

Morphological differentiation among native trout populations in North-Western Greece

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Morphology of native brown trout (*Salmo* spp.) from four major rivers of Western Greece was analyzed using 36 morphometric and 7 meristic characters in order to clarify its taxonomic status and provide insights about the life models followed by these populations. Significant between-population differences were observed in both types of characters. Discriminant analysis allowed correct classification of 92.9% of all specimens. Differences in morphometric traits were related to body shape as well as to fin positioning and length. Cluster analysis carried out separately on mean morphometric and modal meristic values of populations indicated (in both cases) distinct position of the trout population from Louros River. Morphometrics of *S. lourosensis* suggest a spatially restricted resident model of life, in which case conservation measures should be focused on restoration and protection of the uppermost part of the stream where the species is abundant.

Key words: brown trout, morphometrics, body shape, environment, conservation.

INTRODUCTION

Advantages as well as limitations of morphological analysis result from the fact that both meristic (countable) and morphometric (continuous) traits are under complex influence of genotype and environment (Swain & Foote, 1999). Consequently, morphological methods can be applied in a variety of research contexts of fish biology such as phylogeny (Clabaut *et al.*, 2007), stock and hybrid identification (Crespin *et al.*, 1999; Tzeng, 2004; Murta *et al.*, 2008), analysis of life history (Letcher, 2003; Záhorská *et al.*, 2009) and ecomorphological studies (Walker, 1997; Brinsmead & Fox, 2002; Andersson *et al.*, 2006). On the other hand, morphometrics and meristics cannot discriminate the relative contributions of genotype and environmental plasticity to the phenotype under analysis. Therefore, in order to obtain sound conclusions, morphological data need to be carefully interpreted in the context of all available information, for example, hydrological data (Mamuris *et al.*, 1998), zoogeogra-

phical distribution (Genner *et al.*, 2007), molecular genetics (Li *et al.*, 1993) and phylogeny (Klingenberg & Ekau, 1996).

Populations of the species complex conventionally called brown trout (*Salmo trutta* L.) constitute perhaps the most widely distributed, morphologically and behaviorally diverse and genetically highly structured group among freshwater fish species (Bernatchez, 2001; Klemetsen *et al.*, 2003). Even neighboring resident and anadromous populations of the genus *Salmo* typically show considerable genetic differentiation owing to reproductive isolation down to tributaries within major rivers (Davidson *et al.*, 1989; Hindar *et al.*, 1991; Estoup *et al.*, 1998). Such polymorphic species are commonly managed at the population or “stock” level in order to prevent inflation of the species number and until sufficient information for correct species diagnosis is gathered. If some local populations obtain the status of native species, this will have consequences for conservation measures, which in many cases are urgent since these populations are threatened by environmental degradation, harvesting and stocking.

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NW Greece (Epirus) is part of the Adriatic-Ionian ichthyogeographic region of Greece (Economidis & Bănărescu, 1991) and is considered as one of the most isolated zoogeographical units in Europe, possessing many diverse freshwater ecosystems and high degree of fish endemism with endemics often confined to one or few drainages (Economou *et al.*, 2007). According to Kottelat & Freyhof (2007), from the 29 European species of the genus *Salmo*, 14 are found in the Balkan Peninsula, whereas five native species are found in Greece; three of them occur in the region of Epirus.

Early studies of Greek trout populations based on allozymes (Karakousis & Triantaphyllidis, 1990) and morphological analysis (Karakousis *et al.*, 1991) characterized the trout of NW Greece (*i.e.*, Voidomatis and Louros Rivers) as *S. trutta dentex* and reported rather low levels of genetic differentiation and poor morphometric discrimination (about 60%) of local populations. In contrast, further research using mtDNA and microsatellites has revealed that four of the five major brown trout mtDNA lineages (Bernatchez, 2001) are present in the region (Apostolidis *et al.*, 1997, 2008a) and that the populations of brown trout exhibit a strong among-population differentiation and reduced within-population genetic variability (Apostolidis *et al.*, 2008a,b). Nevertheless, the patterns of differentiation observed at microsatellite loci and mtDNA haplotypes were rather incongruent, implying a deep disparity between mitochondrial and microsatellite-based phylogenies (Apostolidis *et al.*, 2008b).

