

Some morphological and biological characteristics of fishes from Tavropos reservoir (western Greece)

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Abstract. A bag-seine net (18–22 mm bar length mesh size) was used to collect two native, the Albanian barbel, *Barbus albanicus* Steindachner, 1870 and the chub, *Leuciscus* cf. *svallize* (Heckel et Kner, 1858) and one introduced, the pumpkinseed, *Lepomis gibbosus* (Linnaeus, 1758), fish species of the Tavropos reservoir (western Greece). The somatic lengths were linearly correlated to each other for all three species. *B. albanicus* and *L.* cf. *svallize* exhibited negative allometric growth, while the *L. gibbosus* grew isometrically. The mouth dimensions were linearly or exponentially correlated to body size for all species. However, the mouth morphology differed among the species indicating differences in foraging ability and resource utilisation. The lifespan of *B. albanicus*, *L.* cf. *svallize* and *L. gibbosus* in Tavropos reservoir was 21, 9 and 3 years respectively. The corresponding growth parameters were: L_{∞} = 47.0 cm, K = 0.064 yr⁻¹, t_0 = -2.76 yr for *B. albanicus*, L_{∞} = 24.3 cm, K = 0.257 yr⁻¹, t_0 = -1.46 yr for *L.* cf. *svallize* and L_{∞} = 11.9 cm, K = 0.506 yr⁻¹, t_0 = -1.67 yr for *L. gibbosus*.

Key words: age, growth, mouth dimensions, *Lepomis gibbosus*, *Barbus albanicus*, *Leuciscus* cf. *svallize*

Introduction

Fish diversity in reservoirs, derived from river fishes, is usually not as extensive as in natural lakes and that is because natural lakes have more stable conditions under which fish evolve. In contrast, riverine species have to live under harsher and more variable conditions (Fernando & Holčík 1991). When a reservoir is formed, several of the riverine species do not adapt and either die or move out of the area. The limnetic ichthyofauna of Tavropos reservoir (created by the damming of river Acheloos in 1962) consists of 5 native and 11 introduced species (Tsekos et al. 1992, Economou - Amilli et al. 2001). Several sensitive riverine species of the original system, with clearly defined niche requirements (e.g. the lotic species *Barbus peloponnesius* Valenciennes, 1842), have not been able to tolerate the lentic conditions and disappeared, while others, such as *B. albanicus* Steindachner, 1870 and *Leuciscus* cf. *svallize* (Heckel et Kner, 1858) survived and established fishable populations (Tsekos et al. 1992).

It is a common policy for the Greek authorities to introduce exotic species in reservoirs aiming in mitigation, restoration, enhancement or creation of new fisheries (*sensu* Hickey 1994). Since 1986, fish stocking is carried out annually in Tavropos reservoir by the local authorities. Some of the introduced species, such as *Oncorhynchus mykiss* (Walbaum, 1792), eventually adapted in the reservoir, while for some others such as *Coregonus lavaretus* (Linnaeus, 1758), the adaptation was easier and small populations have been established (Tsekos et al. 1992).

Well planned and carefully designed fish introductions can improve fish diversity as well as enhancing the ecology and productivity of water but conversely, inappropriate fish stocking can cause long-lasting and often irreversible detrimental effects (Hickey &

Chare 2004). The knowledge of both the existing and the introduced fish population dynamics is required for the better impact assessment of introductions. Towards this direction, the biological characteristics of two native, the Albanian barbel, *B. albanicus* and the chub *L. cf. svallize*, and one introduced, the pumpkinseed, *Lepomis gibbosus* (Linnaeus, 1758), species were studied. These species were the most abundant in the catches with bag-seine nets along the shallow banks of the reservoir.

The Albanian barbel, *B. albanicus*, is an endemic species of western Greece distributed from Peloponnese to Epirus (Economidis & Herzig-Straschil 2003). It is a solitary, benthic and lentic species. Its status is generally safe and only locally vulnerable in Greece (Economidis 1991, Bobori et al. 2001). The chub, *L. cf. svallize* (its taxonomic status and distribution in Greece are still under investigation; see Economou et al. 1991a, Tsigenopoulos & Karakousis 1996, Kottelat 1997), inhabits water bodies on the low plains of low flow and is threatened by the introduction of other species, pollution and habitat destruction (Economidis 1991). Finally, the pumpkinseed, *L. gibbosus*, inhabits the rivers and lakes of N. America and consists one of the most successful introduced species in Europe, probably due to its predatory behaviour and reproductive strategy (nest builder and guarder). Several countries, however, report adverse ecological impact after its introduction (e.g. Garcia-Berthou & Moreno-Amich 2000), which, in Tavropos reservoir, is believed to have been involuntary.

