

## Reproductive Biology of Abu Mullet, *Planiliza abu* (Heckel, 1843), in Karun River, Southwestern Iran

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### Research Article

Received 05 May 2020; Accepted 02 December 2020; Release date 01 Mart 2021.

**How to Cite:** Jorfipour, M., Keivany, Y., Paykan-Heyrati, F., & Ghafouri, Z. (2021). Reproductive biology of Abu Mullet, *Planiliza abu* (Heckel, 1843), in Karun River, Southwestern Iran. *Acta Aquatica Turcica*, 17(1), 17-24. <https://doi.org/10.22392/actaquatr.732149>

### Abstract

Some aspects of the reproductive biology of *Planiliza abu* (Mugilidae) were investigated by collecting of 428 specimens caught with trawl by local fishermen from Karun River, Ahvaz, from November 2016 to September 2017. The total length for males ranged between 10-17.1 (13.6±1.26 SD) cm and for females, between 10.5-17.3 (13.44±1.35) cm. The age range of fish in both sexes was between 0<sup>+</sup>-7<sup>+</sup> years and the most abundant age group was the 4<sup>+</sup>. The sex ratio in the studied fish was equal (P>0.05). The mean egg diameter was significantly different (P<0.05) in different months and the individual size ranged between 0.12 and 0.57 mm. The absolute fecundity ranged from 3600 to 48600 eggs and the relative fecundity from 120 to 900 eggs per 1 g of body weight. The highest hepatosomatic index in females was in February during yolk vitellogenesis (1.89). Based on gonadosomatic index, egg diameter, and monthly distribution of ovarian maturation stages, the spawning season of this fish is long, but peaks in February (GSI 12.35) and March (GSI 12.18). This species appears to have a group synchrony reproductive pattern.

**Keywords:** Mugilidae, Gonadosomatic Index, Spawning period, Fecundity, Egg diameter

### Ebu Kefalinin Üreme Biyolojisi, *Planiliza abu* (Heckel, 1843), Karun Nehri, Güneybatı İran

*Planiliza abu*'nun (Mugilidae) üreme biyolojisi, Kasım 2016'dan Eylül 2017'ye kadar Ahvaz, Karun Nehri'nde yerel balıkçılar tarafından trolle yakalanan 428 örnek üzerinde araştırıldı. Erkeklerin toplam uzunluğu 10-17.1 (13.6 ± 1.26 SS) cm ve dişiler 10.5-17.3 (13.44 ± 1.35) cm. Her iki cinsiyette de balıkların yaş aralığı 0 + -7 + yaş arasında ve en bol olan yaş grubu 4+ ve cinsiyet oranı eşitti (P> 0.05). Ortalama yumurta çapı aylara göre önemli ölçüde farklıydı (P <0.05) ve bireysel boyut 0.12 ile 0.57 mm arasında değişiyordu. Mutlak verimlilik 3600 ila 48600 yumurta ve nispi verimlilik vücut ağırlığının 1 g'ı başına 120 ila 900 yumurta arasında değişiyordu. Dişilerde en yüksek hepatosomatik indeks Şubat ayında yumurta sarısı vitellogeniz sırasında görüldü (1.89). Gonadosomatik indeks, yumurta çapı ve yumurtalık olgunlaşma aşamalarının aylık dağılımına göre, balığın yumurtlama mevsimi uzun ve Şubat (GSI 12.35) ve Mart'ta (GSI 12.18) pik yapar. Bu türün grup eşzamanlı üreme modeline sahip olduğu görülmektedir.

**Anahtar Kelimeler:** Mugilidae, Gonadosomatik İndeks, Yumurtlama dönemi, Verimlilik, Yumurta çapı

### INTRODUCTION

Iran's freshwater fishes consist of approximately 300 species in 109 genera, 30 families, 24 orders, and three classes distributed throughout the basins (Keivany et al., 2016; Esmaeili et al., 2017; Esmaeili et al., 2018; Keivany and Esmaeili, 2019). The mullets are found in temperate to tropical coastal waters, readily entering estuaries, and even reside in freshwaters. This family is an important element of the aquatic ecosystems and many species are of commercial or other significance (Coad, 2017). This family consists of 17 genera with 72 species, amongst which seven are found in Iranian waters (Esmaeili et al., 2018; Keivany and Esmaeili, 2019).