Delling (2003) proposed the existence of four definite species of the genus *Salmo* for the region of Greece: *S. cf. farioides* Karaman, 1937 and *S. dentex* Heckel 1852 are distributed through the Balkan Peninsula in a scattered manner, whereas *S. lourosensis* Delling, 2003 and *S. peristericus* Karaman, 1937 appear as endemic to the Louros River (W. Greece) and Lake Prespa (N. Greece), respectively (Delling, 2010). Kottelat & Freyhof (2007) generally follow Delling (2003) and include only the *S. pelagonicus* Karaman, 1938 inhabiting the upper Aliakmon drainage (N. Greece), which is treated by Delling (2003) as an uncertain *Salmo* species.

Considering the available data about the local trout populations of Western Greece (Table 1), the following issues arise. Firstly, the poor morphometric discrimination of native trouts is rather inconsistent with the molecular data, as the latter suggest a very high level of genetic differentiation. This may result

either from a counter-gradient variation in morphometric traits, which sometimes hides the underlying genetic differences (Marcil *et al.*, 2006) or, otherwise, from an inferior discriminative capacity of traditional distance morphometrics compared with more sensitive methods such as the truss protocol (Strauss & Bookstein, 1982).

Furthermore, the population of *Salmo* from the Louros River requires further study considering the insufficient molecular data (the Louros River was not included in the above-mentioned studies of mtDNA and microsatellite loci).

Finally, the fish morphometrics should be ultimately determined by some environmental selective forces that impose certain constraints on the life history of the population. Therefore, an environmental explanation of morphometric differences would contribute to our understanding of life models followed by different local populations, thus helping to develop a sound conservation strategy.

The aim of the present study is to analyze the morphology of native trout populations from the most important rivers of NW Greece and to consider possible implications for their taxonomy and conservation.

MATERIALS AND METHODS

The study was conducted in NW Greece (Fig. 1), a mountainous region of the country characterized by heavy rainfall and carbonate type catchments (Skoulikidis *et al.*, 2004). Its rivers are characterized as diluted; they also present low total phosphorus concentrations, probably because of the carbonate that may act as a phosphorus sink (Skoulikidis, 2009). The mountainous parts of W Greek rivers are generally characterized by good water quality (Kotti *et al.*, 2005; Skoulikidis, 2009) whereas the lowland parts show different degrees of anthropogenic pollution (Kotti *et al.*, 2005; Katsaounos *et al.*, 2007).

Aoos, Acheloos and Arachthos (Fig. 1) belong to the rain/snowmelt type of rivers with large seasonal discharge variations (mean annual discharge 5.55, 4.38 and 2.52 km³; mean flow 52, 140 and 61 m³ sec⁻¹, respectively) and extensive mountain parts, especially taking into account their tributaries (catchment area 6813, 6478 and 2009 km², respectively). Conversely, the Louros is a spring-type river with a rather stable flow throughout the year and relatively small length, basin area and annual discharge (mean annual discharge 0.95 km³; mean flow 19 m³ sec⁻¹ and catchment area 983 km²). The Louros River has no impor-

TABLE 1. Modal values and ranges of the meristic characters studied (where the distributions had two adjacent modal values, both are given), along with bibliographical data for mt DNA lineage

River	Bibliographical data		Sample size	Standard length range	Gill rakers*	Fin ray number				
	Species ^a	mt DNA lineage				Dorsal	Anal*	Caudal	Pectoral*	Pelvic
Aoos	<i>S. dentex</i>	ME ^b	42	8.2-34.2	15-16 (14-18)	12 (11-13)	10 (9-11)	19 (18-21)	14 (13-14)	9 (8-10)
Arachthos	<i>S. cf. fariooides</i> ^e	MA-AD ^b	30	8.5-31.3	15-16 (14-17)	12 (11-13)	11 (9-11)	19 (18-20)	13 (12-14)	9 (8-9)
Achelooos	<i>S. cf. fariooides</i>	MA-AD ^b	34	8.1-29.9	16 (14-18)	12 (11-13)	10-11 (9-11)	19 (18-20)	13 (12-14)	9 (8-9)
Louros	<i>S. lourosensis</i>	AD ^c	44	9.2-40.4	18 (14-19)	12 (11-13)	10-11 (9-11)	19 (18-20)	13 (11-14)	9 (9-10)
Louros	<i>O. mykiss</i>	N.E. ^d	20	14.8-26.7	16 (15-17)	12 (11-13)	8 (7-10)	19 (18-20)	15 (14-15)	9 (9-10)