The aim of the present work was to provide some biological and morphological characteristics of the three above mentioned species of the Tavropos reservoir. These characteristics include: (a) length-length and length-weight relationships, (b) age and growth analysis and (c) mouth dimensions and their relationship to size. Points (a) and (b) are important in fisheries science, among others for the conversion of length into weight and the estimation of production and biomass of a fish population (Pauly 1993, Petrakis & Stergiou 1995, Moutopoulos & Stergiou 2002, Froese & Pauly 2005), whereas (c) is used in quantifying sized-based feeding patterns and thus defining the ecological role of an organism within the food web (Karpouzi & Stergiou 2003).

Study Area

Tavropos reservoir (western Greece, 39° 20' N, 21° 47' E, altitude 792 m), covers an area of ca 25 km² at maximum water level and has a capacity of 400×10⁶ m³ of water, which is supplied by several streams and torrents with irregular but often permanent flow throughout the year (Economou-Amilli et al. 2001, Fig. 1). The maximum and mean depths are 60 m and 47 m respectively, while the annual water level fluctuation for the period 1988–2001 ranged between 0.14 and 6.75 m (Economou-Amilli et al. 2001). Tavropos reservoir is a warm, monomictic, oligotrophic dam-lake, showing tendency of becoming mesotrophic (Moustaka-Gouni & Nikolaidis 1992); stratification of the water column occurs from May to November (Tsekos et al. 1992).

Fisheries yield in the reservoir has been increasing since 1990 (Economou-Amilli et al. 2001). The annual catches fluctuated from 38 tones in 1990 to 144 tones in 2000 (Fig. 2). The majority of the catches in 2000 consisted mainly of *Cyprinus carpio* Linnaeus, 1758 (60 tones) and *L. cf. svallize* (50 tones). *Carassius gibelio* (Bloch, 1783), *Oncorhynchus* sp. and *B. albanicus* contributed with 20, 5 and 3 tones respectively, while the rest of the species were not fished to a commercial extent (Fig. 2).

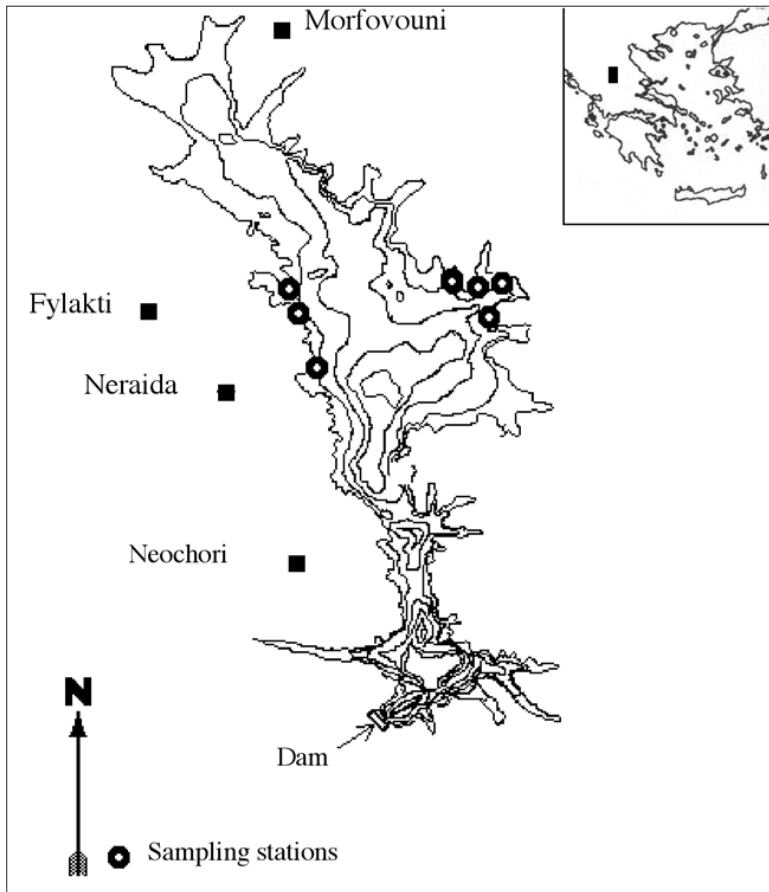


Fig. 1. Map of Tavropos reservoir indicating the sampling stations (●) and the location of the dam.

