

Length-weight relationships of two threatened *Gobio* species endemic to Turkey: *Gobio insuyanus* Ladiges and *Gobio microlepidotus* Battalgil

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Received – 27 February 2019/Accepted – 16 September 2019. Published online: 30 September 2019; ©Inland Fisheries Institute in Olsztyn, Poland
Citation: Ergönül M.B., Breine J., Atasağun S. 2019 – Length-weight relationships of two threatened *Gobio* species endemic to Turkey: *Gobio insuyanus* Ladiges and *Gobio microlepidotus* Battalgil – Fish. Aquat. Life 27: 118-121.

Abstract. The length-weight relationship (LWR) parameters of *Gobio insuyanus* Ladiges, and *Gobio microlepidotus* Battalgil, which are endemic to Turkey, were estimated. The fish were caught by single-pass electrofishing with backpack electrofishing gear. The range for fork length and total weight and the LWR parameters including regression parameters (a , b , and their 95% CI) and the coefficient of determination (r^2) were calculated for both species. The b values were 2.921 for *G. insuyanus* and 2.906 for *G. microlepidotus*. The length-weight relationships were statistically significant for both species ($P < 0.001$). An urgent species conservation plan is highly recommended for *G. insuyanus* in light of its narrow distribution area and the human impacts threatening its natural habitat.

Keywords: Fisheries, *Gobio*, gudgeon, LWR, Insuyu Creek, Lake Tuz

Introduction

A total of 409 freshwater fish species have been reported in Turkey with a high degree (47.4%) of endemism (Çiçek et al. 2018, Fricke et al. 2019). Currently, there is limited knowledge on the fish fauna of given river basins and the natural geographical distribution of several fish species Turkey (Yerli et al. 2016). Furthermore, long-term datasets of fish are insufficient or are not yet available for many river basins (Ergönül et al. 2018). In addition, the length-weight relationship (LWR) parameters of most endemic fish have not been reported yet. The determination of LWRs is considered to be a critical quantitative aspect of fisheries science (Froese 2006).

The genus *Gobio* (Subfamily: Gobioninae) is represented in Turkish freshwaters by 14 species, 11 of which are endemic to Turkey (Çiçek et al. 2018, Fricke et al. 2019). Although, there is considerable data on the systematics of *Gobio* spp. (Naseka et al. 2006, Turan et al. 2012, 2016, 2017), the LWR parameters of the subfamily Gobioninae has received little attention in Turkey (Özdemir 2012, Özdemir and Erk'akan 2012, Erk'akan et al. 2014, Saç et al. 2019). *Gobio insuyanus* Ladiges (Cihanbeyli gudgeon) and *Gobio*

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microlepidotus Battalgil (Beyşehir gudgeon) are local endemics in the Konya Closed River Basin. *G. insuyanus* and *G. microlepidotus* are categorized as critically endangered (CR) and vulnerable (VU), respectively by the International Union of Conservation for Nature (IUCN) (Freyhof 2014a, 2014b). However, there is limited information on the growth characteristics, including LWR parameters, of these two fish species. Thus, the aim of the present study was to estimate the LWR parameters of *G. insuyanus* from Insuyu Creek (Cihanbeyli, Turkey) and *G. microlepidotus* from Üstünler Stream (Beyşehir, Turkey).

Materials and Methods

The fish were caught with single-pass electrofishing using backpack electrofishing gear (Samus 725-MP). The sampling locations were located in the Konya Closed River Basin (Turkey). Sampling was conducted seasonally in Üstünler Stream (Lake Beyşehir drainage) from August 2016 to July 2017 and from March 2017 to February 2018 in Insuyu Creek (Lake Tuz drainage). Electrofishing was conducted by wading upstream in all typical habitats. Fish samples were identified according to Geldiay and Balık (2002), Naseka et al. (2006), and Turan et al. (2012). Fish samples were counted, the length (fork length) and weight of the fish were measured *in situ* (to 0.1 cm and 0.1 g, respectively). The fish were released back into the streams at their catch location. A few of the specimens were sacrificed with an overdose of anesthesia (MS-222) and fixed in formaldehyde

solution (10%) for taxonomic confirmation in the laboratory.

The LWR parameters of the fish and P values were computed with R (version 3.5.2; R Development Core Team 2018) with the FSA package as described by Ogle (2015). The power equation $W = a \times L^b$ was calculated for each species, where W and L indicates body weight (g) and fork length (cm), respectively, and a and b are the coefficients of the functional regression between W and L (Froese 2006).

