Some biological characteristics of Sefidrud loach, *Oxynoemacheilus bergianus* (Teleostei: Nemacheilidae), in Aras River, northwestern Caspian Sea basin

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Abstract: Some 190 specimens of Sefidrud loach, *Oxynoemacheilus bergianus*, were collected from Aras River (Northwestern Iran) and age, size, and some biological characteristics of the samples were investigated from March to July 2013. The maximum age was 3+ years. The specimens ranged in size from 42 to 64mm for males and 45 to 61mm for females in total length, weighing from 0.62 to 2.03g for males and 0.63 to 1.66g for females. Length-weight relationship was estimated as $W = 0.00005TL^{2.81}$ for females, $W = 0.000005TL^{3.11}$ for males and $W = 0.000008TL^{2.97}$ for the sexes combined. Sex ratio was 1M:0.9F, in favor of males ($P<0.05$). The growth model was isometric for males, females and sexes combined. The calculated maximum Fulton’s condition factor ($K_F$) and allometric condition factor ($K_A$) were 0.900 and 0.010 in males and 1.000 and 0.009 in females, respectively. The most frequent age classes in the samples were 2+ years for both males and females. In general, as most other loaches, Sefidrud loach is also a small short lived species with a low frequency in Aras River.

Keywords: Loaches, Growth, Condition factor, Sex ratio, Iran.

Introduction

The Nemacheilidae is a species-rich lineage of the order Cypriniforms, consisting mostly of small benthic fishes inhabiting freshwaters of Europe, Asia and Ethiopia. Little is known about the nemacheilid loaches of Western Asia because of their small size and low value for marketing (Golzarianpour et al. 2009). About 30 species in six genera have been reported from Iran (Nalbant & Bianco 1998; Coad & Nalbant 2005; Prokofiev 2009; Golzarianpour et al. 2011a) and more expected to be described.

They inhabit a variety of inland waters, e.g. turbulent mountain streams to salty rivers in dry lowlands (Abdoli 2000). However, there is little information on their general biology in Iran (Tabiée & Abdoli 2005; Esmaeili & Ebrahimi 2006; Heydarnejad 2009). The loaches are found in most rivers throughout Iran, including Caspian Sea, Tigris, Kor and Persian Gulf river basins (Saadati 1977; Coad 1987, 2000; Keivy et al. 2015).

The Sefidrud loach, *Oxynoemacheilus bergianus* (Derzhavin, 1934) is an endemic widespread member of the nemacheilid fishes reported from Caspian Sea, Urmia and Namak basins (Abbasi et al. 1999; Abdoli 2000; Esmaeii et al. 2010, 2014). Jolodar & Abdoli (2004) and Tabatabaei et al. (2013), Kamaloo & Keivany (2014), Zamani-Faradonbe et al. (2015) and Tabatabaei et al. (2015) have provided some information on the biology of *Oxynoemacheilus bergianus*, but, in general, very little is known about its distribution and biology. Detailed description of its life history has not been given in the literature.
However, providing information on the basic biological parameters of this loach species is fundamental for understanding its life history patterns and implementing effective management and conservation measures. Hence, the aim of this study was to describe the age structure, growth, condition factors and length-weight relationship (LWR) of *O. bergianus* population inhabiting the Aras River system, southwestern Caspian Sea basin in Iran.

### Materials and methods

Monthly sampling of *O. bergianus* was carried out from March 2013 to July 2013 in the last week of each month on different days at two sampling sites in Aras River (39°11′N, 45°08′E). The specimens were caught using a beach-seine with a mesh size of 2mm. The net was chosen for its simplicity and higher catch efficiency in sampling small specimens. Fish specimens were immediately preserved in 10% formaldehyde solution for further examinations. A total of 190 specimens were analyzed. In the laboratory, all specimens were measured for total length (TL) and total body weight (TW). Age was determined from both left and right opercula; banding patterns being reviewed three times (each time by a different person) using a 20-40× binocular microscope under reflected light.

The relationship between TL and TW was determined using the equation:

\[ W = aL^b \]

Where \( a \) is the intercept and \( b \) is the slope (coefficient of allometry), as per Pauly (1984). Pauly (1984) t-test was used to determine if the slope of relationships was significantly different from 3. Sex was determined by visual examination of the gonad tissue. Fulton’s condition factor (\( K_F \)) (Fulton 1904) was calculated using the equation:

\[ K_F = \frac{100 \times W}{L^3} \]

Where \( W \) is the total body weight (g) and \( L \) is the total length (cm). The scaling factor of 100 was used to bring the \( K_F \) close to unit. Allometric condition factor (\( K_A \)) was calculated using the equation of Tesch (1968):

\[ K_A = \frac{W}{L^b} \]

Where \( W \) is the body weight, \( L \) is the total length and \( b \) is the LWRs parameter. Analysis of co-variance (ANCOVA) was performed to test significant differences in weight-length relationships between sexes. Any significant difference in the overall sex ratio was assessed using the Chi-square test (Zar 1984). All statistical analyses were performed at a significance level of 95% using the SPSS 21 software package.