Material and Methods

The ichthyofauna of the Tavropos reservoir was sampled in July 2001 using a bag seine net (length 100 m, height 5 m, bar length mesh size of 18–22 mm). A total of seven samplings were conducted at areas shallower than 10 m (Fig. 1). For all individuals caught, the total (Tl), fork (Fl) and standard length (Sl), the vertical (VMO) and horizontal (HMO) mouth openings were measured to the nearest mm and the total weight (W) was recorded to the nearest 0.1 g. The relationships between different types of length were derived using linear regression. Consequently, the length-weight relationships ($W=aTl^b$) were determined for each species. The parameter b (slope) of the length-weight relationship was tested for differences with the theoretical value 3 using the analysis of t-test (E c o n o m o u et al. 1991b) to assess whether these species exhibit isometric ($b=3$) or allometric ($b\neq 3$) growth. Mouth dimensions were regressed against Tl and the relationship between Tl and mouth area (MA , cm^2) was also estimated, with the latter modelled as an ellipse (E r z i n i et al. 1997, K a r p o u z i & S t e r g i o u 2003): $MA = 0.25\pi \times (VMO \times HMO)$.

Scales were used for age determination and were removed from the left flank of the fish, above the lateral line and below the dorsal fin. Damaged or inconclusive scales were

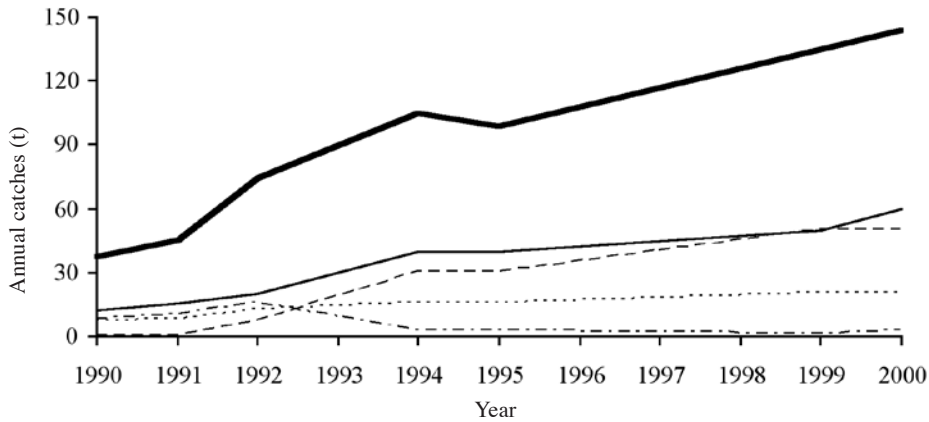


Fig. 2. Annual catches of the commercial fish species (—: *Cyprinus carpio*, ---: *Leuciscus cf. svallize*, - - -: *Carassius gibelio*, ····: *Salvelinus fontinalis*, —█: Total) of Tavropos reservoir for the period 1990–2000.

discarded from further analysis. Age was assigned based on counts of growth marks (annuli) the presence of which has not been directly validated. However, to establish a level of confidence and to allow for more objective reading, scales were read randomly, to avoid bias in assigning ages that might occur from prior knowledge of fish size, on two separate occasions. The scale radius (S) was measured from the focus to the end of the scale on the left diagonal radius. Based on the r^2 value, the relationship between Tl and S was best described by the linear equation $Tl = a + bS$ for all species. Back-calculated lengths at growth mark formation were estimated using the Fraser-Lee equation (Francis 1990):

$$L_i = c + (Tl - c) \times \left(\frac{S_i}{S}\right),$$

where L_i is the total length of the fish when growth mark i was formed, Tl is the total length at time of capture, S_i is the distance from scale centre to growth mark i , S is scale radius and c is the intercept on length axis of the linear regression between Tl and S .

The growth curve was modelled using the von Bertalanffy growth equation:

$$L_t = L_\infty + (1 - e)^{-K(t-t_0)},$$

where L_t is the total length at age t , L_∞ is the asymptotic length, K is a constant expressing the rate at which L_∞ is approached and t_0 the theoretical age at which predicted mean length is zero. The von Bertalanffy growth equation was fitted to mean back-calculated lengths at age (Ricker 1975) for all species. Finally, the most commonly used growth index ($\phi' = \log_{10} K + 2 \log_{10} L_\infty$) (Munro & Pauly 1983), which can be used for comparing growth rates among species, was calculated.