^a according to Delling (2003) and Delling (2010)

^b Apostolidis *et al.* (2008a)

^c Bernatchez (2001)

^d N.E.: not examined

^e reported as *S. cf. fariooides* in Economou *et al.* (2007)

* characters which showed significant differences between groups after Kruskal-Wallis test ($p < 0.001$)

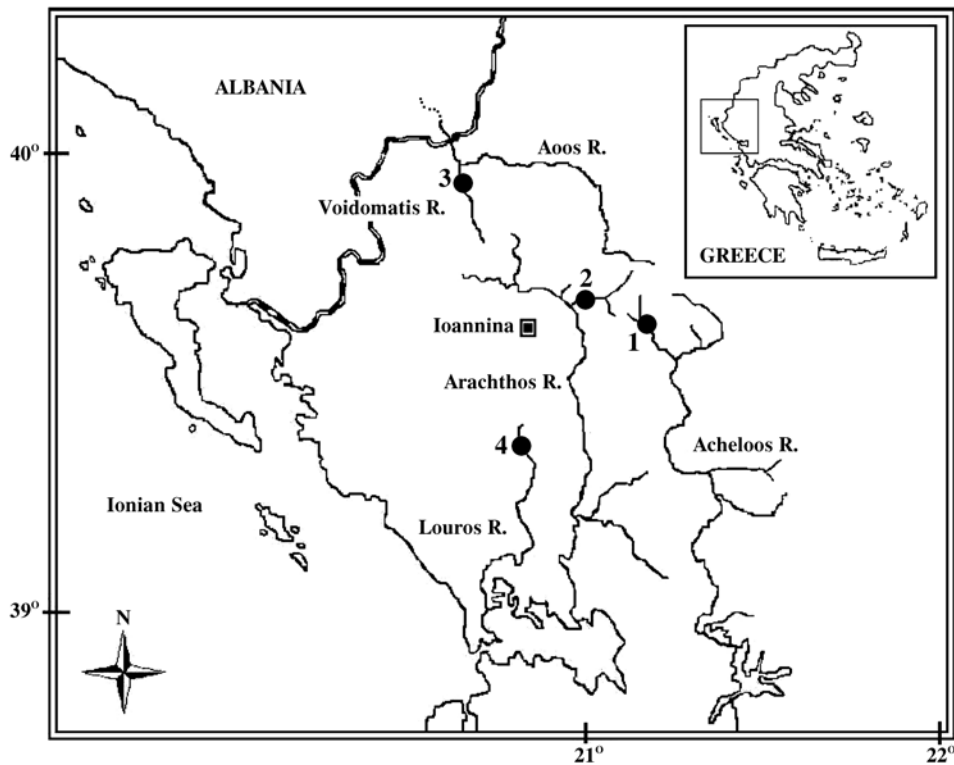


FIG. 1. The study area including the sampling sites.

tant tributary on its mountainous part and becomes a lowland river already at 27 km down from its springs. The sample from the River Aeos originated from its largest tributary, the River Voidomatis, near to Aristi Bridge. The study was conducted at the upstream parts of the rivers, beyond the dams, where the trout populations were sufficiently abundant.

Trout specimens were collected by using a portable electrofishing device (Hans Grassl, Germany) in October 2009. Captured specimens were anaesthetiz-

ed (100 ppm of ethylenglycolmonophenylether), photographed on their left side with fins outstretched and then released in the river.

In addition to the native trout, 20 rainbow trout (*Oncorhynchus mykiss*) were captured from the Louros River in order to provide an “outgroup” for between-population comparisons. This allochthonous trout is extremely abundant in the upper part of the Louros River due to escapement from hatcheries and aquaculture units situated along the river.

