

# Reproductive Biology of the Striped Seabream *Lithognathus mormyrus* (Linnaeus, 1758) from Al Haneah Fishing Site, Mediterranean Sea, Eastern Libya

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**Abstract:** Reproductive biology of *L. mormyrus* was studied using monthly samples totaling 224 fish obtained from Al-Haneah fishing site, eastern Libya Mediterranean Sea. Lengths of the examined fish ranged between 11.5 cm and 23.4 cm. Corresponding weights were 24.5 gm and 160.8 gm. The minimum values of the condition factors,  $K_F$  and  $K_C$ , were 1.38 and 1.21 at the average fish length of 12.4 cm. These values increased with increases in length until they reached maximum values of 1.59 and 1.41 at the length of 22.1 cm. The high values of  $K_F$  and  $K_C$ , Gonado-Somatic Index and oocyte diameter maintained during May, June, July, and August and the monthly changes in gonadal condition, indicated that summer was the breeding season of *L. mormyrus*. The oocyte diameter ranged between  $379 \pm 25.3 \mu$  and  $1,511 \pm 143.3 \mu$  ( $n = 76$ ) with an average of  $895 \pm 111.3 \mu$ . The sex ratio was in favor of females during all months of the study. The overall sex ratio was 1: 1.52. Length at first maturity,  $L_{50}$ , for *L. mormyrus* was found to be 14.15 cm for males and 14.45 for females. Overall average of absolute fecundity was  $4,342 \pm 557$  egg per fish ( $n = 45$ ). The overall average of relative fecundity was  $234 \pm 181$  egg per cm. Absolute fecundity increased with increasing fish length.

**Key words:** Reproductive biology, length at first maturity, oocyte diameter, fecundity, striped Seabream, *Lithognathus mormyrus*.

## 1. Introduction

*Lithognathus mormyrus* [1], striped Seabream or sand steenbras, family Sparidae, is a marine gregarious demersal fish inhabiting sandy shallow coastal waters. It is commonly not more than 30 cm long [2, 3]. It feeds on worms, mollusks, small crustaceans and detritus. It is protandrous hermaphrodite and breeds in summer (Russell *et al.*, 2014). The fish is subtropical, widely distributed in the eastern Atlantic Ocean, the Mediterranean sea, the Red sea and the southwestern Indian Ocean. In Libya it is present along the whole coast and is common in the artisanal catch [4]. The IUCN status of this fish is: Least concern.

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The objective of the present work was to study reproductive biology of *L. mormyrus* obtained from the artisanal catch of Al-Haneah, eastern Libya Mediterranean Sea. The data obtained will be helpful in managing the fisheries of this fish in Libya.

## 2. Methods

### 2.1 AL-Haneah Fish Landing Site

Al-Haneah and vicinity (Fig. 1) is a principal fishing ground on eastern Libyan Mediterranean Sea. *L. mormyrus* is common in its artisanal catch.

### 2.2 The Reproductive Biology Studies

These were the condition factors, the gonado-somatic index, the maturity stages, the length at first maturity, the sex ratio, the breeding season, fecundity and eggs diameter.