Results

The length of *B. albanicus* ranged between 14.2 and 37.1 cm Tl (mean $Tl=19.18$ cm, $n=619$), that of *L. cf. svallize* between 14.1 and 23.4 cm Tl (mean $Tl=18.80$ cm, $n=33$) and that of *L. gibbosus* between 8.5 and 12.1 cm Tl (mean $Tl=10.60$ cm, $n=52$) (Table 1). The three somatic lengths, i.e., total (Tl), fork (Fl) and standard (Sl) length, were highly correlated (all $r^2 > 0.87$)

to each other for all species (Table 2). The length-weight relationships are shown in Fig. 3. The slopes were significantly lower than the theoretical value of 3 for *B. albanicus* (t-test, n=619, P<0.001) and *L. cf. svallize* (t-test, n=33, P<0.001), indicating negative allometric growth. In contrast, the growth of the *L. gibbosus* was isometric (t-test, n=52, P=1.410).

The *VMO*, *HMO* and *MA* are shown in Table 1. All mouth dimensions were linearly related to *Tl* for the three species, except for the *L. gibbosus* whose relationship of *MA* with *Tl* was exponential (Fig. 4). Based on the equations extracted from the *MA* and *Tl* relationships (Fig. 4), the *MA* corresponding to *Tl* of 20 cm was calculated for *B. albanicus* (*MA*=1.27 cm²) and *L. cf. svallize* (*MA*=1.71 cm²). The *MA* of *L. gibbosus* was not calculated because its length range is limited to 12.1 cm. Mouth shapes were represented as ellipses, with that of *B. albanicus* being closer to a circle.

Out of the 704 specimens caught, 359 were used for age reading. According to the annual growth marks present, the lifespan of *B. albanicus*, *L. cf. svallize* and *L. gibbosus* in Tavropos reservoir was 21, 9 and 3 years respectively (Table 3). Five years old fish was the dominant age class in the catches for the *B. albanicus* accounting for 51.7%, while for the *L. cf. svallize* the dominant age class was four years old accounting for 53.9% of the total aged individuals. The three age classes of the *L. gibbosus* had almost equal number of individuals (Table 3).

Table 1. Mean, minimum, maximum total lengths (*Tl*, cm), vertical (*VMO*, cm) and horizontal (*HMO*, cm) mouth openings, mouth area (*MA*, cm²) and the relationships between vertical and horizontal mouth opening and total length and between mouth area and total length for the Albanian barbel, *Barbus albanicus*, the chub, *Leuciscus cf. svallize* and the pumpkinseed, *Lepomis gibbosus* of Tavropos reservoir, caught in July 2001. (n: sample size, SE: standard error, r²: coefficient of determination).

	<i>Barbus albanicus</i>	<i>Leuciscus cf. svallize</i>	<i>Lepomis gibbosus</i>
n	619	33	52
<i>Tl</i> _{min} (cm)	14.20	14.10	8.50
<i>Tl</i> _{max} (cm)	37.10	23.40	12.10
<i>Tl</i> _{mean} (cm)	19.18	18.80	10.60
SE	0.10	0.32	0.09
<i>VMO</i> _{min} (cm)	0.70	0.70	0.60
<i>VMO</i> _{max} (cm)	2.80	2.20	1.30
<i>VMO</i> _{mean} (cm)	1.30	1.66	1.03
<i>VMO</i> vs <i>Tl</i>	$VMO = -0.204 + 0.078Tl$	$VMO = -0.817 + 0.132Tl$	$VMO = -0.299 + 0.125Tl$
r ²	0.715	0.667	0.518
<i>HMO</i> _{min} (cm)	0.60	0.50	0.50
<i>HMO</i> _{max} (cm)	2.10	1.50	0.90
<i>HMO</i> _{mean} (cm)	1.09	1.10	0.72
<i>HMO</i> vs <i>Tl</i>	$HMO = -0.167 + 0.065Tl$	$HMO = -0.595 + 0.090Tl$	$HMO = -0.360 + 0.102Tl$
r ²	0.669	0.603	0.421
<i>MA</i> _{min} (cm ²)	0.33	0.27	0.24
<i>MA</i> _{max} (cm ²)	4.62	2.25	0.92
<i>MA</i> _{mean} (cm ²)	1.14	1.47	0.59
<i>MA</i> vs <i>Tl</i>	$MA = -1.794 + 0.153Tl$	$MA = -2.366 + 0.204Tl$	$MA = 0.0006Tl^{2.9}$
r ²	0.774	0.710	0.537

Table 2. Length-length relationships for *Barbus albanicus*, *Leuciscus cf. svallize* and *Lepomis gibbosus* from Tavropos reservoir, caught in July 2001 (n: sample size, r²: coefficient of determination).

