

## Some Aspects of the Reproductive Biology of the Pink Ear Emperor *Lethrinus Lentjan* (Lacepède, 1802) in Red Sea Coast of Yemen

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### ABSTRACT

Some aspects of the reproductive biology of the *Lethrinus lentjan* (Lacepède, 1802), in Yemen coastal water of the Red Sea were studied from April 2003 to March 2004. Five maturity stages were described for gonad development based on external features. Following the monthly changes of different maturity stages, as well as gonadosomatic indices the spawning season extended from March to June with a peak in April-May. Sexual maturation in female started at about 170 mm and the size at which 50% of females mature was determined as 185mm, being completed at 260mm. Size-related discrepancy in female to male sex ratio was observed where females generally predominated in the smaller sizes and males in the larger sizes. The total fecundity ranged from 80295 for 192 mm TL female to 837251 for 400 mm female.

**Keywords:** Lethrinidae, *Lethrinus lentjan*, fish reproduction, Red Sea, Yemen.

### INTRODUCTION

Fishes of the family Lethrinidae or emperors are indigenous to the tropical and subtropical Indo-Pacific region, except one species that occurs only in the eastern Atlantic and abundant in and around coral reefs (Carpenter and Allen, 1989). With significantly important in fisheries in certain countries, members of genus *lethrinus* are the most important catch by weight. They are caught primarily by hand line, traps, and trawls Carpenter (2001). The *Lethrinus lentjan* (Pink ear emperor) is considered as one of the prime fish species landed and marketed in southern Red Sea (Kedidi, 1984; Heba *et al.*, 1998).

Information on the reproductive biology of a species, such as the length at first sexual maturity, spawning season, and fecundity are crucial for the production of stock assessment models (Hill, 1990). Studies on reproductive biology of *L. lentjan*, including maturation and spawning were carried out in Indian waters (Toor, 1968), in New Caledonian (Loubens, 1980), and in the Red Sea coast of Saudi Arabia (Kedidi, 1984; Wassef *et al.*, 1991). El-Agamy *et al.* (1987) and Ezzat *et al.* (1994) studied the histological developmental stages of gonads in the Arabian Gulf (Qatar) and the Red Sea (Saudi Arabia), respectively. Young and Martin (1982) studied sex ratio and some aspects of histology of developing gonads for this species in Australia.

Despite the commercial importance and abundance of the species in Yemen, there are no publications describing their reproductive biology in this area. The present study investigates some aspects of the reproduction of *L. lentjan* in the Red Sea coast of Yemen, including its spawning season, gonad maturity stages, sex ratio and size at first sexual maturity, and fecundity.

### MATERIALS AND METHODS

Between April 2003 and May 2004, 1068 specimens ranging from 160 to 500 mm of *L. lentjan* were obtained monthly from commercial catches of the local fisheries

caught by handlines at depths 10 - 40m in the coastal waters adjacent to Al-Lyhua (north of the Red Sea coast of Yemen) (Fig. 1). For each fish, total length (TL, mm), total weight (TW, g) and gonad weight were measured. Each individual was sexed and gonads were macroscopically staged as either immature/resting (stage I), development (stage II), mature (stage III), spawning (stage IV) and spent (stage V) adapted from Laevastu (1965). The spawning period was established from the analysis of two variables: (1) Monthly distribution of maturity stages and (2) gonadosomatic index:

$$GSI = W1/W2 \times 100$$

Where, W1 =gonad weight (g) and W2 = Total wet weight of body (g).

Sex ratios were estimated [females/ males]. Chi-squares (X<sup>2</sup>) test ( $\alpha = 0.05$ ) were used to investigate the difference in sex ratios from an expected 1:1 ratio.

