

Some Aspects of the Reproductive Biology of the Keeled Mullet *Liza carinata* (Valenciennes, 1836) in the Bitter Lakes, Suez Canal, Egypt

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Abstract: The reproductive biology of 500 specimens of *Liza carinata* (Family: Mugilidae) collected from catches by gill and trammel nets on Bitter Lakes (Suez Canal, Egypt) was studied. There were monthly variations in sex ratio between females (287 fish = 57.4%) and males (213 fish = 42.6%). Sex ratio was (1: 1.35) for males to females respectively. The length at 50% maturity was 13.5 cm for females and 13.2 cm for males. The breeding season extends from September to January. Oocyte diameters increase from September ($388 \pm 15.8 \mu\text{m}$), until January ($569 \pm 24.8 \mu\text{m}$). The absolute fecundity ranged was from 64009 to 117428 for fish with the total length ranging from 12.5 to 18.4 cm, whereas relative fecundity ranged from 4954 to 6546/cm.

Keywords: Family Mugilidae, *Liza carinata*, Reproductive biology, Bitter Lakes, Suez Canal, Egypt.

INTRODUCTION

The keeled mullet *Liza carinata* (Valenciennes, 1826) locally named "Sehlia" is a mugilid of commercial value for fisheries and aquaculture in Suez Bay and Suez Canal sector (El Ganainy and El Boray, 1999). In spite of the importance of mullets to fishery resources in Bitter Lakes, no management policies have been established to protect this valuable resource in Bitter lakes. *L. carinata* represented about 22% of the total catch of Suez Canal during the last ten (2007- 2017) (GAFRD, 2018). In spite of its abundance, this species has been poorly studied; little information is available on its life cycle in capture fisheries. Thus, Salem and Mohammed (1982), El-Boray (1993), El Ganainy and El Boray (1999), El-Halafawy (2004) and Mehanna, (2004) studied some biological aspects of the species in Suez Bay and Bitter Lakes. *Liza carinata*, the keeled Canal mullet, is species of grey mullet from the family Mugilidae which is found in the western Indian Ocean and eastern Mediterranean Sea. It colonized the Mediterranean by Lessepsian migration from the Red Sea through the Suez. Like most Mugilids, this species reproduces at sea, after which fry undertake a trophic migration shoreward to continue their development in food rich lagoons, rivers and even lakes (Thomson, 1966; El-Mor, 1993; Koutrakis *et al.*, 1994). Therefore the aim of the present work is to investigate the reproductive biology of *Liza carinata* in Bitter Lakes, Suez Canal. These data will be valuable to those who involved in assessing and managements fisheries and Aquaculture of *Liza carinata*.

MATERIALS AND METHODS

A total 500 specimens of *L. carinata* (Fig. 1) were sampled to study the reproductive biology. Monthly samples of *L. carinata* were collected from September 2019 to August 2020 from trammel and gill nets landings in the Bitter Lakes, Suez Canal (Fig. 2). The total length (TL) ranged from 7.5 to 18.4 cm, and total body weight (W) from 5.4 to 69.8 g. Fishes were dissected to determine sex, then the gonads were

weighed to the nearest g (Wg), and the gonado somatic index (GSI) was monthly calculated using the equation: $GSI = Wg/W$ where Wg is wet weight of the gonad.



Fig. (1): The keeled mullet *Liza carinata* (Valenciennes, 1826)

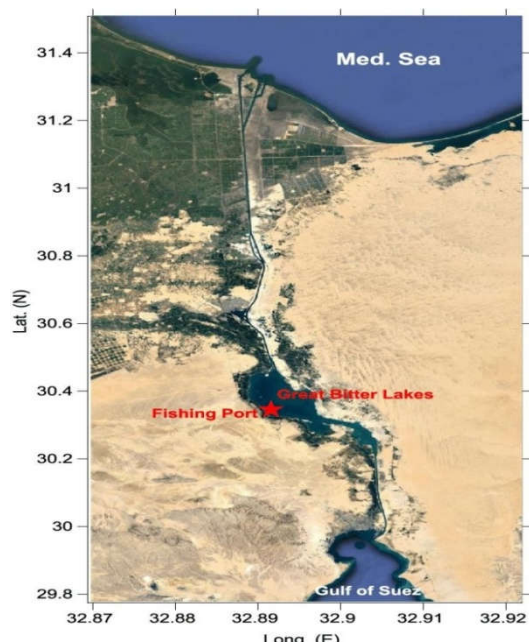


Fig. (2): The Bitter Lakes

Oocytes were separated from the ovarian tissues and put in saline solution (0.9% NaCl) during 24 hours. They were measured under the microscope with the magnification of 40X, then 20 oocytes were taken randomly and their diameters were measured to the nearest 0.01 mm by using one eye-piece micrometer, the average oocyte diameters for mature specimens were calculated. Absolute fecundity was estimated by using a gravimetric method (Bagenal and Tesch, 1978) and the relative fecundity was calculated as related to the fish total length.