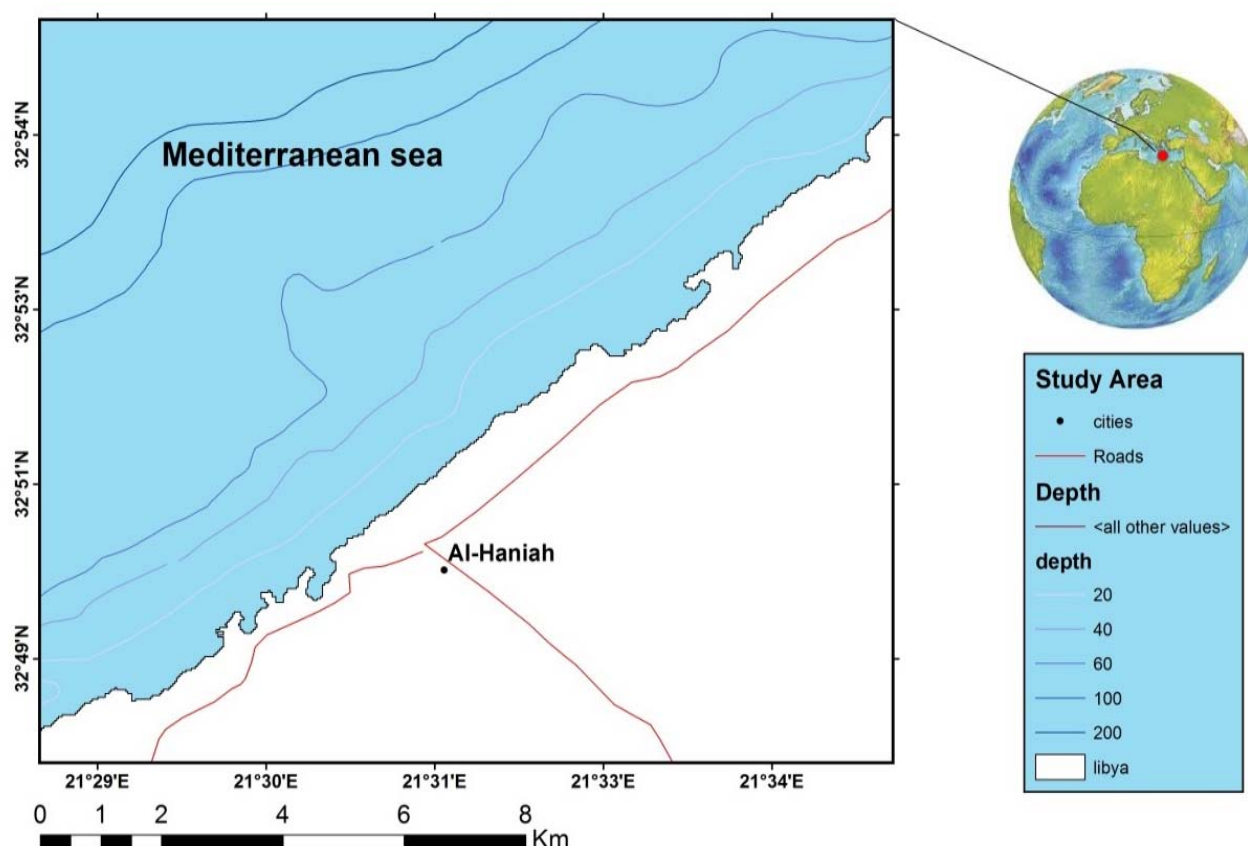


Fig. 1 Al-Haneah fishing site.

### 2.2.1 Collection and Treatment of *L. mormyrus* samples

An average of 19 *L. mormyrus* were collected monthly from Al-Haneah artisanal catch during March 2015 to February 2016 for use in the biological studies. Altogether 224 fish were used. The monthly samples were brought to the Marine Laboratory of the Zoology Department of Omar Al-Mukhtar University. For each fish total length and corresponding weight were measured to the nearest mm and the first decimal of the gram. The abdominal cavity was then cut open with a scissor and the condition of the ovary (maturity stages) according to El-Ganainy and Buxton [5] was observed and recorded. The gonads were then taken out and weighed, ovaries with well-developed eggs were preserved in 10% formalin for later reading the oocyte diameter under the low power of a microscope fitted with an eye piece micrometer. Corresponding

eviscerated fish weights were recorded.

### 2.2.2 The Condition Factor

Monthly Fulton's and Clark's condition factors ("K<sub>F</sub>", "K<sub>C</sub>") for female and male *L. mormyrus* were obtained monthly according to Froese and Bagenal and Tesch [6, 7].

$K_F = 100 (W/L^3)$ ...Fulton's condition factor.

$K_C = 100 (EW/L^3)$ ...Clark's condition factor.

W: whole fish weight in grams

EW: eviscerated fish weight in grams

L: fish length in centimeters

The factor 100 was used to bring K close to unity.

### 2.2.3 Gonado-Somatic Index (GSI)

GSI was determined monthly according to Anderson and Gutreuter and Akter *et al.* [8, 9].

$GSI = 100 \text{ wt of gonad (gm) / wt of whole fish (gm)}$

GSI: Gonado-somatic index

wt: weight

#### 2.2.4 Maturity Stages

These were recorded monthly as I: immature, II: developing, III: mature, IV: regressing, V: regenerating [5].

#### 2.2.5 Length at First Maturity ( $L_{50}$ )

$L_{50}$ , the length at which 50% of individuals were mature, was obtained by plotting the percentage mature fish in each length class of the whole population versus length. From the curve,  $L_{50}$  was the length corresponding to 50% mature.

#### 2.2.6 Sex Ratio

Sex ratio was determined by counting the number of males and females in the monthly samples studied.

#### 2.2.7 The Breeding Season

The breeding season was established from analysis of the monthly variation in the condition factor, the GSI and the maturity stages.

