



Reproductive biology of the Golden grey mullet *Liza aurata* (Risso, 1810) in Bardawil Lagoon, Egypt

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ABSTRACT

This study deals with information about the reproductive biology of the golden grey mullet, *Liza aurata* from Bardawil Lagoon, North Sinai, Egypt. Monthly random samples of *Liza aurata* were collected from the commercial catch in different landing sites of the Bardawil Lagoon during one fishing season from May 2017 to February 2018. Sex ratio, length at first maturity (Lm), and gonado-somatic index (GSI) were addressed.

During the whole period of the current study, the sex ratio showed that the females (F) outnumbered the males (M) (1M: 1.5F). The GSI was found to be greatest from November to January and reached its highest value in December, considering that *Liza aurata* is a winter spawner. The Lm was determined as 20.0 cm for females and males. The length at first capture (Lc) was estimated to be 19.5 cm. It is essential to maximize length at first capture larger than a length at first sexual maturity (> 20.0 cm). This can be achieved by widening the mesh size used to catch *Liza aurata* to permit the fish to breed, recruit and maintain the stock of this fish.

INTRODUCTION

In spite of the fact that the fish of the mullet family in the Bardawil Lagoon contributes to a great extent in the Egyptian economy due to its high quality, there is not enough studies about its dynamics and management. Moreover, it is worthy to mention that, the grey mullets are one of most highly important species inhabiting the Bardawil Lagoon (Mehanna, 2006).

Mulletts (family: Mugilidae) are the highly important fish resources in Bardawil Lagoon as they contribute to about 24.69% of the total fish production of the Bardawil Lagoon (GAFRD 2019). In the afore- mentioned lagoon, three species can be identified that form the main commercial catch of mullets; namely, *Mugil cephalus*, *Liza ramada* and *L. aurata*. They are caught by veranda or bouss fishing gear in the lagoon. For the

high economic value of mullets, their biology in different Egyptian water bodies has been subject to extensive studies (**Rafail, 1968; El-Sedafy, 1971; El-Maghraby *et al.*, 1973; Fayek, 1973; Hashem *et al.*, 1973; Hashem *et al.*, 1977; Salem & Mohammed, 1982; Hosny & Hashem, 1995**).

On the other hand, there are no adequate studies to assess population dynamics and management of *Liza aurata* in the Bardawil Lagoon (**El-Gammal & Mehanna, 2004; Mehanna, 2004; Mehanna & Amin, 2005**).

The golden grey mullet, *Liza aurata*, is a mugilidae species in which adults are neritic usually in schools; entering lagoons and lower estuaries (**Thomson *et al.*, 1990**). The golden grey mullet is widely distributed along the Atlantic Coast from Morocco to the bay of Biscay (**Trewavas, (1973)**) and along both the European and the African Coasts, as well as in the Mediterranean and Black Seas where it plays a crucial economic role in supporting artisanal fisheries (**Mc Dowall, 1988; Blaber, 1997**).

In the central and eastern Mediterranean, several studies on its biology and fisheries have dealt mainly with ecology (**Katavic, 1980; Fazli *et al.*, 2008**), age and growth (**Arruda *et al.*, 1991; Koutrakis & Sinis, 1994; Fehri-Bedoui & Gharbi, 2005; Abdallah *et al.*, 2012**), breeding season (**Gondolfi & Orsini, 1968; Hotos *et al.*, 2000; Fehri-Bedoui *et al.*, 2002**), morphological characters (**Minos *et al.*, 1994**) and seasonal occurrence of fry (**Katselis *et al.*, 1994**).

Tereshenko (1950) reported that, males of golden grey mullet precede females in maturity; males mature at the age of 3, while females reach maturity at the age of 4. The spawning peak for mullet in the Caspian Sea occurs in late August (**Avanesov, 1972**). Reproduction is one way through which fish can generally ensure the sustainability of their populations, and hence, various reproductive strategies including migration and fast gonad maturation are commonly used to maximize the breeding opportunities (**Bekova *et al.*, 2019**).