Results

A total of 53 *G. insuyanus* and 91 *G. microlepidotus* were caught during the surveys. The range for fork length and total weight, LWR parameters including regression parameters (a , b , and their 95% CI), and coefficients of determination (r^2) are presented in Table 1. The b values were 2.921 and 2.906 for *G. insuyanus* and *G. microlepidotus*, respectively. The relationship between the length and weight of both species was significant ($P < 0.001$).

Discussion

Over the last few decades the surface and underground water sources of the Konya Closed River Basin have been exploited intensely particularly for impoundment and irrigation (RBPAP 2013). Decreases in precipitation rates have also been problematic for freshwater organisms inhabiting the basin. Most of the natural freshwater wetlands, with

Table 1

Range for fork length (FL) and total weight (W) and LWR parameters, including regression parameters (a , b , and their 95% CI), and coefficients of determination (r^2) for *Gobio insuyanus* and *Gobio microlepidotus*

Species	n	FL (cm) (min-max)	W (g) (min-max)	a (95% CI)	b (95% CI)	r^2
<i>G. insuyanus</i>	53	4.4-16.1	0.9-57.2	0.0171 (0.0109-0.0278)	2.92 (2.716-3.126)	0.941
<i>G. microlepidotus</i>	91	4.0-15.7	0.8-47.9	0.0156 (0.0119-0.0204)	2.906 (2.788-3.023)	0.964

the exception of some large lakes such as Lake Beyşehir, have dried up or shrunk to a great extent (Durmaz-Dıvrak 2010); our field observations confirm this. The present study included some other sampling locations in the Lake Tuz sub-catchment; however, during the surveys we observed that most of the streams had totally dried up or had shrunk, with the exception of the headwaters of Insuyu Creek. Furthermore, we also observed that approximately 100-150 m downstream from the stream pool of the Insuyu Creek headwaters, the water level was less than 10 cm with a very narrow stream bed (<30 cm). Such poor conditions are far from those that can support aquatic life. Thus, *G. insuyanus* seems to be trapped in the stream pool of Insuyu Creek. The headwaters of Insuyu Creek are used for irrigation and as a source of drinking water by surrounding villages, which directly effects the future of *G. insuyanus*. Thus, there is an urgent need for a species conservation plan for *G. insuyanus* that includes ensuring flow regime above critical levels in the stream bed and fish movements in the basin, which has limited freshwater sources. Lake Beyşehir is the main and largest surface water body in the basin, and water scarcity is not expected to effect Beyşehir gudgeon for the moment. Furthermore, available information (Çiçek et al. 2018) indicates that Beyşehir gudgeon has a larger distribution area.

According to the Bayesian LWR predictions in FishBase (Froese and Pauly 2019), parameters *a* and *b* in the current study were within the ranges reported for *G. insuyanus* and *G. microlepidotus*. The range for *a* values were reported as 0.00505-0.01724 for *G. insuyanus* and 0.00366-0.01807 for *G. microlepidotus*. The range for *b* values were reported as 2.90-3.24 for *G. insuyanus* and 2.86-3.24 for *G. microlepidotus* (Froese and Pauly 2019). There is only one report on the LWR parameters of *G. insuyanus* that is based on 16 specimens from the same locality (Insuyu Creek) in which the *a* and *b* value ranges were 0.0075-0.0112 and 3.059-3.229, respectively. Several factors, including season, food availability, sexual maturity, size range, and condition, can influence LWR parameters (Tesch 1971). The lower

abundance of fish samples in the sampling localities and the use of one type of fishing gear to catch the fish could have had an effect on the estimated LWR parameters for these two fish species. Therefore, the results of this study should be considered as tentative estimates. Future studies focusing on the growth features of these fish species should account for possible factors that affect fish growth. The results of this study contribute to the knowledge of the LWR parameters of two threatened *Gobio* species. LWRs are useful particularly for estimating standing-crop biomass when length-frequency distribution data is available and also for estimating unknown length from known weight and vice versa (Petrakis and Stergiou 1995).

Author contributions. M.B.E. designed the study, performed the field work, and wrote the paper; J.B. and S.A. analyzed the data and participated in writing the paper.

Acknowledgements. The authors are grateful to Dr. S. Cevher Özeren for assistance in identifying the fish species.

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