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Length–weight relationships of four non-native cyprinid from the semiarid region in North-East of Algeria

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Abstract. Length-weight (L-W) relationships for 4 non-native cyprinid species collected in the Ain Zada reservoir (North-East of Algeria): *Cyprinus carpio* (Linnaeus, 1758), *Hypophtalmichthys molitrix* (Valenciennes, 1844), *Hypophtalmichthys nobilis* (Richardson, 1845) and *Carassius auratus gibelio* (Bloch, 1782). The values of the exponent b are in the L-W relationships ranged from 2.43 to 3.37. This is the first L-W parameters reported for four non-native freshwater fish in Algeria.
Key words: Stock biomass, fish condition indicators, population dynamics, stock assessment.

Introduction. Cyprinid fishes have received much attention from evolutionary biologists, as they show a wide distribution around the world and occur in almost every freshwater environment (Szlachciak & Strakowska 2010). Cyprinidae family includes the greatest number of species used by humans of any family of fishes in the North Africa (Mimeche et al 2013). In Algeria, about 27 non-native fish species was introduced and at least 303 introduction events, either intentional or accidental, were recorded in the literature (Kara 2011).

The Asian carp is introduced in Algeria between 1858 and 1931 (Kara 2011; Dieuzeide & Roland 1951; Kottelat 1997). In 1986, the authorities introduced for the first time the alevins, spawner phytophagous and carnivorous in the Ain Zada reservoir, for control and aquaculture. These introductions reflect prevailing attitudes and values by the public authorities in which the primary concern is a socioeconomic benefit (Kara 2011).

In the aim to transform the growth-in-length equations to growth-in-weight, the length–weight relationships (LWR) have been used for estimate stock biomass from limited sample sizes, as indicators of fish condition and used for stock assessment models, also to compare the life histories of some species among regions and other aspects of fish population dynamics (Kohler et al 1995; Petrakis & Stergiou 1995; Gonçalves et al 1997; Moutopoulos & Stergiou 2002, Andreu-Soler et al 2006) and is an important tool in fish biology, physiology, ecology and fisheries assessment (Oscoz et al 2005). This paper tries to apply the recommendations given by Froese (2006).

The present paper is the first published information on length–weight relationships of 4 non-native fish species in the reservoirs of semiarid regions of Algeria.

Material and Method. This study was conducted in the Ain Zada Reservoir (05'' 80' 36° N, 40'' 18' 05° E), a big dam located in a semiarid region in the Bou Sellam basin (Figure 1), northeastern Algeria (Bordj Bou Arreridj City).

The area has a semiarid Mediterranean climate, characterized by a relatively temperate winter also hot and dry summer, the rainy season runs among September and May, announcing the end of the wet season.

The Bou Sellam basin is characterized too by an interannual variability of rainfall,

where we note that much of the rain falls in this region were during a few weeks in the form of downpour, then great droughts ahead after these downpours. The average annual rain falls vary between 300 and 700 mm.

The Ain Zada reservoir is fed by Oued Bou Sellam, the reservoir stored a volume of water about 125 hm^3 and regulating a volume of 50 hm^3 per year to ensure the drinking and industrial water needs for the rapidly growing populations of Bordj Bou Arreridj and Setif cities.