$$X^2 = \sum (f_i - F)^2 / F, \text{ (Zar, 1984)}$$

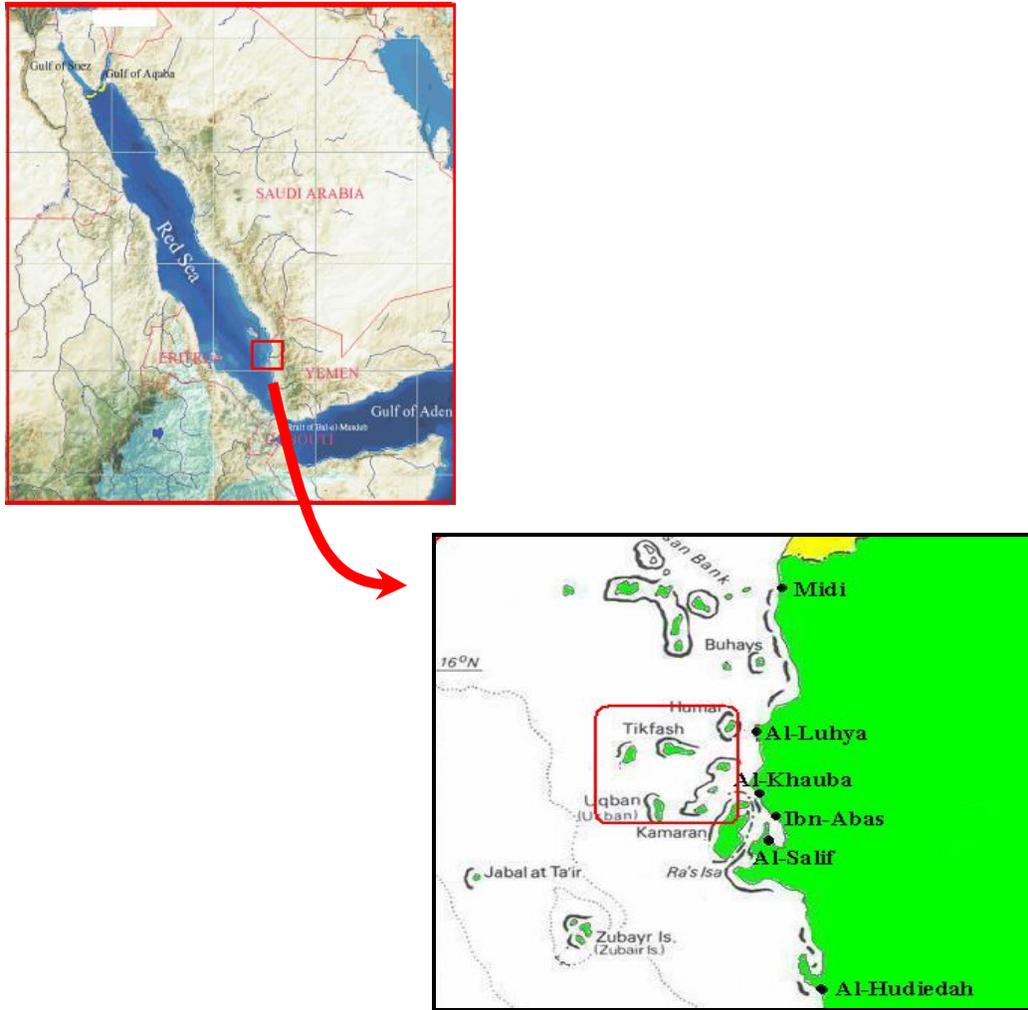
Where  $f_i$  = number of females or males observed, F = number of females or males expected. Size (TL) at first sexual maturity was obtained through the relative frequency of all mature females (stages II- V) by size class using a logistic regression as follows:

$$F = 1 / (1 + e^{a + bx L})$$

Where (F) is the frequency of mature females for each length class interval (L), (a) and (b) are the parameters of the logistic curve. The size at first maturation ( $L_{50}$ ) as the length in which 50% of the females joined the reproductive population, was estimated as:  $L_{50} = -a / b$  (Lewis and Fontoura, 2005) and curve fitted by SPSS.

Total fecundity defined as standing stock of advanced yolked oocytes in the ovary (Hunter *et al.*, 1992) and was estimated for maturity stage (III) using gravimetric method (Bagenal and Tesh, 1978). The preserved gonads were blotted on blotting paper and weighed.

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**Figure (1):** Map of the Red Sea coast of Yemen and the study area water adjacent for Al-luhya.

Sub-samples of about 0.02g were dissected from the dried ovary and inspected under the microscope and oocytes were counted. Total fecundity was estimated as the mean number of oocytes from sub-samples raised to the total ovarian weight by:

$$F = N_s / W_s \times W_g$$

where F is the fecundity,  $N_s$  is the mean number of eggs in the sub-sample,  $W_g$  is gonad weight, and  $W_s$  is the sub-sample weight.