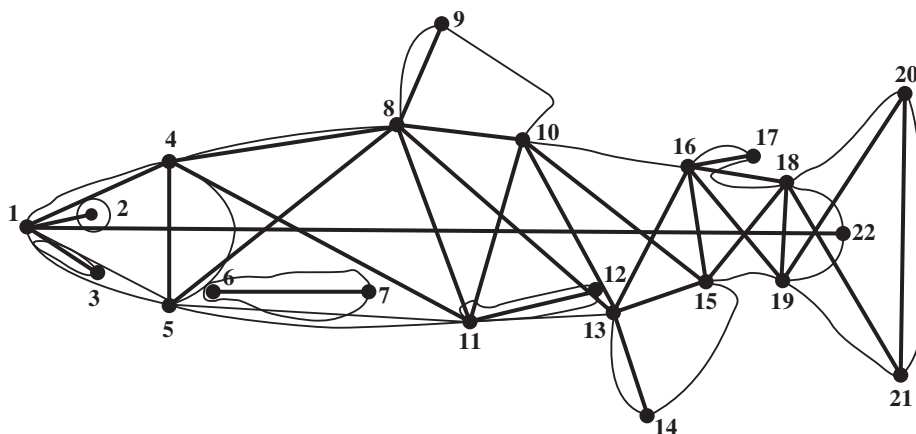


FIG. 2. Landmarks and distances used in morphometric analysis.

Morphometric analysis was carried out on a set of distances among several landmarks defined on the digital photos of fish (Fig. 2, Table 2). Distances were determined using image-analyzing software (NIKON Digital Sight DS-L2). A total of 36 raw variables were recorded. To remove the effect of size, all individual

measurements were standardized according to the formula:

$$D_i^* = D_i \times (L_{Sav} \times L_{Si}^{-1})^b,$$

where D_i^* is the standardized measurement, D_i is the measured character length, L_{Sav} is the overall (arith-

TABLE 2. Studied meristic and morphometric characters, codes and variable names used in multivariate analyses

Meristic Characters	Code name	Variable
Number of scales of lateral line	LLS	L
Number of gill rakers of 1 st branchial arch	GR	R1
Number of rays of dorsal fin	DFR	DF
Number of rays of pectoral fin	PFR	P1
Number of rays of pelvic fin	VFR	V1
Number of rays of anal fin	AFR	A
Number of rays of caudal fin	CFR	C
Morphometric	Landmarks	Distances
Dorsal head length	L1-L4	D1
Ventral head length	L1-L5	D2
Head height	L4-L5	D3
Distance between the upper end of head to the insertion of dorsal fin	L4-L8	D4
Distance between the lower end of head to the insertion of pelvic fin	L5-L11	D5
Distance from the upper end of head to the origin of pelvic fin	L4-L11	D6
Distance from the lower end of head to the insertion of dorsal fin	L5-L8	D7
Distance from the insertion of dorsal fin to the origin of pelvic fin	L8-L11	D8
Dorsal fin base	L8-L10	D9
Distance from the origin of pelvic fin to the insertion of anal fin	L11-L13	D10
Distance from the insertion of dorsal fin to the insertion of anal fin	L8-L13	D11
Distance from the origin of pelvic fin to the end of dorsal fin	L10-L11	D12
Distance from the end of dorsal fin to the insertion of anal fin	L10-L13	D13
Distance from the end of the dorsal fin to the insertion of adipose fin	L10-L16	D14
Base of anal fin	L13-L15	D15
Distance from the end of dorsal fin to the end of anal fin	L10-L15	D16
Distance from the insertion of anal fin to insertion of adipose fin	L13-L16	D17
Distance from the insertion of adipose fin to end of anal fin	L15-L16	D18
Distance from the insertion of adipose fin to upper origin of caudal fin	L16-L18	D19
Distance from the postanal to the lower origin of caudal fin	L15-L19	D20
Distance from the postdorsal to the lower origin of the caudal fin	L16-L19	D21
Distance from the postanal to the upper origin of caudal fin	L15-L18	D22
Distance of the upper origin to the lower origin of caudal fin	L18-L19	D23
Distance of the upper origin to the upper tip of caudal fin	L18-L20	D24
Distance from the lower origin to the lower tip of caudal fin	L19-L21	D25
Distance from the upper origin to the lower tip of caudal fin	L18-L21	D26
Distance from the lower origin to the upper tip of caudal fin	L19-L20	D27
Distance from the upper tip to the lower tip of caudal fin	L20-L21	D28
Distance from the snout to the center of eye socket	L1-L2	D29
Maxillary length	L1-L3	D30
Pectoral fin length	L6-L7	D31
Length of the 1st ray of dorsal fin	L8-L9	D32
Length of the 1st ray of pelvic fin	L11-L12	D33
Length of the 1st ray of anal fin	L13-L14	D34
Height of adipose fin	L16-L17	D35