Species	Somatic length relationship	r ²	n
<i>Barbus albanicus</i>	$SI=0.864TI-0.609$	0.987	619
	$FI=0.899TI-0.240$	0.988	
	$SI=0.958FI-0.349$	0.994	
<i>Leuciscus cf. svallize</i>	$SI=0.926TI-1.383$	0.992	33
	$FI=0.977TI-0.982$	0.994	
	$SI=0.945FI-0.414$	0.993	
<i>Lepomis gibbosus</i>	$SI=0.792TI+0.336$	0.871	52
	$FI=0.949TI+0.015$	0.975	
	$SI=0.831FI+0.363$	0.885	

Scale radius was linearly correlated to *TI* for *B. albanicus* ($TI=6.324+0.146S$, $r^2=0.83$, $n=294$), *L. cf. svallize* ($TI=6.916+0.085S$, $r^2=0.74$, $n=26$) and *L. gibbosus* ($TI=7.245+0.028S$, $r^2=0.51$, $n=39$). The intercept of the regressions was used to back calculate lengths at age (Table 3).

The von Bertalanffy growth equation parameters were (Table 4):

$$B. albanicus: L_t = 47.0(1 - e^{-0.064(t+2.76)}),$$

$$L. cf. svallize: L_t = 24.3(1 - e^{-0.257(t+1.46)}),$$

$$L. gibbosus: L_t = 11.9(1 - e^{-0.506(t+1.67)}),$$

and the ϕ' values 2.15, 2.18 and 1.85 for *B. albanicus*, *L. cf. svallize* and *L. gibbosus* respectively (Table 4).

Discussion

The estimated parameter *b* of the length-weight relationship for *B. albanicus* was similar to that reported for the species from the oligotrophic lake Trichonis, and lower than the others reported in several freshwater systems of Greece (E c o n o m o u et al. 1999). The same parameter for the *L. cf. svallize* lied within the range of length-weight relationships derived from monthly samplings performed in Kremasta reservoir (E c o n o m o u et al. 1991a). Our results were within the range of *b* values collected by K l e a n t h i d i s et al. (1999) in their review of length-weight relationships for 24 species of Greek inland waters including *L. cf. svallize* and *B. albanicus*. Finally, the parameter *b* for *L. gibbosus* was lower than the only available work for Greek population of the species in Kerkini reservoir where positive allometric growth is reported (G i a p i s 2003). Differences in the parameters of the length-weight relationships may be due to the size range of the individuals caught because of gear selectivity, the sample size or the condition of the fish, which generally changes as a function of many factors (e.g. season, area, sex, feeding, sampling and preservation techniques; L e C r e n 1951).

The relationships between mouth dimensions have been reported for marine fishes (K a r p o u z i & S t e r g i o u 2003). Such relationships for marine fishes have been found to be linear, log-linear and exponential (K a r p o u z i & S t e r g i o u 2003 and references therein). On the other hand, data on mouth morphology of freshwater fishes is

Table 3. Summary of total length-at-age data for *Barbus albanicus*, *Leuciscus cf. svaltze* and *Lepomis gibbosus* aged using scales.

