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Mouth Size and Body Length Relations for Freshwater Fish Species

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Abstract

We estimated the relationships between total vertical, horizontal and mouth area with total length for seven fish species caught from Lake Volvi (Northern Greece) during September 2016-February 2017. All relationships were significantly allometric ($P<0.05$) and were described by the power regression with r^2 values ranging from 0.435 to 0.882. The establishment of such relationships is important for defining the ecological position of species in the food web, as well as for fishery management purposes.

Keywords: Mouth dimensions, mouth area, length–mouth relationships; lakes

Introduction

The relationships between mouth dimension and body size are used to: (a) quantify size-based feeding patterns, (b) determine the types of prey consumed, (c) identify predator–prey relationships, (d) define the ecological position of organisms within food and (e) for fisheries management purposes (e.g. hook type & size, bait size, etc) (Erzini et al., 1997; Karpouzi & Stergiou, 2003; and references therein). Although such studies have been extensively presented in the Mediterranean marine waters (Karpouzi and Stergiou 2003; Karachle and Stergiou 2012), they are generally lacking for the European (e.g., Lammens & Visser 1989) and specifically for Greek freshwater systems (i.e. Bobori et al. 2006; Chalkia & Bobori 2006; Karachle et al. 2014).

In the present study the relationships of horizontal (HMO) and vertical (VMO) mouth opening and mouth area (MA) with total length (TL) were estimated for seven freshwater fish species in Lake Volvi: *Abramis brama* (Linnaeus, 1758), *Alosa macedonica* (Vinciguerra, 1921), *Carassius gibelio* (Bloch, 1782), *Cyprinus carpio* Linnaeus, 1758, *Esox lucius* Linnaeus, 1758, *Perca fluviatilis* Linnaeus, 1758 and *Rutilus rutilus* (Linnaeus, 1758). Four of these seven species (*A. brama, C. gibelio, C. carpio, P. fluviatilis*) have been also presented by Karachle et al. (2014) concerning the same area and here we expand the corresponding relationships by including larger sizes of the same species that exclusively represent the commercial part of the professional fisheries catches. The above relations are of high importance, because they quantify prey-size related feeding patterns and thus define the ecological niche of species (Karachle & Stergiou, 2012).

Materials and Methods

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Sampling was *in situ* conducted from September 2016 to February 2017 (10 fishing trials), in Lake Volvi with a small-scale fishing vessel (5.80 m of length) using gillnets of different mesh sizes (from 24 mm to 80 mm measured from knot to knot) depending on the targeted species. Lake Volvi (surface area of 68 Km^2) located in Northern Greece (40°41'N 23°28'E) and consists the second largest natural lake of Greece with significant fisheries exploitation and high fisheries landings (Bobori and Economidis, 2006).

TL, HMO and VMO were measured to the nearest 0.1 cm for 973 individuals. Considering that MA shape has an elliptic form (Erzini et al., 1997), MA (in cm^2) was estimated based on the following equation:

$MA = \pi * (HMO/2) * (VMO/2)$, where $\pi = 3.14$

For establishing relationships between HMO–TL, VMO–TL, and MA–TL the power regression ($Y = aX^b$) was used, where *a* is the coefficient of shape, and *b* is the exponent indicating the dimensional balance (Lleonart et al. 2000). Allometric model, instead of other types of models (i.e., linear, exponential, and logarithmic), is the most suitable for identifying changes in body shape (e.g. Lleonart et al. 2000; Katsanevakis et al. 2007; Karachle and Stergiou, 2012).

Results and Discussion

Overall, 973 individuals were measured with sample size ranging from 90, for *A. brama*, to 197, for the Volvi endemic *A. macedonica* and all relations were significantly ($P<0.05$) described by the power regression (Table 1). For all studied species the slopes of the regressions were significantly different from null ($P < 0.05$) with r^2 values being higher than 0.435 (for *A. brama* for HMO-TL).

Power regression is the type of the relationship mostly appropriate to be used when dealing with morphometric data (Lleonart et al. 2000). The comparison of the relationships for the species included both in the present study and in Karachle et al. (2014) showed higher MA in the former for *A. brama*, *C. gibelio* and *C. carpio* and lower MA for *P. fluviatilis*. This was might be due to different length ranges, because almost half of the individuals sampled here were larger than the maximum length reported in Karachle et al. (2014) depending on species. Concluding, the estimated relations will facilitate estimating the trophic level of species, for which estimates are generally lucking to freshwater systems (Bobori et al., 2013).

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Table 1. Relationships between horizontal mouth opening (HMO), vertical mouth opening (VMO) and mouth area (MA) with total body length (TL) for seven fish species from the Lake Volvi (North Greece). n = number of individuals; SE_b = standard error of slope b; r^2 = coefficient of determination. All relationships were highly significant ($p<0.01$). * indicates the species for which mouth dimensions were firstly presented.

Family/Species	N	TL range	$HMO=aTL^b$	SE_b	r^2_{HMO}	$VMO=aTL^b$	SE_b	r^2_{VMO}	$MA=aTL^b$	SE_b	r^2_{MA}
Abramis brama	90	24.5-51.5	$y=0.0096x^{1.374}$	0.167	0.435	$y=0.0009x^{1.483}$	1.127	0.607	$y=5*10^{-5}x^{2.858}$	0.254	0.590
*Alosa macedonica**	197	15.0-26.5	$y=0.0350x^{1.174}$	0.081	0.521	$y=0.2248x^{0.814}$	0.052	0.554	$y=0.0062x^{1.987}$	0.103	0.658
Carassius gibelio	136	23.5-37.8	$y=0.0533x^{1.061}$	0.069	0.636	$y=0.0628x^{1.060}$	0.069	0.637	$y=0.0026x^{2.121}$	0.106	0.748
Cyprinus carpio	147	36.0-91.0	$y=0.0029x^{1.624}$	0.109	0.604	$y=0.0010x^{1.923}$	0.107	0.689	$y=2*10^{-6}x^{3.557}$	0.190	0.708
*Esox lucius**	117	33.0-85.5	$y=0.1890x^{0.898}$	0.039	0.816	$y=0.2466x^{0.831}$	0.036	0.821	$y=0.0366x^{1.729}$	0.058	0.882
Perca fluviatilis	101	21.0-49.0	$y=0.1933x^{0.902}$	0.054	0.733	$y=0.2347x^{0.751}$	0.066	0.565	$y=0.0356x^{1.653}$	0.099	0.736
*Rutilus rutilus**	156	16.1-35.0	$y=0.0106x^{1.518}$	0.094	0.593	$y=0.0638x^{1.039}$	0.067	0.571	$y=0.0005x^{2.557}$	0.115	0.728