### Results

Males ranged from 42 to 64mm (52.48±4.29SD) and 0.62 to 2.03g (1.12±0.30g), while females ranged from 45 to 61mm (51.70±4.06mm) and 0.63 to 1.66g (1.05±0.27g). Opercula readings revealed that the majority of specimens were in age group 2+, with 3+ being the oldest age recorded for both sexes. Observed length-at-age in the population was different between sexes, males being longer and heavier than females (Table 1). Length and weight frequency distribution of the fish (Figs. 1 & 2)

<table>
<thead>
<tr>
<th>Age group</th>
<th>Total length±SD</th>
<th>Min.-Max.</th>
<th>Total weight ± SD</th>
<th>Min.-Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1+</td>
<td>51.63±4.18</td>
<td>48-60</td>
<td>1.05±0.31</td>
<td>0.81-1.73</td>
</tr>
<tr>
<td>2+</td>
<td>53.06±3.68</td>
<td>42-62</td>
<td>1.15±0.25</td>
<td>0.62-1.91</td>
</tr>
<tr>
<td>3+</td>
<td>58.50±3.69</td>
<td>56-64</td>
<td>1.61±0.28</td>
<td>1.39-2.03</td>
</tr>
<tr>
<td>Female</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1+</td>
<td>49.9±4.12</td>
<td>46-59</td>
<td>0.94±0.26</td>
<td>0.63-1.58</td>
</tr>
<tr>
<td>2+</td>
<td>52.42±3.60</td>
<td>45-60</td>
<td>1.07±0.22</td>
<td>0.7-1.62</td>
</tr>
<tr>
<td>3+</td>
<td>56.5±6.36</td>
<td>50-61</td>
<td>1.18±0.52</td>
<td>0.8-1.66</td>
</tr>
</tbody>
</table>
indicated that the most frequent size classes in the samples were 47-57mm and 0.7-1.1g for males and females. Males were rare in length classes longer than 62-64.5mm.

The length-weight relationships were estimated as \( W = 0.00005T^{2.81} \) for females, \( W = 0.000005T^{3.11} \) for males and \( W = 0.000008T^{2.97} \) for the sexes combined, indicating an isometric growth model for males, females and sexes combined (\( P > 0.05 \)) (Fig. 3). The overall ratio of males to females was 1M:0.9F and Chi-square analysis indicated a significant difference from the expected ratio of 1:1 (\( \chi^2 = 16.84, P < 0.05 \)).

The total length-weight relationships were evaluated for males, females and sexes combined. A significant relationship with the high regression coefficient (\( r > 0.92 \)) was found between the length and weight of the Sefidrud loach. Age frequency distribution of the fish (Fig. 4) indicated that the most frequent age classes in the samples were 2 year for males and females.

The different condition factors including allometric and Fulton’s of \( O. bergianus \) in Aras River.
are shown in Table 2. Minimum and maximum $K_A$ ranged from 0.008 to 0.01 for males and 0.005 to 0.009 for females, with mean values calculated as 0.01±0.0008 and 0.006±0.0006 for males and females, respectively. The $K_F$ ranged from 0.61 to 0.90 for males and 0.57 to 1.00 for females, with mean values calculated as 0.73±0.06 and 0.75±0.07 for males and females, respectively.

### Discussion

Because of lack of data on the *O. bergianus*, it is rather difficult to describe the current position of biology and ecology of the species. The sample size clearly indicates the low frequency of the species in the river, an indication that the species might be at risk because of ecological threats. Unfortunately, very little ecological data exists for Nemacheilid species (e.g., Tabatabaei et al. 2013).