Age class	n	TL (cm) at capture	Back calculated TL for particular years (cm)																						
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21		
<i>Barbus albanicus</i>																									
V	152	17.8	10.4	12.8	14.6	16.1	17.4																		
VI	53	19.2	10.8	13.4	15.2	16.7	17.9	18.9																	
VII	44	20.5	10.8	13.1	15.0	16.5	17.8	19.1	20.2																
VIII	21	22.5	11.0	13.7	15.7	17.5	19.0	20.2	21.3	22.3															
IX	12	23.8	11.1	13.4	15.2	16.8	18.4	19.7	21.1	22.4	23.6														
X	8	24.9	11.5	13.6	15.5	17.2	18.8	20.1	21.5	22.7	23.7	24.6													
XVI	2	32.7	12.0	14.4	16.4	18.4	20.3	22.0	23.7	25.2	26.6	27.9	29.0	30.0	30.9	31.7	32.1	32.5							
XVII	1	34.2	12.7	14.9	17.6	19.5	21.4	23.2	24.7	26.3	27.8	29.3	30.7	31.5	32.0	32.5	33.0	33.5	34.0						
XXI	1	37.1	12.2	14.9	16.8	18.5	20.1	21.8	23.1	24.3	25.4	26.4	27.5	28.5	29.6	30.6	31.5	32.4	33.3	34.2	35.1	36.0	36.8		
Weighted average			10.7	13.1	14.9	16.5	17.8	19.4	20.9	22.7	24.1	25.7	29.0	30.0	30.9	31.6	32.2	32.8	33.7	34.2	35.1	36.0	36.8		
<i>Leuciscus cf. svaltze</i>																									
II	3	14.7	9.7	12.2																					
III	3	18.3	10.8	14.4	16.9																				
IV	14	18.9	11.4	14.6	16.8	18.1																			
V	3	19.4	11.8	15.2	16.7	18.0	19.0																		
VII	1	21.5	10.7	14.2	16.8	18.1	19.5	20.3	21.1																
VIII	1	22.5	11.0	15.0	17.6	19.8	20.6	21.2	21.7	22.3															
IX	1	23.4	12.4	16.3	17.6	18.5	19.5	20.3	21.2	22.0	22.8														
Weighted average			11.2	14.4	16.9	18.2	19.4	20.6	21.4	22.2	22.8														
<i>Lepomis gibbosus</i>																									
I	10	9.9	9.0																						
II	14	10.5	8.7	10.0																					
III	15	11.2	8.7	9.9	10.7																				
Weighted average			8.8	10.0	10.7																				

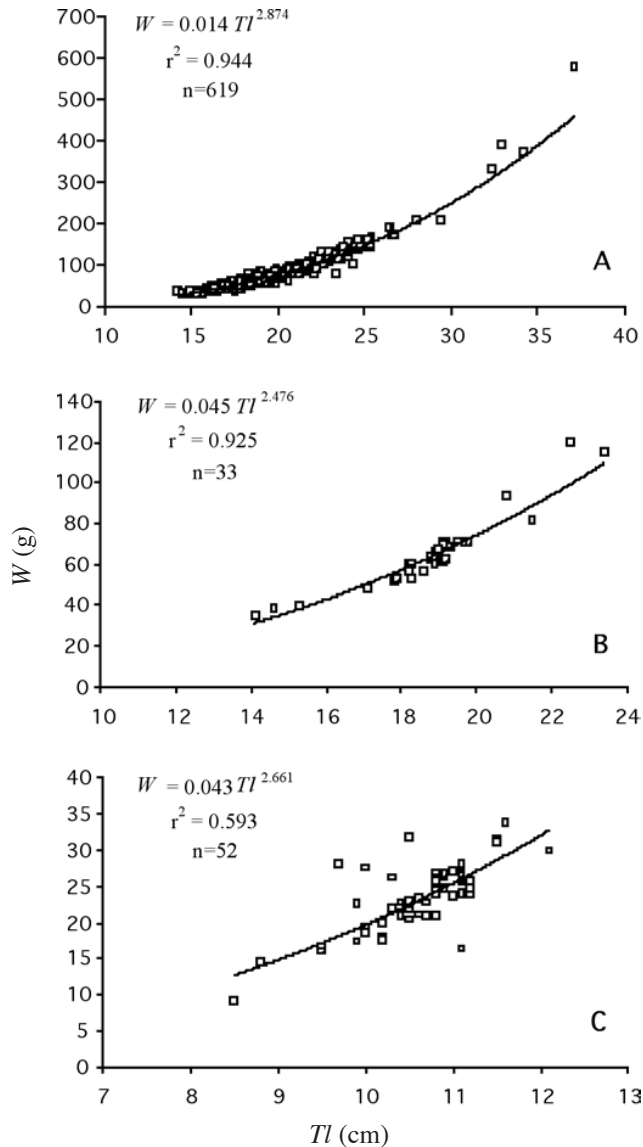


Fig. 3. Total length (TL , cm) – total weight (W , g) relationships for *Barbus albanicus* (A), *Leuciscus cf. svallize* (B) and *Lepomis gibbosus* (C) from Tavropos reservoir, July 2001.

limited worldwide (e.g. Boubée & Ward 1997, Mittelbach & Persson 1998, Piet 1998, Adams & Huntingford 2002).

In the present study mouth shapes were represented as ellipses, with that of *B. albanicus* being closer to a circle. The relationships between VMO , HMO and MA and body size (TL) were linear and highly significant ($P < 0.05$, $r^2 > 0.7$) for *B. albanicus* and *L. cf. svallize* and exponential ($P < 0.05$, $r^2 > 0.5$) for *L. gibbosus*.