RESULTS

Sex Ratio

The variations of sex ratio in *L. carinata* were studied monthly. The results showed that females dominant during all the year, particularly in autumn months. The sex ratio is not constant throughout the different months; females outnumber the males in

September (57.5%), October (58.6%), November (55.7%), December (56.5%) and 57.1% in January (Table 1). There were monthly variations in sex ratio between females (287 fish =57.4%) and males (213 fish = 42.6%). The overall sex ratio of males to females during this study period was 1: 1.35. The differences between sex ratios were not statistically significant when compared to the expected 1:1 sex ratio ($P>0.05$), although the monthly sex ratios of all analyzed species showed variability.

The length at first sexual maturity

The distribution of immature and mature fish as for each length groups was analyzed to determine the size at 50% sexual maturity (L_{50}). All females with a total length higher than 16.4 cm are mature (Figure 3 & 4). First maturation size was determined for males as ($L_{50}= 13.2\text{cm}$) (Fig. 3). First maturation size was determine for females as ($L_{50} = 13.5\text{cm}$) (Fig. 4).

Table (1): Monthly variations in sex ratio of *Liza carinata* from Bitter Lakes, Suez Canal during 2019-2020

Months	No. of fish	Males		Females		Sex ratio
		No.	%	No.	%	
Sep.(2019)	120	51	42.5	69	57.5	1 : 1.35
Oct.	99	41	41.4	58	58.6	1 : 1.41
Nov.	88	39	44.3	49	55.7	1 : 1.26
Dec.	23	10	43.5	13	56.5	1 : 1.30
Jan. (2020)	21	9	42.9	12	57.1	1 : 1.33
Feb.	7	3	42.9	4	57.1	1 : 1.33
Mar.	7	3	42.9	4	57.1	1 : 1.33
Apr.	3	1	33.3	2	66.7	1 : 2.00
May	3	1	33.3	2	66.7	1 : 2.00
Jun.	15	7	46.7	8	53.3	1 : 1.14
Jul.	42	20	47.6	22	52.4	1 : 1.10
Aug.	72	28	38.9	44	61.1	1 : 1.57
Total	500	213	42.6	287	57.4	1 : 1.35

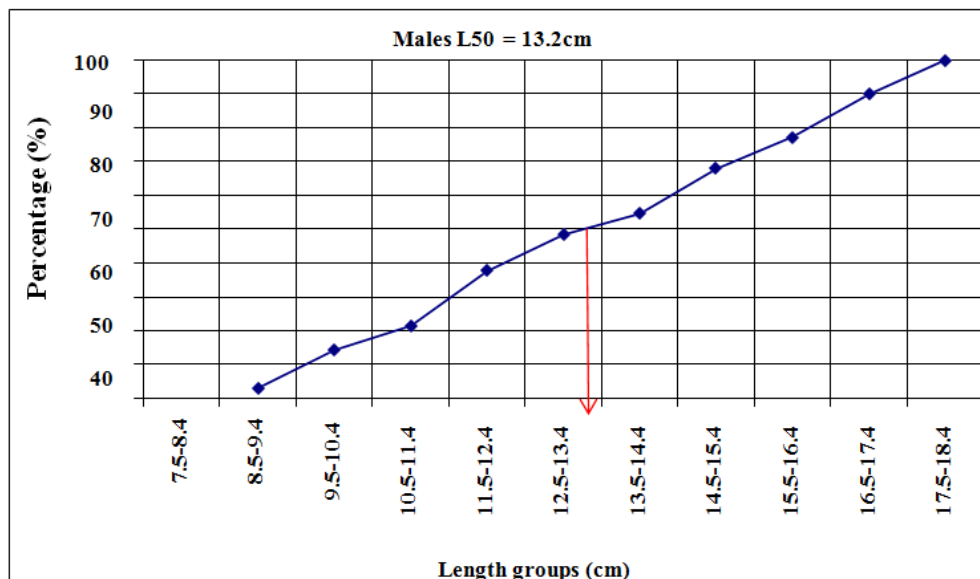


Fig. (3): Length at first sexual maturity of males *Liza carinata* from Bitter Lakes, Suez Canal in 2019-2020