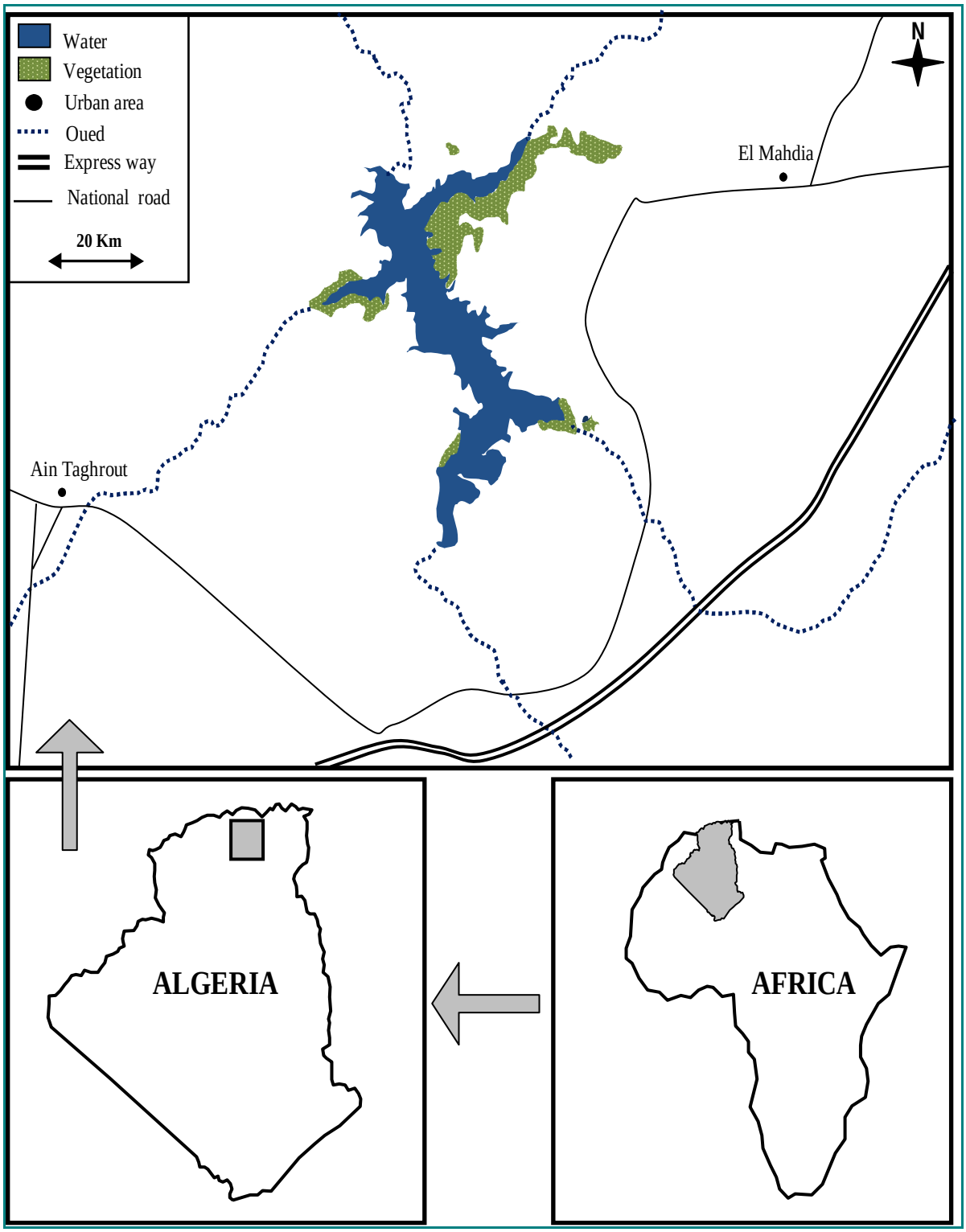

Figure 1. Location of the study area.

Fish samples were collected monthly from January 2012 until June 2012 using multi-mesh gill nets. In this reservoir, *Luciobarbus callensis* is the only native species and coexists with other non-native fish.

The captured specimens were preserved in neutralized formaldehyde solution (7%) and transported into the laboratory for identification to the lowest taxonomic level according to Kottelat & Freyhof (2007). Total length (TL; ±0.1 mm) and weight (W; ±0.1 g) were recorded.

The length–weight relationships were calculated using the formula (Le Cren 1951):

$$W = a\ TL^b$$

were estimated by linear regression after logarithmic transformation of the data (Froese 2006):

$$\log W = \log a + b \log TL$$

where: W - total weight;
TL - total length;
a - the intercept;
b - the regression slope.

Statistical analyses were performed with SPSS (SPSS, Chicago, IL, USA) software package.

