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# Some aspects of the life history of *Oxynoemacheilus bergianus* (Actinopterygii: Nemacheilidae) from the Jajrud River in the Namak Lake basin, Central Iran

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## ABSTRACT

The length-weight relationship, breeding season and condition factor of *Oxynoemacheilus bergianus* from Jajrud River in the Namak Lake basin, Tehran Province, Central Iran, were investigated. Sampling was performed from March 2017 to February 2018. The biometric measurements and the body and gonad weights were monthly carried out for one year log sampling occasions, in a total of 546 specimens. The range of total length in males and females were 3.8-7.5 and 3-7.6 cm, and the range of total weight were correspondingly 0.36-3.53 and 0.2-4.67 g respectively. The calculated coefficient of determination ($r^2$) in males and females was found to be 0.94 and 0.95, respectively reflecting a positive allometric ($b > 3$, $p > 0.05$) growth in both sexes. The gonadosomatic index and modified gonadosomatic index showed that *O. bergianus* spawns in the middle of spring in May. In agreement with that, the condition factor reached the minimum (0.60) in February, while the maximum (0.96) in May. Since there is poor conservation status of the species, this study aims to give a contribution for biologists and wildlife managers.

**Keywords:** Allometric, Breeding season, Condition factor, Length-weight relationship.
**Article type:** Research Article.

## INTRODUCTION

Loach fishes of the superfamily Cobitoidea are abundantly found in Iran and East Mediterranean countries such as Turkey, Syria, Iraq, Lebanon and Jordan (Pourshabanan *et al*. 2017a; Coad 1995, 2020; Fricke *et al*. 2021). Nevertheless, a little is known on the biology of loaches in Iran, especially for what concerns life histories and reproductive cycles (Saadati 1977; Mousavi-Sabet *et al*. 2016, 2017; Pourshabanan *et al*. 2017a). These fishes are inhabitants of 19 Iranian watersheds; 53 loach species are allocated in nine genera and furtherly subdivided into two families of Nemacheilidae and Cobitidae (Esmaeili *et al*. 2018). *Oxynoemacheilus bergianus* (Derzhavin, 1934) is a widespread member of the Nemacheilid fishes reported from the Caspian Sea, Urmia and Namak lake basins in Iran (Abbasi *et al*. 1999, 2017; Esmaeili *et al*. 2018; Fricke *et al*. 2021). However, because of the small size and the poor commercial interest, studies regarding biological characters and life history are especially limited for this species (Naderi Jolodar & Abdoli 2004; Zamani-Faradonbe *et al*. 2015; Jamali *et al*. 2015; Pourshabanan

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*et al*. 2017b). Hence, new studies focusing on the basic biological parameters are required for identifying life history patterns and implementing effective management and conservation measures. Gonadosomatic index (GIS) is a parameter used to describe the breeding biology of fish and can also be used to assess ovarian maturation (Bibak *et al*. 2012; Nandikeswari *et al*. 2014; Forouhar Vajargah *et al*. 2019). The GSI and modified gonadosomatic index (MGSI) are also used as seasonal indicators of fish fertility. Moreover, these can be used to describe the total fertility or fertility capacity for each fish in each season (Shafi 2012). The length-weight relationship (LWR), is often used to evaluate weight from length or conversion of growth equations of length to growth in weight (Bibak *et al*. 2012; Bibak *et al*. 2013; Forouhar Vajargah *et al*. 2020a). Moreover, it is essential for determining seasonal changes in fish growth. In fact, changes in the LWR provide important clues in determining whether environmental cues can alter fish development (Vesaghi *et al*. 2016; Sattari *et al*. 2018; Bibak *et al*. 2019; Forouhar Vajargah *et al*. 2020b). Linked to the LWR, the condition factor (K) is a parameter which shows the competency of a specific water body over the growth of fishes and it is also an index of species average size (Alam *et al*. 2014). In order to get a better overview of the life history of *O. bergianus*, the aim of this study was to describe the breeding period, length-weight relationship and condition factor of the populations inhabiting the Jajrud River in the Namak Lake basin, Tehran Province, Central Iran.