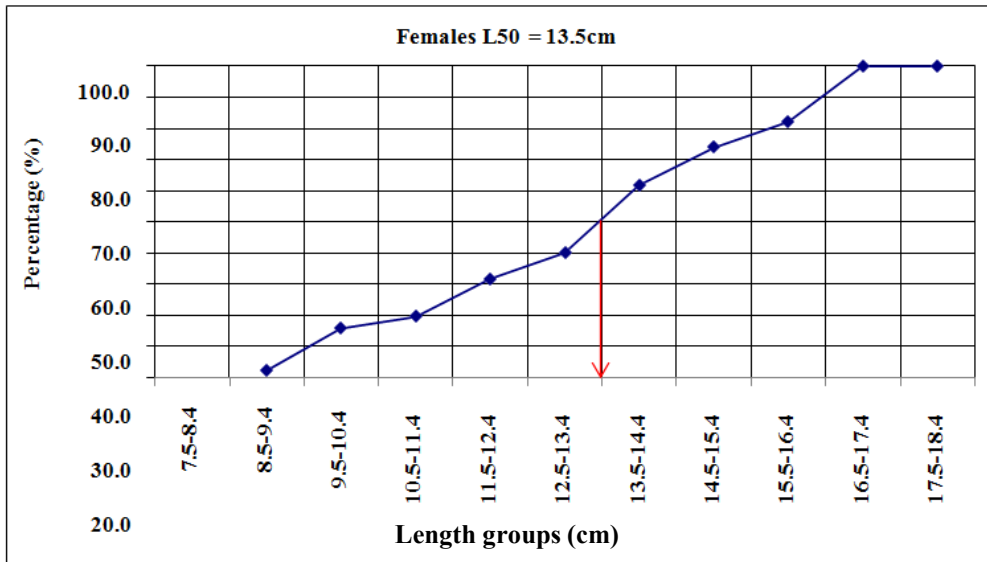


Fig. (4): Length at first sexual maturity of females *Liza carinata* from Bitter Lakes, Suez Canal in 2019-2020

Gonado somatic index G.S.I.

The monthly change in G.S.I. is represented in figures (5 and 6). *Liza carinata* have a long spawning season, which extend from September to January. G.S.I. of males was lower than that of females. The average G.S.I. of the males increased from September (4.11%), October (5.22%), November (6.11%),

December (7.43%) and reached the peak on January (7.80%) (Fig. 5).

Oocytes diameter:

Minimum, maximum and average oocyte diameter of *Liza carinata* females over the period of study are presented in Table (2).