Results and Discussion. In this study, four species from Cyprinidae family were sampled/recorded in the reservoir: *Cyprinus carpio* (Linnaeus, 1758), *Hypophtalmichthys molitrix* (Valenciennes, 1844), *Hypophtalmichthys nobilis* (Richardson, 1845) and *Carassius auratus gibelio* (Bloch, 1782). Other species at exist in this reservoir but not captured in this study; *Perca fluviatilis* (Linnaeus, 1758), *Abramis brama* (Linnaeus, 1758), and *Aspius aspius* (Linnaeus, 1758) cited by Kara (2011). *Ctenopharyngodon idella* (Valenciennes, 1844) and *Squalius cephalus* (Linnaeus, 1758) catched by the professional fisherman; this is the first record of *S. cephalus* in this area. Mimeche et al (2013) reported his presence in K'sbo reservoir (M'Sila City) in the south of this basin. Length and weight mean are summarized in Table 1. According to fishbase data (http://www.fishbase.org version 01/ 2015), we report new maximum total lengths for 2 species: 112 cm in *H. molitrix,* 37.5 cm in *C. auratus gibelio*.

Table 1

Mean length and weight values of fishes collected in Ain Zada reservoir

Species	*Length (cm)*			*Weight (g)*	
	N	*Mean ± SD*	*Min-Max*	*Mean ± SD*	*Min-Max*
C. carpio carpio	114	29.00 ± 0.66	19.9-48.6	344.00 ± 23.52	122.0-1360.7
H. molitrix	95	24.17 ± 1.70	13.2-112	9596.87 ± 445.27	14.2-20000.0
H. nobilis	91	23.15 ± 0.90	83-132	19774.67 ± 5666.52	6500-36000
C. auratus gibelio	93	23.66 ± 0.26	24.6-37.5	453.00 ± 13.58	281.9-870.3

N - individuals, SD - Standard deviation.

This research provides the first reference on length–weight relationships for four non-native freshwater fish in Algeria (Table 2).

All length–weight relationships were highly significant ($P < 0.001$), with r^2 values being greater than 0.87. Slopes (*b* values) of the length–weight relationships ranged from 2.43 ± 0.05 for *C. carpio* to 3.37 ± 0.14 for *H. nobilis* (Table 2).

Table 2

Length–weight relationship (LWR) parameters and values (*a* and *b*) and condition factor for five fish species caught in Ain Zada reservoir

Species	*N*	*a*	*SE (a)*	*CI 95% (a)*	*b*	*SE (b)*	*CI 95% (b)*	r^2
C. carpio carpio	114	-1.04	0.07	1.18-0.89	2.43	0.05	2.33-2.53	0.95
H. molitrix	95	-2.43	0.12	2.67-2.19	3.26	0.06	3.14-3.39	0.96
H. nobilis	91	-2.58	0.28	3.14-2.02	3.37	0.14	3.09-3.64	0.87
C. auratus gibelio	93	-1.79	0.11	2.02-1.56	3.04	0.07	2.88-3.19	0.94

N- individuals, SE - the standard error of the slope (a, b), CI - confidence interval, r^2 - the coefficient of determination.

Parameter *b* values remained mostly within the expected range of 2.5–3.5 (Froese 2006), but can vary between 2 and 4 (Bagenal & Tesch 1978) for most fishes. The mean value of 3.025 (SE = 0.21). The median of *b* was 3.150, whereas 75% of the values ranged between 3.04 and 3.37 (Figure 2).