#### 2.2.8 Fecundity

Total or absolute fecundity (TF) is the total number of eggs in the ovaries of a fish prior to spawning [10]. In the present study mature ovaries were removed from their fish and placed in 10% formalin for one day to allow the eggs to harden. Each ovary was then taken out of the formalin, dried with a tissue paper and weighed. Three small sub samples were taken from the front, mid and rear parts of the ovary, weighed and atomized by rubbing gently with fingers.

The number of eggs in each sub sample was counted under the low power of a microscope. The number of eggs in the ovary based on each sub sample was calculated as:

$$\text{Number of eggs in the ovary} = \text{OW (gm)}/\text{SW (gm)}$$

\*NS [7] OW: ovary weight (gm)

SW: sub sample weight (gm)

NS: total number of eggs in sub sample.

Total fecundity was then obtained by averaging the numbers of eggs per ovary calculated from each of the three sub samples.

Relative fecundity (RF) is the number of eggs per unit length (cm) or the number of eggs per unit weight (g) of fish. To estimate relative fecundity individual fecundities were divided by corresponding lengths or weights [11].

#### 2.2.9 Egg Diameter

The egg diameter ( $\mu$ ) was established monthly with aid of a microscope fitted with an eye piece micrometer. Each month individual dimeters of 10 non deformed and rounded oocytes taken from different parts of ovaries of individual females were measured under the low power of the microscope. The average diameter was then calculated.

### 3. Results

#### 3.1 Lengths, Corresponding Weights, and Condition Factors

In the present study fish lengths ranged between 11.5 cm and 23.4 cm. Corresponding weights were 24.5 gm and 160.8 gm. All fish lengths were divided into 6 length classes with class range of 1.9 cm as shown in Table1.

The minimum values of the condition factors  $K_F$  and  $K_C$  were 1.38 and 1.21 at the average observed length of 12.4 cm (Table 1 and Fig. 2). These values increased with increases in length until they reached maximum values of 1.59 and 1.41 at the maximum observed length of 22.1 cm.

**Table 1** Fish lengths, weights and condition factors ( $K_F$  and  $K_C$ ), per length class range of 224 *L. mormyrus* from Al-Haneah coast. Number of fish within each class range is given between two brackets.

Length class range cm	Average length cm	Average weight gm	$K_F \pm \text{S.D.}$	$K_C \pm \text{S.D.}$
11.5-13.4 (39)	12.4	24.5	$1.38 \pm 0.71$	$1.21 \pm 0.56$
13.5-15.4 (37)	14.3	39.7	$1.44 \pm 0.99$	$1.24 \pm 0.76$
15.5-17.4 (34)	16.2	59.2	$1.49 \pm 1.02$	$1.29 \pm 0.95$
17.5-19.4 (41)	18.3	83.7	$1.55 \pm 1.09$	$1.32 \pm 0.99$
19.5-21.4 (40)	20.5	133.5	$1.57 \pm 1.11$	$1.34 \pm 1.01$
21.5-23.4 (33)	22.1	160.8	$1.59 \pm 1.20$	$1.41 \pm 1.08$

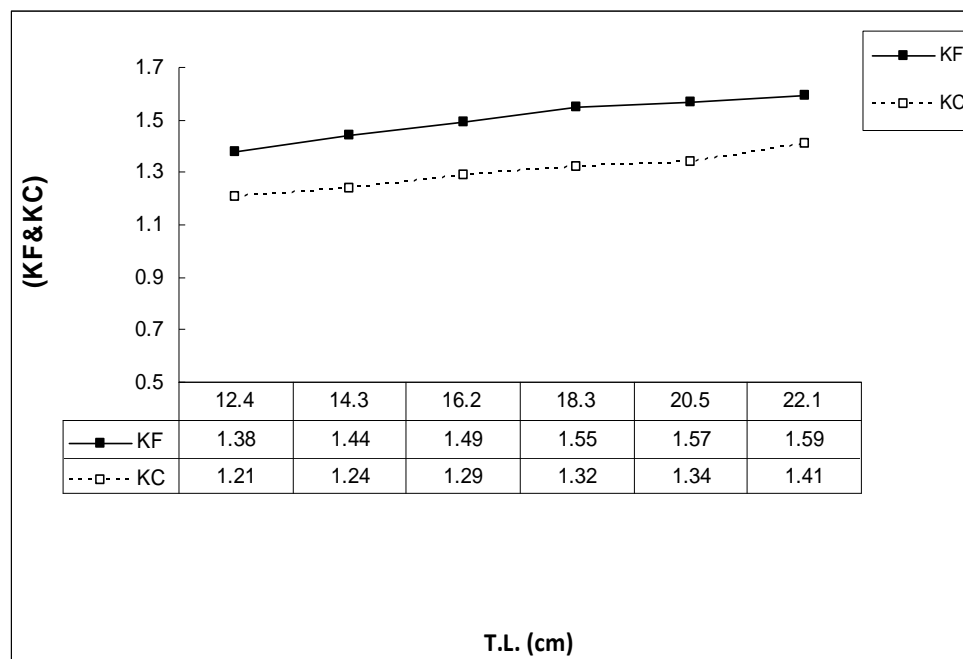


Fig. 2 The relationship between condition factor and length of *L. mormyrus* from Al-Haneah coast.