### RESULTS

In the present study, the maturity stages of gonads of *L. lentjan* were classified according to the scale of Laevastu (1965) with a slight modification. At a macroscopic level, the morphological characteristics of the vast majority of the paired gonadal lobes of *L. lentjan* could be classified as either ovaries or testes.

The sequence of the maturity stages for females and males were identified as given in (Table1).

### Gonad maturity stages

Monthly changes in ovarian maturity stages are shown in Figure (2). It can be seen that the females of *L. lentjan* that possessed developing ovaries, *i.e.* stage II, were first recorded after spawning season between 5.06% in September to 15.25% in December then they were prevalent in January (52.17%) but decreased in April (5.08%). Many of females *L. lentjan* collected from February to May contained ovaries both of mature and spawning stage, *i.e.* stage III and IV, where mostly prevailed together in March and April, where they represented by 38.67.02% and 38.84% to 37.29% and 40.68% respectively. Females with stage V started to appear in April by about 10.17% then prevailed in May with 51.72%. From June to December the females with stage I (immature and resting) were prevailed from July

**Table (1):** Maturity stages of *L. lentjan* for females and males in the Red Sea coast of Yemen.

Stages	Female	Male
<b>Stage I Immature/ resting</b>	Ovaries are small; often flesh-colored or wine-colored with tubular-shaped in large juveniles and resting, transparent. Oocytes not recognized with naked eye. Only a few large juveniles were obtained during the period of study but no small ones.	Testes very small, transparent and thread-like
<b>Stage II Maturing</b>	Ovaries one third to two thirds of body length cavity, with torpedo-shaped and rounded and translucent. The ovaries are variable in color from pinkish to yellow hue, rich in blood vessels and many oocytes were visible through ovary wall	Testes flat to partially swollen, tapering towards anterior end, cream in colour with single blood vessels on ventral side
<b>Stage III Mature</b>	Ovaries occupy two thirds to full length cavity. Rounded and full, yellow to radish in colour. Oocytes clearly rounded, lightly transparent	Testes reddish to white; rich in blood vessels. It swollen, full in appearance, almost triangular in shape at posterior end.
<b>Stage IV Spawning</b>	Ovaries are similar to those of previous stage, but oocytes extricable by gentle pressing of the abdomen. Walls elastic. Rounded or may be slightly flaccid. May also contain spaces between oocytes	Testes are swollen, white to ivory in colour. Gonad walls loose, soft and unsymmetrical. Sperm may be extruded under pressure. May have brown tinges at the end
<b>Stage V Spent</b>	Ovaries shrunken (not completely empty) to about 2/3 length of body cavity. Ovary radish with brown tinges at anterior ends, usually containing a few left-over eggs	Testes dark reddish to grey, flaccid, brown tinges at ends of lobes

(86.96%) to December (81.36%) with maximum percentage of 94.94% in September. The stage III and IV appeared in the catch from February to May, that may indicated that *L. lentjan* has a long spawning season.

From figure (3) it was noticed that, the males with stage I (immature and resting) prevailed from July (50.5%) to December (61.9%) with maximum percentages recorded in September and October (90.5% and 88.9%), but this stage was absent in January and March. The stage II appeared all the year round, except April, but dominated in January (57.2%). Numerous of males of *L. lentjan* collected from December to July had testes either in mature or spawning stage, i.e. stages III and IV, which prevailed during the period from February to April. Moreover stages V started to appear in February (4.3%), increased until June (43.5%) then decreased afterwards.

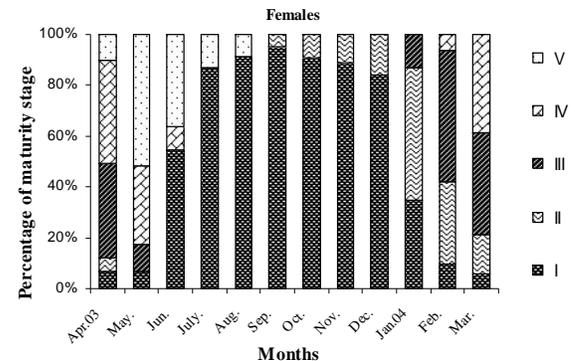
The monthly means of gonadosomatic indices (GSI) of female *L. lentjan* show continuous increase from December (0.55) to reach the highest value (2.43) in March then declined till June and remained below 0.4 from July to November. The lowest value (0.24) occurred in October (Fig. 4).

