai

Mullets (family: Mugilidae), are the most important fish resources in Bardwell Lagoon, where they contributed about 35.5% of the total fish production in the lagoon (Gafrd, 2018). Three species namely: *Mugil cephalus*, *Liza ramada* and *L. auraia* are the main constituents of the commercial catch of mullets in the lake. Mullets are exploited by Veranda or Bouss fishing method in the Lake (Mehanna, 2006).

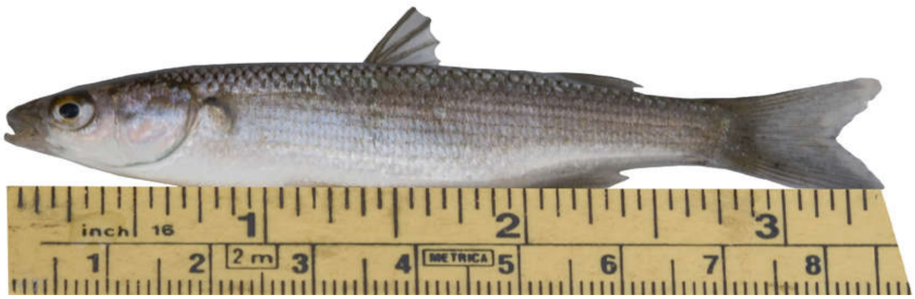
The fisheries of Bardwell lagoon are one of the unique Egyptian northern fisheries that are characterized by its fish production. Before best use for any fisheries, some understanding is needed of the basic biology and behavior of species concerned in fisheries. During this study, ecological and biological parameters, such as growth and mortality rates, maturity and spawning season and catch parameters were estimated for *Liza ramada*.

In view of the importance of the knowledge on species individual growth, it leads to determination of other parameters of its stock and eventually to a more precise resource developing (Al-Beak, 2016). Age information is important as it forms the basis for the calculations of growth and mortality rates and productivity estimates, making it essential for fisheries management (Al-Beak *et al.*, 2017).

This study is designed to provide fishery managers with current and validated biological and population structure on, *Liza ramada* which may be useful for the improvement of its fishery in the Bardwell lagoon.

MATERIALS AND METHODS

Samples of *L. ramada* were taken randomly during the period from fishing season 2017. Age and growth rates of 1200 thin-lipped grey mullet, *Liza ramada* from the Bardawil lagoon were estimated from ring counts on scales during April to December 2017. Total length by (cm) and total weight by (g.) was measured. Several scales (5–6) were removed from below of pectoral fin, washed and stored dry in individually labeled envelopes. In the laboratory, scales were washed with sodium hydrochloride (5%) and cleaned with pure water and mounted dry between two glass slides. The scales were then examined by a projector for age determination with 33 x magnification.



Liza ramada

Scale radius from the focus of the scale to successive annuli was measured to the nearest 0.01. Total length- scale radius relation calculated according to Whitney and Calendar (1956) as: **L = a + b R** ***where***, **L**: is total length of fish (in cm) and **R**: is magnified scale radius (in mm), a and b are constants.

Back calculated length measured by Lea's equation (1920). Ln = (L- a) (Sn/S) +a, where, Ln = is length of fish at age "n", Sn = is magnified scale radius to "n" annulus, S = is magnified total scale radius, L = Observed length and a = constant representing the intercept.

To calculate theoretical fish growth in length and weight, Von Bertalanffy (1949) model were used and then method of Ford, 1933, Walford, 1946 was present to estimate the constants of the Von Bertalanffy growth model.

The gonads after being removed were weighed to the nearest 0.01 g; monthly, the gonad somatic indices (GSI) were calculated by Bariche *et al.*, 2003 equation GSI= (Gonad Weight / (Body Weight - Gonad Weight))*100. Monthly, sex ratio for different length groups was calculated.

The absolute fecundity (Fabs.) is defined as the number of mature eggs in the ovaries during the spawning season. 80 mature ovaries of adult females were used for length ranged from 21.8 to 42.4 cm total length. The total fecundity was calculated as: F= ((Gonad Weight * Egg Number in the subsample) / subsample Weight) Yeldan and Avsar (2000). The relative fecundity (Frel) was calculated as: Frel =Fabs /(B.L or B.W. The relationship between the total length (LT) and fecundity was calculated using the least squares method.

Estimation of the instantaneous mortalities rate includes natural, fishing, and total mortalities. The total mortality coefficients (Z) were obtained by Chapman and Robinson (1960)method, which obtained from the calculation of the survival rate (S) as Z = - Ln S. The natural mortality coefficient (M) was calculated by Hewitt and Hoenig (2005) method as, M= $4.22/T_{max}$. Fishing mortality coefficient "F" was estimated directly by subtracting the value of the natural mortality from the value of the mean total mortality as F= Z-M. Estimation the exploitation rate (E) by Gulland (1971) as, E= F/ (F+M) where, E is exploiting rate, F is fishing mortality, M is natural mortality.