*Planiliza abu* inhabits Asian countries such as Iraq, Syria, Pakistan, Iran, and Turkey (Turan et al., 2004; Coad, 2020) and was reported from Iranian tributaries of the Tigris River basin including Karun River. It appears in fish markets as a regular food fish in Ahvaz, Khuzestan, and is an important food

fish in southern Iraq (Coad, 2020). Knowledge of the reproductive cycle and factors affecting it are important issues in fish and fishery biology (Tomkiewicz et al., 2003; Asadollah et al., 2017; Keivany et al., 2017a). It has three key components including sexual maturity, reproductive period, and fecundity, which are important demographic characteristics, essential for understanding a species life history (Mousavi-Sabet et al., 2017; Ghafari et al., 2019). There are some works on the biology of this fish in nearby countries (Mhaisen and Al-Jaffery, 1989; Doğu et al., 2013; Mohamed, 2014; Ay and Özcan, 2016; Birecikligil et al., 2017), but almost none in Iran. The main object of this study was to provide data on the reproductive biology of *P. abu*, including sex ratio, gonadosomatic index, fecundity, oocyte diameter, and spawning season which are necessary for conducting conservation and management programs in Karun River.

## MATERIALS and METHODS

Some 428 specimens of *Planiliza abu* (Mugilidae) caught with trawl by local fishermen from Karun River, Ahvaz, from November 2016 to September 2017, were sampled. All the collected specimens were fixed and preserved in 10% formaldehyde solution and transferred to the ichthyology laboratory. For each specimen, total length (TL) and standard length (SL) were measured using digital calipers with a precision of 0.01mm and body weight (W) was taken on a digital balance to the nearest 0.01g. Age determination was carried out through scales from between the lateral line and the dorsal fin, 5-10 scales washed with warm water and the age was determined under the microscope by counting the annual growth circles (Hsu and Tzeng, 2009; Ellender et al., 2012). The sex ratio deviation from 1:1 was tested statistically by chi-squared analysis (Sokal and Rohlf, 1973). Gonadosomatic Index (GSI) was used to investigate the monthly changes in gonads to estimate the spawning season of this species:  $(GSI = W_g/W \times 100)$ ; ( $W_g$ ) is the ovaries weight and ( $W$ ) the body weight (Biswas, 1993). Also, the monthly Hepatosomatic Index (HSI) was calculated using the formula:  $HSI = [WL / W] \times 100$ , where  $WL$  is the liver weight and ( $W$ ) the body weight. To calculate absolute fecundity, total eggs were counted in 20 ovaries by gravimetric method. While relative fecundity was determined as the proportion of absolute fecundity to the eviscerated body weight. To calculate absolute fecundity, ovaries in stages IV or V were used. Egg diameter was measured with a scaled ocular micrometer. After identifying the various stages of sexual maturation, diameter of sex cells was measured during different growth phases under magnifications of 40× by a scaled ocular micrometer. The stage of gonad maturity was determined visually following Brown-Peterson et al. (2011) which is widely used in different works (e.g., Abaszadeh et al., 2013; Hamzeh et al., 2017; Siami et al. 2017; Keivany et al., 2018a; Ghafouri et al., 2019). Reproductive seasonality was determined by examination of the monthly changes in the gonadosomatic index. The obtained data were analyzed in SPSS 16.0 and Microsoft Excel 2016 software packages. One-way ANOVA followed by Duncan post-hoc was used to analyze differences in means of GSI% and egg diameter of fish at 95% confidence level.