Compared to some other species, *O. bergianus* has one of the smallest sizes (total length and weight), not exceeding 87mm and 5.84g (Zamani-Faradonbe et al. 2015) (Table 3) and males exhibit a much wider range in length and a higher maximum length than females. Variation in mean size (length and weight) of the population of a species could be explained on the basis of the different exploitation patterns and/or ecological conditions. In this sense, while the loach is not subject to commercial exploitation, variations in the environmental conditions of the area seem to be the main factors affecting Sefidrud loach populations. The maximum age of *O. bergianus* was less than that observed by Patimar et al. (2009, 2010) in *Paracobitis malapterura* and *Paraschistura kessleri*. Patimar et al. (2009, 2010) found a maximum age of 4+ years for *P. malapterura* in Zarrin-Gol River (now has been considered as *P. hiricanica*, see Mousavi-Sabet et al. 2015) and *P. kessleri* in Zanglanlou River. The exponents of total length–somatic weight relationship of *O. bergianus*, estimated in the Aras River, showed that the somatic weight increased isometrically with the total length. Golzarianpour et al. (2011b) and Hasankhani et al. (2014) reported the value of exponent $b$ in *O. angorae* (possibly a synonym of *O. bergianus*) as 3.01 and 2.81, respectively. Tabatabaei et al. (2015) reported the value of exponent $b$ in *O. bergianus* as 2.83 for *O. bergianus* and as 2.93 for *P. malapterura* from Kordan River, which is consistent with our result. The estimated $b$-values in our study differed from the results reported by Patimar et al. (2009), who found a positive allometric growth in females (3.81) and a negative allometric growth in males (2.62) and from Tabiee & Abdoli (2005), who found a negative allometric growth ($b_{male}$= 2.80 and $b_{female}$= 2.77) for *P. malapterura* from the Zarrin-Gol River. Golzarianpour et al. (2011b), found an isometric growth in *O. brandtii* from the Zarrineh River, *O. farsicus* from the Kor River and *O. angorae* from the Jajroud River, respectively, which is consistent with our result. Weight-length relationships produced good fits and biologically sound results and could be used for comparison proposes. The total

### Table 2. Condition factors for males, females, and sexes combined of *Oxynoemacheilus bergianus* in Aras River.

<table>
<thead>
<tr>
<th>Condition factor</th>
<th>N</th>
<th>Min</th>
<th>Max</th>
<th>Mean ± SD</th>
<th>CL95%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male $K_F$</td>
<td>100</td>
<td>0.61</td>
<td>0.90</td>
<td>0.73±0.06</td>
<td>0.72-0.74</td>
</tr>
<tr>
<td>Male $K_A$</td>
<td>100</td>
<td>0.008</td>
<td>0.01</td>
<td>0.01±0.0008</td>
<td>0.0099-0.0101</td>
</tr>
<tr>
<td>Female $K_F$</td>
<td>90</td>
<td>0.57</td>
<td>1.00</td>
<td>0.75±0.07</td>
<td>0.74-0.76</td>
</tr>
<tr>
<td>Female $K_A$</td>
<td>90</td>
<td>0.005</td>
<td>0.009</td>
<td>0.006±0.0006</td>
<td>0.0059-0.0061</td>
</tr>
<tr>
<td>Combined sex $K_F$</td>
<td>190</td>
<td>0.57</td>
<td>1.00</td>
<td>0.75±0.06</td>
<td>0.743-0.757</td>
</tr>
<tr>
<td>Combined sex $K_A$</td>
<td>190</td>
<td>0.006</td>
<td>0.01</td>
<td>0.008±0.0006</td>
<td>0.0079-0.00807</td>
</tr>
</tbody>
</table>

N: Number; Min: Minimum; Max: Maximum; SD: Standard Deviation; CL: Confidence Limit for mean values; $K_F$: Fulton’s condition factor; $K_A$: Allometric condition factor
length-somatic weight relationship showed that growth model was not different in males and females. Analysis of the data available in the literature (Przybyliski & Valladolid 2000, Slavik & Rab 1996, Patimar et al. 2011a, b, Alavi-Yeganeh et al. 2011, Daneshvar et al. 2013) shows that the value of $b$ in fish species can vary considerably, indicating a change in body form with species, itself probably an effect of different environmental conditions and species characteristics (i.e. morphological characteristics of the species).

Sex ratio in *O. bergianus* was 1M:0.9F in favor of males. Nikolsky (1980) reported that sex ratio varied considerably from species to species; but in the majority of species, it is close to one. However, subsequent changes in this ratio may be explained by a number of hypotheses, including differences in habitat preference according to the season or sex, sampling errors, or selective mortality (Fernandez & Rossmann 1997). Sex ratio was also different from species of Nemacheilidae, e.g., *Paracobitis malapterura* (Patimar et al. 2009) and *Barbatula barbatula* (Vinyoles et al. 2010).

There is no published information on the condition factor of *O. bergianus* to be compared with the present results. The condition factor (K) reflects, through its variations, information on the physiological state of the fish in relation to its welfare. The condition factor also gives information when comparing two populations living in certain feeding, density, climate, and other conditions; when determining the period of gonad maturation; and when following up the degree of feeding activity of a species to verify whether it is making good use of its feeding source (Weatherley 1972). The present study provides, for the first time, some information on age, growth and condition factor of Sefidrud loach, *O. bergianus*, in Aras River. We hope that our results would stimulate further studies on the biology of this species in the future.

### Reference


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