

Length-weight relationship and condition factor of three endemic fish species, *Ponticola bathybius*, *Neogobius caspius* and *Neogobius pallasii* (Perciformes: Gobiidae) from the Southern Caspian Sea basin, Iran

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Abstract: In this study, the length-weight relationships (LWRs) and condition factors were estimated for 445 specimens belonging to three gobiid species viz. *Ponticola bathybius* (Kessler, 1877), *Neogobius caspius* (Eichwald, 1831) and *Neogobius pallasii* (Berg, 1916) from the Southern Caspian Sea basin. Total length and total weight of the examined specimens ranged 4.9-28.3 cm and 0.64-263.4 g, respectively. The length-weight parameter *b* of the studied species found between 2.47 (*N. caspius*) and 3.45 (*N. pallasii*) with *r*² ranging 0.831 to 0.988. LWR and K parameters are reported first time for *N. pallasii* from the Caspian Sea basin. The condition factor estimated was calculated from 0.94 (*N. pallasii*) to 0.98 (*N. caspius*) and 1.00 (*P. bathybius*). The basic biological information on the LWRs of these three gobies will be useful as baseline information for further biological research in the region.

Keywords: Gobiidae, goby, condition factor, Southern Caspian Sea basin

INTRODUCTION

Study of the length-weight relationship (LWR) is important in fisheries science as it provides valuable information on fish condition (Bagenal, 1978). It is applied to compare the interregional morphological variation of a single species' populations (Froese, 2006; Ali et al., 2013), to estimate the weight of a specimen from its length and vice versa, to estimate the biomass, understanding the life cycle, evaluation of the fish stocks, ontogenetic changes and growth studies (Froese, 2006; Cherif et al., 2008; Mouludi-Saleh and Eagderi, 2019; Eagderi et al., 2020a; Eagderi et al., 2020b; Mouludi-Saleh et al., 2021).

Condition factor (K) states condition of fish species viz. well-being of a certain species and its degree of fatness, the state of sexual maturity, the degree of food sources availability, and age and sex of some species and is significance for management and conservation of natural populations (Bagenal, 1978; Sarkar et al., 2009; Muchlisin et al., 2010).

In the Iranian coast of the Caspian Sea, 43 species of the family Gobiidae in 15 genera have been reported (Esmaeili et al., 2018; Eagderi et al., 2020c). The species members of the genus *Neogobius* is three (Froese and Pauly, 2008; Esmaeili et al., 2018; Eagderi et al., 2020c) and those of the genus *Ponticola* is six in the southern Caspian Sea (Eagderi et al., 2020c). These genera are great importance due to their

relatively large size (10 to 35 cm) (Berg, 1949; Rahimov, 1991). Therefore, in this study, LWRs and K are provided for *Ponticola bathybius*, *Neogobius caspius* and *N. pallasii* from the Southern Caspian Sea basin.

MATERIAL AND METHODS

A total of 165 specimens of *P. bathybius*, 102 *N. caspius* and 178 *N. pallasii* were collected between September 2012 and April 2019 using seine nets (mesh size: 4, 6 and 8 mm) from The Anzali Wetland, Turkman, Langrud, Chaboksar, Sefidroud and Lisar shores of the Southern Caspian Sea. All sampled fishes were anesthetized with a 1% clove oil solution and fixed with 10% buffered formalin then transferred to the laboratory for further studies. For each specimen, total length (TL) was measured with a digital caliper to the nearest 0.01 mm and body weight (BW) was recorded using a digital scale to the nearest 0.1 g.