The monthly variations in condition factors  $K_F$  and  $K_C$  during the study period, March 2015 to February 2016 are shown in Fig. 3. During March  $K_F$  and  $K_C$  were 1.22 and 0.94 in order. Then they increased during April and recorded the highest values of 1.71 and 1.49 in May. High values were maintained during June, July and August. The monthly values then decreased gradually and reached a minimum of 1.27 and 0.98.

### 3.2 The Gonado-Somatic Index

Changes in monthly Gonado-Somatic Indices (GSI) of males of *L. mormyrus* during the study period are shown in Fig. 4. Highest GSI were recorded in May (4.67%), June (5.22%), July (4.76%) and August (5.81%). A sharp decrease occurred in September (1.41%). Low values were maintained during October (0.96%) to February (1.09%). The lowest value was during January (0.74%). It is, therefore, concluded that the breeding season of males of this fish is May to August, i.e. summer.

The GSI for females (Fig. 5) recorded high values during May (6.76%), June (7.61%), July (8.88%) and August (9.79%). The GSI values then decreased sharply during September (3.50%) and the following

months and reached a minimum value of 1.72 during January. From this we can conclude that the breeding season of female *L. mormyrus* is May to August i.e. summer.

### 3.3 Sex Ratio

During all the study period the ratio of Males: Females was in favor of females (Table 2). Of the 224 fish examined during the study period 89 were males (39.7%) and 135 were females (60.3%), giving an overall ratio of 1: 1.52. The highest values were recorded during the breeding season, in May (69.2%), June (64.7%), July (65%) and August (63%).

### 3.4 The Oocyte Diameter

The oocyte diameter in March was  $617 \pm 33.1$  (Table 3). It then increased during April ( $722 \pm 34.5$   $\mu$ ), May ( $1,123 \pm 77.8$   $\mu$ ), June ( $1,333 \pm 105.6$   $\mu$ ), July ( $1,432 \pm 129.2$   $\mu$ ) and reached the maximum in August ( $1,511 \pm 143.3$   $\mu$ ). The oocyte diameter then dropped to the lowest value of  $379 \pm 25.3$   $\mu$  in October. During the period November, December and January the oocytes were either not present or too small to be measured.

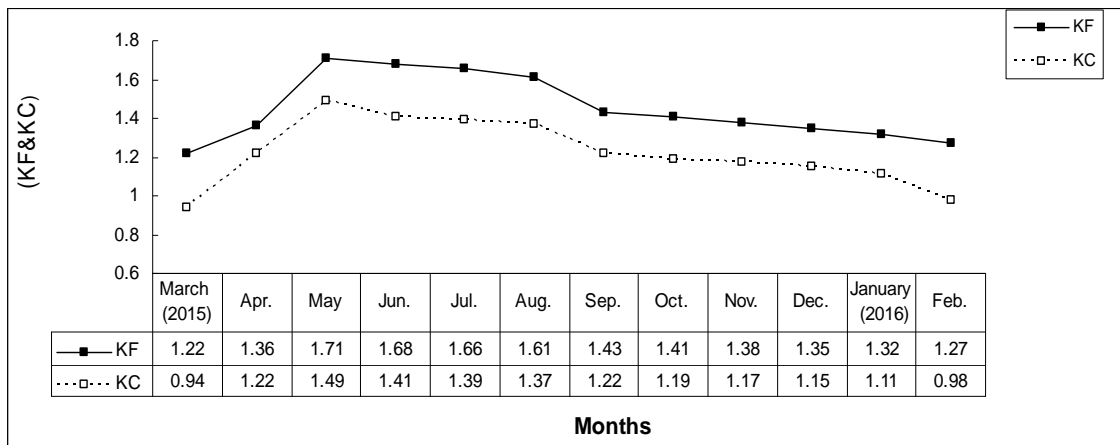


Fig. 3 Monthly variations of condition factors of *L. mormyrus* from Al-Haneah coast.