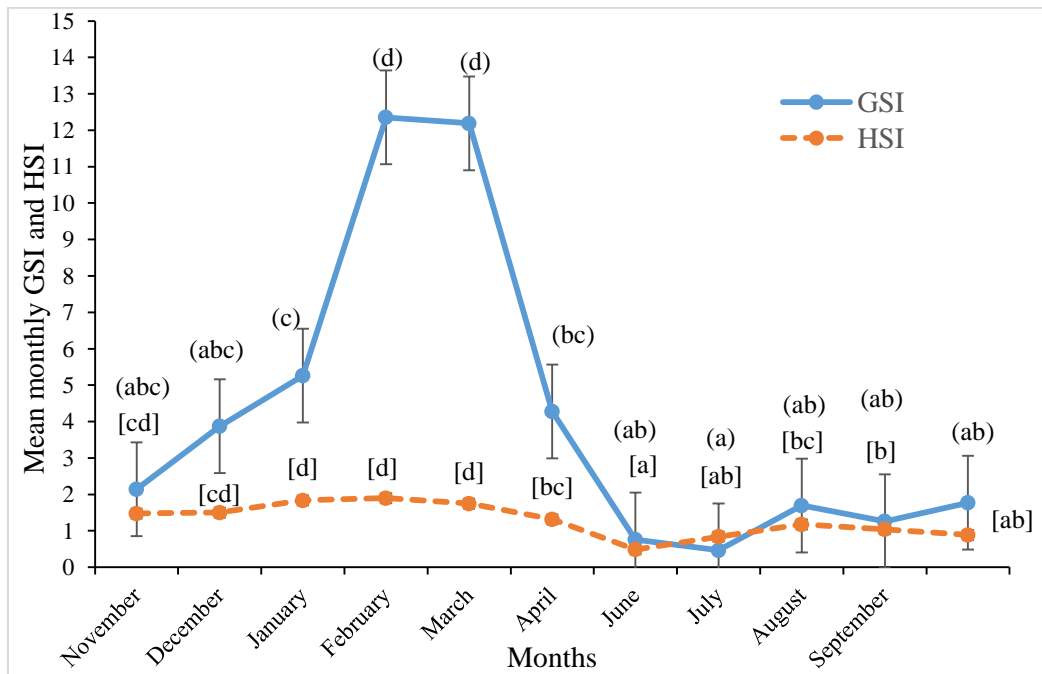
## RESULTS

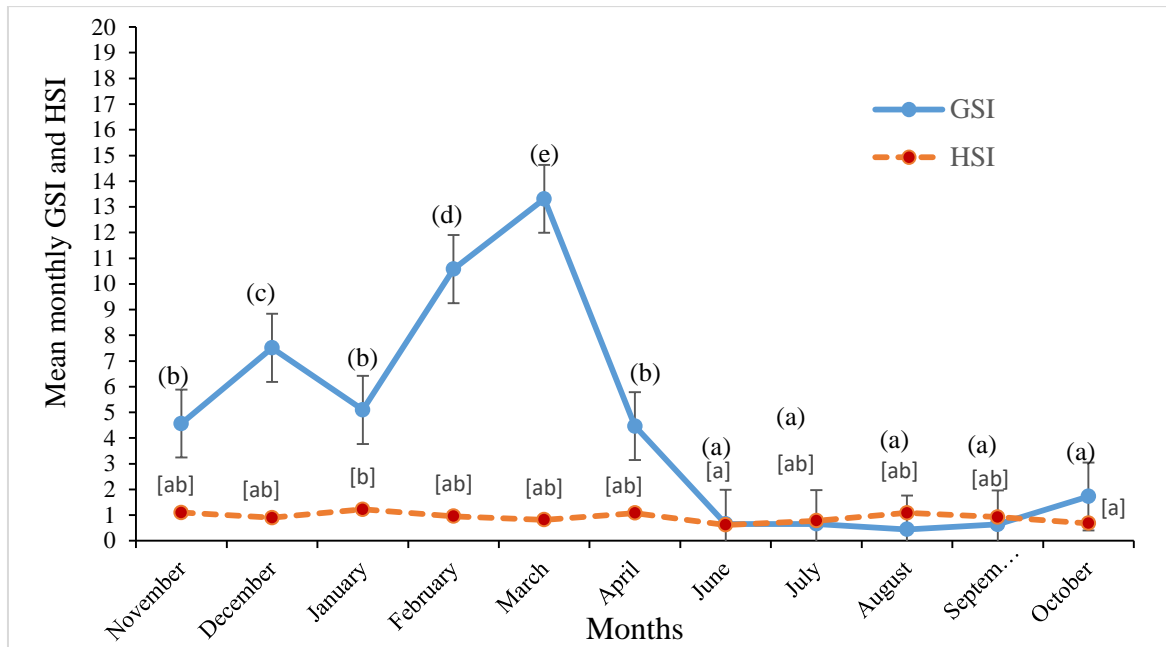
The length and weight of males ranged from 10.00 to 17.10 ( $13.16 \pm 1.26$ ) cm and 12.92 to 71.28 ( $30.51 \pm 8.64$ ) g and those of females from 10.50 to 17.30 ( $13.44 \pm 1.35$  SD) cm and 16.23 to 69.89 ( $33.00 \pm 9.41$ ) g, respectively (Table 1). The age of this species ranged from 0<sup>+</sup> to 7<sup>+</sup> years. The dominant age group was the 4<sup>+</sup> years for both males and females (Table 2). Amongst the 428 collected specimens, 221 were females and 207 were males, giving an overall sex ratio of about 1M:1F ( $X^2 = 0.45$ ;  $P > 0.05$ ). Assessment of the spawning period of *P. abu* in Karun River was based on the GSI, analysis of seasonal development in mean egg diameter, and direct observation of the gonads. Significant differences were found in the males and females GSI. Also, significant differences were found in females egg diameters ( $p < 0.05$ ) in different months. The highest GSI value for both sexes occurred from February to March. The GSI increased gradually in November and reached the maximum value in February and decreased gradually from April to June (Figure 1). The highest HSI value for males was in July and for females in January to February. Significant differences were found in HSI in different months ( $P < 0.05$ ). The egg diameter ranged from 0.12 to 0.57 mm and the mean values were significantly different during the year ( $P < 0.05$ ). The highest mean egg diameter ( $0.48 \pm 0.04$  mm) was observed in February and the lowest one in August ( $0.19 \pm 0.04$  mm) (Figure 2). The mean of the absolute fecundity of 20 females determined during the spawning period was 3600-