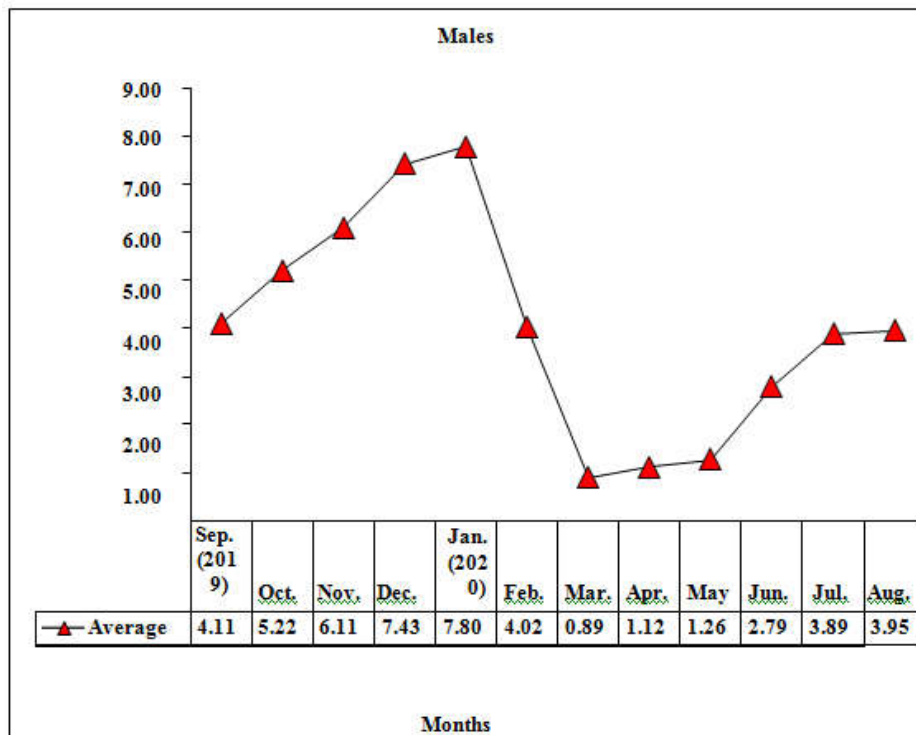


Fig. (5). Monthly variations in the average gonado-somatic indices of males *Liza carinata* from Bitter Lakes, Suez Canal in 2019-2020.

G.S.I. of females was higher than that of males. The average G.S.I. of the females increased from September (13.3%), October (15.5%), November (16.2%), December (17.5%) and January was the highest value of G.S.I. (17.9%) (Fig. 6).

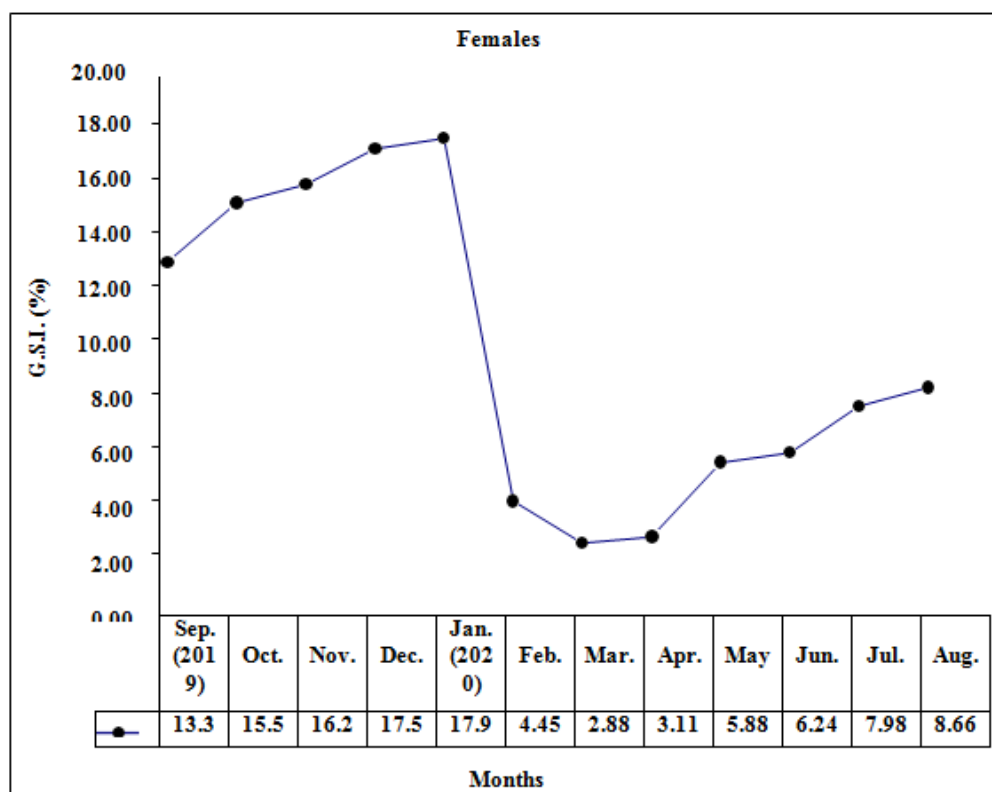



Fig. (6). Monthly variations in the average gonado-somatic indices of females *Liza carinata* from Bitter Lakes, Suez Canal in 2019-2020

Table (2): Monthly variations of oocyte diameters of *Liza carinata* from Bitter Lakes, Suez Canal

Months	Number of Fish	Oocytes diameter		Eye piece micrometer
		Egg-Diameters (μ)		Egg-Diameters (μ)
		Minimum	Maximum	
Sep. (2019)	26	314	460	
Oct.	31	403	515	
Nov.	35	433	535	
Dec.	10	302	637	
Jan. (2020)	11	281	698	
Feb.	4	-	-	
Mar.	4	-	-	
Apr.	2	-	-	
May	2	-	-	
Jun.	8	-	-	
Jul.	22	17	23	
Aug.	19	31	57	
Average				362±20.5

- = The egg diameters were very minute and difficult to measure

The minimum average oocyte diameters were recorded in July ($47 \pm 5.1 \mu\text{m}$). The average oocyte diameters increase strongly in September (388 ± 15.8) and then the increase continued in the following months to reach the maximum value in October (443 ± 26.1), 491 ± 32.2 in November, 511 ± 29.3 in December and $569 \pm 24.8 \mu\text{m}$ in January. The egg diameter in fish samples was not measured in the good accuracy in period from February till June, because the diameters were very minute and difficult to measure.