Fish reproductive biology (onset and duration of spawning, sex ratio, maturity stages, length- (Lm) and age (tm) at first maturity, and fecundity) is important in fisheries research, stock assessment, and management. Presumably, it may be useful in research planning, data analysis and presentation (**Tsikliras *et al.*, 2013**).

The population characteristics of fishes, and in particular those concerning their reproduction, are very important inputs in the assessment and management of fish stocks (**Froese, 2006**). This paper was conducted to present reproduction biology of the golden grey mullets, *L. aurata*, in Bardawil Lagoon as a basic step to launch a modern fishery management strategy for this species.

MATERIALS AND METHODS

The Bardawil Lagoon (a shallow and hyper-saline lagoon) lies in the north of Sinai, and in the southern east of the Mediterranean Sea. It is located between 31°03'N and 31°14'N and between 32°40'E and 33°30'E. The Lagoon is shallow with a maximum depth of 6.5 m in its western arm, a minimum depth of 0.3 m, and an average depth of 1.21 m (Zaghloul *et al.* 2018).

A total number of 605 specimens of the golden grey mullets, *L. aurata*, were collected and the following measurements were calculated.

- 1- Sex ratio
- 2- G.S.I. by equation of **Albertine-Berhaut (1973)**;
where $GSI = (\text{Gonad Weight} / \text{Body Weight}) \times 100$.
- 3- The length at first capture "Lc" was determined from the catch curve according to **Pauly (1984a, 1984b)**.
- 4- Length at first maturity. The total body length was plotted against the frequency percentage of mature individuals during the spawning season, and then the length at 50% was considered as the length at first maturity (**Sendecor, 1956**).

RESULTS AND DISCUSSION

1. Sex ratio

The results of the study have revealed that females dominated over males, but males have shown earlier maturity. The sex ratio of golden grey mullets, *L. aurata*, was 1: 1.5 where males were represented by 242 individuals whereas females were 363 individuals. Table (1) shows that the two sexes were not nominally equally distributed during different months. Females predominated during all months since they constituted 60.0 % of the collected samples during the period of the study.

The analysis of the sex proportion showed significant differences between the proportions of males and females according to month and size. Overall, females outnumbered males (1: 1.5), which is a significant departure from the hypothetical ratio of 1:1. This result is in agreement with the findings of **Abdallah *et al.* (2013)** who assessed that the M:F ratio was 1M:1.45F in the Gulf of Gabes. On the other hand, **Fazli *et al.* (2008)** reported that the ratio was 1M:1.42F in the Iranian waters of the Caspian Sea, which was greater than that noted by **Ghadirnejad *et al.* (2010)** who determined a ratio of 1:1.22 in the same study area.

Furthermore, the present result is lower than that of **Ilkyaz *et al.* (2006)** who detected a ratio of 1:1.87 in Homa Lagoon Aegean Sea. The phenomenon of female predominance in the old age group has been reported for mullet species (**Quignard &**

Farrugio, 1981; Ghadirnejad, 1996; Ghaninejad *et al.*, 2010) and for other species as well. This is likely due either to selective fishing in relation to the morphological differences and behavioral procedures among sexes **Wenner (1972)** as ripe females are heavier and consequently more vulnerable, or to a different longevity that may modify.

Table 1. Monthly variation in sex ratio of *Liza aurata* in Bardweil Lagoon during 2017

Month	Total	Females		Males		Females: Males
		No.	%	No.	%	
May	45	26	57.8	19	42.2	1: 1.37
June	47	31	66.0	16	34.0	1: 1.94
July	57	34	59.6	23	40.4	1: 1.49
Aug.	59	34	57.6	25	42.4	1: 1.36
Sep.	69	39	56.5	30	43.5	1: 1.30
Oct.	68	37	54.4	31	45.6	1: 1.19
Nov.	79	49	62.0	30	38.0	1: 1.63
Dec.	72	42	58.3	30	41.7	1:1.40
Jan.	42	24	57.1	18	42.9	1:1.33
Feb.	67	47	70.1	20	29.9	1:2.35
Total	605	363	60.0	242	40.0	1:1.50

2. Gonado Somatic Index (GSI)

Table (2) presents the monthly changes in males and females GSI of *L. aurata*. The GSI values of males were lower than females. The GSI lowest value of males (M) (0.3) was recorded in July, and it started to increase slightly from September, October, and November, whereas the highest value (4.4) was recorded in December. A similar pattern was observed with the values of GSI of females (F). It attained the lowest value (0.5) in July and increased slightly reaching its highest in December (5.7). This indicates that *L. aurata* in Bardawil Lagoon is a winter spawner.

