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Biological Aspects of the Thicklip Grey Mullet (*Chelon labrosus*) in Bardawil Lagoon, Egypt

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ABSTRACT

Despite its ecological and economic importance, information on the reproductive biology of the thicklip grey mullet *C. labrosus* in Bardawil Lagoon, North Sinai, Egypt remains limited. This study investigated key biological aspects of the species, including its length-weight relationship, condition factors, and reproductive biology, with emphasis on spawning season and length at first sexual maturity. A total of 472 individuals were monthly collected from various landing sites around Bardawil Lagoon, during the fishing season from May to December 2023. The length–weight relationships for *C. labrosus* showed isometric growth patterns for males, females, and both sexes combined. The monthly condition factor (K) values fluctuated over the course of the study period. The reproductive period, as indicated by the gonado-somatic index (GSI), was determined to occur during November and December. The overall sex ratio of males to females (M: F) was 1:1.4, indicating a predominance of females in the population. The length at first sexual maturity (L_m) was estimated to be 25.3cm for both males and females. Absolute fecundity showed an increase with total length and was modeled by the power function $F_{abs} = 0.0264\ W^{2.20}$. Meanwhile, relative fecundity steadily rose, ranging from 356 to 1,420 eggs per centimeter and from 30.1 to 75.5 eggs per gram. To protect *C. labrosus* population in Bardawil Lagoon, it is recommended to prohibit the use of fishing gear with illegal mesh sizes and other destructive methods. Increasing the mesh size to selectively target fish larger than 25.3cm would help ensure that individuals have the opportunity to reproduce before being caught.

INTRODUCTION

The thicklip grey mullet (*C. labrosus*) is a coastal species belonging to the Mugilidae family. It generally reaches a length of around 32cm (13 inches), although individuals have been recorded at up to 75cm (30 inches) in length (**Froese & Pauly, 2007**). It is a euryhaline fish species frequently found in coastal lagoons, intertidal marshes, and earthen ponds along the northeastern Atlantic and Mediterranean shores. Together with other mullet species, it plays a locally significant role in traditional, lowintensity aquaculture within these ecosystems (**Yúfera & Arias, 2010**). This species reproduces during winter, and its eggs and larvae develop in the open water as part of the planktonic community (**Drake *et al*., 1984**).

It is considered a marine-estuarine opportunist species, as it primarily enters estuaries during its juvenile stage, using them as alternative habitats to other coastal areas (**Baptista *et al*., 2010**). This species is omnivorous, feeding primarily on benthic diatoms, epiphytic algae, small invertebrates, and detritus (**Zouiten *et al*., 2008**). Moreover, *C. labrosus* often supports artisanal fisheries (**Cardona *et al*., 2008**). As a consumer of low trophic level species, it can be cultured in an economically efficient way, particularly in extensive aquaculture systems (**Khemis *et al*., 2006**).

The relationship between length and weight is fundamental in fisheries science and management. It is commonly used to estimate the weight of a fish based on its length and to compare growth patterns across different regions (**Tsoumani *et al*., 2006**). The length–weight relationship is also useful for determining whether growth is isometric or allometric (**Ricker, 1975**). The condition factor provides valuable information in case of comparing populations from different regions, climates, and environmental conditions (**Weatherly & Gill, 1987**). Therefore, the condition factor of fish species is essential for understanding their life cycle.

Information of a species' reproductive biology is essential for managing populations and understanding potential stock changes (**Qasim & Al-Zaidy, 2024**). In recent years, there has been a growing interest in fundamental biological studies, particularly in reproductive biology. This increased attention is largely due to the decline in natural populations of many species and the rising reliance on aquaculture to offset these reductions (**Lone *et al*., 2008a**).

Research on mullet species—particularly *Chelon labrosus*—in Egypt, especially in Bardawil Lagoon, continues to be scarce despite their ecological and economic importance. This study aims mainly to investigate the reproductive biology of the thick-lipped grey mullet (*C. labrosus*) in Bardawil Lagoon, with the goal of supporting effective fisheries management strategies. However, there remains a clear gap in knowledge regarding the reproductive cycle, spawning season, and maturity stages of this species in the lagoon's unique hypersaline environment. Understanding these aspects is essential for establishing sustainable exploitation measures. Therefore, this study addresses this gap by hypothesizing that the reproductive pattern of the species differ from those in other Mediterranean habitats owing to the lagoon's distinct environmental conditions.

MATERIALS AND METHODS

This study was conducted in Bardawil Lagoon (Fig. 1), which is separated from the Mediterranean Sea by a sandy barrier featuring two narrow inlets. The lagoon is considered a natural depression with a depth ranging between 1 and 3 meters (**El-Aiatt & Shalloof, 2019**).

Fig. 1. Bardawil Lagoon

The thick-lipped grey mullet (*C. labrosus*) was randomly selected every month from a variety of landing sites in the area of Bardawil Lagoon in North Sinai. During all of the fishing season, which extended from May to December 2023, sampling was conducted. Owing to the limited availability of this species, specimens were collected from the landing sites where the fish appeared, namely Telloul or Aghzwan. In certain months, samples were obtained from both landing sites concurrently.