metic) mean standard length for all fish from all samples and L_{Si} is the standard length of the specimen. The value of b was estimated for each character from the observed data as the slope of the regression of D_i on S_i using all fish in all groups (Karakousis et al., 1991; Leonart et al., 2000).

In addition, seven meristic characters were measured (see Table 2). Between-groups differences in meristic variables were assessed with the Kruskal-Wallis test followed by pairwise comparisons.

The standardized morphometric values were subjected to a variety of multivariate analyses. Firstly, the discriminative power of the set of original variables was tested by a preliminary analysis of variance and then by discriminant analysis. Afterwards, the dimensionality of the data was reduced by principal component analysis and multivariate analysis of variance was run again on the principal components (PCs) in order to interpret the pattern of morphometric variation among groups. Since the variance of some PCs was not homogeneous among groups, Tamhane's T2 test was used for pairwise comparisons (Neave et al., 2007).

Finally, the fish groups corresponding to different ecosystems were subjected to hierarchical clustering using the mean rescaled values of PCs and the modal rescaled values of meristic characters in order to assess the similarities of morphologic profiles of the populations. PCs rather than original variables were used in this analysis in order to avoid redundancy of characters. All analyses were done with SPSS 17.0.

RESULTS

Considering the meristic characters (Table 2), significant differences among groups (Kruskal-Wallis test, $p < 0.001$) were observed in the number of gill rakers and in the number of rays in anal and pectoral fins. The distributions of the meristic as well as morphometric variables were unimodal and close to normal, with no sign of significant sample heterogeneity (Kolmogorov-Smirnov, $p > 0.05$).

Considering the morphometric characters (Table 2), multivariate analysis of variance revealed significant differences between fish groups (Wilks' lambda 0.006, $F = 9.3$, $p < 0.001$). All raw variables contained a significant part of between-group variation (Table 3), except for the length of the adipose fin (D35). Consequently, the latter variable was not included in further analysis.

The most significant differences were detected among variables related to body height and fin length. Using all raw variables, it was possible to correctly discriminate 92.9% of cases. A re-classification summary is presented in Table 4. The first canonical discriminant function (CDF) was loaded mainly by the measurements of fin lengths and discriminated the group of *O. mykiss* which had the smallest fins. The second CDF was loaded by the measurements reflecting the posterior body height and discriminated, somewhat more loosely, the groups of native trouts.

Principal component analysis showed a complex, multidimensional pattern of variation among the raw variables (Kaiser-Meyer-Olkin measure 0.47). Eight PCs explaining approximately 80% of the total variance were extracted. Measurements having high loading scores on the two first PCs after varimax rotation are shown at Fig. 3A. The first PC was related to the height of the posterior body part, which was by far the most variable feature of body shape in our study. The second PC reflects the length and position of fins. Higher values of this PC were associated with long pectoral, ventral and anal fins, with a longer lower part of caudal fin as well as with a more rostrally positioned dorsal fin. The third PC was related mainly to the measurements of the head, including the mouth-to-eye distance and the length of the lower lip. The fourth PC was clearly related to the length of the tail trunk. Finally, the fifth and last well-interpretable PC was associated with the size of the caudal fin.