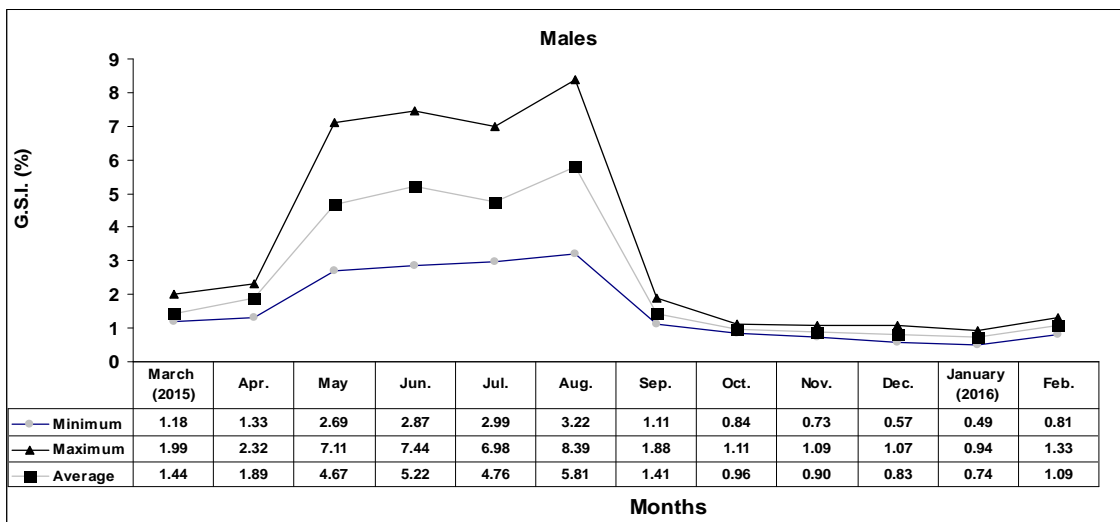


Fig. 4 Monthly variations of minimum, maximum and average gonado-somatic indices values of males *L. mormyrus* from El-Haneah coast.

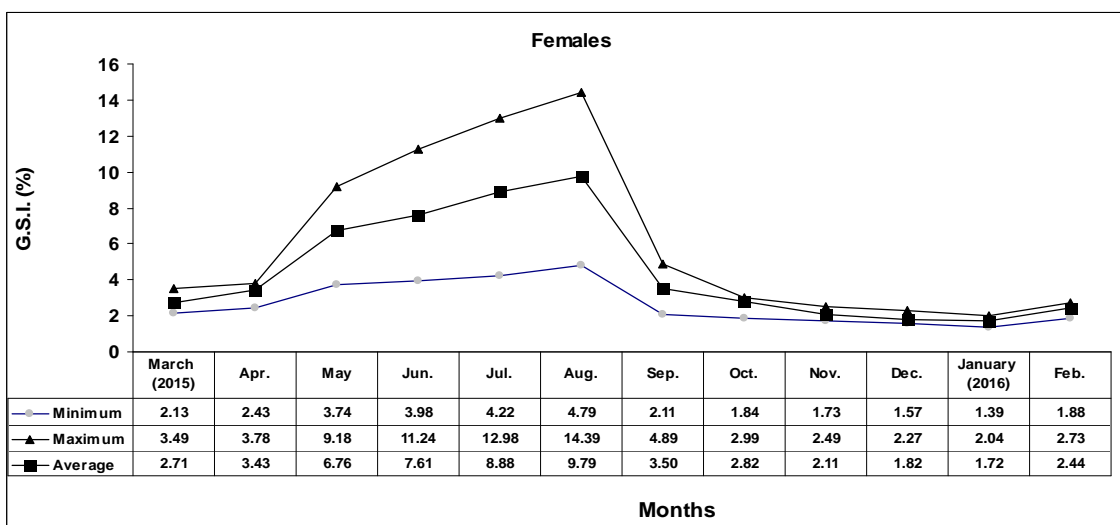


Fig. 5 Monthly variations of minimum, maximum and average gonado-somatic indices of females *L. mormyrus* from El-Haneah coast.

