

Reproduction of Klunzinger Mullet, *Liza klunzingeri*, in coastal waters of Khuzestan Province. (Persian Gulf)

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Abstract: Some reproduction characteristics of keeled mullet, *Liza klunzingeri*, were studied during Apr. 2003 to Feb. 2004 in Khuzestan waters of the Persian Gulf. A total of 836 samples were monthly collected from two fish landings of Bahrekan and Hendijan; 727 specimens were studied from point of sex determination, and 60 specimens were studied from the fecundity point of view. This species was found to have more abundance in autumn (esp. Oct-Nov). The samples composed of 89(12.2%) male, 467(64.2%) female and 171(23.6%) immature; the sex ratio was M:F = 1:5. The advanced stages of maturity (4th & 5th) were found in October onward. The highest Gonadosomatic Index was in December and the lowest was in June. The maximum absolute and relative fecundities were 183040 and 2232, respectively; the minimum absolute and relative fecundities were 44700 and 582, respectively. The minimum and maximum egg diameter was 0.04mm (stage 2nd) and 0.75mm (stage 6th).

Keywords: Keeled mullet, *Liza klunzingeri*, Fecundity, GSI, Sex ratio,
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Introduction

The waters of the Persian Gulf are environmentally unique with an unusual faunal assemblage (Carpenter *et al.*, 1997). The Persian Gulf is a semi-closed water body connected to the Oman Sea through narrow Strait of Hormuz. The maximum width is 640 km with the average depth of 35m (Reynolds, 1993). The Persian Gulf is in the subtropical zone lying almost entirely between the latitudes of 24° and 30°N and longitudes of 49° to 61° 25'E.

The dominant large-scale current with a counter-clockwise movement and less saline water enters the Strait of Hormuz at the surface and more saline water leaves the area at the bottom (Hunter, 1983; Reynolds, 1993). The entire water column is well mixed and lies within the photic zone. However, primary productivity for the Persian Gulf is apparently only in average, being higher than most of the Red Sea but lower than the Arabian Sea (Sheppard *et al.*, 1992).

Next to oil, fisheries represent the second most important natural resource and the most important renewable natural resource (Carpenter *et al.*, 1997). The Persian Gulf possesses various commercially important fish species. Keeled mullet, *Liza klunzingeri* (syn. *L. carinata*) locally called "Maid"- is one of them. This species has significant stocks in eastern coastal waters of Khuzestan Province and its catch has recently increased considerably (more than 7743t in 2003-2004)(Fishery statistics-unpublished data). Not much information on the biology of this fish is available in the area. Fecundity and reproduction of this fish in Kuwait's waters of the Persian Gulf (Abou-Seedo & Dadzie, 2004), and its larval development (Ismail *et al.*, 1998) are among a few studies conducted on this species. The present study has been conducted to determine the fecundity, spawning season, length of maturity and sex ratio of this fish in the Iranian waters of the Persian Gulf.

Materials and Methods

Sampling

Persian Gulf waters off Khuzestan Province abound with this fish, which is caught by purse seines and then landed at two landing sites of Bahrekan and Hendijan

where the samples were collected. Geographical location of sampling sites is shown in Fig 1.



Figure 1: Geographical location of sampling sites for *L. klunzingeri*

Sampling- twice per month- started in April-May 2003 and lasted until Jan-Feb. 2004. At least 60-70 specimens were randomly collected per month. The randomly selected samples were transported in ice box to laboratory for further biological measurements.

Laboratory works

A total of 836 samples were brought to the laboratory of which 727 adult specimens were selected for determination of various stages of sexual developments. Fish were weighed ($\pm 0.01g$) and their body depth and length (total & fork) measured. Then, the gonads were removed and weighed ($\pm 0.001g$). The stages of gonad maturity and fecundity were determined following the methods proposed by Biswas (1993). To calculate fecundity, 60 ovaries (in high maturity

stage) were placed in Gilson's fluid for two or three months to facilitate the separation of eggs. Spawning season was determined by both the following methods:

- 1) GSI (Gonadosomatic Index): $(\text{Gonad weight} / \text{Total body weight}) \times 100$

The gonadosomatic index or maturity index is an indirect method for estimating spawning season of a species (Biswas, 1993).

- 2) L_{M50} (Length of Maturity): For this purpose, individuals were examined for their maturity stages throughout the year. The length of the fishes (both males and females) at first maturity was determined by plotting the percent number of males and females in 4th & 5th stages of maturity to the total number of fishes examined in a particular size group.