48600 (22400±11000) eggs and relative fecundity was 120-900 (500±210) eggs/g body weight. Fecundity-total length, fecundity-weight and fecundity-ovary weight relationships in *P. abu* in Karun River was as  $F=3.66L^{3.19}$  ( $r^2=0.16$ ),  $F=12.29W^{1.95}$  ( $r^2=0.43$ ) and  $F=1230.10X^{1.26}$  ( $r^2=0.84$ ), respectively (Figures 3, 4).

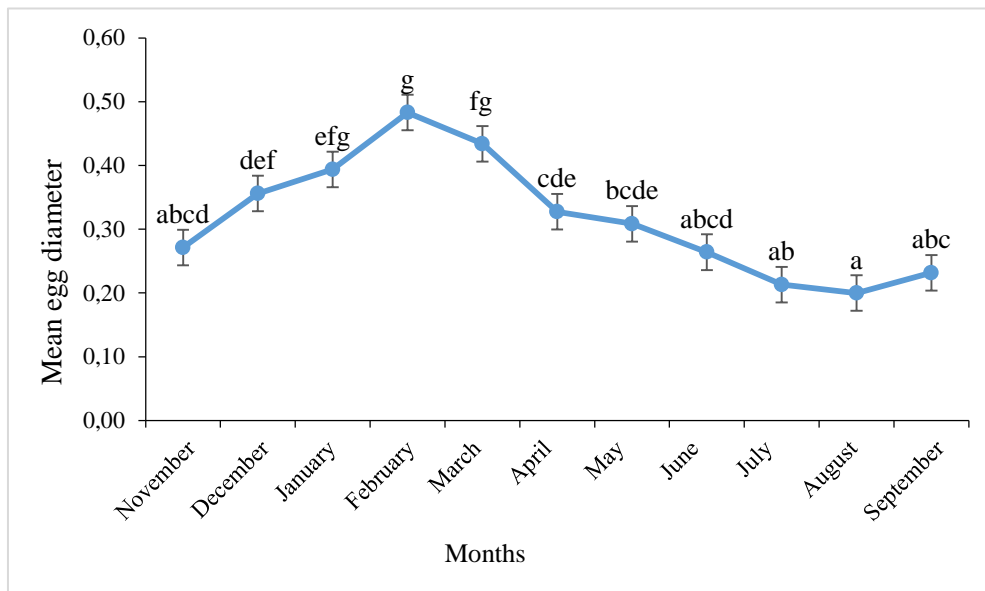
**Table 1.** Mean egg diameter variations in *Planiliza abu* in Karun River from November 2016 to September 2017