In the present study the GSI values among ripe females are higher than those of males; the values of females appeared to be around 5.7. This result is similar to that recorded in the Tunisian waters in which the GSI values of females appeared to be around 5, while lower values (about 2) were recorded for males (**Fehri- Bedoui *et al.*, 2002; Abdallah, 2005**). The difference between male and female GSI values suggests that energy invested by males for gamete production is probably less than that invested by females; this could be due to physiological and hormone. The reproductive cycles of both males and females are synchronized, the gonad pre-maturation phase is practically inexistent since maturation, which occurs in October, immediately follows the long period of quiescence (January to September), while spawning occurs in November and

December. In the Mediterranean, the breeding period of the golden grey mullet is very brief and occurs almost during the same period at different localities (**Abdallah et al., 2013**).

Table 2. Monthly average of G.S.I of both females & males of *L. aurata* during 2017

Month	Females		Males	
	No. of fish	G. S. I.	No. of fish	G. S. I.
May	26	1.2	19	0.5
June	31	0.6	16	0.6
July	34	0.5	23	0.3
Aug.	34	0.8	25	0.5
Sep.	39	1.9	30	1.1
Oct.	37	3.2	31	2.5
Nov.	49	3.9	30	3.0
Dec.	42	5.7	30	4.4
Jan.	24	5.2	18	3.9
Feb.	47	3.6	20	2.4

In the present study, the spawning season extended from November to January. Table (3) shows the spawning periods of *Liza aurata* in different areas. **Gondolfi and Orsini (1968)** and **Ghittino (1983)** reported that, breeding occurs from September to November in Italy. A study conducted in western Greece by **Hotos et al. (2000)** indicated an earlier and much longer spawning period that extends from August till November. **Cambrony (1983)** who studied *L. aurata* in the Languedoc area found a reproductive cycle that extends from August to October Table (3),.

Table 3. Spawning period of *Liza aurata* from different Mediterranean localities

Authors	Area	Spawning period
Ghondolfi & Orsini, 1968	Laguna de Venezia (Italy)	From September to November
Cambrony, 1983	Languedoc	From August to October
Karapetkova & Zhivkov, 1995	Bulgaria	From June to October
Miller & Loates, 1997	Mediterranean	From July to November
Hotos et al., 2000	West Greece	From August to November
Fehri- Bedoui et al., 2002	Tunisian Coasts	From October to November
Patimar, 2008	Caspian Sea	From May to July
Ghaninejad et al., 2010	Caspian Sea	From September to November
Abdallah et al., 2013	Gulf of Gabes, Tunisia	From October to December
Present study	Bardawil Lagoon, Egypt	From November to January

3.Length at first capture Lc and length at first maturity Lm

In the present study, the length at first capture was 19.5 cm for males and females as shown in Fig. (1). This result is lower than the length at first maturity for males and females 20.0 cm (Fig. 2, 3). It is essential to maximize length at first capture to be larger than that at first sexual maturity (> 20.0 cm). This can be achieved by widening the mesh size used to catch of golden grey mullets, *L. aurata*, to permit the females to breed at least once.