## MATERIALS AND METHODS

A total 546 specimens of *Oxynoemacheilus bergianus* was caught in 12 sampling occasions carried out (on a monthly basis) from March 2017 to February 2018 by a hand net (65 cm diameter and mesh size 1×1 mm; Table 1).

**Table 1.** The number of samples in different months.

| Month | Male | Female | Total |
|---|---|---|---|
| January | 16 | 34 | 50 |
| February | 10 | 32 | 42 |
| March | 17 | 36 | 53 |
| April | 21 | 9 | 30 |
| May | 16 | 10 | 26 |
| June | 18 | 28 | 46 |
| July | 12 | 34 | 46 |
| August | 27 | 23 | 50 |
| September | 31 | 19 | 50 |
| October | 31 | 20 | 51 |
| November | 28 | 24 | 52 |
| December | 37 | 13 | 50 |

Samplings were carried out downstream of the Latyan Dam (35°47′ N, 51°40′ E) and Mamloo Dam (35°34′ N, 51°47′ E) in Jajrud River, Namak Lake basin, Tehran Province, Central Iran (Fig. 1). The collected specimens were transferred to the Laboratory of Zoology, University of Tehran and kept alive in tanks with aeration for a few days prior to data recording and dissection. Total length (TL), standard length (SL) and fork length (FL) of each specimen were measured with a RS PRO 150 mm Digital Caliper, China with an accuracy of 0.01 mm (Fig. 2). Proper dissecting instruments were used to remove the left body wall and gonads by severing their mesenteric attachments. Body and gonadal weights (g) were measured with a digital balance Sartorius, Germany (0.001 g). The whole fish and gonads were fixed and preserved in buffered formalin solution (5%) for histological activities. To study the monthly changes in the gonads and to estimate spawning season, two indices were used: Gonadosomatic index (GSI) and modified gonadosomatic index (MGSI) which were calculated as followed equations (Nikolsky 1963). The sex of immature samples was identified using histological studies.

$$GSI = \frac{\text{gonad weight}}{\text{total body weight}} \times 100$$

$$MGSI = \frac{\text{gonad weight}}{\text{weight of fish} - \text{weight of gonad}} \times 100$$

The length-weight relationship was calculated using the following equation (Ricker 1973):

$$W = a\,L^{b}$$

W → whole body weight (g)
L → total length (mm)
a → intercept of the regression

b → regression coefficient (slope).
The parameters *a* and *b* were estimated by the least-squares method based on logarithms (Zar 1996):

Log (W) = log (a) + b log (L)