Estimation the recruitment was done by (Gulland, 1969) equation as: $R = R`\ e^{M\ (Tc - Tr)}$, *where:* "R" is the number of recruits *i.e* the number of fish a live at age Tr, "R`" is the number of fish a live at the age "Tc" at which they are first retained by the gear in use, "M" is the natural mortality, "Tc" is the age at first capture, and "Tr" is the age at recruitment. R` = C (F + M) / F, where "C" is the annual catch number.

RESULTS

1- Body length – scales radius relationship

Scales of 1200 of *L. ramada* were caught during season 2017. Data for *L. ramada* between fish length and scale radius show a linear relationship (Fig. 1).

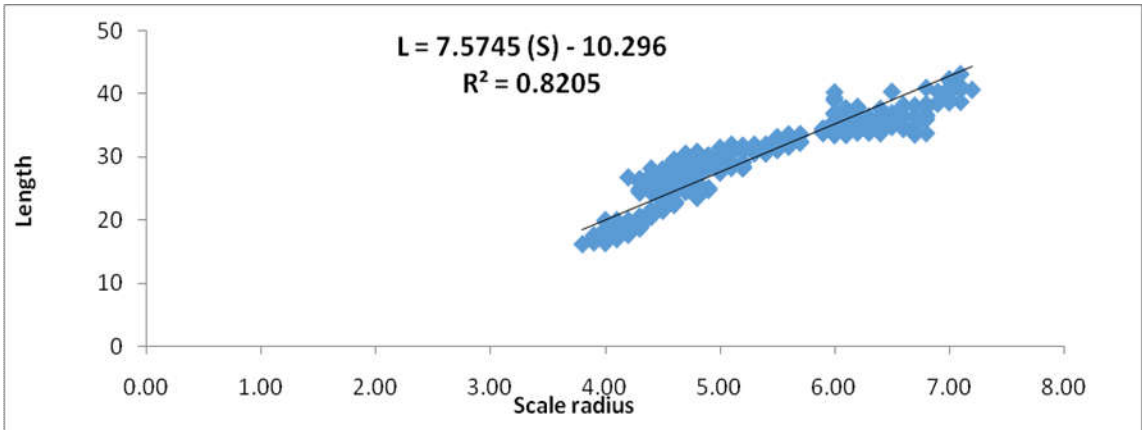


Fig. (1): Total length – scale radius relationship of *L. ramada* in Bardawil lagoon during 2017

1. Length - weight relationship

Data analysis of 2254 *L. ramada* samples ranged between 11.0 and 44.9 cm in total length and between 11.4 and 667.3 gm. in total weight of females, males and combined sexes calculated for the length – weight relationship and found that the slop b= 2.9362 (females), 2.9417 (males) and 3.0185 (combined sexes) that means the thin lip grey mullet has isometric growth Fig. (2).

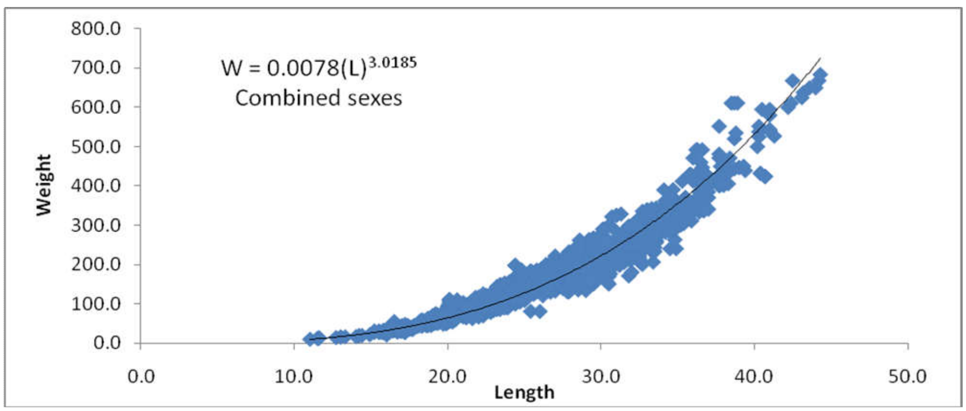


Fig. (2): Length weight relationship of *Liza ramada* in Bardawil lagoon during 2017

2. Condition factors

Monthly average values of the relative coefficient of condition factor (Kc) from May 2017 to January 2018 follows some trends of fluctuations in both males and females. It is also evident that the condition factor generally increases from lowest values in May to highest values in September and October (Fig. 3).

