

## LENGTH–WEIGHT RELATIONS OF SEVEN NATIVE FISH SPECIES (ACTINOPTERYGII) FROM THE LOUROS RIVER, GREECE

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**Abstract.** Length–weight relations were estimated for 7 native fish species of the Louros River in north-western Greece, 6 of them being endemic to the Ionian Sea ecoregion. The  $b$  values ranged from 3.05 to 3.21. Five species, namely *Cobitis hellenica* Economidis et Nalbant, 1996; *Pelasgus thesproticus* (Stephanidis, 1939); *Gasterosteus gymnurus* Cuvier, 1829; *Economidichthys pygmaeus* (Holly, 1929); and *Valencia letourneuxi* (Sauvage, 1880) displayed an isometric growth pattern ( $b = 3$ ) while the remaining two species—*Salmo lourosensis* Delling, 2011 and *Telestes pleurobipunctatus* (Stephanidis, 1939)—showed a positive allometric growth ( $b > 3$ ). New maximum lengths are given for three species. Moreover, this study constitutes the first world report on the length–weight relations for 5 species and the first report for the Ionian Sea ecoregion for two other species.

**Keywords:** Length–weight relations, Louros River, native fish, Cyprinidae, Gasterosteidae, Salmonidae, Valenciidae

There is an increasing interest in scientific literature regarding fish length–weight relations (LWRs), (see Froese et al. 2011 for details). Yet, fisheries management and conservation have been increasingly relying on LWRs which when properly estimated, can be informative on the condition factor and somatic growth type (isometric or allometric) of a fish species (Le Cren 1951). LWRs can also be used for the determination of the biomass, since they allow the conversion of length to weight. They are also useful in life history studies (Petraakis and Stergiou 1995, Froese et al. 2011) and/or in comparisons of species growth between sexes, among seasons and regions (Froese 2006, Moutopoulos et al. 2013).

Up to now, the knowledge on the length–weight relations of the freshwater fishes in Greece have suffered either from a limited number of species investigated (Tsoumani et al. 2006, Tsoumani et al. 2013) or focused mainly on lake ecosystems (Kleanthidis et al. 1999, Tsoumani et al. 2006, Bobori et al. 2010), and river ecosystems (Petriki et al. 2011, Sapounidis et al. 2011).

The Louros River is located in north-western Greece (Ionian Sea ecoregion, Oikonomou et al. 2014). It is a spring-type river with a rather stable mean flow ( $10.6 \text{ m}^3 \cdot \text{s}^{-1}$ ) throughout the year, relatively small length (73.5 km) and the drainage area ( $952 \text{ km}^2$ ), and an annual discharge of  $0.95 \text{ km}^3$  (D’Alessandro et al. 2013). The Louros River delta is char-

acterized by high ecological value at both national and international level. In the presently reported study, we estimated the LWR parameters for 7 native fish species sampled from the Louros River, namely *Cobitis hellenica* Economidis et Nalbant, 1996; *Pelasgus thesproticus* (Stephanidis, 1939); *Gasterosteus gymnurus* Cuvier, 1829; *Economidichthys pygmaeus* (Holly, 1929); and *Valencia letourneuxi* (Sauvage, 1880); *Salmo lourosensis* Delling, 2011; and *Telestes pleurobipunctatus* (Stephanidis, 1939).

Fish samples were collected bi-monthly from December of 2011 until November of 2012, from nine stations along the main river course. The samplings were conducted using a backpack portable electrofishing device (Hans Grassl type IG200/2) by a single downstream-to-upstream zigzag pass. All individuals were identified in situ according to Kottelat and Freyhof (2007). The fish were subsequently photographed, weighted, and released back into the river following national policy-relevant sampling protocols. Total weight (TW) was determined to the nearest 0.001 g using a digital portable balance and the standard length (SL) was measured to the nearest 0.1 mm using the ImageJ software (1.47 version).

The LWR parameters were estimated according to the formula:

$$W = aL^b$$

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Table 1

Estimated parameters of the length–weight relations of seven native fish species of the Louros River, Greece