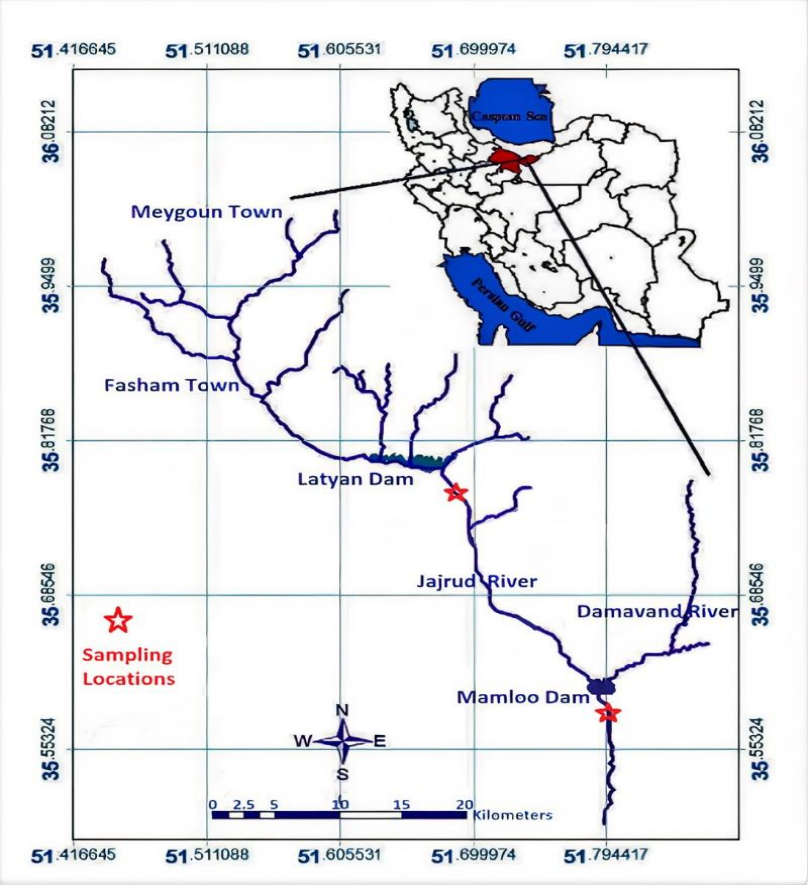


**Fig. 1.** Study area and sampling locations in the Jajrud River, Iran in the present study (modified from Mirzaei *et al*. 2014).

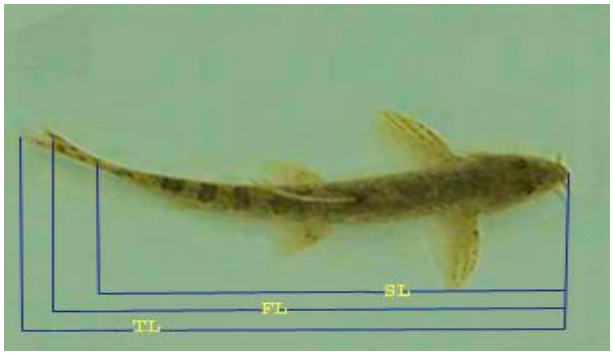


**Fig. 2.** Length measurements in *Oxynoemacheilus bergianus* in the present study.

As Ricker (1973) stated, an increases were considered:
Isometric when $b = 3$,
Allometric when *b* is other than 3 or less than 3 (positive if $b > 3$, negative if $b < 3$).
Condition factor (K) was calculated by the following equation (Froese 2006):

$$k = \frac{100w}{l^3}$$

W → Total weight.

L → Standard length.
K→ Condition Factor.
The Kolmogorov-Smirnov test was used to determine the normality of the data. The data were analyzed within the SPSS version 19.0 software package and Microsoft Excel 2010 software.

## RESULTS

282 female and 264 male specimens of *O. bergianus* were collected from Jajrud River in the one-year sampling period. The range of total length (TL) and total weight of males and female were 3.8-7.5 cm, 3-7.6 cm, 0.36-3.53 g and 0.2-4.67 g respectively. Relationships between length-weight were highly significant ($p < 0.001$) with coefficient of determination ($r^2$) for males and females as 0.94 and 0.95, respectively. The growth of males and females was found to be positive allometric ($b > 3$, $p > 0.05$) (Table 2; Figs. 3-4). The minimum and maximum of fork lengths were 3.7- 7.3 cm for males and 3-7.3 cm for females, respectively. The values for standard length in males and females were 3-6.7 cm and 2.6-6.6 cm, respectively (Table 3).

**Table 2.** Length-weight relationships, total length and total weight for both sexes in *O. bergianus.*

| | | TL | TW | TL | TW | Length-Weight | |
|---|---|---|---|---|---|---|---|
| **Sex** | N | Min-Max | Min-Max | Mean ± SD | Mean ± SD | b | $R^2$ |
| Male | 264 | 3.8-7.5 | 0.36-3.53 | 5.82 ± 0.85 | 1.46 ± 0.64 | 3.14 | 0.94 |
| Female | 282 | 3-7.6 | 0.2-4.67 | 5.21 ± 1.08 | 1.23 ± 0.94 | 3.42 | 0.95 |

Note: TL: Total Length; TW: Total Weight; $R^2$: Coefficient of Determination.