The potential equation, $W = a\,L^b$ (**Ricker, 1975**), which describes the relationship between length and weight, has two constants: a and b. W is the total weight (g), and L is the total length (cm). Using the formula $t_s = (b-3)/S_b$, the t-test was used to test the null hypothesis of the isometric growth (H_0: b= 3). For assessing significant differences between slopes (b) between two regressions for the same species, t_s stands for the student's t-test, b for the slope, and S_b for the standard error of the slope with $\alpha = 0.05$ (**Sokal & Rohlf, 1987; Morey *et al*., 2003; Zar, 2010**).

$K = (W * 100) / L^3$ (**Hile, 1936**) was the formula used to compute the condition factor on a monthly basis. L is the length in centimeters, while W is the weight in grams.

The overall sex ratio was calculated as the number of males: number of females (**Vazzoler, 1996**). A chi-square test (**Sokal & Rohlf, 1987**) was performed using XLSTAT 2021 software to determine if significant differences existed between observed sex ratios and the expected 1:1 ratio, and it was calculated using the following equation, $X^2 = \Sigma$ (O-E) 2)/E, where O is the observed value and E is the expected value. The result is then compared with the tabulated chi-squared value for one degree of freedom and a probability of 0.05.

Once the gonads were removed, the specimens were sexed both visually and under a microscope for the younger ones. The detached gonads (Fig. 2) were weighed to the nearest 0.01g. Using **Albertine-Berhaut**'s **(1973)** equation, the gonado somatic indices (GSI) were monthly computed to determine the spawning season. GSI is equal to Gonad Weight / 100 * Body Weight.

Fig. 2. Female *C. labrosus* gonads from Bardawil Lagoon in 2023

Plotting the total body length against the frequency percentage of mature individuals during the spawning season made it possible for the determination of the length at first maturity. The length at 50% was then regarded as the length at first maturity (**Sendecor, 1956**).

Absolute fecundity refers to the total count of mature eggs present in the ovaries during the spawning period. To estimate fish fecundity, 17 mature ovaries were collected, then washed, dried, and weighed.

Total fecundity was determined using the formula: F_{abs} = (gonad weight × number of eggs in the subsample) / subsample weight (**Yeldan & Afsar, 2000**). Relative fecundity (F_{rel}) was then calculated by dividing the absolute fecundity by either the body length or body weight of the fish: $F_{rel} = F_{abs}$ / (body length or body weight).

RESULTS

Length - weight relationship

A total of 472 thick-lipped grey mullet (*C. labrosus*) specimens were collected from Bardwil Lagoon between May and December 2023. Their total lengths ranged from 14.3 to 43.1cm, with weights varying between 40.0 and 770g. The length-weight relationship was modeled using a power equation:

- For males: $W=0.0096\ L^{3.05}$ (R^2 = 0.9576)
- For females : $W=0.0113\ L^{3.00}$ (R^2 = 0.9416)
- For combined sexes: $W=0.0105\ L^{3.\ 02}$ (R^2 = 0.9508) (Figs. 3, 4, and 5).