The feeding preferences and the foraging behavior of the three species differ. The *L. cf. svallize* is an omnivore, feeding on a broad spectrum of prey including algae and

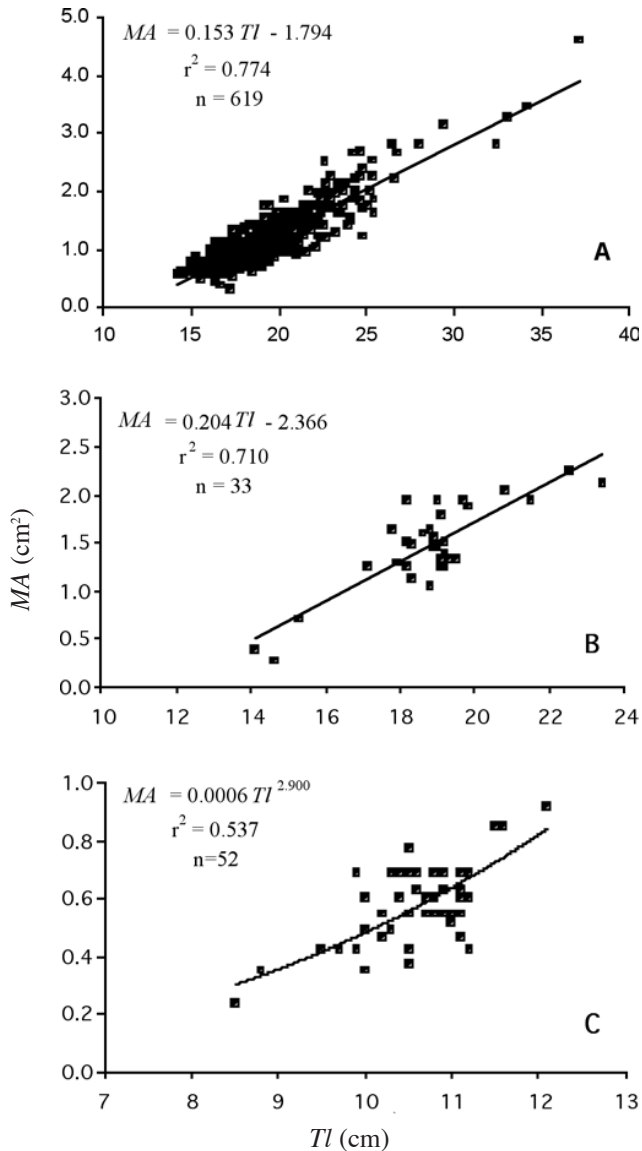


Fig. 4. Mouth area (MA, cm²) – total length (TL, cm) relationships for *Barbus albanicus* (A), *Leuciscus cf. svallize* (B) and *Lepomis gibbosus* (C) from Tavropos reservoir, July 2001.

macrophytes, zooplankton, insects, fishes and detritus (E c o n o m o u et al. 1991a). The broadening of the feeding habits of a species may be the result of foraging difficulties or poor food availability and has been related to water level fluctuations (E c o n o m o u et al. 1991a). The species *B. albanicus* also feeds on more than one trophic level and its prey consists of benthic organisms (D a o u l a s & E c o n o m i d i s 1989). Plant material and detritus are more important to its diet than zooplankton and insect larvae (D a o u l a s & E c o n o m i d i s 1989). These species are sympatric in another reservoir of western Greece (Kremasta) where the potential for interspecific competition is reduced by the partitioning

Table 4. Growth parameter (L_{∞} : asymptotic length, cm; K : growth coefficient, yr⁻¹; t_0 : hypothetical age at zero length, yr; t_{max} : maximum recorded age, yr; ϕ' : growth index) estimates for *Barbus albanicus*, *Leuciscus cf. svallize* and *Lepomis gibbosus* from Tavropos reservoir and other areas of their Greek distribution (M: males; F: females; C: sexes combined).