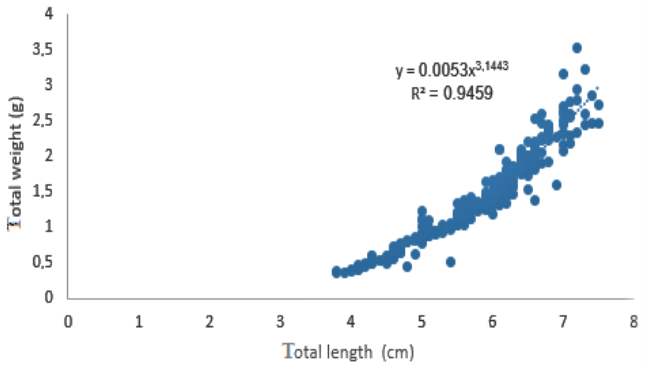


**Fig. 3.** The length-weight relationships in male *Oxynoemacheilus bergianus.*

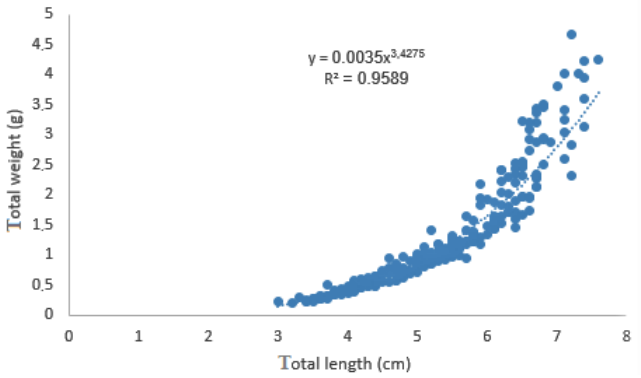


**Fig. 4.** The length-weight relationships in female *Oxynoemacheilus bergianus.*

**Table 3**. Fork and standard lengths for both sexes in *O. bergianus.*

| | FL | SL | FL | SL |
|---|---|---|---|---|
| Sex | Min-Max | Min-Max | Mean ±SD | Mean ±SD |
| Male | 3.7-7.3 | 3-6.7 | 5.59±0.81 | 4.78±0.76 |
| Female | 3-7.3 | 2.6-6.6 | 5±1.04 | 4.3±0.93 |

Note: FL: Fork length; SL: Standard length.

Based on calculated GSI and MGSI, females with mature ovaries appeared in March and April and became dominant in May; then after a considerable reduction in the rate of occurrence was observed until January. The ovaries showed a secondary increasing weight from September through October, as well (Figs. 5-6). Males got maturity similar to females in May and exhibited a significant reduction in weight through August (Figs. 7-8). Two reproductive peaks were observed in this fish. The highest peak was reported in May and the second in October. The condition factor for both sexes was maximum (0.96) in May, while minimum (0.60) in February (Fig. 9).