The length-weight relationship was determined by the method of least squares using the equation of $W = aL^b$ and logarithmically transformed into $\text{Log}(W) = \text{Log}(a) + b \text{log}(L)$ (Froese, 2006), where *W* is the total body weight (g), *L* is the total length (cm) and "a" is the intercept and "b" is the slope. Prior to regression analyses, log-log plots of the length-weight pairs were performed to identify outliers (Froese et al., 2011). Outliers perceive in the log-log plots of all species were removed from the regression. The student's t-test (ts)

was used to determine whether the parameter b is significantly different from the expected or theoretical value of 3. Fulton's condition factor (K) was estimated by the equation: $K = 100 \times (W/TL^3)$ (Fulton, 1904), where W is the total body weight (g), L is the total length (cm) and scaling factor of 100 was used to fetch the K close to the unit factor. All statistical analyses were performed in Excel 2016 and PAST v 2.17b (Hammer et al., 2001) software.

RESULTS AND DISCUSSION

The length-weight relationship (LWR) data of fish species is an important parameter in their dynamic population studies, playing a key role in fisheries assessments. In the current study, LWR parameters of 445 gobiid fishes belonging to three species were estimated. Total lengths and weight of

P. bathybius, *N. caspius* and *N. pallasii* ranged 6.95-28.36 cm, 2.3-263.4 g and 8.20-13.20 cm, 7.0-21.6 g, 4.92-12.55 cm and 0.6-24.6 g, respectively. The results of LWR data of the three studied species, including values of the slope parameter (b), intercept (a), coefficient of determination (r^2) and 95% CL of b , a and condition factor (K) of the studied species are presented in Table 1.

The results showed b -values of the studied species ranging 2.47 (*N. caspius*) to 3.45 (*N. pallasii*) and coefficient of determination (r^2) 0.83 to 0.98, indicating the length increased with increasing weight of the fish (Konan et al., 2007; Tah et al., 2012; Koffi et al., 2014; Cicek et al., 2019). The b -value based on Froese, 2006 is between 2.5 and 3.5 or 2-4 (Tesch 1971), which all calculated b -values were within this expected ranges in this study.

Table 1. Descriptive statistics and length-weight relationship parameters for three gobiid species from the Southern Caspian Sea basin 2012-2019

Species	n	Total length (cm)	Total weight (g)	LWR parameters			Condition factor (K)	Growth pattern	P	t		
		min-max	min-max	a	b	r ²					95% CL of b	95% CL of a
<i>P. bathybius</i>	165	6.95-28.36	2.3-263.4	0.003	3.32	0.988	3.28-3.35	0.002-0.0047	1.00±0.18	A ⁺	<0.05	38.78
<i>N. caspius</i>	102	8.20-13.20	7.0-21.6	0.032	2.47	0.831	2.25-2.70	0.013-0.026	0.98±0.12	A ⁻	<0.05	-75.81
<i>N. pallasii</i>	178	4.92-12.55	0.6-24.6	0.003	3.45	0.902	3.25-3.67	0.002-0.005	0.94±0.18	A ⁺	<0.05	59.48

N= number of individuals; Min= minimum; Max= maximum; a= intercept; b= slope; CL= confidence limits; r²= coefficient of determination.

In LWRs, b -values which are higher and lower than 3 indicated positive and negative allometric growth patterns, respectively. Based on the results, allometric growth pattern was positive for *P. bathybius* and *N. pallasii*, and negative for *N. caspius*. Abdoli et al. (2009) estimated the b -value of *P. bathybius* as 2.44 lower than our result (3.32). Aghajanpour et al. (2016) and Mahdipour et al. (2017) in their study reported b -value for *N. caspius* 2.85-3.0 and 3.17 which is different with our study. LWR and K parameters have been reported for the first time for *N. pallasii* from the Caspian Sea basin. LWRs may change during the events of life cycle, growth, and onset of maturity, gut fullness, sampling techniques, and availability of food (Le Cren, 1951).

Fulton's condition factor (K) of the studied species ranging 0.94 to 1.00. Higher value of the condition factor indicates suitability of a specific water body for growth of fish (Mouludi-Saleh and Eagderi, 2019; Abbasi et al., 2019). The condition factor fluctuating is based on the seasonal variations of the gonads and feeding intensity (Biswas, 1993). Finding of the present study will be helpful in biological studies and fisheries management.

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