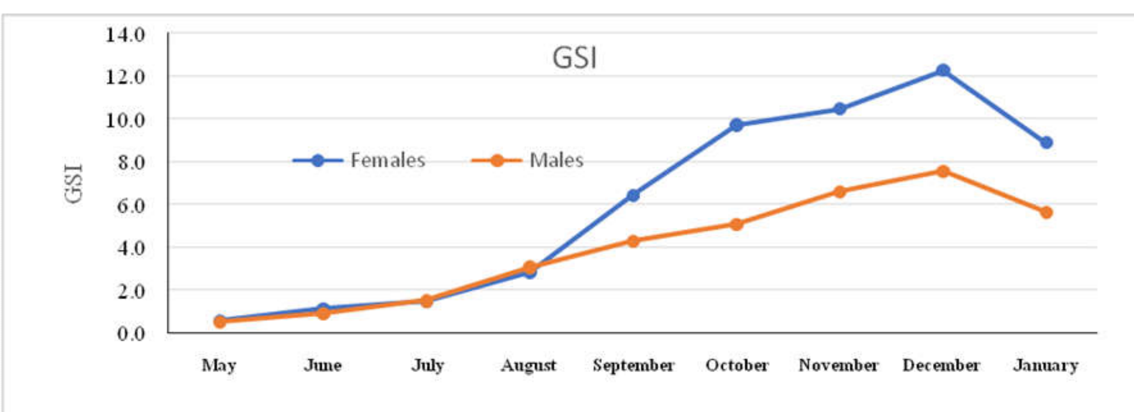


Fig. (3): Average composite condition factor (Kc) of *L. ramada* in Bardawil lagoon during 2017

3. Theoretical growth in length and weight

The constants of the Von Bertlanffy growth model show some slowly growths (K= 0.292 yr^{-1}) of *L. ramada* to reach its asymptotic length (L_∞) Table (1).

4. Fecundity

The number of eggs gradually increased with the increasing of *L. ramada* length or weight, at length 21.8 cm (77g.) to lay eggs about 326062.5, reaching the maximum of 1476488.5 eggs for a fish at length 42.3 cm (605.5g.). The relative fecundity gradually increased from 14957 to 34905.2 eggs per cm. The absolute fecundity increased with a total length and described by power equation $F = a L^b$ as $F = 144.55 L^{2.4855}$

5. Age composition

In the lagoon, the age composition of *L. ramada* population shows that age group I is the dominant among 6 age groups and age group V is the lowest (Table 2).

Table (1): Constants of Von Bertlanffy equation for combined, male and female of *L. ramada* in Bardawil lagoon during fishing season 2017

Sex	Constants Von Bertlanffy	Ford (1933) – Walford (1946) method
♀♂	L_∞	44.62
	K	0.2920
	T_o	-0.9400
	W_∞	743.6

Table (2): Age composition of *L. Ramada* in Bardwell lagoon during 2017

Age groups	Females		Males		Sexes Combined	
	Number	%	Number	%	Number	%
0	116	18.6	37	6.4	153	12.8
I	282	45.3	282	48.9	564	47.0
II	114	18.3	106	18.4	220	18.3
III	53	8.5	76	13.2	129	10.8
IV	38	6.1	60	10.4	98	8.2
V	20	3.2	16	2.8	36	3.0
Total	**623**	**100**	**577**	**100**	**1200**	**100**

6. Mortalities

Total Mortality (Z) and survival rate (S) was found S= 0.3٧ yr^{-1}, Z = ٠.٩٨ yr^{-1} for males, S= 0.3٧ yr^{-1}, Z = 0.99 yr^{-1} for females, and S = 0.3٧ yr^{-1}, Z = ٠.٩9 yr^{-1} for combined sexes. The length at first capture was calculated from cumulated catch curve and found Lc= 26.5, 24.1 and 24.7 cm for males, females, and combined sex respectively.

The instantaneous natural mortality (M) of *L. ramada* males M= 0.39 yr^{-1}, M= 0.46 $yr^{-1}$for females, and M= 0.41 yr^{-1} for Combined sex.

Fishing mortality (F) were calculated by subtracting the natural mortality coefficient (M) from the total mortality coefficient (Z) and was found F= 0.59 yr^{-1}, F= 0.53 yr^{-1} for females, and F= 0.58 yr^{-1} for combined sex.