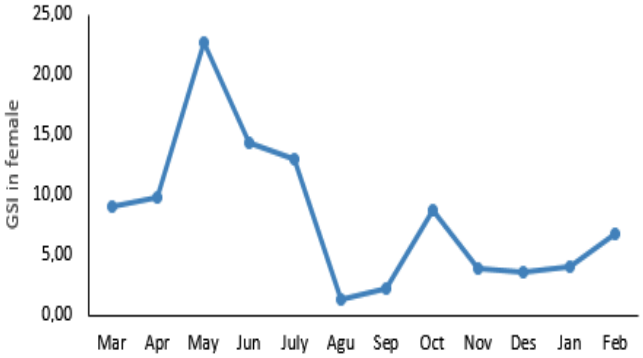


**Fig. 5.** Seasonal fluctuations in GSI, female *Oxynoemacheilus bergianus.*

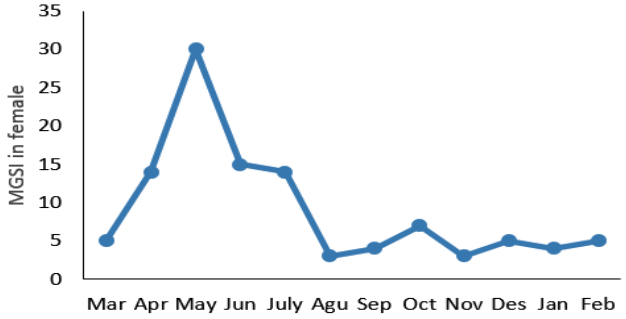


**Fig. 6.** Monthly changes in MGSI, female *Oxynoemacheilus bergianus.*

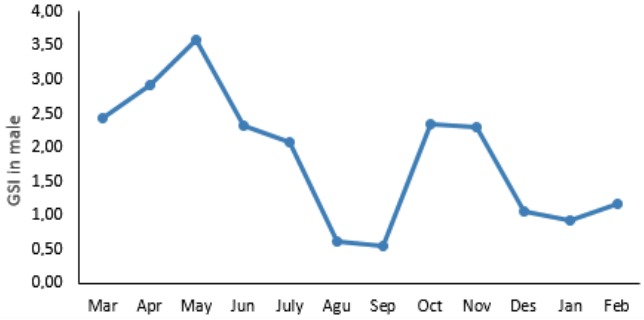


**Fig. 7.** Seasonal fluctuations in GSI, male *Oxynoemacheilus bergianus.*

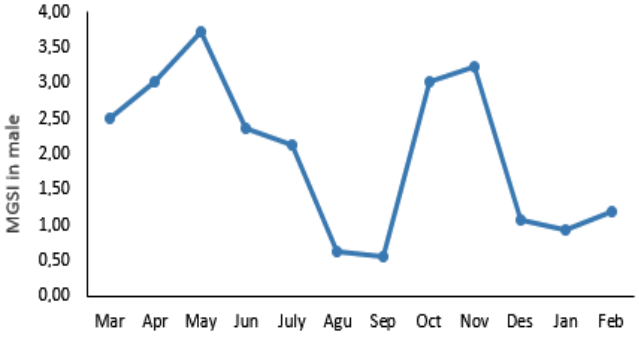

**Fig. 8.** Monthly changes in MGSI, male *Oxynoemacheilus bergianus.*

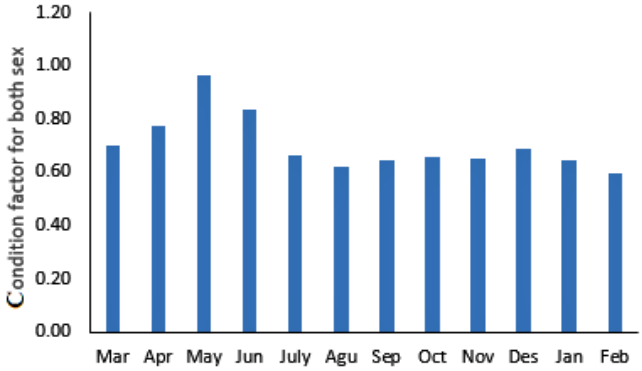


**Fig. 9**. Combined condition factor for both sexes in *Oxynoemacheilus bergianus.*

## DISCUSSION

The present study showed some quantitative traits of Nemacheilid fish species, *Oxynoemacheilus bergianus* in central Iran. Based on GSI and MGSI in both sexes, the reproductive period of this species was inintiated in February and peaked in May (Figs. 5-8). The highest GSI values are related to the ripe and the ripe running stages in gonads, while the lowest, represent totally spent stage or initiation of developing stage (recovering stages) (Mirghiyasi *et al*. 2016). Our results is consistent with those obtained by Pourshabanan *et al.* (2017a) on the spawning season in females of *O. bergianus* in the Namak Lake basin. In species that spawn in late spring and in summer such as the loaches, the GSI remains low in winter and then sharply rises just before the spawning season due to increasing food availability and temperature (Wootton 1998; Mansouri-Chorehi *et al*. 2016). In the study by Mirghiyasi *et al.* (2016) on the *O. persa* from the Iranian Kor River basin, the gonadal stages exhibited that this endemic species spawns in the middle of spring which is in line with the gonadosomatic index (GSI). The variations in this index are related to different environmental conditions such as water temperature (Conover 1990). According to Mousavi-Sabet *et al.* (2011, 2012), in the loach genus *Cobitis* in Iran, spawning occurs in May when the water temperature is about 19.1- 25.1 °C. Measuring the length and weight and also specifying their relationship can display a great information concerning to the composition of populations, age at maturity, competition rate, lifespan, mortality and aquatic growth (Fafioye & Oluajo 2005; Hanif *et al*. 2020). The regression coefficient (b) value is commonly found in fish between 2 and 4 (Gonzalez Acosta *et al*. 2004). The allometric law or principle, known as the principle of growth measurement, in its most comprehensive form, is the simplest possible rule in association with relative growth. Accordingly, it simply suggests that the relative increase in the variable "y" to the relative increase in the variable "x" is a constant value (Bertalanffy 1938). The value "b" indicates the type of fish growth, i.e. homogeneous or heterogeneous (Pauly 1983). In fish with homogeneous growth (with the same growth rate in all body dimensions), if the body length is doubled, then the weight is approximately double as well (Biswas 1993; King 2013). Thus, it can be concluded that in