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LENGTH-WEIGHT RELATIONSHIPS OF FISH SPECIES IN MARMARA LAKE, WEST ANATOLIA, TURKEY

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ABSTRACT

The study reports on length–weight relationships (LWRs) for 13 fish species (*Atherina boyeri, Cobitis fahirae, Alburnus battalgilae, Cyprinus carpio, Carassius gibelio, Ladigesocypris mermere, Pseudorasbora parva, Petroleuciscus smyrnaeus, Rhodeus amarus, Vimba vimba, Sander lucioperca, Gambusia affinis, Knipowitschia mermere*) of 6 families in Marmara Lake, which is an alluvial set lake in west Anatolia, Turkey. Fish were caught between March 2012 and February 2013 with trammel nets and gillnets. The length–weight relationship was calculated using the expression: log (W) = log (a) + b log (L). Parameters of LWR are computed as "*a*" ranging from 0.0053 to 0.0385, "*b*" from 2.346 to 3.429, and "r^2" from 0.814 to 0.994. Growth types were determined to be isometric, positive allometric and negative allometric for 4, 4 and 5 species, respectively. In addition, the present study includes first records of LWR for two endemic and two native species in freshwater of Turkey.

The results would be useful for the protection of the presence of endemic species and sustainable fisheries in the lake.

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INTRODUCTION

The fishing data of Marmara Lake have been analyzed for the past ten years. Carp (*Cyprinus carpio*) has been found as the most commercial fish species, in addition to pike-perch (*Sander lucioperca*), wels (*Silurus glanis*) and bleak (*Alburnus battalgilae*). On the other hand, silver gold fish (*Carassius gibelio*) was stated in the lake but the price is not as good as for other commercial fishes despite the important production from the lake.

There are some studies for weight–length relationship (LWR) regarding fish species in freshwater of different geographic regions in Turkey (Tarkan et al., 2006; Torcu-Koç et al., 2006; Ergüden and Göksu, 2009; İlhan et al., 2012). Data of LWR in fishes could be useful to estimate the biomass of a fish species from their length observations for yield assesment (Froese, 1998; García et al., 1998). In addition, this relationship can be used (i) to estimate the growth type (isometric and allometric) from the length and weight of fish (Ricker, 1975), (ii) to determine the condition of fish and (iii) to compare life history characteristics of a fish species in different localities (Pauly, 1993; Petrakis and Stergiou, 1995; Goncalves et al., 1997; Hossain et al., 2013).

MATERIALS AND METHODS

Marmara Lake (38° 37′ 17" N; 28° 01′ 00" E), an alluvial set lake 12 km long and 6 km wide, is located near Manisa, West Anatoliae, Turkey (Lahn, 1948). Its altitude is circa 75 m and maximum and average water depths are 6.7 and 4.7 m, respectively (Altınayar et al., 1994). Trammel nets (mesh size: 10, 20, 30, 40 and 50 mm), gillnets (mesh size: 10, 20, 30, 40 and 50 mm) and seine-nets (mesh size: 10 mm) were used to collect monthly fish samples from March 2012 to February 2013. Total length (TL) was measured with a precision of 0.1 cm using a measuring board, and body weight (W) with an accuracy of 0.01 g and 0.1 g using a digital balance in small and large fishes, respectively. LWR parameters (*a* and *b*) were estimated by linear regression expressed by the equation log W = log *a* + *b* * log L; where W: weight (g), L: TL (cm), log a: intercept and b: slope of the regression line (Froese, 2006). In order to determine the type of growth, t_s =

b - 3 / se(b), the equation was used (Sokal and Rohlf, 1987) where t_s: t-test value, b: slope and se(b): the standard error of the slope. Finally, in order to determine whether it was isometric or allometric growth, the calculated t-test value was compared with the critical value in the table.

RESULTS AND DISCUSSION

This study examined 3233 individuals from 13 species. Table 1 presents the sample size, the minimum and maximum TL and W measurements for each species, the TL–W relationships, parameters *a* and *b*, the standard error of the slope and the coefficient of determination r^2. The expected range of 2.5<b<3.5 (Froese, 2006) was confirmed for all species. With an analysis of length range, four species (*Alburnus battalgilae, Gambusia affinis, Cobitis fahirae, Sander lucioperca*) showed isometric growth, the following four species: *Petroleuciscus smyrnaeus, Rhodeus amarus, Vimba vimba* and *Knipowitschia mermere* indicated a positive allometric growth, and finally five species (*Atherina boyeri, Cyprinus carpio, Carassius gibelio, Ladigesocypris mermere, Pseudorasbora parva*) showed a negative allometric growth. The study represents the first reference to LWRs for two endemic (*L. mermere* and *K. mermere*) and two native (*A. battalgilae* and *P. smyrnaeus*) species in freshwaters of Turkey. Tarkan et al. (2006), Torcu-Koç et al. (2006), Ergüden and Göksu (2009) have published reports about the length-weight relationship parameters of some of the freshwater fish species in inland waters of Turkey. Tarkan et al. (2006) reported positive allometric growth for *A. boyeri*, *C. gibelio*, *R. amarus*, *V. vimba* in Marmara region. They also stated both positive and negative allometric growth for *C. carpio* in different localities of Marmara region. The growth types were given by İlhan et al. (2012); *C. fahirae* and *R. amarus* showed positive allometries, *V. vimba* isometric growth and *C. bergamae* negative allometries. Additionally, İlhan et al. (2014) reported about the length-weight relationship parameters of *Rhodeus amarus* from 9 river basins of Turkey. According to their reports, growth types were determined as isometric for 5 basins and as negative allometric for 4 basins.