F	Species	IUCN	<i>n</i>	SL [cm]		TW [g]		Parameters of the length–weight relations				<i>P</i>	<i>t</i> -test	
				Min	Max	Min	Max	<i>a</i>	95% CI of <i>a</i>	<i>b</i>	95% CI of <i>b</i>			<i>r</i> <sup>2</sup>
Cb	<i>Cobitis hellenica</i> •	EN	15	2.609	7.131	0.171	3.545	0.008	0.005–0.013	3.094	2.723–3.466	0.961	<0.001	0.55
Cp	<i>Telestes pleurobipunctatus</i>	LC	279	2.017	12.888	0.121	42.440	0.012	0.011–0.013	3.210	3.158–3.263	0.981	<0.001	7.86*
	<i>Pelagus thesproticus</i> •	NT	105	1.692	6.178	0.071	5.348	0.016	0.013–0.020	3.107	2.972–3.243	0.953	<0.001	1.57
Gs	<i>Gasterosteus gymnuris</i>	LC	89	1.501	5.792	0.060	2.524	0.014	0.012–0.016	3.076	2.958–3.194	0.969	<0.001	1.28
Gb	<i>Economidichthys pygmaeus</i> •	LC	219	1.247	5.142	0.030	2.946	0.017	0.015–0.019	3.052	2.944–3.161	0.934	<0.001	0.95
Sa	<i>Salmo lourosensis</i> •	—	42	6.587	31.899	4.093	602	0.015	0.011–0.019	3.098	3.003–3.193	0.991	<0.001	2.07*
Va	<i>Valencia letourneuxi</i> •	CR	13	1.593	4.415	0.048	1.943	0.017	0.011–0.027	3.166	2.641–3.691	0.941	<0.001	0.69

• constitutes the first world report on the LWR, **Bold**: new maximum standard lengths, \**b* statistically different from 3 at 0.05 significance level; F = family, IUCN = IUCN Conservation Status, *n* = number of individuals, SL = standard length, TW = total weight, CI = confidence intervals, *r*<sup>2</sup> = coefficient of determination, *P* = *P* value of *b*; Cb = Cobitidae, Cp = Cyprinidae, Gs = Gasterosteidae, Gb = Gobiidae, Sa = Salmonidae, Va = Valenciidae; CR = critically endangered, EN = endangered, LC = least concern, NT = near threatened.

by the least squares method through the transformed equation (Tesch 1971):

$$\log TW = \log a + b \cdot \log SL$$

where: TW is the total weight of the fish [g], SL is the standard length [cm], *a* is the intercept, and *b* is the slope of the regression line. The statistical significance level of the coefficient of determination (*r*<sup>2</sup>) and 95% confidence limits of *a* and *b* were also estimated. Obvious outliers were identified and removed, according to the plot of the log TW over log SL (Froese 2006). The estimated *b* values were tested by *t*-test to check whether the growth of each species is isometric (*b* = 3, all fish dimensions increase at the same rate), negative allometric (*b* < 3, a fish increases less in weight than predicted by its increase in length), or positive allometric (*b* > 3, a fish increases more in weight than predicted by its increase in length) (Froese et al. 2011). All analyses were performed in the R statistical and programming environment (R 3.0.2, Anonymous 2013).

A total of 762 individuals, representing 6 families and 7 species, were measured. The family and species name, IUCN Conservation status, sample size (*n*), SL and TW ranges, intercept *a*, slope *b*, 95% confidence intervals of *a* and *b*, *P* values of *b* and coefficient of determination (*r*<sup>2</sup>) are summarized in Table 1. Length and weight data were pooled together for each species without sampling site and sex discrimination. The sample size ranged from 13 individuals for *Valencia letourneuxi* and 15 for *Cobitis hellenica* to 219 for *Economidichthys pygmaeus* and 279 for *Telestes pleurobipunctatus*, respectively. All relations were statistically significant (*P* < 0.001), with high *r*<sup>2</sup> values ranging from 0.934 (*Economidichthys pygmaeus*) to 0.991 (*Salmo lourosensis*).

The *a* values obtained ranged from 0.008 (*Cobitis hellenica*) to 0.017 (*Economidichthys pygmaeus* and *Valencia letourneuxi*). The values of *b* rose from 3.05 for *Economidichthys pygmaeus* to 3.21 for *Telestes pleurobipunctatus*. The majority of the species displayed isometric growth (*b* = 3). Two species (*Salmo lourosensis* and *Telestes pleurobipunctatus*) exhibited a positive allo-

metric growth (*b* > 3). Yet, the allometric growth of *Salmo lourosensis* has been already observed by Liasko et al. (2012) under the morphological analysis of the native trout populations of north-western Greece. Since described *b* values correspond to the observed length ranges, extrapolation of these parameters to different length ranges should be handled with caution (Petrakis and Stergiou 1995).

To the best of our knowledge, herein, new maximum lengths are presented for *Economidichthys pygmaeus* (SL<sub>max</sub> = 5.142 cm), *Pelagus thesproticus* (Stephanidis, 1939) (SL<sub>max</sub> = 6.178 cm), and *Salmo lourosensis* (SL<sub>max</sub> = 31.899 cm) (Table 1). Moreover, this study constitutes the first world report on the LWRs for 5 species (*Cobitis hellenica*, *Economidichthys pygmaeus*, *Pelagus thesproticus*, *Salmo lourosensis*, and *Valencia letourneuxi*). For two species (*Gasterosteus gymnuris* and *Telestes pleurobipunctatus*) we provided the first length–weight relation parameters for the Ionian Sea ecoregion.

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