

## Notes on the distribution and taxonomic status of *Gobio gobio* from the Morača River basin (Montenegro)

Radek ŠANDA<sup>1</sup>, Věra LUSKOVÁ<sup>2</sup> and Jasna VUKIĆ<sup>3</sup>

<sup>1</sup> National Museum, Department of Zoology, Václavské náměstí 68, 115 79 Praha, Czech Republic; e-mail: rsanda@seznam.cz

<sup>2</sup> Institute of Vertebrate Biology, Academy of Sciences of the Czech Republic, Květná 8, 603 65 Brno, Czech Republic; e-mail: luskova@ivb.cz

<sup>3</sup> Department of Ecology, Charles University, Viničná 7, 128 44 Praha, Czech Republic

Received 30 November 2004; Accepted 20 March 2005

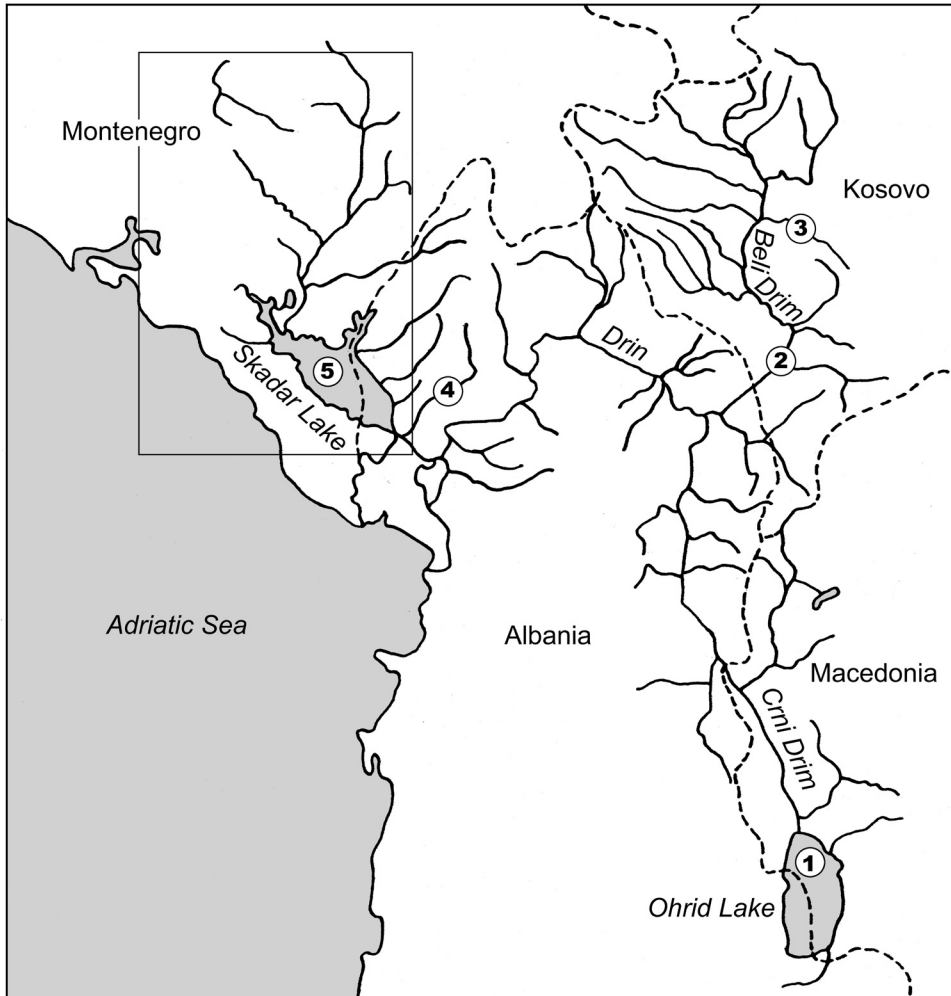
**Abstract.** The occurrence of common gudgeon in the River Morača drainage of southern Montenegro was investigated. Low numbers of specimens were recorded in four out of five localities investigated on the Zeta River and at a single locality on the lower part of the River Morača. Allozyme analysis revealed that the specimens examined belong to the species *Gobio gobio* (Linnaeus, 1758). The lower number of lateral line scales in common gudgeon from the Ohrid-Drim-Skadar system, as compared with other European populations, probably indicates clinal variability. The results also demonstrate that the subspecies *Gobio gobio ohridanus* Karaman, 1924 is not a valid taxon.