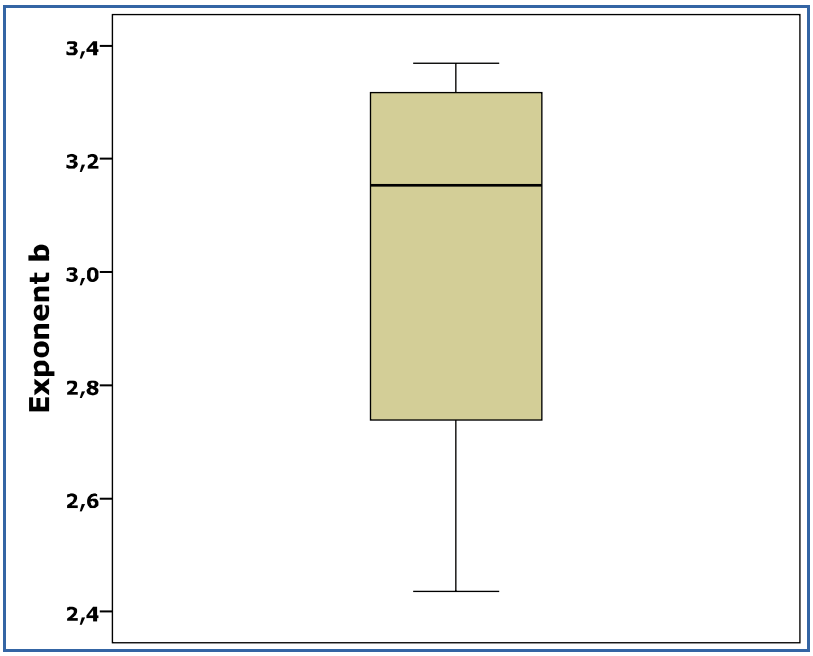

Figure 2. Box-Whiskers plots of the exponent b of the length-weight relationships ($W = aL^b$) for the four fish species in Ain Zada Reservoir. The central box covers 75% of data values, the horizontal line indicates the median, and the vertical line represents the range of the values.

The length–weight relationship in fishes can be affected by habitat, season, gonad maturity, sex, health, preservation techniques, even time of day (because of changes in stomach fullness); and differences in the observed length ranges of the specimen caught (Oliva-Paterna et al 2009). However, the population of *C. carpio* is outside of the expected range (2.436 ± 0.051). We can explain the low *b*-values by the effects of environmental seasonality, the reproductive cycle of the species and to the transfer of energy to the gonads (Mimeche et al 2013).

The *b*-values calculated for *C. carpio* and *H. nobilis*, *H. molitrix* and *C. auratus gibelio* from the Ain Zada reservoir in north east of Algeria when compared with those obtained by other authors in different area are presented in Table 3.

Table 3

Parameters b and length obtained from different areas for four fish species

Species	*Locality (Area)*	*Total Length (cm)* Mean	Min- Max	*b*	*Reference*
C. carpio	Lake Volvi Greece	-	7.8-18.1	2.67	Kleanthidis et al (1999)
	Lake Niushan China	46.05	12.4-82.3	2.966	Ye et al (2007)
	all regions of Croatia	-	15.20-73.50	2.895	Treer et al (2008)
	Segura river basin (southeast-ern Spain)	-	10.0-23.8	3.68	Andreu-Soler et al (2006)
	Iberian Peninsula (Spain)	-	7.1-59	3.070	Miranda et al (2006)
H. molitrix	Lake Niushan in China	39.70	15.2-64.1	3.162	Ye et al (2007)
	Missouri River USA	-	23.1-88.0	3.13-3.70	Wanner & Klumb (2009)
H. nobilis	Lake Niushan China	45.45	24.2-73.4	3.167	Ye et al (2007)
	Missouri River USA	-	32.2-120.0	2.75-2.96	Wanner & Klumb (2009)
C. auratus gibelio	Lake Volvi Greece	8.2	25.2	3.11	Kleanthidis et al (1999)
	Lake Niushan China	14.84	5.5-31.8	3.100	Ye et al (2007)
	All regions of Croatia	-	5.10-29.20	2.976	Treer et al (2008)

Conclusions. *C. carpio* and *H. nobilis*, *H. molitrix* and *C. auratus gibelio* present a large tolerance range overlooked the variable environmental conditions in semiarid reservoir and establish new viable populations disperse widely and incorporated in large numbers in the ecosystem. Tarkan et al (2012) showing the growth of the fishes introduced into artificial water bodies is faster than that observed in populations of natural lakes and flowing waters. Thus, certain characteristics of the species as a strong physiological tolerance or dispersal limitation (Lauzeral et al 2010; Segurado et al 2011), a high reproductive rate and reproductive strategies (Ruesink 2005; Tarkan et al 2012), aggressive behavior and competitiveness (Conrad et al 2011; Moyle & Marchetti 2006). Environmental conditions similar to those of the native zone (Moyle & Marchetti 2006).

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