Results

The length range for adult males and females were 158-195mm and 157-225 mm, respectively. All of the length data was classified into 10mm groups and the analysis of total length distribution frequency of all individuals is shown in Fig. 2. This species was found to have more abundance in 175mm length.

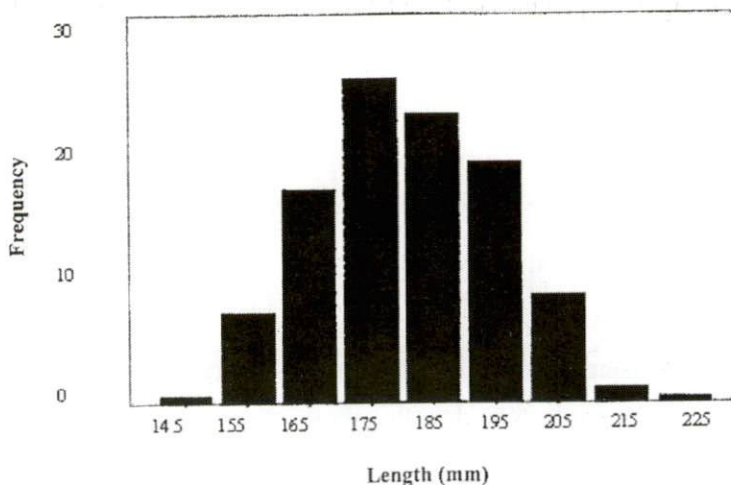


Figure 2: Length frequency distribution of *L. klunzingeri* in Khuzestan Provincial waters (2003-2004)

Results from biometry of 727 specimens showed direct relationship between the length and the weight (Fig. 3).

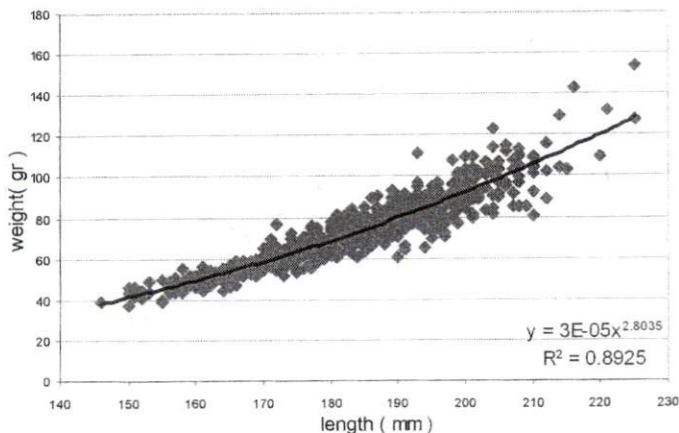


Figure 3: Length-weight relationship of *L. klunzingeri* in Khuzestan provincial waters (2003-2004)

Weight frequency distribution of the fish is shown in Fig. 4. The minimum, maximum and mean weight of the fish were 36.8, 154 and 71.13g (SD =17.13), respectively. Weight frequencies of 62.2 and 77.6 g were dominant groups.

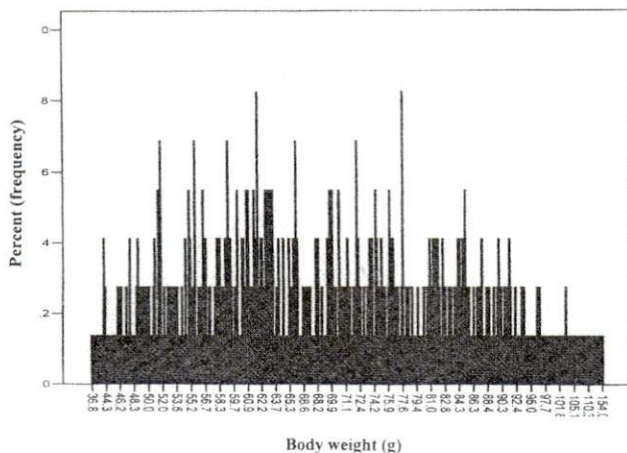


Figure 4: Weight frequency distribution of *L. klunzingeri* in Khuzestan provincial waters (2003-2004)

The sample was composed of 89(12.2%) male, 467(64.2%) female and 171(23.6%) immature individuals. Overall sex ratio of ♀5:1♂ was observed which was significantly different from the expected ratio of ♀1:1♂ ($P < 0.05$). According to the results, the sex ratio of the samples greatly varied throughout the year. In the months of April-May until August-September and December-January no male was encountered in the samples at all; male individuals, however, peaked and exceeded the females in Feb-Mar (Fig 5). The highest ratio of immature, female and male individuals was encountered in Apr-May, Dec-Jan and Feb-Mar, respectively.