**Key words:** common gudgeon, distribution, taxonomy, Adriatic Sea drainage, Zeta River

### Introduction

The common gudgeon, *Gobio gobio* (Linnaeus, 1758), is a species widely distributed in Europe. A number of subspecies and lower categories of *Gobio gobio* have been described (Kottelat 1997, Bănărescu et al. 1999). Three subspecies have been described from the hydrological system Ohrid-Drim-Skadar (Adriatic Sea drainage) in the western part of the Balkan Peninsula: *Gobio gobio ohridanus* Karaman, 1924 from Ohrid Lake, *Gobio gobio skadarensis* Karaman, 1936 from Skadar Lake, and *Gobio gobio albanicus* Oliva, 1961 from the River Kir in Albania. Grupče & Dimovski (1975) and Šorić & Ilić (1988) concluded that all populations from the Ohrid-Drim-Skadar system belong to the subspecies *Gobio gobio ohridanus*. Kottelat (1997) included this subspecies in the synonymy of the species *Gobio gobio* (Linnaeus, 1758). However, Bănărescu et al. (1999) recognised *Gobio gobio ohridanus* as one of five valid European subspecies.

*G. gobio* in Montenegro inhabits both Skadar Lake (Ivanović 1973) and its tributary, the Morača River drainage (Marčić 1995). Nevertheless, the details of the distribution of this species have been inadequate. The River Morača is the main tributary of Skadar Lake, which is the largest lake of the Balkan Peninsula, with an area varying between 370 and 600 km<sup>2</sup> (Beeton 1981). Lakes Skadar and Ohrid and the River Drim, compose the largest river system (Fig. 1) in the western Balkan zoogeographic region (Bănărescu 1992), and drains in to the Adriatic Sea basin. The Morača River is 99 km long but has an area of only 390 ha. The spring of the River Morača lies at an altitude of 975 m a.s.l., while its mouth is at only 6 m a.s.l. It is a typical karstic Mediterranean river, flowing through limestone and dolomite bedrock. Discharge fluctuates greatly during the year. Its mean value in Podgorica is



**Fig. 1.** A map of the Ohrid-Drim-Skadar system. Localities with confirmed occurrence of *Gobio gobio* are indicated by numbers.

163 m<sup>3</sup> s<sup>-1</sup> (Drećun et al. 1985). The River Morača has several tributaries, of which rivers Zeta, Mrtvica and Cijevna are the most important (Fig. 2). These three rivers are permanent, whereas other inflows often dry out during summer. The largest tributary is the River Zeta (about 50km long) with a mean discharge in its mouth of 74 m<sup>3</sup> s<sup>-1</sup> (Martinović – Vitanović & Kalafatić 1995).