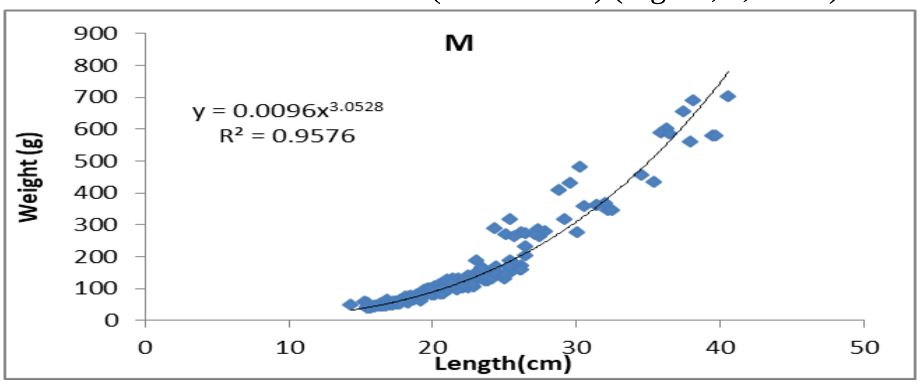

Fig. 3. Length–weight relationship of male *C. labrosus* from Bardawil Lagoon

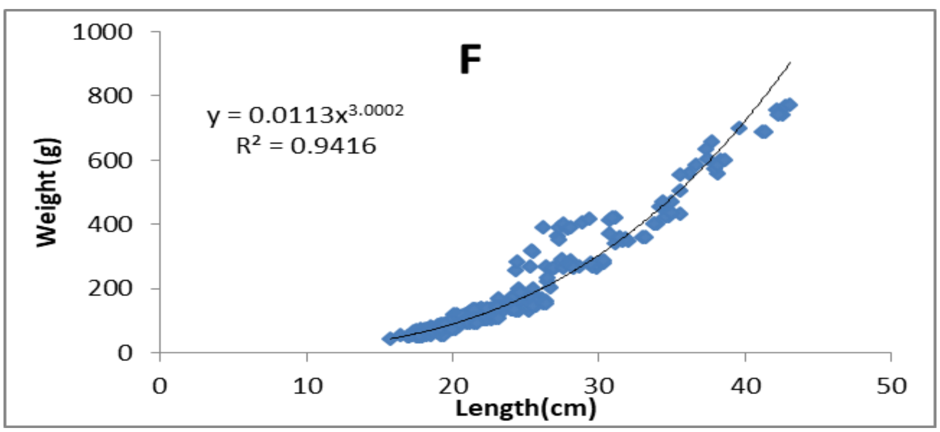

Fig. 4. Length–weight relationship of female *C. labrosus* from Bardawil Lagoon

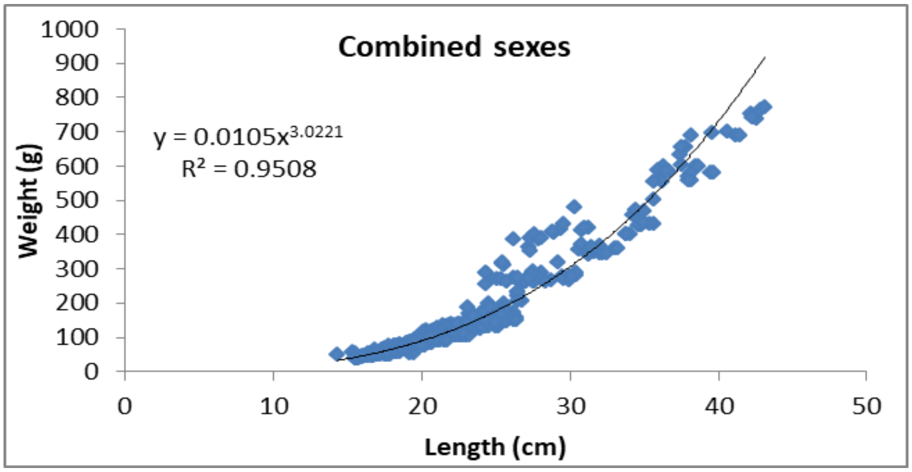

Fig. 5. Length–weight relationship of combined sexes *C. labrosus* from Bardawil Lagoon

The monthly length-weight relationship for males, females, and combined sexes was estimated using the power equation (Table 1).

The length–weight relationship in males was isometric during May, June, July, September, and November, and positively allometric in August and December. In females, it was isometric in June, September, November, and December, and positively allometric in May, July, and August. For both sexes combined, the relationship was isometric in October, November, and December, and positively allometric from May to September.

Table 1. Different parameters of length-weight relationships of *C. labrosus* in Bardawil Lagoon during the period of study

Month	FN	L(cm)	W(g)	a	B	S_b	R^2	GT
				Males				
May	25	18.1	69.1	0.0113	2.9898	-0.12	0.93	I
June	24	18.9	77.8	0.0118	2.9750	-0.19	0.96	I
July	21	19.4	88.1	0.0201	2.8075	-0.87	0.89	I
August	21	19.9	94.5	0.0078	3.1242	0.95	0.96	+ A
September	27	19.5	86.2	0.0125	2.9574	-0.26	0.93	I
October	25	22.7	156.7	0.0050	3.2763	1.28	0.91	+ A
November	29	26.3	250.6	0.0147	2.9223	-0.47	0.92	I
December	24	29	315.1	0.0085	3.0885	0.49	0.93	+ A
total	196	21.9	145.4	0.0096	3.0528	1.14	0.96	+ A
				Females				
May	29	23.1	170.5	0.0090	3.0702	0.51	0.95	+ A
June	36	23.3	174.3	0.0120	2.9872	-0.08	0.92	I
July	30	23.5	180.7	0.0080	3.1190	0.68	0.92	+ A

August	36	24.6	200.1	0.0056	3.2154	1.24	0.91	+ A
September	37	23.1	163	0.0089	3.0919	0.6	0.92	+ A
October	38	25.2	211.3	0.0155	2.9019	0.94	0.96	I
November	34	24.1	182.4	0.0156	2.8910	0.98	0.95	I
December	36	26.7	264.7	0.0114	2.9830	-0.25	0.98	I
total	276	24.2	194.3	0.0113	3.0002	0.004	0.94	I
Combined sexes								
May	54	20.822	123.546	0.0092	3.0639	0.73	0.96	+ A
June	60	21.548	135.705	0.0099	3.0435	0.44	0.94	+ A
July	51	21.769	142.553	0.0098	3.0520	0.42	0.93	+ A
August	57	22.881	161.205	0.0072	3.0140	1.25	0.93	+ A
September	64	21.569	130.559	0.0078	3.1278	1.25	0.94	+ A
October	63	24.165	189.614	0.0116	2.9968	-0.03	0.94	I
November	63	25.124	213.784	0.0144	2.9216	-0.82	0.94	I
December	60	27.64	284.853	0.0100	3.0287	0.001	0.97	I
total	472	23.2	174	0.0105	3.0221	0.69	0.95	+ A

FN: Fish number; W = Weight (g); L = Average Length (cm); a and b are constants; S_b: Standard error of the slope (b) with 95% confidence Interval (*t-test*), R^2: Coefficient of determination and GT: The growth type (I: Isometry, (+) A: Positive allometry).