Months	Mean TL±SD (mm)	Mean TW±SD (g)	Egg diameter range	Mean egg diameter ±SD
November 2016	14.32±0.96	37.24±8.62	0.14-0.45	0.27±0.08
December	13.53±0.71	29.66±3.89	0.29-0.40	0.35±0.03
January	13.33±0.89	30.84±5.63	0.25-0.48	0.39±0.06
February	15.24±1.04	46.27±7.10	0.42-0.57	0.48±0.04
March	14.10±0.98	38.11±7.49	0.34-0.48	0.43±0.04
April	12.44±0.83	26.43±5.92	0.22-0.41	0.32±0.07
May	11.95±1.06	22.54±6.05	0.25-0.38	0.30±0.04
June	11.93±0.55	24.76±2.78	0.20-0.40	0.26±0.06
July	11.78±0.89	22.65±5.09	0.13-0.27	0.21±0.05
August	12.55±0.93	27.64±6.76	0.12-0.22	0.19±0.04
September 2017	13.52±0.73	34.60±6.11	0.16-0.34	0.23±0.04





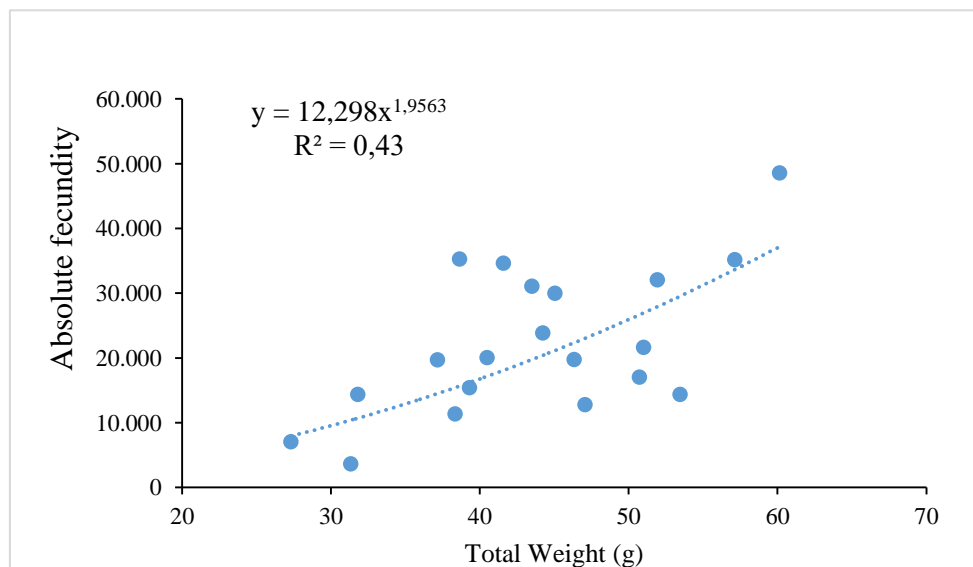
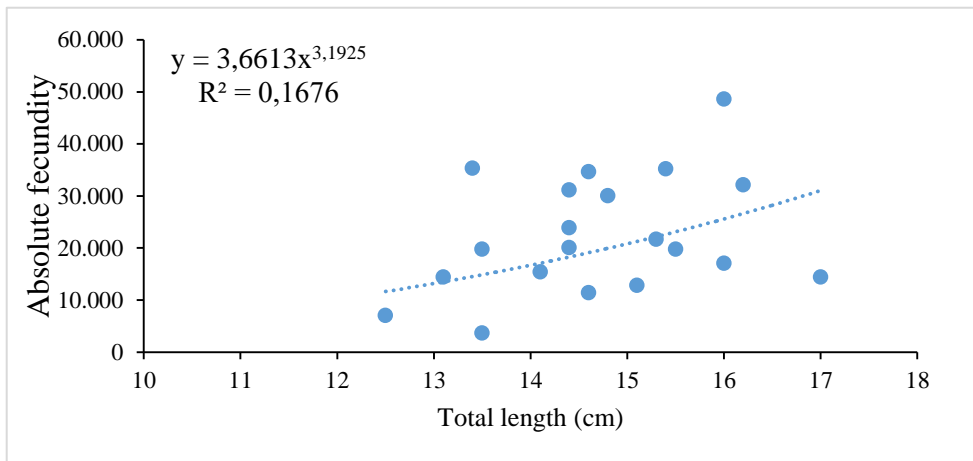
**Figure 1.** GSI and HSI variations in females (Top) and males (Bottom) of *Planiliza abu* in Karun River from November 2016 to September 2017