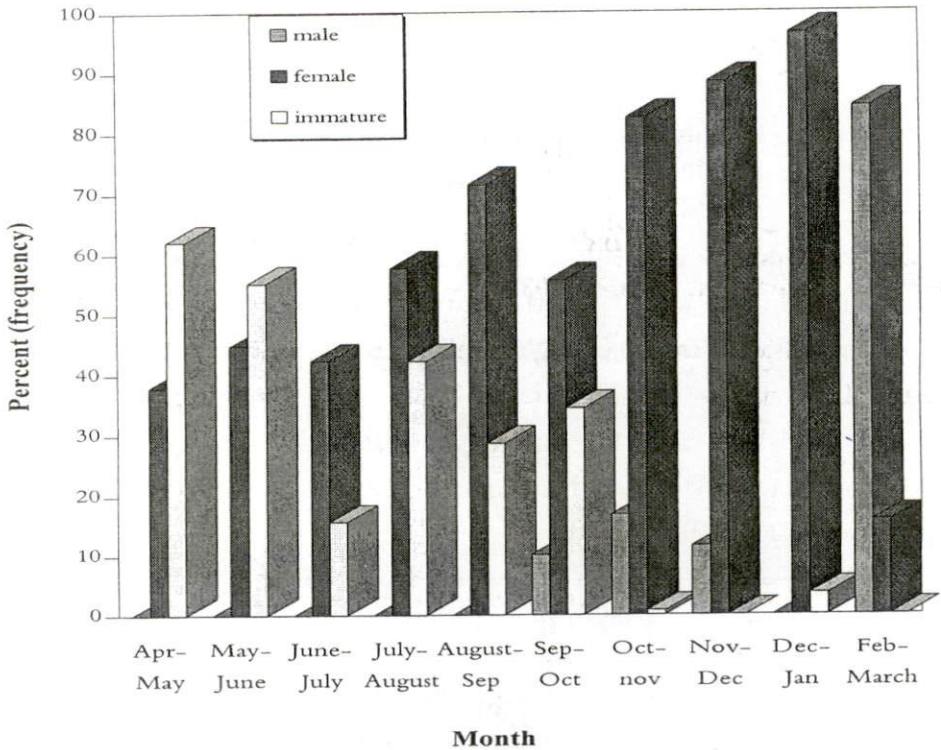


Figure 5: Sex ratio distribution of *L. klunzingeri* in Khuzestan provincial waters (2003-2004)

Regarding fecundity, the maximum absolute and relative fecundities were found to be 183040 and 2232, respectively; the minimum absolute and relative fecundities were 44700 and 582, respectively.

The highest Gonadosomatic Index of 5.75 was found in Nov-Dec and gradually decreased in later months, reaching its lowest level of 0.14 in May-Jun (Fig 6). This fish is, therefore, assumed to be a winter spawner.

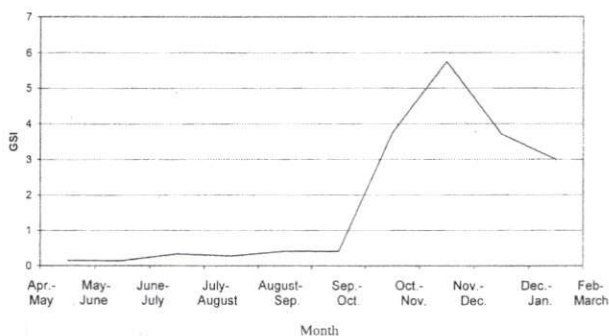


Figure 6: Gonadosomatic Index variation of *L. klunzingeri* in Khuzestan Provincial waters (2003-2004)

Having various length groups as well as percentage of high stage maturity groups, L_{M50} curve was drawn (Fig. 7), which shows the first maturity for 50% of the sampled fish occurs at 176mm (FL). Analysis of fish length data and stage of sex maturity indicated that the first maturity occurred at length of 170mm (FL) for female and 180mm (FL) for male.