Condition factor

The monthly mean condition factor for females, males, and combined sexes showed that females and the combined sexes had similar values throughout the study period. Males exhibited similar condition factors to females and the combined sexes only during October, November, and December. However, from May to September, males had lower condition factors compared to females and the combined sexes. The highest condition factors were recorded in July for the combined sexes (1.382) and in December for females (1.384), while males reached their peak in November (1.371) (Figs. 6, 7, and 8). A decline in condition factor (K) was noted in males during May (1.160), in females during November (1.305), and in the combined sexes during September (1.301). The average condition factors for males, females, and combined sexes over the study period were 1.24, 1.35, and 1.35, respectively.

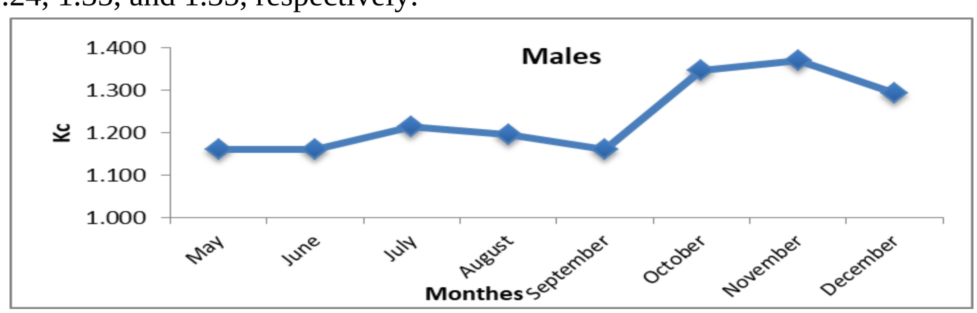

Fig. 6. Monthly values of condition coefficient for males of *C. labrosus* during 2023

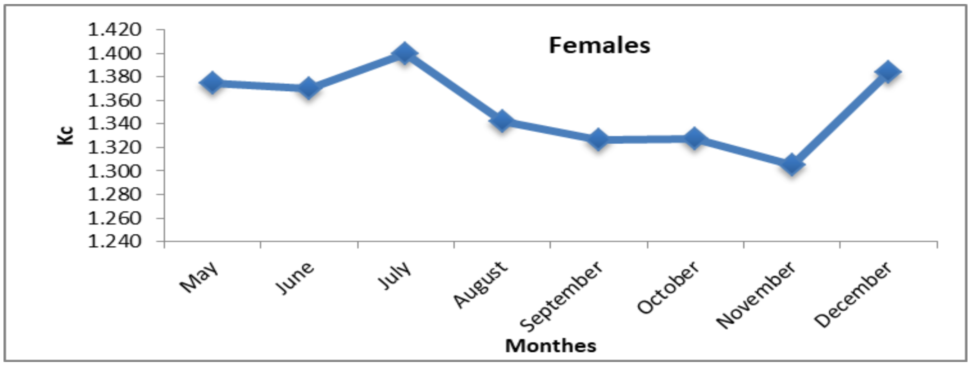

Fig. 7. Monthly values of condition factor for females of *C. labrosus* during 2023

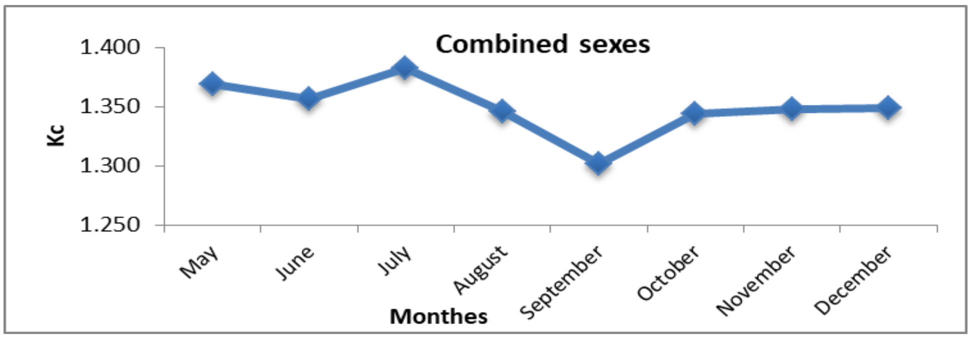

Fig. 8. Monthly values of condition factor for combined sexes of *C. labrosus* during 2023

Sex ratio

In the entire sample of *C. labrosus*, the sex ratio was 1:1.4 (one male to 1.4 females), or equivalently 1:0.71 (one female to 0.71 males), with 196 males and 276 females recorded. Table (2) indicates that the distribution of sexes varied across different months (Fig. 9). Females were dominant in all months (Fig. 9), comprising over 58% of the total sample collected during the 2023 fishing season.