**Table 2** Monthly variations in sex ratio of *L. mormyrus* from Al-Haneah coast.

Months	No. of fish	Males		Females		Sex ratio
		No.	%	No.	%	
March (2015)	21	8	38.1	13	61.9	1: 1.63
Apr.	22	10	45.5	12	54.5	1: 1.20
May	13	4	30.8	9	69.2	1: 2.25
Jun.	17	6	35.3	11	64.7	1: 1.83
Jul.	20	7	35.0	13	65.0	1: 1.86
Aug.	27	10	37.0	17	63.0	1: 1.70
Sep.	18	8	44.4	10	55.6	1: 1.25
Oct.	17	6	35.3	11	64.7	1: 1.83
Nov.	21	10	47.6	11	52.4	1: 1.10
Dec.	18	8	44.4	10	55.6	1: 1.25
January (2016)	17	7	41.2	10	58.8	1: 1.43
Feb.	13	5	38.5	8	61.5	1: 1.60
Total	224	89	39.7	135	60.3	1: 1.52

**Table 3** Monthly variations of oocyte diameters ( $\mu$ ) of *L. mormyrus* from El-Hanea coast.

Months	Number of fish	Egg Diameter ( $\mu$ )		
		Minimum	Maximum	Average
March (2015)	3	467	754	617 $\pm$ 33.1
Apr.	5	477	956	722 $\pm$ 34.5
May	6	995	1,237	1,123 $\pm$ 77.8
Jun.	5	1,212	1,438	1,333 $\pm$ 105.6
Jul.	7	1,310	1,578	1,432 $\pm$ 129.2
Aug.	9	1,352	1,688	1,511 $\pm$ 143.3
Sep.	3	488	588	533 $\pm$ 40.8
Oct.	4	311	444	379 $\pm$ 25.3
Nov.	11	M	M	M
Dec.	10	M	M	M
January (2016)	10	M	M	M
Feb.	3	389	422	408 $\pm$ 31.1
Average				895 $\pm$ 111.3

M = The eggs were either not present or were too small for their diameters to be measured.

During February the oocyte diameter was (408  $\pm$  31.1  $\mu$ ). The average oocyte diameter for all the examined 45 fish was 895  $\pm$  111.3  $\mu$ .

### 3.5 Maturity

11.2% and 8.2% of males and females *L. mormyrus* in order in the class length 11.5-13.4 cm were mature (Table 4). Percentage maturity for males and females increased in the following class ranges such that all males and females in the class ranges 19.5-21.4 cm and 21.5-23.4 cm in order were mature.

### 3.6 Length at First Maturity

Length at first maturity  $L_{50}$  is the length at which half the population is mature and the other half is not. For *L. mormyrus*  $L_{50}$  was found to be 14.15 cm for males (Fig. 6) and 14.45 for females (Fig. 7).

### 3.7 Absolute and Relative Fecundity

Overall average of absolute fecundity for the 45 examined fish was 4,342  $\pm$  557 egg per fish (Table 5). The overall average of relative fecundity was 234  $\pm$  181 egg per cm.

**Table 4** The percentage of mature and immature fishes at different length ranges of *L. mormyrus* from Al-Haneah coast.

Total length (cm)		Males		Females	
Range	Average	% Immature	% Mature	% Immature	% Mature
11.5-13.4	12.4	88.8	11.2	91.8	8.2
13.5-15.4	14.3	45.8	54.2	49.8	50.2
15.5-17.4	16.2	32.5	67.5	38.5	61.5
17.5-19.4	18.3	18.6	81.4	28.6	71.4
19.5-21.4	20.5	—	100	11.1	88.9
21.5-23.4	22.1	—	100	—	100

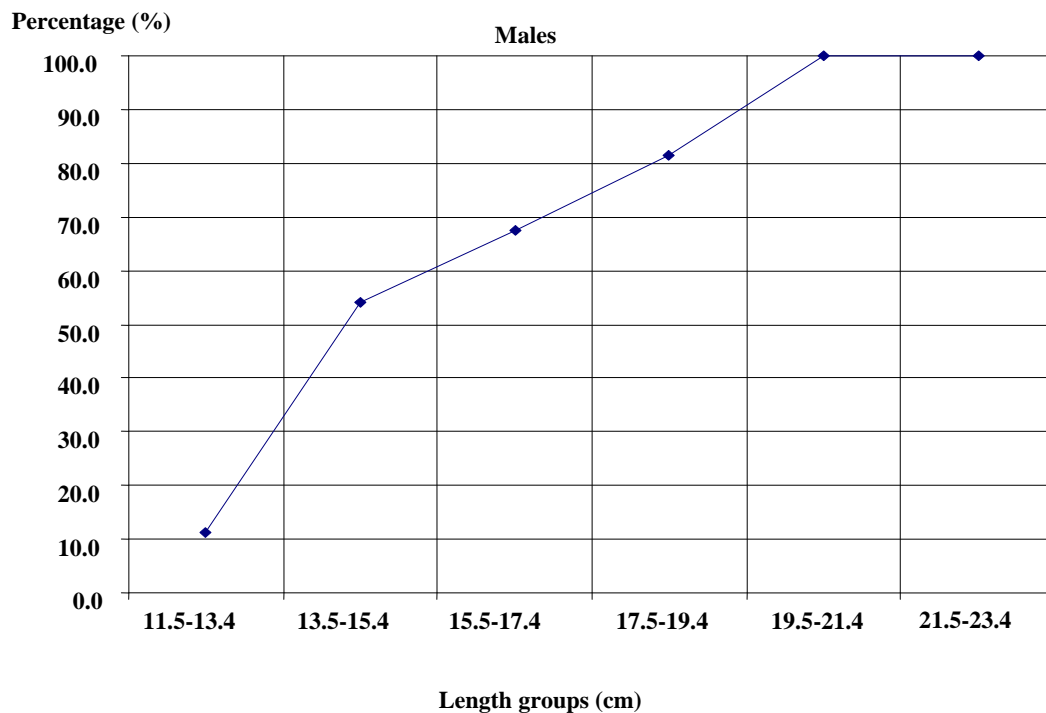
Remarks: Data expressed as percentage, (—) No fish in length group occurred.