Fecundity

The ovaries of 154 *Liza carinata* females were examined (Tables 3). The smallest mature female had a total length of 12.5 cm and weight 23.5g. Its ovary

weight was 3.23 g (13.74% of the body weighed) with minimum absolute fecundity of 61357 ripe eggs. The largest female had a T.L. of 18.4 cm and weight of 69.8 g. Its ovary weighed 24.83 g (35.57% of the body weight) with maximum absolute fecundity of 120768 ripe eggs. The average absolute fecundity ranged from 64009 ± 4111 to 117428 ± 14321 for fish total length ranging from 12.5 to 18.4 cm. The overall average absolute fecundity recorded 87731 ± 9317 ripe eggs/fish while relative fecundity ranged from 4954 to 6546 ripe eggs/cm with overall average relative fecundity 5640 ± 889 /cm. It is clear that absolute and relative fecundity increased with the increase of the total length.

Table (3): Relation between fecundity and total body length (cm) of females *Liza carinata* from Bitter Lakes, Suez Canal in 2019-2020

Total length (cm)		No.	Absolute Fecundity			Relative Fecundity
Range	Average		Minimum	Maximum	Average	F/T.L. (cm)
12.5-13.4	12.92	27	61357	66754	64009 ± 4111	4954
13.5-14.4	13.95	28	67473	77452	72474 ± 5453	5195
14.5-15.4	14.96	27	72329	87317	79334 ± 7254	5303
15.5-16.4	15.94	25	90799	94794	93808 ± 11312	5885
16.5-17.4	16.95	23	96337	102314	99337 ± 13456	5961
17.5-18.4	17.94	15	113411	120768	117428 ± 14321	6546
The overall average absolute fecundity					87731 ± 9317	5640 ± 889

DISCUSSION

Data on the reproductive biology of *Liza carinata* are very important for preserving their stocks and regulating their fishing strategies. These data would help in estimating their fishing seasons. The present study has a further importance in being the first work on reproductive biology of *Liza carinata* from Bitter Lakes, Suez Canal.

The reproductive biology of different species of mullet fishes have been studied by many authors (Ezzat, 1965; Mohammad, 1982; El-Mor, 1993; Muus and Nielsen, 1999; Mehanna, 2004; Cardona, 2006; Koutrakis, 2011; El-Ganainy *et al.*, 2014 and Hefiny *et al.*, 2016).

In the present work, the overall sex ratio was (1 : 1.35) for *Liza carinata*, these results are in agreement with those results of *Liza carinata* in Suez Canal, Egypt, where the sex ratio was (1 : 1.33) (El-Mor, 1993).

The sex ratio was not constant throughout the year, particularly during breeding season of *Liza*

carinata (El-Ganainy *et al.*, 2014 and Hefiny *et al.*, 2016).

Despite females were the dominant sexes in *Liza carinata*. Studied El-Mor (1993), mentioned that it is possible that females of *Liza carinata* are heavier during spawning season and get caught during the year in large number resulting in an unbalanced sex ratio. They may account for the slight female biased sex ratio in the present study.

Generally, in the natural fish community (Mugilid family) males mature first before the females and are ready to participate in spawning activity (Ezzat, 1965; Mohammad, 1982; El-Mor, 1993; Muus and Nielsen, 1999; Cardona, 2006; El-Ganainy *et al.*, 2014 and Hefiny *et al.*, 2016). In the present work, the maturation size was determined for males ($L_{50} = 13.2$ cm) and for females ($L_{50} = 13.5$ cm). These values are smaller than those recorded in Lake Timsah, Egypt, where smallest mature male *Liza carinata* was 13.9 cm in total length, while mature female was 14.2 cm in total length (El-Mor, 1993). Also, in Lake Timsah, Egypt, the smallest mature male *Liza carinata* was

13.4 cm in total length, while mature female was 13.8 cm in total length (Mohammad, 1982). These results are larger than those recorded in our observation, these variations in the beginning of maturity may depend on water temperature (Cardona, 2006). Actually, common Mullet fish, which live in warm waters are maturing earlier than those that live in cold water (Koutrakis, 2011).