Parameters of the LWR in fishes can be affected by such factors as area, habitat, sex, seasonal variations, feeding habits, gonad maturity and investigation techniques in the observed length ranges of the individual caught (Tesch, 1971), all of which were not considered by the present study. The aim of this study was to produce length-weight relations for spe-

Table 1. Descriptive statistics and estimated parameters of weight–length relationship ($W = aL^b$); n, number of fish in sample; a and b, parameters of relationship; Se (b), standard error of slope (b); R^2, coefficient of determination (R < 0.05); t-test, A+, Pozitive Allometric (t-test; $t > t_{0.05}$, n>200 = 1.65); A-, Negative Allometric (t-test; $-t > t_{0.05}$, n>200 = 1.65), I, Isometric (t-test; $t < t_{0.05}$, n>200 = 1.65)

Family	Species	n	Total length (cm) Min-Max (Mean ± Se)	Total weight (g) Min-Max (Mean ± Se)	*a*	*b*	Se (*b*)	r^2	t-test
Atherinidae	*Atherina boyeri*	101	3.70-8.70 (6.26 ± 0.088)	0.40-5.40 (1.84 ± 0.074)	0.0084	2.908	0.050	0.971	-1.843^{A-}
Cobitidae	*Cobitis fahirae*	8	5.10-7.40 (5.73 ± 0.240)	0.70-1.80 (1.09 ± 0.117)	0.0176	2.346	0.458	0.814	-1.427^{I}
Cyprinidae	*Alburnus battalgilae*	298	14.60-24.10 (18.63 ± 0.066)	31.60-141.60 (66,64 ± 0.823)	0.0102	2.997	0.065	0.876	-0.049^{I}
	Cyprinus carpio	120	11.30-49.00 (25.68 ± 0.611)	24.00-1790.00 (316.32 ±21.300)	0.0310	2.796	0.038	0.979	-5.407^{A-}
	Carassius gibelio	2213	6.80-27.50 (14.54 ± 0.069)	4.90-372.20 (57.72 ± 0.967)	0.0173	2.974	0.010	0.976	-2.645^{A-}
	Ladigesocypris mermere	33	2.60-8.80 (6.70 ± 0.230)	0.70-10.80 (4.75 ± 0.422)	0.0385	2.481	0.117	0.936	-4.440^{A-}
	Pseudorasbora parva	116	5.20-11.0 (8.81 ± 0.148)	1.60-14.60 (7.72 ± 0.305)	0.0121	2.929	0.036	0.983	-1.981^{A-}
	Petroleuciscus smyrnaeus	87	4.40-13.80 (7.37 ± 0.279)	1.30-45.70 (9.82 ± 1.193)	0.0091	3.284	0.029	0.994	9.947^{A+}
	Rhodeus amarus	105	2.80-6.50 (4.25 ± 0.081)	0.26-4.49 (1.26 ± 0.089)	0.0089	3.328	0.056	0.972	5.878^{A+}
	Vimba vimba	79	14.20-24.90 (19.26 ± 0.371)	36.30-236.90 (98.68 ± 6.227)	0.0053	3.283	0.061	0.974	4.645^{A+}
Percidae	*Sander lucioperca*	29	11.30-22.20 (19.30 ± 0.541)	13.70-95.70 (68.93 ± 4.411)	0.0091	2.996	0.080	0.981	-0.054^{I}
Poecilidae	*Gambusia affinis*	5	2.60-3.90 (3.30 ± 0.204)	0.20-0.80 (0.52 ± 0.087)	0.0145	2.945	0.803	0.818	-0.069^{I}
Gobiidae	*Knipowitschia mermere*	39	2.00-2.70 (2.33 ± 0.027)	0.08-0.23 (0.13 ± 0.006)	0.0069	3.429	0.238	0.849	1.804^{A+}

cies in Marmara Lake (West Anatolia) which will be helpful for sustainable fishery management and conservation programs in the region.

Sažetak

DUŽINSKO-MASENI ODNOSI RIBA U JEZERU MARMARA, ZAPADNA ANATOLIA, TURSKA

Studıja prikazuje dužinsko-maseni odnos (LWR) za 13 ribljih vrsta (*Atherina boyeri, Cobitis fahirae, Alburnus battalgilae, Cyprinus carpio, Carassius gibelio, Ladigesocypris mermere, Pseudorasbora parva, Petroleuciscus smyrnaeus, Rhodeus amarus, Vimba vimba, Sander lucioperca, Gambusia affinis, Knipowitschia mermere*) iz 6 porodica aluvijalnog jezera Marmara koje se nalazi u zapadnoj Anatoliji, Turska. Primjerci riba su uhvaćeni između ožujka 2012. i veljače 2013. s povlačnom mrežom i mrežom stajaćicom. Odnos dužine i mase je izračunat pomoću izraza: log (W) = log (a) + b log (L). Parametri LWR računati kao: "*a*" kreću se od 0.0053 do 0.0385, "*b*" od 2.346 do 3.429 i "r^2" od 0.814 do 0.994. Tip rasta je okarakteriziran kao izometrijski za 4 vrste, pozitivno alometrijski također za 4 vrste te negativno alometrijski za 5 vrsta. Osim toga, ova studija uključuje prve zapise LWR za dvije endemske i dvije autohtone vrste u slatkim vodama Turske. Rezultati će biti korisni za zaštitu nazočnosti endema i održivog ribarstva jezera.

Ključne riječi: LWR, rast, endemske vrste, autohtone vrste, slatke vode

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