The chi-squared test results showed that for the months of May, June, July, September, October, November, and December, the calculated chi-squared values were smaller than the tabulated value of 3.841 at the 0.05 significance level. This indicates that the differences between the numbers of males and females during these months (Table 2) were not statistically significant, suggesting that the observed variations may be due to random chance or natural variability. In contrast, during August, the calculated chi-squared value exceeded the tabulated value (3.841), indicating a statistically significant difference between the observed distribution (21 males and 36 females) and the expected 1:1 ratio. Therefore, the difference in the number of males and females in August is unlikely to be due to chance alone.

Table 2. Monthly variations in sex ratio of *C. labrosus* in Bardawil lagoon during 2023

Month	Total no.	Males	%	Females	%	Chi-square	M:F
May	54	25	46.3	29	53.7	0.296	1 : 1.2
June	60	24	40.0	36	60.0	2.400	1 : 1.5
July	51	21	41.2	30	58.8	1.588	1 : 1.4
August	57	21	36.8	36	63.2	3.947	1 : 1.7
September	64	27	42.2	37	57.8	1.563	1 : 1.4
October	63	25	39.7	38	60.3	2.680	1 : 1.5
November	63	29	46.0	34	54.0	0.397	1 : 1.2
December	60	24	40.0	36	60.0	2.400	1 : 1.5
Total	472	196	41.5	276	58.5		1 : 1.4

n = 472 and significance level used ($P < 0.05$).

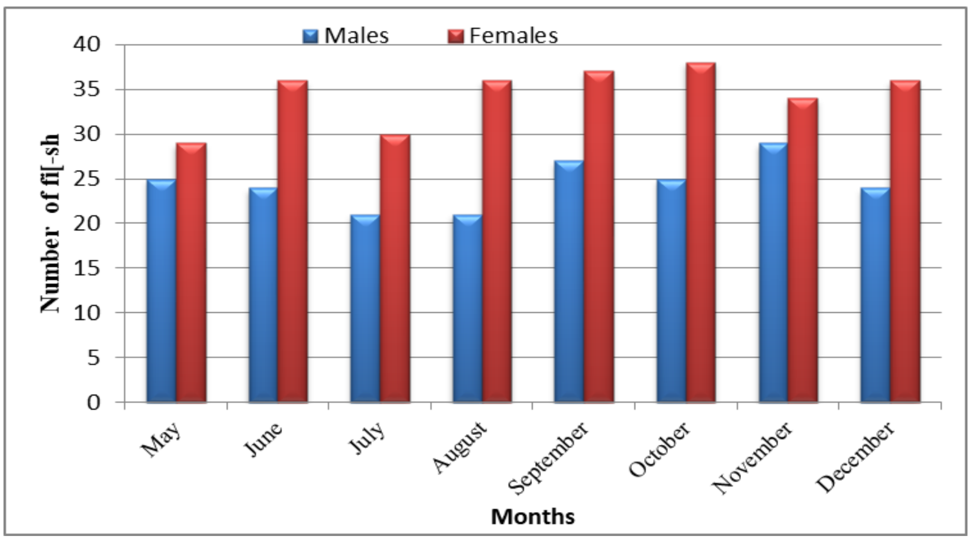

Fig. 9. Monthly sex ratio of *C. labrosus* in Bardawil Lagoon during the study period

Length at first maturity (L_m)

The length at first maturity (L_m) for both male and female *C. labrosus* was determined to be 25.3cm (Figs. 10, 11).

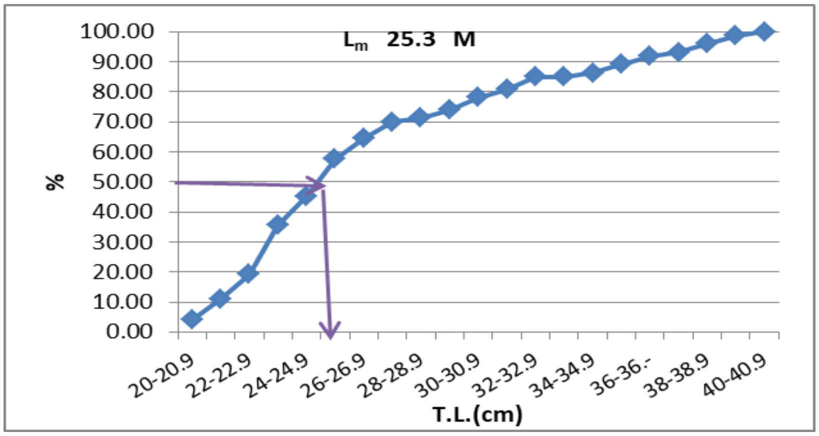

Fig. 10. Length at first maturity (L_m) of males of *C. labrosus* from Bardawil Lagoon during 2023