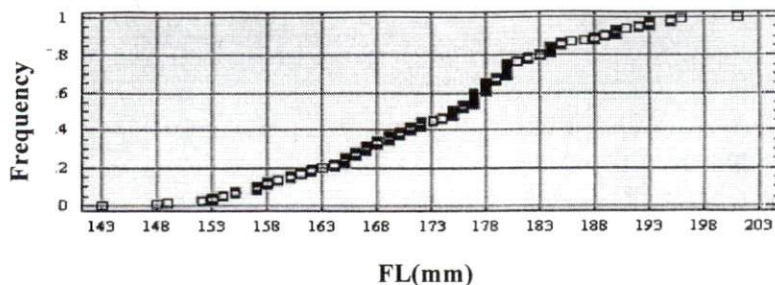


Figure 7: Length of maturity of *L. klunzingeri* in Khuzestan Provincial waters (2003-2004)

Measurement of ova diameter from 81 samples at 2nd to 6th stages of maturity revealed the minimum and maximum egg diameters were 0.04mm and 0.75mm from the 2nd and 6th stages of maturity, respectively; the maximum and minimum ova diameter frequency (Fig. 8) was in 0.42 and 0.04mm groups (mean =0.36 and SD =0.11). Mean of ova diameter in various stages of ovary development is shown in Table 1, which indicates increase in ova diameter with increase in stages of sexual maturity.

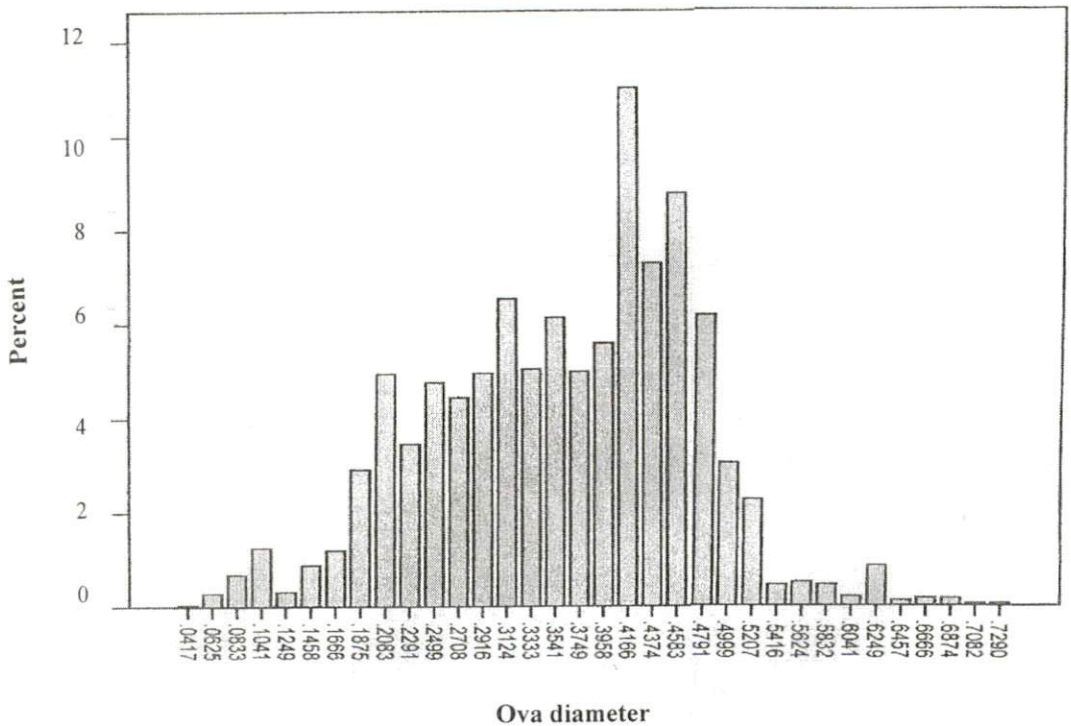


Figure 8: Frequency distribution of ova diameter of *L. klunzingeri* in Khuzestan Provincial waters (2003-2004)

Table1: Mean of ova diameter in various stages of ovary development of *L. klunzingeri* in Khuzestan Provincial waters (2003-2004)

Ova diameter (mm)			Number	Maturity Stages
Mean	Max	Min		
0.15	0.20	0.10	200	2
0.25	0.31	0.20	600	3
0.27	0.33	0.21	1000	4
0.38	0.52	0.27	4300	5
0.46	0.52	0.40	1900	6

Various stages of gonad development frequency have been shown in Fig. 9. From April to September, all of the samples were in low maturity stages (1, 2); in October, 98.4% of them was in stage 2 and 1.6% (all of which were female) in stage 4. In November to March, all of the maturity stages (1-6) were seen with various percents.