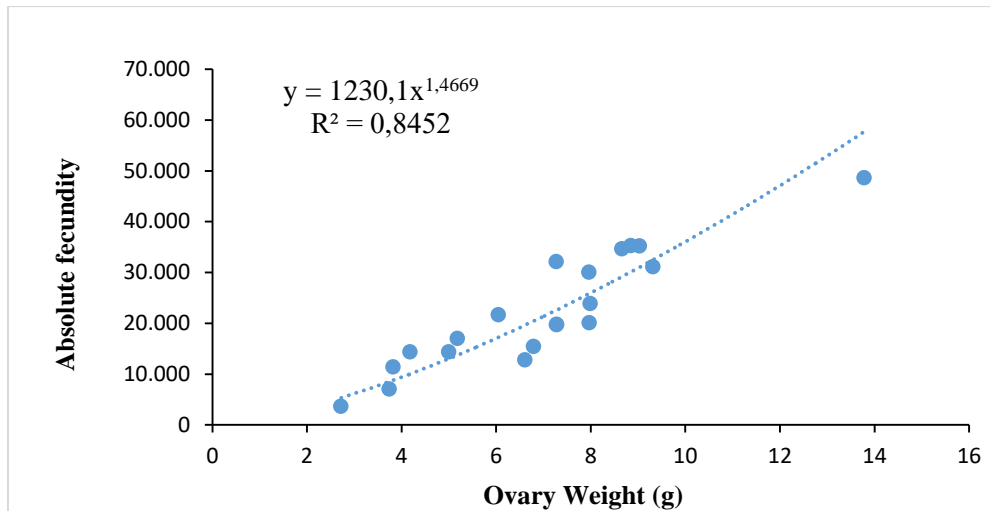
**Figure 2.** Variation of mean egg diameter (mm) in female *Planiliza abu* in Karun River in different months

**Table 2.** Number and sex ratios of *Planiliza abu* specimens in different age groups

Age group	Sex	Number	M:F ratio	P=0.05
0 <sup>+</sup>	M	0	0	-
	F	1		
1 <sup>+</sup>	M	4	4	P>0.05
	F	1		
2 <sup>+</sup>	M	29	1.52	P>0.05
	F	19		
3 <sup>+</sup>	M	52	1.01	P>0.05
	F	51		
4 <sup>+</sup>	M	65	0.89	P>0.05
	F	73		
5 <sup>+</sup>	M	36	0.76	P>0.05
	F	47		
6 <sup>+</sup>	M	16	0.72	P>0.05
	F	22		
7 <sup>+</sup>	M	5	0.62	P>0.05
	F	8		



**Figure 3.** Fecundity-total length, fecundity-weight relationship in *Planiliza abu* in Karun River from November 2016 to September 2017