Species	Sex	L_{∞} (cm)	K (yr ⁻¹)	t_0 (yr)	t_{max} (yr)	ϕ'	Reference
<i>Barbus albanicus</i>							
Kremasta reservoir*	F	38.3	0.080	-0.91	12	2.07	Daoulas & Economidis (1989)
Kremasta reservoir*	M	25.6	0.140	-0.78	9	1.96	Daoulas & Economidis (1989)
Tavropos reservoir	C	47.0	0.064	-2.76	21	2.15	Present study
<i>Leuciscus cf. svallize</i>							
Kremasta reservoir*	F	22.8	0.320	0.12	8	2.22	Economou et al. (1991b)
Kremasta reservoir*	M	20.3	0.410	0.25	7	2.23	Economou et al. (1991b)
Tavropos reservoir	C	24.3	0.257	-1.46	9	2.18	Present study
<i>Lepomis gibbosus</i>							
Kerkini reservoir	C	19.4	0.152	-0.52	8	1.76	Giapis (2003)
Kerkini reservoir	M	26.7	0.088	-1.04	7	1.80	Giapis (2003)
Kerkini reservoir	F	19.9	0.133	-0.76	8	1.72	Giapis (2003)
Tavropos reservoir	C	11.9	0.506	-1.67	3	1.85	Present study

* Growth parameters estimated by the mean lengths at age given by the authors.

of resources between them (Daoulas & Economidis 1989, Economou et al. 1991a). The *L. gibbosus* is a carnivore feeding on insect larvae and copepods often exhibiting cannibalistic behavior (Giapis 2003). In both its native and introduced range, the *L. gibbosus* is an omnivore and feeds upon the most abundant prey items (Copp et al. 2004 and references therein). The feeding preferences and behavior between *L. cf. svallize* and *B. albanicus* are similar and differ from those of *L. gibbosus* that is a more specialized carnivorous feeder. Moreover, the position of *L. gibbosus* in the food web is higher (higher trophic level) than the other two species. The fact that the diets of sympatric fish species often show little overlap can be attributed, in many cases, to differences in either mouth gape or feeding behaviour (e.g. Motta 1988, Mittelbach & Persson 1998). Indeed, mouth morphology plays an important role in foraging ability and resource exploitation and consequently on fish diet (Stergiou & Fourtouni 1991, Labropoulou & Markakis 1998, Karpouzi & Stergiou 2003).

The oldest specimens of *B. albanicus*, *L. cf. svallize* and *L. gibbosus* were 21, 9 and 3 years of age respectively. The lifespan of *L. cf. svallize* in Tavropos reservoir agreed with the maximum reported age for the species from the adjacent Kremasta reservoir. In contrast, *B. albanicus* in Kremasta reservoir is reported to reach 12 yr of age at a size of 25 cm (Daoulas & Economidis 1989). This value is lower than the corresponding 12 yr old individual from our study (Table 3). The lifespan of *L. gibbosus* observed was lower than that of a northern Greece reservoir (Kerkini: Giapis 2003) despite the fact that the observed lengths at age in our study fall within the range of lengths at age reported for Kerkini reservoir (Giapis 2003). Individual growth variability, which is common for any naturally occurring fish population, can be attributable to differences in environmental conditions, fishing activity and predation pressure (e.g. Wootton 1998, Jennions &

Telford 2002) and may account for differences in the observed lengths at age between populations of the same species. Specifically for *L. gibbosus*, according to a recent review (Copp et al. 2004), the growth rate among distant populations may significantly differ, with the adult growth in North American (native) populations being faster than that of European ones (introduced).

The calculated K values for *L. cf. svallize* and *B. albanicus* indicated that the former attained its L_{∞} at a higher growth rate than the latter, which, in turn, has a longer lifespan. Indeed, the rate at which L_{∞} is reached is slower for long lived species and higher for short lived species (Wootton 1998). However, the growth rate of both *L. cf. svallize* and *B. albanicus* was reduced with age.

In general, growth parameters of the species of Tavropos reservoir agreed with those reported from other studies in Greek inland waters (Table 4). The estimated L_{∞} and K for *B. albanicus* was similar to that reported for an adjacent reservoir (Kremasta reservoir, river Acheloos drainage area) (Daoulas & Economidis 1989), considering the difference in lifespan. Moreover, data from natural systems (lake Trichonis: $Tl=38.9$ cm; River Ladon: $Tl=24.4$ cm; Economidou et al. 1999) indicate a similar growth pattern for the western Greece populations of *B. albanicus*. The same is also true for *L. cf. svallize* which has only been studied in Kremasta reservoir (Economidou et al. 1991b). Indeed, the growth parameters of the two populations are similar (Table 4) indicating that they have originated from the same ecosystem i.e. river Acheloos. After the damming of the river at several sites, fish populations were isolated but did not evolve or phenotypically adapt to their new environments and hence did not express different growth characteristics. Although in some cases it is clear that genetic isolation is responsible for intraspecific differences in growth patterns, additive effects of environmental conditions (e.g. temperature, density of food and diseases) are also important (Loughurst & Pauly 1987).

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