The mean monthly GSIs of the males of *L. lentjan* started to increase earlier and remained high for longer time than those of females. They increased from 0.11 in November to 0.35 in February, where the highest value was recorded and then remained at low values between 0.30 and 0.18 from March to May, then declining progressively to the lowest value (0.083) in October.

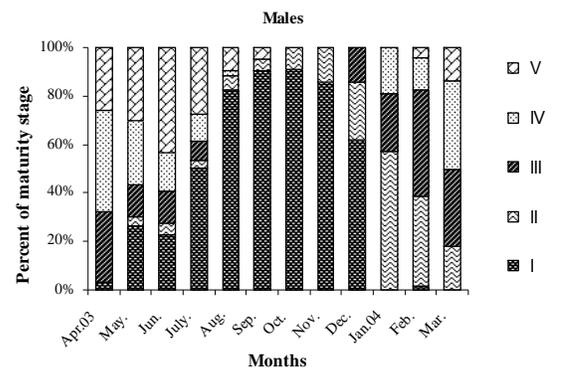
**Sex ratio**

The ratios of females to males in monthly samples of *L. lentjan* varied greatly among months. It showed that

females and males alternatively dominated the population during the sampling period (Table 2). The overall sex ratio was 1.1:1 females to males, with no significant deviation from the expected 1:1 ( $X^2 = 1.08$ ;  $p > 0.05$ ).



**Figure (2):** Monthly changes in ovarian maturity stages of *Lethrinus lentjan* from the Red Sea coast of Yemen.



**Figure (3):** Monthly changes in testes maturity stages of *Lethrinus lentjan* from the Red Sea coast of Yemen.

**Table (2):** Monthly variation of sex ratio for females and males of *L. lentjan*.

Month	No. Females	No. Males	F : M	X <sup>2</sup>	0.05
Apr.03	59	31	1.9 : 1	8.71	*
May	29	53	0.5 : 1	7.02	*
Jun.	33	21	1.6 : 1	2.67	
Jul.	23	34	0.7 : 1	2.12	
Aug.	23	52	0.4 : 1	11.21	*
Sep.	79	63	1.3 : 1	1.80	
Oct.	44	22	2.0 : 1	7.33	*
Nov.	27	23	1.2 : 1	0.32	
Dec.	59	24	2.5 : 1	14.76	*
Jan.04	23	21	1.1 : 1	0.09	
Feb.	31	57	0.5 : 1	7.68	*
Mar.	121	116	1.0 : 1	0.11	
<b>Total</b>	<b>551</b>	<b>517</b>	<b>1.1 : 1</b>	<b>1.08</b>	

\* Value shows significant deviation from the expected ratio 1 : 1, X<sup>2</sup> = (chi-square)

However, the sex ratios for females and males grouped into 20 mm length class intervals showed that the females dominated the smallest length groups, from length groups 170-189 mm to 230-249 mm, and males dominated in larger length groups 230-249 mm (Fig. 5).

**First sexual maturity**

The smallest mature female was 176 mm. The length at which 50% of the females of *L. lentjan* reached sexual maturity, i.e. L50, was 185 mm (Fig. 6). While all females larger than 260 mm were mature 100%. The estimation of length at first maturity in males was difficult to estimate in this study.

**Fecundity**

The number of oocytes (total fecundity) ranged from 80295 for 192 mm TL females to 837251 for 362 mm females (Table 2). The egg production of *L. lentjan* generally increased with the increase of fish length, and/or of weight. The relationship between total fecundity (TF) and total length TL (mm) is as follows:

$$RF = 9.510^{-6} TL^{3.526} \quad (r2 = 0.853).$$

The relationship between total fecundity (TF) and body weight (W) is as follows:

$$RF = 0.407W^{1.15} \quad (r2 = 0.861)$$

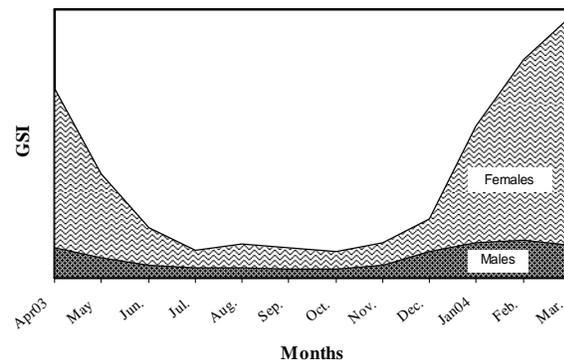
On the other hand, the relative fecundity of *L. lentjan* as shown in (Table 3) increases generally with increased length and weight, but with slight deviation from that trend.