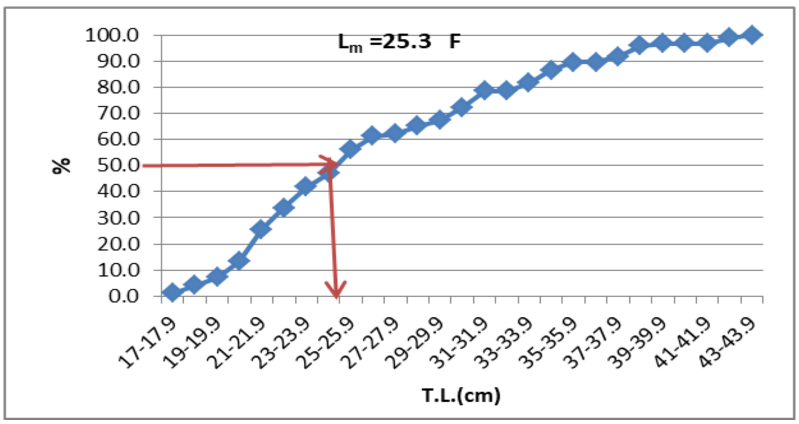

Fig. 11. Length at first maturity (L_m) of females of *C. labrosus* from Bardawil Lagoon during 2023

Gonado- somatic index (GSI)

The monthly variations in the gonado-somatic index (GSI) for male and female *C. labrosus* are shown in Fig. (12). GSI values for males were consistently lower than those for females. The lowest male GSI (0.139) was observed in June, followed by a gradual increase from September through November, reaching a peak of 5.133 in December. Females exhibited a similar trend, with the lowest GSI (0.091) in May and the highest value (7.168) in December. These patterns indicate that *C. labrosus* in Bardawil Lagoon spawns during the winter season.

Table (2) and Fig. (12) present the changes in the average GSI for males and females throughout the year. For males, monthly GSI values ranged from 0.139 in June to 5.133 in December, while for females, values varied from 0.091 in May to 7.168 in December (Table 2). Fig. (12) depicts the annual cycle of gonadal volume for both sexes.

Overall, GSI values peaked between October and December and were the lowest from May to July.

Table 2. Monthly values for gonado - somatic index (GSI) for male (M) and female (F) *C. labrosus* from Bardawil Lagoon during fishing season 2023

Month	GSI (M) (±SD)	GSI (F) (±SD)
May	0.145(±0.0500)	0.091(±0.0576)
June	0.139(±0.0844)	0.167(±0.1384)
July	0.232(±0.4046)	0.375(±0.2505)
August	1.185(±0.8298)	1.034(±0.9110)
September	1.874(±1.6008)	1.813(±1.3831)
October	2.124(±1.2617)	3.197(±2.3299)
November	3.747(±2.6899)	5.960(±2.8334)
December	5.133(±2.1279)	7.168(±5.0157)

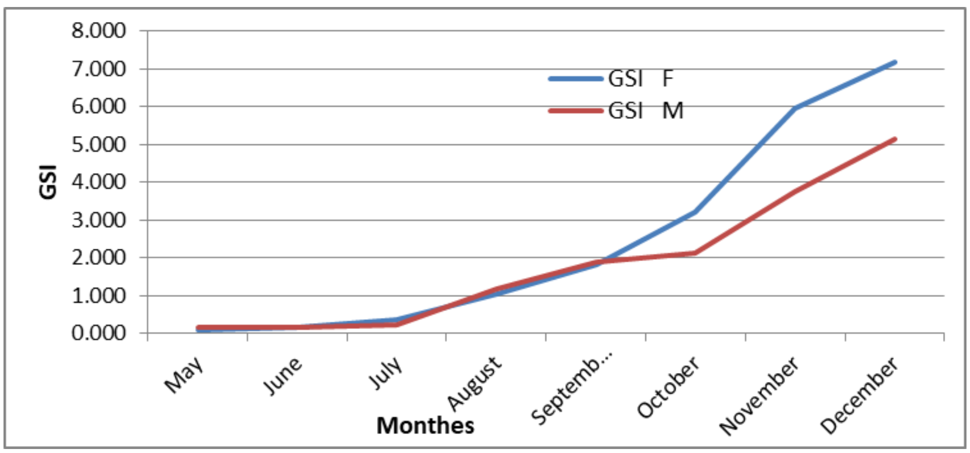

Fig. 12. Changes in gonado somatic index (GSI) of *C. labrosus* in Bardawil Lagoon during 2023

Fecundity

The fecundity of 17 mature female *C. labrosus*, with total lengths ranging from 31 to 43.1cm, was assessed. The number of eggs per gram of gonadal tissue varied between 376 and 1,000, depending on the size of the fish, resulting in absolute fecundity values ranging from 13,600 to 61,200 eggs per individual. Fecundity was estimated using 17 fully mature females collected in December. Since a total of 36 females were obtained during that month, the selected individuals represented a substantial proportion of the available sample.