**Figure 4.** Fecundity-ovary weight relationship in *Planiliza abu* in Karun River from November 2016 to September 2017

## DISCUSSION

The length of the females was higher than that of the males as seen in many other fishes (Asadollah et al., 2017; Keivany et al., 2017b, 2018b). In this study, the maximum observed total length and weight of *P. abu* was 17.3 cm and 71.28 g, respectively. In other studies, the maximum reported fork length and weight is 22.1 cm and 136.6 g in Atatürk Dam Lake (Doğu et al., 2013), 22 cm and 66.1 g in East Hammar marsh of Iraq (Mohamed, 2014) and 18.5 cm and 66.40 g in the Orontes River, Turkey (Ay and Özcan, 2016), 65.0 cm (Garbin et al., 2014) in southeastern coastal regions of Brazil and 23.1 cm and 166.1 g in Ceyhan River Basin of Turkey (Birecikligil et al., 2017). In general, the differences in the length of the fish could be due to differences in the fishing methods and seasons, different geographic areas, biological and ecological conditions, or inter-species differences.

The study of reproductive biology is an effective method for recognizing the stocks and life cycle of fishes (Abedi et al., 2011). The sex ratio in this study was equal (1M:1F), however, it differed in different seasons and length classes. In other studies, the sex ratio of *P. abu* was reported as 1M:2.7F in Khozestan Province, Iran (Chelemal et al., 2009), as equal in Atatürk Dam Lake (Doğu et al., 2013) and as 1M:1.3F in the Orontes River, Turkey (Ay and Özcan, 2016). These differences are most probably related to sexual differences in growth rate, natural mortality rate, and energetic cost of reproduction (Stergiou et al., 1996). Also, it is suggested that dominance of one sex relative to the other can be due to different behaviors leading to an easier catch of one sex and differences in mortality of the sexes (Keivany et al., 2017a).

Gonadosomatic (GSI) and hepatosomatic (HSI) indices are among the biological indicators used to determine the fish spawning season (Ghanbahadur et al., 2013). The HSI for females is more important because of the vitellogenesis performed for eggs in the liver. Typically, in many fish species, at the peak of spawning, the GSI is in the highest value and the HSI in the lowest (Keivany and Soofiani, 2004). The lowest value of HSI in *P. abu* was in May and the highest in February. The monthly variation in HSI was lower in males than in females. In the present study, the HSI and GSI showed a similar trend, probably indicating the continued feeding of the fish (Dopeikar et al., 2015). The monthly variation in GSI was highly associated with the seasonality of the maturity stages assigned macroscopically. An increase in the GSI of females was observed from January which peaked in February and March and decreased from April to May. In the case of males, the spawning season lasted from February to March and peaked in March. Şahinöz et al. (2011), in Turkey's Atatürk Dam Lake, found the highest GSI of female *P. abu* in April and that of males in May.

The mean maximum egg diameter was significantly different during the year. The size of the egg increased during the spawning season. The highest mean egg diameter was observed in February. In the study of the reproductive biology of *P. abu* in Turkey, the mature egg diameter was in the range of 0.31 to 0.63 with a mean of 0.44 mm (Ay and Özcan, 2016). Egg diameter variations in fish are probably one of the important strategies in determining reproductive activities (Tomasini et al., 1996). The maximum absolute fecundity of *P. abu* was 48000 oocytes and that of the relative fecundity was

910 Oocytes per gram of body weight. Fecundity is the most common criterion for determining the potential of reproduction in fishes (Nichol and Acuna, 2001). In the study of Ay and Özcan (2016), *P. abu* fecundity was calculated for 51 adult females in the spawning season, and the absolute fecundity ranged between 12000-25000 eggs with an average of  $14400 \pm 1600$  eggs. Several factors such as size and age of females, life history strategy, food supply, and water temperature affect the fecundity (Thrope et al., 1984). The GSI peak, the maximum diameter of the eggs, and the highest number of hydrated oocytes were observed in January-March, therefore the spawning peak of *P. abu* occurred in February-March. Macroscopic development of the testes followed a similar trend to those of the ovaries. It could be concluded that *P. abu* is a group synchronous multiple batch spawner with a long period of reproduction which lasts from January to March and peaks in February-March.

**Acknowledgments:** We would like to thank S. Asadollah, M. Zamani-Faradonbe and K. Mohammadi-Sarpiri for their help in laboratory. This study was financially supported by Isfahan University of Technology.

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