**Table 5** Relationship between fecundity and total body length (cm) of *L. mormyrus* from El-Hanea coast.

Total length (cm)			Absolute Fecundity		Relative Fecundity	
Range	Average	No. fish	Minimum	Maximum	Average	TF/TL (cm)
11.5-13.4	12.4	6	655	876	754 ± 73.8	60
13.5-15.4	14.3	8	812	1,324	1,099 ± 73.8	76
15.5-17.4	16.2	10	1,439	2,148	1,876 ± 89.6	115
17.5-19.4	18.3	5	2,777	6,546	4,765 ± 133.5	260
19.5-21.4	20.5	8	5,434	10,987	8,119 ± 173.9	396
21.5-23.4	22.1	8	7,431	11,678	10,987 ± 214.1	497
Average	Total =	45			4,342 ± 557	234 ± 181

TF: Total Fecundity.

TL: Total fish length in cm.



**Fig. 6** Length at first maturity of males *L. mormyrus* from Al-Hanea coast.

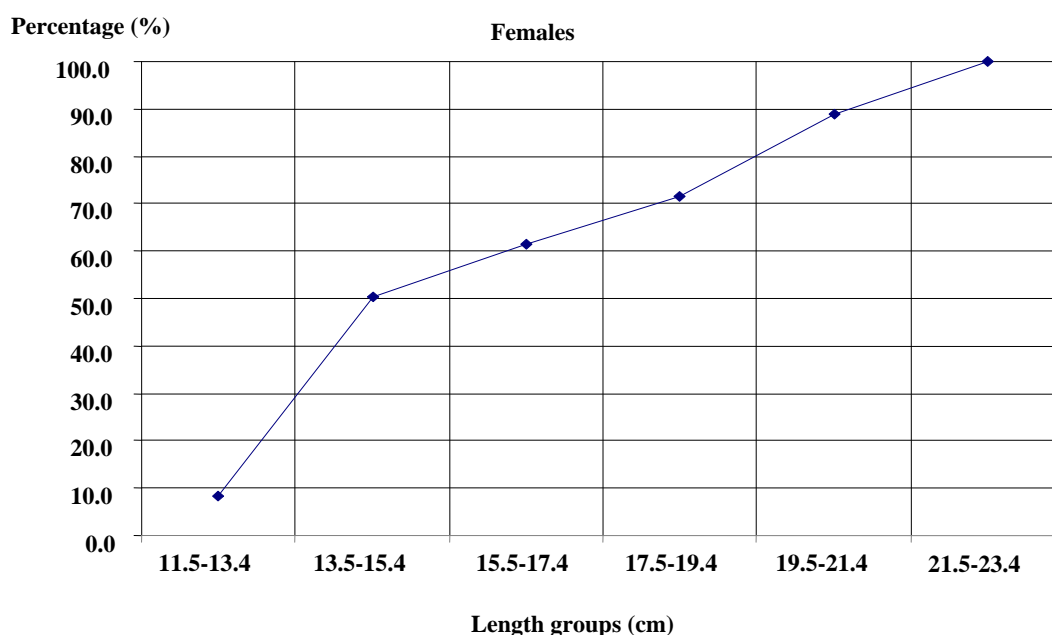


Fig. 7 Length at first maturity of females *L. mormyrus* from Al-Haneah coast.