The average relative fecundity for these females was 52 eggs per gram of total body weight. The relationship between total weight and absolute fecundity (Fig. 13) was best described by the power function: $F = 0.0264\, W^{2.1985}$ (R^2=0.933).

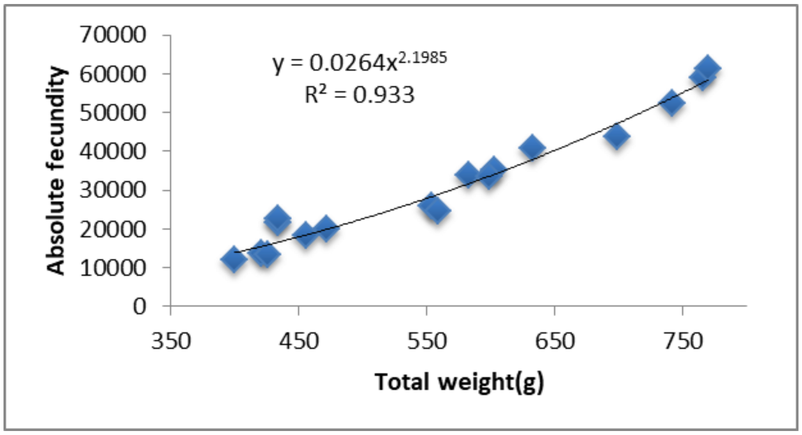

Fig. 13. The relationship between total weight and absolute fecundity for female *C. labrosus* in Bardawil Lagoon during fishing season 2023

DISCUSSION

The *C. labrosus* specimens examined in this study showed considerable variation in size, with weights ranging from 40.0 to 770.0g and total lengths from 14.3 to 43.1cm. The length and weight of *C. labrosus* samples in the Um-Hufayan Lagoon, Libya, varied from 11.1 to 25.9cm and 25.594 to 166.647g, respectively (**El-Mor *et al*., 2020**). The length-weight relationship is a fundamental biological characteristic of fish, showing how weight increases in proportion to length. In this study, the estimated length-weight equations for males, females, and combined sexes were:

- Males: $W=0.0096\ L^{3.05}$ ($R^2 = 0.9576$)
- Females: $W=0.0113\ L^{3.00}$ ($R^2 = 0.9416$)
- Combined sexes: $W=0.0105\ L^{3.02}$ ($R^2 = 0.9508$)

The analysis of *C. labrosus* from Bardawil Lagoon in 2023 revealed that the 'b' value was close to 3 for males, females, and combined sexes, suggesting an isometric length–weight relationship. The variations in 'b' values shown in Table (3) may be due to differences in sample size, collection season, and sampling methods. Additionally, differences in the exponent 'b' observed in fish from various locations can be linked to environmental conditions and geographic factors (**Andreu-Soler *et al*., 2006**).

Our findings indicate that these parameters are affected by various factors, including seasonal variations, habitat conditions, reproductive maturity, sex, feeding behavior, stomach content, general health, and preservation techniques (**Hossain *et al*., 2006**).

Table 3. Variation of 'b' values in LWR of *C.labrosus* from different locations

Location	b- value	Reference
Greece	3.04	**Koutrakis and Sinis (1994)**
Aegean sea	2.931	**Buhan (1998)**
Aegean sea	3.084	**Egemen *et al.*, (1999)**
Óbidos Lagoon, Portugal	3.048	**Moura and Gordo (2000)**
Greece	2.993	**Koutrakis and Tsikliras (2003)**
Agean sea	3.061	**Acarlı *et al.*, (2014)**
Agean sea	3.09	**Kara *et al.*, (2017)**
North West Wales	3.32	**Tulkani (2017)**
Köyceğiz Lagoon in Turkey	3.06	**Reis and Ate (2019)**
Bardawil Lagoon (Egypt)	3.022	Present study

The 'b' values in the length-weight relationship (LWR) indicate the type of growth in a fish species. When b= 3, growth is isometric, meaning the fish becomes proportionally more robust as length increases (**Bagenal & Tesch, 1978**). If b ≠ 3, growth is allometric, and the fish becomes either thinner or more elongated with increasing length (**King, 1996**). The results of this study show that *C. labrosus* exhibited isometric growth for males, females, and combined sexes. Additionally, the monthly length-weight relationship was predominantly isometric across all groups. Comparisons with previous studies reveal both similarities and differences in length-weight parameters, as summarized in Table (3). **Nikolsky (1963)** demonstrated that environmental conditions can have either positive or negative effects on fish growth, which may explain why the same fish species exhibits different growth patterns in varying habitats.

The average condition factors during the study period were 1.24 for males, 1.35 for females, and 1.35 for the combined sexes. **Reis and Ate (2019)** reported a condition factor of 1.3 for *C. labrosus*, which is similar to the results of our study. In the present research, condition factor values closely match those reported by other researchers, although differences may exist in other regions. These variations could be attributed to factors such as environmental nutrient availability, population density, sample size, sampling period, and age (**Yılmaz & Polat, 2011**).