The pattern of between-group variation of PCs (Table 5) was generally consistent with the results of the discriminant analysis. Significant differences were detected in all eight PCs. The first PC, which reflected the posterior body height, was significantly higher for the Louros population ($p < 0.001$) followed by the populations of Acheloos and Aoo (Fig. 3B). Finally, among the native trouts, population of Arachthos had the lowest value ($p < 0.001$) and therefore is characterized by the thinnest, most streamlined body shape. Considering the second PC, the highest values were observed in the populations of Acheloos and Arachthos, whereas the hatchery-reared allochthonous *O. mykiss* shows the lowest value ($p < 0.001$).

According to hierarchical cluster analysis (between-group linkage), performed separately on the mean rescaled PC values and modal rescaled meristic values (Fig. 4), the farthest position is occupied by *O. mykiss*, which is expected. Among the Greek populations, the outermost one is that from the Louros River, whereas the morphometric and meristic clustering is

TABLE 3. Results of MANOVA on the raw morphometric variables

Distance*	F	p value	Partial Eta ²	Distance*	F	p value	Partial Eta ²
D1(L1-L4)	17.816	< 10 ⁻³	0.302	D19(L16-L18)	13.796	< 10 ⁻³	0.251
D2(L1-L5)	14.855	< 10 ⁻³	0.265	D20(L15-L19)	4.797	< 10 ⁻³	0.104
D3(L4-L5)	2.954	0.022	0.067	D21(L16-L19)	22.241	< 10 ⁻³	0.350
D4(L4-L8)	35.825	< 10 ⁻³	0.465	D22(L15-L18)	11.819	< 10 ⁻³	0.223
D5(L5-L11)	3.620	0.007	0.081	D23(L18-L19)	34.469	< 10 ⁻³	0.455
D6(L4-L11)	20.019	< 10 ⁻³	0.327	D24(L18-L20)	10.091	< 10 ⁻³	0.197
D7(L5-L8)	31.629	< 10 ⁻³	0.434	D25(L19-L21)	11.149	< 10 ⁻³	0.213
D8(L8-L11)	62.685	< 10 ⁻³	0.603	D26(L18-L21)	17.785	< 10 ⁻³	0.301
D9(L8-L10)	23.492	< 10 ⁻³	0.363	D27(L19-L20)	5.548	< 10 ⁻³	0.119
D10(L11-L13)	3.641	0.007	0.081	D28(L20-L21)	16.757	< 10 ⁻³	0.289
D11(L8-L13)	94.862	< 10 ⁻³	0.697	D29(L1-L2)	16.738	< 10 ⁻³	0.289
D12(L10-L11)	61.229	< 10 ⁻³	0.597	D30(L1-L3)	19.979	< 10 ⁻³	0.326
D13(L10-L13)	56.619	< 10 ⁻³	0.579	D31(L6-L7)	126.600	< 10 ⁻³	0.754
D14(L10-L16)	11.460	< 10 ⁻³	0.217	D32(L8-L9)	33.744	< 10 ⁻³	0.450
D15(L13-L15)	7.168	< 10 ⁻³	0.148	D33(L11-L12)	18.411	< 10 ⁻³	0.309
D16(L10-L15)	36.936	< 10 ⁻³	0.472	D34(L13-L14)	33.865	< 10 ⁻³	0.451
D17(L13-L16)	69.328	< 10 ⁻³	0.627	D35(L16-L17)	1.141	0.11	0.022
D18(L15-L16)	54.200	< 10 ⁻³	0.568				

* Landmarks used for definition of the distances appear in parentheses

TABLE 4. Summary of re-classification of native trout specimens based on discriminant analysis^a

Group	Predicted Group Membership					Total
	Aoos	Arachthos	Acheloos	Louros	<i>O. mykiss</i>	
Aoos	40	1	1	0	0	42
Arachthos	3	26	1	0	0	30
Acheloos	1	0	32	1	0	34
Louros	2	0	2	40	0	44
<i>O. mykiss</i>	0	0	0	0	20	20