**DISCUSSION**

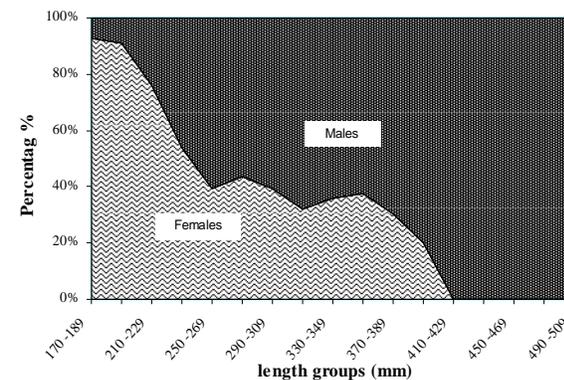
Changes in the monthly mean GSI of the collected fish were used in conjunction with visual determinations of gonad maturity stages of adults to estimate the spawning season (Rhodes and Sadovy, 2002). The trends exhibited by the monthly mean GSIs and the

prevalence of various gonad stages in sequential months illustrated the spawning period of *L. lentjan* in Red Sea coast of Yemen. Thus, the GSI of *L. lentjan* was high during period from February to June. However, a few spawning females were caught in February and June. The occurrence of high percentage of females with spawning gonads (stage IV) in the samples in, at least, three consecutive months from March to May and the subsequent emergence of spent fish until June suggests that *L. lentjan* in the Red Sea coast of Yemen has prolonged spawning season extending from March to Jun. The spent gonads of *L. lentjan* in the study area appeared in full in April in females. Although the gonads flaccid partly appeared in March which means that discarding eggs probably begin this month.

The population sizes of lethrind species seem to be strongly related to biological characteristics, such as the length of spawning period and testicular size and, where the species occurring in smaller populations possess small testis (smallness GIS) and exhibit protogynous hermaphroditism with relatively long spawning period (Ebiswa, 1999). The main spawning period in *L. lentjan* so far reported varies widely from place to another. It occurred twice a year, December-February and June – August in Indian waters (Toor, 1968). Nzioka (1979) found that the spawning season of *L. lentjan* occurs



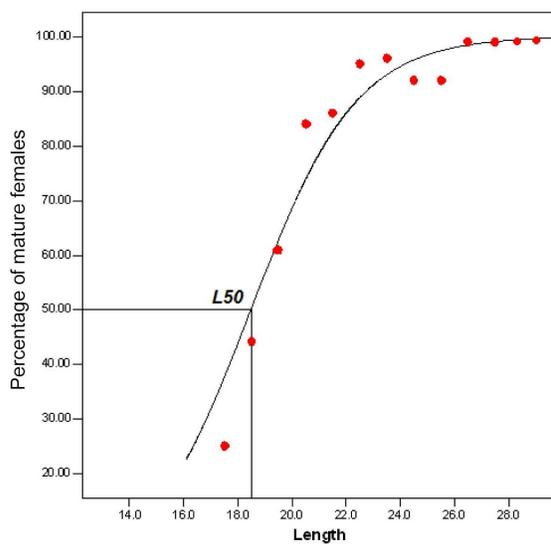
**Figure (4):** The monthly means of gonadosomatic indices (GSI) of *L. lentjan*.



**Figure (5):** Variation of sex ratio of *L. lentjan* in the different length groups.

**Table (3):** The mean total fecundity and relative fecundity of *L. lentjan* from the Red Sea coast of Yemen.

Mean Total length (mm)	Mean Total weight (gm)	No.	Fecundity x 10 <sup>3</sup>	Relative fecundity by length TF/TL	Relative fecundity by length TF/TW
192	125.7	6	80.295	417.5	639.0
209	159.0	9	167.324	800.6	1052.4
227	207.7	11	216.404	954.5	1041.8
244	254.4	6	296.490	1214.1	1165.4
271	344.3	3	321.614	1188.2	934.0
292	409.0	1	460.145	1575.8	1125.0
320	584.0	1	534.146	1669.2	914.6
340	737.0	1	811.900	2387.9	1101.6
362	881.0	1	837.251	2316.0	950.3