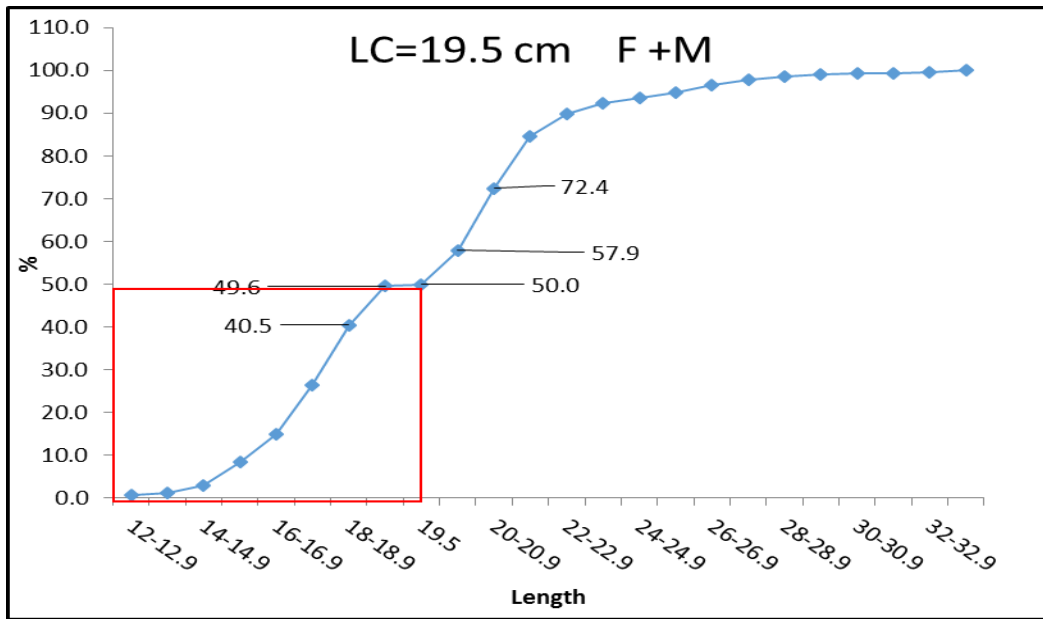


Fig. 1. Length at first capture for combined sexes of *L. aurata* during 2017.

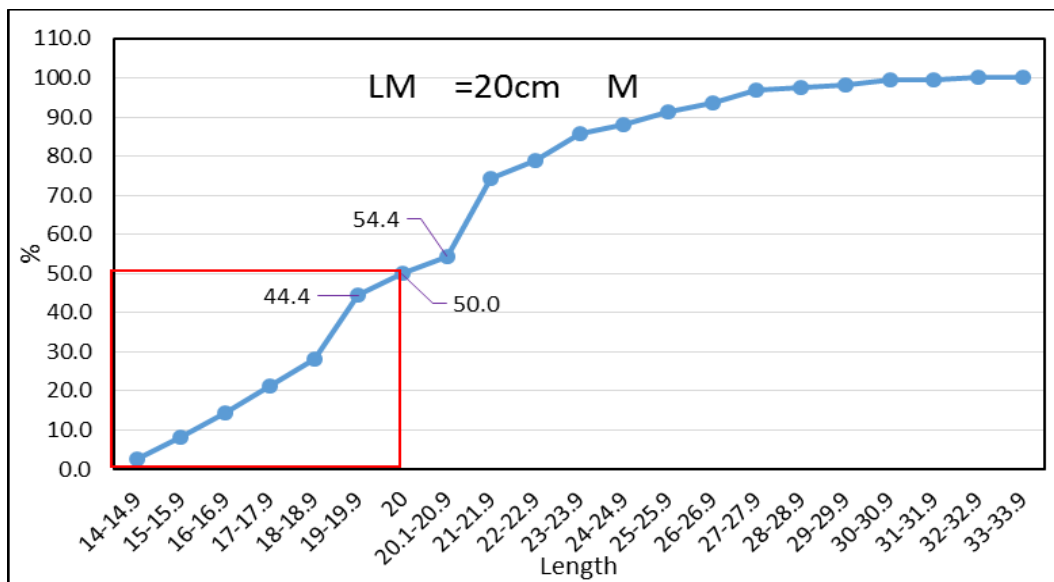


Fig. 2. Length at first maturity for males of *L. aurata* in Bardawil Lagoon during 2017