The exploitation rate is defined as a ratio of fishing mortality to total mortality (E = F / Z). The exploitation rate was found E= 0.60 yr^{-1}, E= 0.54 yr^{-1} for females, and E= 0.59 yr^{-1} for combined sex.

7. Recruitment

The average number of *L. ramada* recruits that annually enter the stock of Bardawil lagoon are R= 17691319 recruits, on other hand, total number of recruits that annually obtained by the gear are R`= 8802088 recruits.

DISCUSSIONS

Biological management of fisheries resources is generally aimed at preventing overfishing and optimizing yield. Age and growth parameters are the most important study to our understanding of the species biology was enabled to control of fishing.

Scales are the most commonly used as it is easy to sample and read (Lagler, 1956). Also, to ease of removal and handling of scales and it can be taken without killing the fish; as the case of studying age and growth for reared fish (Wassef, 1978).

The value of length-weight relation (b) shows isometric growth that agreed with Enin (1994) and

Mehanna (2006) but more than that obtained by Kasımoğlu *et al.* (2011) in Turkey (the Southern Aegean Sea) and *Salem et al.* (2010) and El- Aiatt and Shalloof (2018) in Bardawil lagoon. The variation may be due to stages in ontogenetic development, as well as differences in condition, length, age, sex and gonadal development, Nikolsky (1963). Geographic location and some environmental conditions such as temperature, organic matter, quality of food, time of capture, stomach fullness, disease, parasitic loads Bagenal and Tesch (1978), temperature, organic matter, quality of food and the water system in which the fish live. Bilgin *et al.* (2006) can also affect weight at- age estimates.

Value of the coefficient of condition 'Kc' gets directly affected, if fish does not obey the cube law. The present results confirmed by El- Aiatt and Shalloof (2018) of *L. ramada* in Bardawell lagoon ranged between 0.81 to 0.99 and Göçer and Ekingen (2003) in Mersin Bay, but less than Kasımoğlu *et al.* (2011) where recorded the condition factor of *L. ramada* in Gökova Bay of the Southern Aegean Sea, Turkey ranged between 0.45 to 1.12. The highest value of condition factor in our study was recorded in August, September, and October, that might be due to developing of gonad weight or occurrence of mature fish, while the lowest value of condition factor (November and December) corresponding to the end of spawning season of *L. ramada* in the lagoon as well as decreased feeding activity.

The gonad somatic index of *L. ramada*in current study agree with that published by Amany (2016) of *Liza ramada* in Bardawil lagoon and El Halfway *et al.* (2007) in Timsah Lake. Sagi and Abraham *et al.* (1985) reported that *Liza ramada* has maximum GSI values during period of migration to the sea. The spawning period of *L. ramada* as reported by Eisawy *et al.* (1974); Salem and Mohammed (1982); Yerli (1991) and Ergene (2000) were agreement with present study. The spawning seasons were different in other location as Neretv a river delta (Eastern Adriatic, Croatian coast) where the highest GSI value (8.33%) was found in October (Glamuzina *et al.,* 2007).

In the present study, sex ratio of *L. ramada* was about one male to 1.08 female. Many studies found that, the different species have different sex ratios and even inside the same species collected from different localities. EL-Halfawy *et al.* (2007) in Lake Timsah, Suez Canal was 1:1.7 with percentage 37% & 63% for male and female, respectively. Kasımoğlu *et al.* (2011) in the Southern Aegean Sea Turkey the sex ratio was one male to 1.26 female. Ergene (2000) in Akgöl-Paradeniz Lagoons (Göksü Delta) found that the sex ratio of *L. ramada* was 53.74% to 43.28% female and male respectively.

The absolute fecundity was increased with total length and described by power equation F = a Lb as F= 144.55 L 2.4855 (R^2 = 0.922) and the relative fecundity gradually increased from 14957 to 34905.2 eggs per cm. The absolute fecundity reported by other workers, Farrugio and Quignard (1974) in Tunis reported an absolute fecundity of 82 202 to 434 787 eggs and relative fecundity of 604 to 1454 eggs per 1 g for lengths ranging from 255 to 345 mm (SL). In Egypt, El Maghraby (1974) reported 45 568 to 316 828 eggs absolute fecundity and 728 to 992 eggs per 1 g relative fecundity. Abdalhafid and El-Mor (2014) from Ain El-Ghazala lagoon (Libya) as 51231 to 236557 eggs in fishes ranged in length from 16.5 to 32.4 cm. Brazilian. Hickling (1970), in southern England, found only two ripening females of *L. ramada* with 581 000 and 1 243 000 eggs with lengths 490 to 530 mm, respectively. Ergene (2000) found 234 720 to 435 265 eggs for ages III and IV respectively. These differences can be attributed either to the high spatial variation of the studies, thus to different environmental conditions or to the methods used that produce variable results (*e.g.*, counting or not the oocytes that will not mature), but mainly to the differences in length, weight or age in the samples of the different authors, since absolute fecundity increases as those parameters increase (Hotos *et al.* 2000).