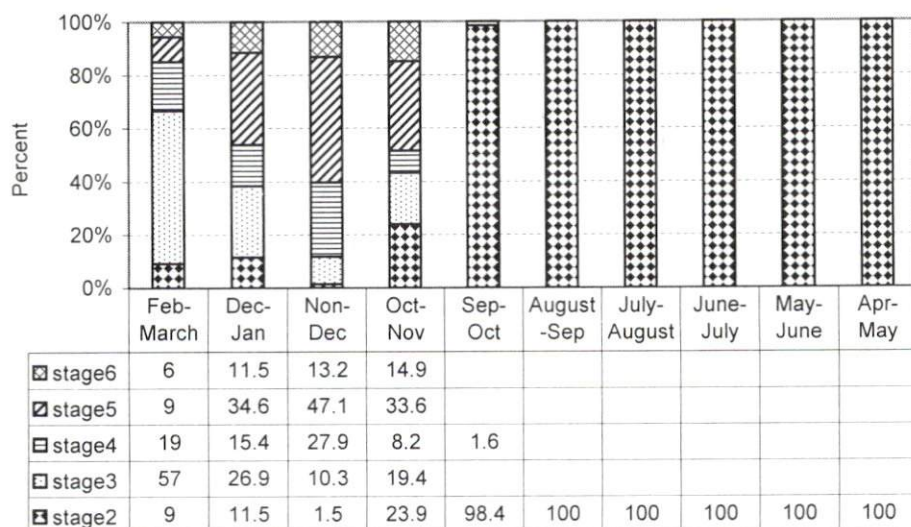


Figure 9: Various stages of gonad development frequency distribution of *L. klunzingeri* in Khuzestan Provincial waters (2003-2004)

Discussion

Keeled mullet, *Liza klunzingeri*, has been reported from various parts of the Indian Ocean, Mediterranean Sea and as far as coastal waters of Japan and China (Golani, 2002; Luna, 2004). It enjoys significant stocks in waters of the Persian Gulf. The maximum recorded length for this fish in the present study was 225mm, but the maximum and common lengths of 200mm and 150mm, respectively, had earlier been reported from the Persian Gulf waters (Carpenter *et al.*, 1997). The maximum lengths of 180mm (Torres, 2004) and 300mm (Golani, 2002) have also been reported for this species from other water bodies.

The highest gonadosomatic index was recorded in Nov-Dec and the lowest was in May-Jun (Fig. 6). Besides GSI, based on other evidences such as ova diameter (Fig. 8) and seeing the advanced stages of maturity (4th & 5th) in October onward (Fig. 9), it could be assumed that spawning of *L. klunzingeri* occurred in Feb-Mar. In studies conducted in Kuwaiti waters, the spawning of this fish was reported to occur between December and February (Ismail *et al.*, 1999), which differs a little in the beginning month from the present study- and November to March (Abou-Seedo & Dadzie, 2004), which assumes longer spawning period than the present study.

Gonadosomatic index variation in relation to fish length indicated that the first sexual maturity in male and female occurred at 160mm and 155mm fork lengths (FL), respectively. Abou-Seedo and Dadzie (2004) reported that males reached the maximum reproductive capacity at 131-170mm, and females at 141-180mm total length, which correspond with the length of first sex maturity in this study (the first sexual maturity at 160mm and 150mm fork length for male and female, respectively, corresponds with 175mm and 170mm total length).

Sex ratio varies from one species to another. According to our results, the sex ratio of *L. klunzingeri* greatly varied throughout the year (Fig. 5), but an overall sex ratio of (♂)1:5(♀) was estimated that significantly differed from the expected ratio

of 1:1. The sex ratios of (♂) 1.5:1(♀) (Ismail *et al.*, 1999) and (♂)1:2(♀) (Abou-Seedo & Dadzie, 2004) for the same species were reported from Kuwaiti waters.

The female gonad and its function in *L. klunzingeri* are similar to other osteichthyes. With due attention to the kind of ovary and its GSI variation, process of ovary development in keeled mullet follows an annual rhythm.

The maximum and minimum fecundities were found in Oct-Nov (autumn) and in Feb-Mar (winter), respectively. The maximum absolute fecundity of *L. klunzingeri* found in this study (183040) corresponds with the one (185929) reported from Kuwaiti waters (Abou-Seedo & Dadzie, 2004), but the minimum absolute fecundity (44700) found in this study differs from that of Kuwait's (88896).

Keeled mullet was found to have a synchronous ovary, because it possessed a single batch of maturing eggs in its ovaries. The spawning in this fish is adapted to an annual rhythm. The cycle of maturation and depletion of gonads occurs only once a year. The gonads show a regular seasonal change; at any given time, the state of maturity is almost uniform in all the individuals of the population, although there are many large and small eggs in some ovaries at the same time, but it does not indicate a partial spawning in this species, because in some fish small eggs will remain in ovary and gradually reabsorbed (Nikolsky, 1963). Ovary synchrony in this species has also been reported from Kuwaiti waters (Abou-Seedo & Dadzie, 2004).

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