In the present study, from the average gonado somatic index (G.S.I.), *Liza carinata* have definite spawning season, which extends from September to January. This result corroborated those observed in Suez Canal, Egypt (El-Mor, 1993) and in Suez Bay (El-Ganainy *et al.*, 2014; Hefiny *et al.*, 2016).

Environmental factors probably accounted for most of the variations observed in Mullet fishes spawning times (Cardona, 2006; Luc-Gervais *et al.*, 2018).

In this work, the increase in the oocyte diameter of *Liza carinata* was evident from September ($388 \pm 15.8 \mu\text{m}$) to January ($569 \pm 24.8 \mu\text{m}$). The increase in egg diameter was mainly due the deposition of large amounts of proteins and lipids in the developing eggs (Luc-Gervais *et al.*, 2018).

The number of eggs produced by females vary greatly according to species, size, age, region, period and techniques used, thus a considerable variability has been shown in different populations of mullets (Oren, 1975). Also the egg diameters were comparable with those obtained by Mohammad (1982) in Lake Timsah, Suez Canal, Egypt where the mean egg diameter of *Liza carinata* is about 400-650 μ . El-Ganainy *et al.* (2014) in Suez Bay, Egypt, determined the absolute fecundity from 60732 to 98549 for females varied in total length from 13.6cm to 18.4 cm, In the present work, the average absolute fecundity ranged from 64009 to 117428 ripe eggs/fish of total length ranging from 12.5 to 18.4 cm and relative fecundity ranged from 4954 to 6546 ripe eggs/cm with overall average relative fecundity 5640/ cm.

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بعض الجوانب البيولوجية لتكاثر سمكة السهلية ليزا كاريناتا في البحيرات المرة - قناة السويس - مصر

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تعتبر عائلته البوري family Mugilidae من العائلات السمكية الهامة في شرق البحر المتوسط من ناحية مصاندها أو إنتاجيتها من الاستزراع البحري. توجد اسماك هذه العائلة في معظم بحار ومحيطات العالم خاصة في مياه البحر المتوسط. اسماك هذه العائلة متوسطه الحجم سباحة تعيش مجتمعه وتشتمل العائلة علي ٦٤ نوع تعيش في المياه المعتدلة والاستوائية ويتركز منها ثمانية أنواع في الحوض الشرقي للبحر المتوسط. سمكه السهلية *Liza carinata* من اسماك العائلة البورية الهامة قاطنة البحر الأحمر وهي سمكه تهاجر من البحر إلي النهر للتغذية وتعود للبحر لإتمام عمليه التكاثر وتكمله دوره الحياة. الغرض من الدراسة هو تكوين قاعدة بيانات بيولوجيه لتكاثر سمكه السهلية في البحيرات المرة في قناة السويس تمهيدا لتنظيم مصاندها واستزراعها مستقبلا. تم تجميع حوالي ٥٠٠ عينه من اسماك السهليه في الفترة من سبتمبر ٢٠١٩م وحتى أغسطس ٢٠٢٠م من مصيد البحيرات المرة من الصيادين مباشرة. بدراسة العلاقة بين طول ووزن السمكه مثلث بعلاقة خطيه وكانت قيمه b مثاليه ومعامل الارتباط عالي. وبدراسة معاملي الحالة KC&KF وجد أن القيم تسجل اعلي المستويات في موسمي الخريف والشتاء والربيع. وكان الشق الجنسي العام للسمكة 1:35 للذكور والإناث علي التوالي. وسجل بداية النضج الجنسي للإناث عند $L_{50}=13.5\text{cm}$ أما الذكور فكان $L_{50}=13.2\text{cm}$ حيث وجدت جميع الذكور ذات طول كلي اعلي من 14.2cm جميعهم بالغه. للسمكة موسم تكاثر محدد يمتد من سبتمبر إلي يناير. كان متوسط قطر البيض في الدراسة الحالية 362 ± 20.5 وكان المتوسط العام للخصوبة المطلقة 87731 ± 9317 بويضة/سمكه للأطوال الكلية من 12.5سم إلى 18.4سم. أما الخصوبة النسبية فكانت تتراوح بين ٤٩٥٤ إلي ٦٥٤٦ بويضة/سم وكان المتوسط العام 5640 ± 889 بويضة/سم.