The estimated length at first maturity (L_{50}) for both male and female *C. labrosus* in this study was 25.3cm, considerably lower than the L_{50} values reported by **Turnbull (2022)**, namely 43.9 and 43.1cm for females and males, respectively. However, **Froese and Pauly (2019)** reported a length at first maturity of 29.5cm for *C. labrosus*. A study conducted by researchers at the University of Plymouth (**Turnbull, 2022**) analyzed organic matter in 144 *C. labrosus* specimens collected from the IFCA South Zone. Gonadal assessments were carried out to determine reproductive maturity, and the length at which 50% of the population reaches maturity (L_{50}) was estimated using standard statistical methods, specifically logistic regression. This study is particularly valuable for the IFCA's understanding of mullet maturity because of its appropriate methodology, timing, and sampling locations. **Turnbull (2022)** reported L_{50} values of 43.9cm for females and 43.1cm for males, which align well with findings from other research conducted in England and beyond **(Kennedy & Fitzmaurice, 1969**, **Hickling, 1970**) indicating that these estimates are likely reliable.

Some studies, particularly those conducted in the Mediterranean, have reported lower L_{50} values, especially for thin-lipped grey mullet and golden mullet (**Hotos, 1999**). This difference is likely attributed to faster maturation rates in warm-water environments compared to those in the UK. In contrast, **Hickling (1970)**, based on a sample of 1,377 thick-lipped grey mullet in England, reported an L_{50} of 47cm for females. **Harrison (2003)** stated that, females grow faster than males. The thick-lipped grey mullet reached sexual maturity in the Mediterranean at 35.5 cm, and its maximum recorded length was 60.0cm (**Ben-Tuvia, 1986**).

In their review of the reproductive biology of the Mugilidae family, **Gonzalez-Castro and Minos (2016)** highlighted that the gonado- somatic index (GSI) is a reliable measure of gonadal physiological status, and its monthly fluctuations can effectively identify the species' spawning period. They also pointed out that data from fish caught in shallow lakes, estuaries, or nearshore shoals—areas linked to marine aggregations—serve as good indicators of the actual timing of spawning and correspond with peak GSI values during the spawning season.

Our results indicate that the spawning season of *C. labrosus* occurs in December. This finding aligns with previous studies, including **Heldt (1948)** in Tunisia (Western Mediterranean), who reported spawning during December, January, and February; **Dieuzeide *et al*. (1955)** in Algeria referring to December, January, February, and March; **Ermen (1961)** in Turkey (Eastern Mediterranean) mentioning December, January, February, and March; **Karvounaris (1963**) in Italy relating spawning to December, January, and February; and **Brusle and Brusle (1977**) in Tunisia noting December and January.

The spawning season of *C. labrosus* was somewhat delayed in Croatia (Western Mediterranean), occurring during January, February, and March (**Morovic, 1963**); in Brittany (Atlantic) during February, March, and April (**Thong, 1969**); and in Southwest England (Atlantic) during January, February, March, and April (**Hickling, 1970**). However, the spawning season was earlier than in our study in Northwest Wales, where it took place during October, November, and December (**Tulkani, 2017**). The duration of the spawning season varies between 2 to 6 months among populations of thick-lipped grey mullet (**Ibáñez & Colín, 2014**). Variability in gonad size dimorphism reported in different studies may be attributed to the timing and location of fish capture relative to their spawning grounds (**González-Castro & Minos, 2016**). Additionally, these variations could be attributed to climate changes across different regions.

Regarding fecundity, the findings revealed that it was estimated to average 31,270 eggs per female, ranging from 12,047 eggs in a mature female measuring 33.8cm in total length and weighing 400g to 61,200 eggs in the largest female at 43.1cm and 770g. Fecundity was found to be predictable based on body weight. However, the fecundity estimates in this study are lower than those reported in other regions: **Ezzat (1965)** reported 176,463 eggs in the Berre Lagoon; **Thong (1969)** found 528,320 eggs in France; **Hickling (1970**) recorded 499,308 eggs in England and Wales; and **Tulkani (2017)** reported an average fecundity of 1,547,751 eggs in Northwest Wales. It is worthnoting that these studies often had smaller sample sizes and size ranges, which could explain some of the differences observed. These variations may be caused by variations in egg diameters. Additionally, population-specific variations in fecundity may exist, potentially influenced by environmental factors such as temperature and productivity (**Ibáñez & Colín, 2014**). A further explanation for these discrepancies can be regional climate change.

CONCLUSION

To protect the thicklip grey mullet (*C. labrosus*) in Bardawil Lagoon, it is recommended to prohibit the use of illegal mesh sizes and other destructive fishing practices. This will allow females to mature, reproduce, and replenish the population. Moreover, increasing the mesh size to target fish exceeding the length at first maturity (25.3 cm) would allow individuals to reproduce before capture, since **El-Aiatt *et al.* (2025)** reported a smaller length at first capture (21.9 cm) in the same area and period.

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