these fish the "b" value should be equal to 3. If the growth is isometric (growth in all dimensions is the same), "b" is not equal to 3, depending on the fish species, the growth may be positive ($b > 3$) or negative ($b < 3$) allometric. In the present study, the combined "b" value of males/female was higher than 3 (3.28) and displayed a positive allometric growth (Table 2; Figs. 3-4). Length-weight relationships for nine Nemacheilid loaches were evaluated by Golzarianpour *et al.* (2011) from different basins in Iran. These authors found that the value of parameter "b" for *O. bergianus* from Jajrud River was 3.01 ± 0.10 with isometric growth. Zamani-Faradonbeh *et al.* (2015) and Jamali *et al* (2015) reported that "b" value in *O. bergianus* from Totkabon and Aras rivers in southern and northwestern Caspian Sea basin, Iran, were equal to 2.98 and 2.97, respectively and also in these cases, the growth can be considered highly isometric. The length-weight relationships in fishes can be dependent on some factors such as season, habitat, gonad maturity, sex, diet, health and preservation techniques of the populations (Wootton 1998), which were not evaluated in the present study. Therefore, differences between the present date and other studies could potentially be attributed to the combination of these factors. The monthly condition factor (CFs) based on standard length were observed to be higher (0.96) in May than in other months, reflecting that specimens had better conditions in this month, while the lowest value (0.60) observed in February (Fig. 9). Zamani-Faradonbeh *et al.* (2015) reported that the CFs values were 0.83 ± 0.167 in *O. bergianus* and 0.94 ± 0.149 in *Cobitis keyvani* from Totkabon River, a tributary of Sefidrud River, Southern Caspian Sea basin, Iran. The condition factor is a parameter that reflects

interaction between biotic and abiotic factors in the biological conditions of fishes. Thus, this index may vary among fishes in different habitats (Blackwell *et al*. 2000; Hossaini *et al*. 2020). The CFs value of a given fish population increases in the spring and peaks in May, as a result of the increased food in this season. Condition factors ≥ 1 represent a good rate of feeding and suitable environmental condition (Ujjania *et al*. 2012). Our results, estimate a CFs < 1 for *O. bergianus* which is probably due to lack of optimal environmental conditions for the individuals in Jajrud River.

## CONCLUSION

The present study provides new data on LWR, breeding season and CF for *O. bergianus* that would be useful for fishery biologists and managers. However, more studies on the fish population biology are needed for better understanding the factors affecting fish growth especially in the Iranian river basins.

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## CONFLICT OF INTEREST

The authors declare no conflict of interest.

## DATA AVAILABILITY STATEMENT

Data are available only on personal request to the corresponding author.

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