^a 92.9% of original grouped cases were correctly classified

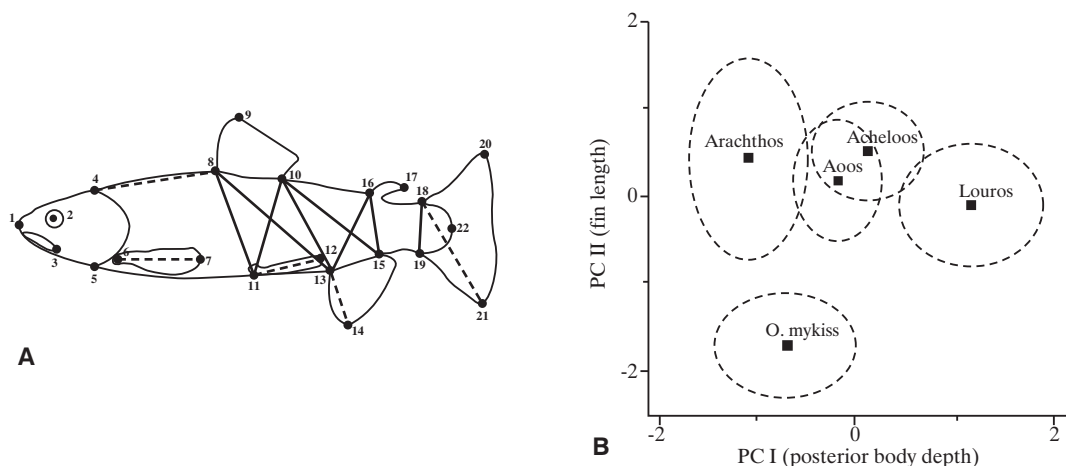


FIG. 3. A. Morphometric variables with high scores for the two first principal components. PCI: continuous lines; PCII: dashed lines. B. Plot of the first two principal components derived from raw morphometric variables. Black squares: mean values; Dashed circles: standard deviations.

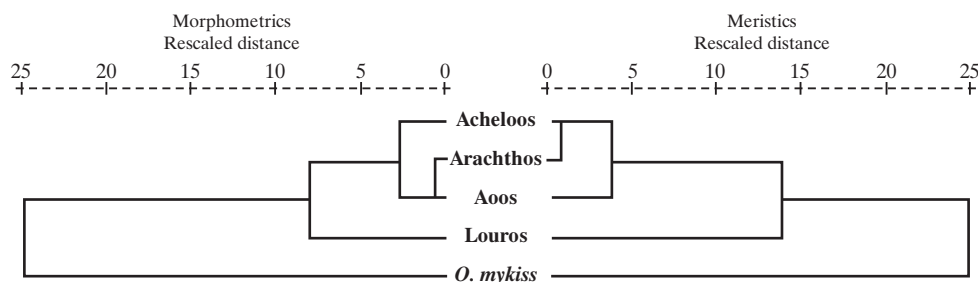


FIG. 4. Hierarchical cluster analysis based on mean PC values and modal values of meristic characters. Method: between-group linkage; the values are rescaled on (0; 1) interval.

TABLE 5. Between-group differences of the principal components (PC) calculated from the raw variables

Principal component	F	<i>p</i> value	Partial Eta ²
PC1	70.56	< 10 ⁻³	0.63
PC2	32.85	< 10 ⁻³	0.44
PC3	4.43	0.002	0.10
PC4	6.01	< 10 ⁻³	0.13
PC5	3.40	0.011	0.08
PC6	18.58	< 10 ⁻³	0.31
PC7	3.31	0.012	0.07
PC8	3.48	0.009	0.08

not consistent as regards the remaining three groups. According to the meristic characters, populations of Acheloos and Arachthos are most closely related; instead, the morphometric characters suggest that the populations of Arachthos and Aaos are the most similar in respect to the body form morphology.

DISCUSSION

Morphological analysis attempted in this study revealed significant differences in morphology among native populations of trout from NW Greece. In contrast with earlier studies (Karakousis *et al.*, 1991), a good discrimination of samples (92.9%) was achieved. One of the reasons might be the better sensitivity of the truss protocol compared to the traditional distance methods (Strauss & Bookstein, 1982).