Absolute fecundity increased with increasing fish length from  $754 \pm 73.8$  egg per fish at the average total fish length of 12.4 cm to  $10,987 \pm 214.1$  egg per fish at the average total length of 22.1 cm.

The same trend was observed for the relative fecundity. It ranged from a minimum of 60 egg per centimeter at the average total length of 12.4 cm to 497 egg per centimeter at the average total length of 22.1 cm.

#### 4. Discussion

In the present study lengths of *L. mormyrus* studied ranged between 11.5 cm and 23.4 cm, corresponding to the weights 24.5 gm and 160.8 gm. Previous studies pointed that *L. mormyrus* can grow to a maximum length of about 55 cm, with a weight of around 1 kg, but the common size is 20-30 cm [12, 13], it grows relatively fast during the first few years of life attaining approximately 50% of its maximum length during the second year [13-20].

In the present study the condition factors  $K_F$  and  $K_C$  increased with increasing fish length from 1.38 and 1.21 in order at the class range 11.5-13.4 cm to 1.59

and 1.41 at the class range 21.5-23.4 cm. The larger the fish is the larger the condition factor. Matić-Skoko [21] studied growth of juvenile *L. mormyrus* from the DućeGlava, eastern Adriatic Sea. The obtained condition factor of 1.245 is close to the range of condition factors observed in the present study. Monthly variation of  $K_F$  and  $K_C$  was also determined in the present study.  $K_F$  and  $K_C$  recorded high values during May, June, July and August suggesting that summer is the breeding season of *L. mormyrus*. Same conclusion was also deduced from changes in monthly Gonado-Somatic Indices (GSI) of males and females. The highest GSI were recorded in May, June, July and August. A sharp decrease occurred in September. Low values were maintained during October to February. This was also supported by the observation that gravid females were encountered during summer. Previous studies agree that the reproductive season of *L. mormyrus* is summer [20, 22-25] or spring and summer [26-30].

During all the study period the ratio of Males: Females was in favor to females. The overall ratio was 1: 1.52. Kraljević *et al.* reported the ratio for the



western Istrian coastal waters as 1: 1.62. Ramos and Lorenzo *et al.* [20, 25], off the Canary islands reported 1: 0.85 and EMRE *et al.* [31], in the Beymelek Lagoon (Antalya, Turkey) reported 1: 1.84. *L. mormyrus* is protandric hermaphrodite [20, 25, 31, 32]. It starts its adult life as a male and later changes its sex to female at a length of about 21 to 30 cm (4-9 years) according to Bizsel *et al.* [13], or 25 cm to 35 cm according to the Malawi home page and Wikipedia, internet.

In the present study the oocyte diameter increased gradually through the months March, April, May, June, July and August where it reached the maximum value of  $1,511 \pm 143.3 \mu$ . The oocyte diameter then dropped to the lowest value of  $379 \pm 25.3 \mu$  in October. During the period November, December and January the oocytes were either not present or too small to be measured. This indicated that the reproductive season of *L. mormyrus* was summer. Firat *et al.* [33], found that the average diameter of mature *L. mormyrus* egg was  $0.71 \pm 0.1286$  mm. They also mentioned that generally, striped sea bream eggs have a diameter of 0.55-1.02 mm. In the present study the average oocyte diameter of *L. mormyrus* was  $895 \pm 111.3 \mu$ .

In the present study in the class length 11.5-13.4 cm, 11.2% and 8.2% of male and female *L. mormyrus* in order were mature. Length at first maturity,  $L_{50}$ , is the length at which half the population is mature and the other half is not. In the present study  $L_{50}$  for *L. mormyrus* was found to be 14.15 cm for males and 14.45 cm for females. Sexual maturity for this species was reported by Suau, UNESCO, Kraljević *et al.* [28, 34], and Wikipedia, internet, to occur at a minimum length of 14.1 cm for males at age two. FAO [27], reported that this species matures at lengths of 13.3 cm. Lorenzo *et al.* [20] and Kallianiotis *et al.* [35], reported that the lengths at 50% maturity for males and females were 16.2-20.7 cm and 19.0-24.6 cm consecutively. According to Monteiro *et al.* [36], (Algarve, south Portugal), the length at first maturity was similar for males and females and the value for both sexes combined was 16.08 cm corresponding to an age

between 1 and 2 years.

In the present study the overall average absolute fecundity and relative fecundity were  $4,342 \pm 557$  egg per fish and  $234 \pm 181$  egg per cm in order. Both absolute fecundity and relative fecundity increased with increasing fish length. We did not find any previous studies on fecundity of *L. mormyrus*.

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