The first sexual maturity for *L. ramada* in Bardawil lagoon during the study period was determined by examination of gonads to determine the sex and the stage of maturity. Based on percentage occurrence of mature fishes in various size groups, the length and age at first sexual maturity for *L. ramada* was determined as 27.5 cm (2.29 yr.) for females and 27.3 cm (2.32 yr.) for males. The first sexual maturity (length and age at first maturity) and spawning season considered among of the important factors which taken into consideration for catch of *L. ramada* in Bardawil lagoon. The first sexual maturity for male and female of *L. ramada* was occurred at smaller size and lower age in Bardawil lagoon.

Immature individual of these species are represent by 36.42% of total catch, so it could be said that the fishing gear in the lagoon is harmful to this species according to Cetini *et al*. (2002) where mentioned that, if the percentage of immature specimens in total catch is above 50%, fishing gear would be considered as very harmful, if it is between 20 and 50%, it is considered as medium harmful, and if it is under 20% then the harmful influence of fishing gear is acceptable.

All fishes aged from 0 to 5 years. Most fish belong to 0,1and 2 age classes (78%). The fishes older than 5th year have disappeared. Most stock assessments are based on estimates of numbers of fish per age classes. All age-at-length data from an entire stock are often combined without weighting, under the assumption that differences between gear types and regions can be disregarded (ICES, 2005). A proportion of young fish is a higher in catches than other age classes, may be caused by variation in length-at-age distributions or in the relative abundance in young fish or may be the fishing gear is more harmful. The exploitation history of fish populations affects their demography and sustained heavy exploitation results in truncated age structures by removing the largest (and presumably older) individuals (Ricker, 1969; Goni, 1998).

The instantaneous mortality coefficients (Z, F and M) in present study were less than Salem *et al.* (2010) found that, the total mortality coefficient (Z) the natural mortality (M) and fishing mortality (F) as 1.55, 0.61 and 0.94 respectively. In present study, the exploitation rate was higher as E=0.54 where must be reduce to 0.5. 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. The exploitation rate in the present study is equal to that obtained by Salem *et al.* (2010) as they found E = 0.60, also, lower than Mehanna (2006) were recorded that Z=1.22, M=0.16, F= 1.06 $year^{-1}$and exploitation rate equal 0.87 for the same species in the same lagoon.

In the present study, the length at first capture (Lc) was 24.7 cm of combined sexes of *L. ramada* in Bardawil lagoon, 2017. Mehanna (2006) in Bardawil lagoon, found that, the length at first capture was Lc =18, 45 (0.77 yr.). The length and age at first sexual maturity for *L. ramada* was determined as 27.5 cm (2.3 yr.) for females and 27.3 cm (2.32 yr.) for males. This meaning for the management purpose, the current length at first capture should be raised from 24.7 cm to about 27.5 cm to maintain sufficient spawning biomass. These results were agreed with Mehanna (2006) for the same species and the same lagoon where she recorded that, length at first capture should be raised from 18.45 cm to about 30 cm to maintain sufficient spawning biomass.

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ديناميكية أفراد سمكة الطوباره في بحيرة البردويل شمال سيناء مصر

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تعد مصايد بحيرة البردويل من المصايد الفريدة من نوعها في شمال مصر والتي تتميز بإنتاجها السمكي الوفير والغير ملوث. وقد تم تجميع ١٢٠٠ عينة من أسماك الطوباره (*Liza ramada*) وهى من أفراد العائله البوريه من بحيرة البردويل، شمال سيناء، خلال موسم الصيد ٢٠١٧ من أبريل إلى ديسمبر. تمت دراسة بعض المتغيرات البيولوجية مثل علاقات الطول بالوزن ومعاملي الحالة وبيولوجية التكاثر. والدراسة أثبتت نموا مثاليا للسمكة في البحيرة وان للسمكة موسم تكاثر ممتد من أكتوبر إلى ديسمبر. يظهر التركيب العمري لسكان سمكة الطوباره أن الفئة العمرية الأولى هي المسيطرة بين ستة مجموعات عمرية والفئة العمرية الخامسة هي الأدنى. الشق الجنسي للسمكة كان ١ للذكور والإناث 1.08. الحد الأقصى لخصوبة السمكة كان١٤٧٦٤٨٨ بيضة لكل سمكة بطول ٤٢.٣ سم (٦٠٥.٥ جم).