**Figure (6):** Percentage of mature females. The proportion of sexually mature females within each size class is plotted using logistic regression. Lines indicate length at 50% maturity (L<sub>50</sub>).

most of the year with peaks in March/April, October/November in East African coast. In New Caledonian lagoon, gonad at maturation stage was found during August–December in *L. lentjan* (Loubens, 1980). In the Red Sea coast of Saudi Arabia *L. lentjan* has a prolonged spawning season extending from March to July with the peak in April–May (Kedidi, 1984 and Wassef *et al.*, 1991). In the Qatari waters of the Arabian Gulf the spawning occurred during the period from April to July (El-Agamy *et al.*, 1987). These records indicate the main spawning period of *L. lentjan* varies widely depending on survey location, may be due different seasonal patterns of environment (Fishelson *et al.*, 1987; Robertson, 1991).

The overall sex ratio of *L. lentjan* in the present study did not show any significant deviation from the expected ratio of 1: 1 ( $X^2 = 1.08$ ;  $p > 0.05$ ). The analysis of sex ratios within length groups suggests that sex change from females to males (protogynous) could be the principal reason; so the female bias in small

length groups is eliminated in the larger length groups (Brule *et al.*, 2003). Similar changes in sex ratio with fish length for this species have been described by Loubens (1980), Young and Martin (1982), and Wassef *et al.* (1991). Several lethrins exhibit sex reversal and are considered protogynous hermaphrodite (Young & Martin, 1982; Ezzat *et al.*, 1994) as for *L. lentjan*. The *L. lentjan* is protogynous hermaphroditism (Al-Areeki, 2007).

In the present study, the presence of testis stages from II to V for long a period (February–July) without symmetric testis lobes may suggest that both group-spawning and pair-spawning sites exist within a single population (Warner and Hoffman, 1980; Ebiswa 1997; 1999). Many fishes of the protogynous hermaphroditism, such as *Lethrinus atkinsoni*, forms short-term spawning aggregations and pair-spawns in single-male/multi-female clusters (Colin *et al.*, 1987; Sadovy *et al.*, 1992; Ebisawa 1999). In red hind (*Epinephelus guttatus* = protogynous), spawning occurs in aggregations at several sites within loosely defined areas located towards the edge of the insular platform (Sadovy *et al.*, 1994)

The length at first sexual maturity (L<sub>50</sub>) of females was 185mm, smaller than the 230mm recorded in New Caledonia (Lubens, 1980) and the 210mm in the Red Sea off Saudia Arabia (Wassef *et al.*, 1991). Size differences at first maturity were observed for females in other species (Dadzie *et al.*, 2000; Brule *et al.*, 2003) and from place to place (Pati, 1982)

The annual fecundity of *L. lentjan* during the present study, (80.295 to 837.251 for fishes of 192 and 362 mm total length, respectively) differs from the reported that 128.180 to 1009.875 for fishes of 220 and 410 mm total length, respectively, by Wassef *et al.* (1991). This slight difference may be due to local environmental variation or to sampling. Within a given species, fecundity may vary as a result of different adaptation to environmental habitat (Withames *et al.*, 1995).

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## دراسة بعض سمات بيولوجية التكاثر لسمكة الامبراطور (ليثرينيس لينتجان) على ساحل البحر الاحمر اليمنى

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### الملخص العربى

تم دراسة بعض سمات بيولوجية التكاثر لسمكة الإمبراطور المصادرة من ساحل البحر الاحمر اليمنى في الفترة من أبريل 2004 حتى مايو 2005. وقد تم وصف خمس مراحل لنضج المناسل اعتمادا على صفاتها المظهرية. من خلال تتبع مراحل نضج المناسل ودالة المناسل تبين أن فترة وضع البيض لهذا النوع تمتد من شهر فبراير حتى يونيه، وكانت الذروه فى أبريل- مايو. بدأت الاناث تنضج عند طول 150 مم ونسبة نضج الاناث عند 50% كانت عند طول 195 مم وجميع الإناث كانت ناضجه عند طول 260 مم فما فوق. أوضحت نسبة الجنس تناقص أعداد الإناث وزيادة الذكور مع زيادة الطول، حيث سادت الإناث فى الاطوال الصغيرة والذكور فى الأطوال الكبيرة. تراوجت الخصوبة بين 80295 عند طول 192 مم و 873251 عند طول 400 مم.