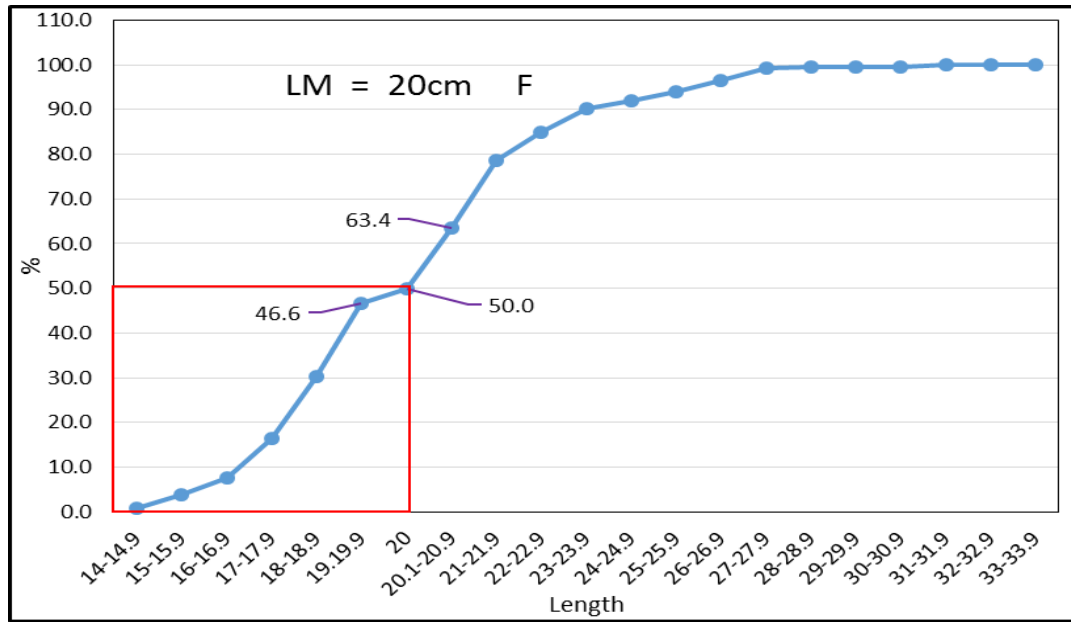


Fig. 3. Length at first maturity for females of *L. aurata* in Bardawil Lagoon during 2017

In the present study, the length at first maturity was 20 cm for both males and females, and it is less than the length at first maturity of *L. aurata* in many regions and studies. In this context, in the gulf of Gabes, the length recorded was 23.73, 23.84 and 23.79 cm TL for female, male and combined sexes, respectively (Abdallah *et al.*, 2013). On the other hand, Ezzat (1965) indicated that the *L. aurata* was mature at size 27 and 34 cm, respectively, for males and females in the gulf of Marseille. While, Fehri-Bedoui and Gharbi (2005) determined that specimens of 21.95 cm and 21.41 cm reached maturity, respectively, for females and males, in the Tunisian waters. Hotos *et al.* (2000) asserted that first maturation of the golden grey mullet in the Klisova Lagoon (W. Greece) occurs at age 1+ for both sexes; Ghaninejad *et al.* (2010) noted that the golden grey mullet of the Caspian Sea is mature at 28.4 cm (FL). Moreover, Fazli *et al.* (2008) recorded maturity at the length of 26 cm (FL) in the Iranian coastal waters, whereas Saad and Hamoud (2001) estimated the maturity length at 50% of *L. aurata* in the Syrian waters (Eastern Mediterranean) to be 34 cm (TL).

The difference in high variability in first maturation may be attributed mainly to the variability of environmental conditions in different areas, assuming that low temperature and photoperiod may be the main factors.

CONCLUSION

1. Sex ratio (1M :1.5 F)
2. Length at first capture = 19.5 cm.
3. Length at first maturity = 20.0.

4. From the study, it was found that the peak of the spawning season of *L. aurata* is in December of each year.

Recommendations

- The length at first capture (L_c) must be greater than that at first sexual maturity (L_{m50}) to ensure that at least 50% of the fish has matured and spawned even once before capture to keep fishing on fish stocks of *L. aurata* ($L_c = \text{or } >L_{m50} = \text{or } >20.0 \text{ cm}$).
- Fishing efforts should be reduced during the spawning season (From November to January) of golden grey mullet, *L. aurata*.

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