The morphological differences observed in the present study could be attributed either to genetic differentiation of the populations or to environmental plasticity or both. Morphometric traits are considered to reflect adaptive responses of a population to its local environment (Swain & Foote, 1999). There are cases where differences in morphometrics detected in wild populations are assumed to persist entirely due

to environmental plasticity (Tudela, 1999); most frequently, however, variation in body shape is expected to have a significant genetic component arising due to evolutionary plasticity, *i.e.* due to rapid genetic changes within the gene pool in response to local selective pressures (Hänfling & Brandl, 1998; Genner *et al.*, 2007; Shao *et al.*, 2007; Herler *et al.*, 2010). Specifically, in the natural history of brown trout, adaptation to different environmental regimes is conceived as an important factor of genetic structuring (Ferguson, 1989) and morphometric features may well be affected by this process. Accordingly, some experiments have demonstrated that, in brown trout, variations in body shape can persist after a “common garden” rearing (Pakkasmaa & Piironen, 2001).

According to the results of the present study, the trout population from the Louros River appears sharply distinct from the remaining three groups, both in morphometric (deeper body) and meristic traits (a high number of gill rakers, Dunn’s multiple comparison test, $p < 0.05$ or 0.01). Hierarchical cluster analysis based on allozyme alleles performed by Apostolidis *et al.* (1996) placed the populations from the Louros and the Aaos Rivers in the same cluster; our results, however, support rather the suggestions of Delling (2003, 2010) and Kottelat & Freyhof (2007) that the Louros trout represents a different endemic species.

As regards the remaining three groups, the differences among them were pronounced. This may be attributed to stable conditions which prevail in the majority of Greek streams and probably exert a counter-gradient influence on morphometric traits (Karakousis *et al.*, 1991). The results of meristic clustering suggest that the populations of the Acheloos and the Arachthos Rivers are closer to one another than to the Aaos population. This is in agreement with the available data from allozyme and microsatellite analysis (Apostolidis *et al.*, 1996, 2008b).

Among the environmental factors that may have shaped the observed differences in morphometrics, the most important should be related to abundance of food sources as well as to swimming habits and performance. In our study, the trout populations are located exclusively in the upstream parts of the rivers; consequently, the existence of dams surely is restrictive for the trout habitat but should not influence directly the trout morphometrics.

The Louros trout is characterized by a deeper body which is more effective during burst swimming (Webb, 1984) and may be associated with higher swimming costs but also with a higher capacity to accumulate energy reserves (Boily & Magnan, 2002). Therefore, its deep body seems to be more appropriate for a resident life model and should also imply sustained competition and more aggressive behavior (Holtby et al., 1993). The Louros River has a distinct eco-hydrological profile because of its nearly constant discharge throughout the year. Probably due to this fact, the river can sustain a very rich and abundant invertebrate community, which has been characterized as an “outlier” among other Greek rivers (Skoulikidis et al., 2004). Such a constant environment with densely distributed and rich food sources must indeed favor the resident life model with strong territorial behavior and can explain the morphological pattern of *S. lourosensis*.

Conversely, the slender body type and longer fins, such as those of the Arachthos trout, are more appropriate for distantly migrating stream populations actively searching for food (McLaughlin & Grant, 1994; Liao, 2007). Remarkably, the values of the PC reflecting the fin length were the lowest in the group of hatchery-derived *O. mykiss*.

High degrees of genetic differentiation across Greek native trouts imply a conservation strategy focused at the population level (Apostolidis et al., 2008a). Moreover, conservation measures should take into account the available biological data. According to Kottelat & Freyhof (2007), *S. lourosensis* is an endangered species due to its restricted habitat (27 km to the Agios Georgios dam). Moreover, the results of our morphometric analysis suggest predominantly resident habits of *S. lourosensis*. These results are also confirmed by our preliminary data about population abundances showing that, even within its restricted habitat, the Louros population is distributed highly unevenly. Consequently, conservation efforts should be concentrated on the small most upstream area of the river (no more than 10 km), where the

species is sufficiently abundant.

In conclusion, the present study demonstrated a good discrimination of native trout populations from NW Greece by means of morphometrics. The population of the Louros River appears morphologically distinct; morphometrics of Louros trout suggest a resident model of life and therefore have implications for a sound conservation strategy.

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