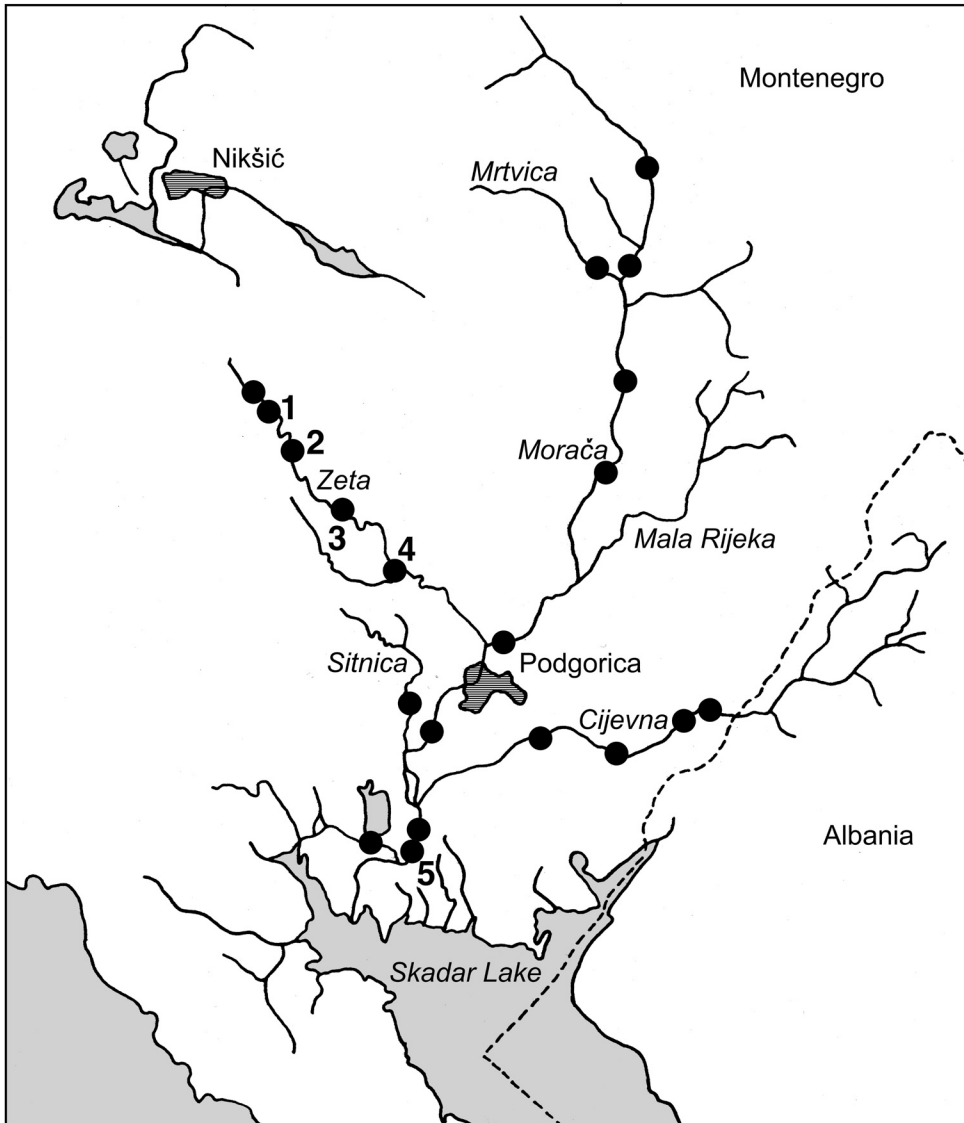
The aim of this study is to present the up-to-date information on the distribution of *G. gobio* in the Morača River system and to discuss the taxonomic status of this population.

## Materials and Methods

Fishes were caught at 20 localities in the Morača River system (Fig. 2) by electrofishing and, at some places, also by hand nets in the summer 2002 and 2003. Three specimens of *G. gobio*

**Table 1.** Description of localities with occurrence of *Gobio gobio*. The locality numbers correspond to numbers in Fig. 2. Sampling was conducted in 2002. \* At locality 3, additional data about species composition were obtained in 2003. Species found in 2003 are underlined and number of specimens is not shown. \*\* At locality 5, only one juvenile *Gobio gobio* was found in a pit, which remained on the bank after gravel mining. Most of the other species were found in the river. Due to different habitat, number of specimens is not shown.

Locality (no. of captured <i>G. gobio</i> is in parentheses)	Coordinates	Width (m) Depth (m)	Velocity ms <sup>-1</sup>	Substratum	Vegetation	Species composition (no. of specimens is in parentheses)
1. River Zeta in village Glava Zete (4)	N 42°39'20.7" E 19°00'22"	20-30; up to 3	~ 0.5	mostly stone and gravel with sand, wooden debris	moss on stones	<i>Barbus rebeli</i> (2), <i>Phoxinus phoxinus</i> (14), <i>Leuciscus cephalus</i> (7), <i>Telestes montenegrinus</i> (4), <i>Pachychilón pictum</i> (1), <i>Barbatula zetensis</i> (1), <i>Salmo trutta</i> (3), <i>Gasterosteus aculeatus</i> (9), <i>Anguilla anguilla</i> (2)
2. River Zeta under village Glava Zete (3)	N 42°39'04" E 19°00'26.4"	20-30; up to 5	0.3 - 1	stones and gravel in the mainstream, sand around banks, abundant wooden debris	no vegetation	<i>Barbus rebeli</i> (1), <i>Phoxinus phoxinus</i> (46), <i>Leuciscus cephalus</i> (9), <i>Alburnus alburnus</i> (5), <i>Telestes montenegrinus</i> (11), <i>Pachychilón pictum</i> (19), <i>Gasterosteus aculeatus</i> (2), <i>Salmo trutta</i> (1), <i>Anguilla anguilla</i> (1), <i>Lethenteron zanandreae</i> (2)
3. River Zeta in town Danilovgrad (4 spec. caught in 2002; 3 spec. caught in 2003)*	N 42°33'24.4" E 19°06'35.3"	30-40; up to 6	0.3	silt with gravel and small stones	dense macrophytes	<i>Barbus rebeli</i> (5), <i>Phoxinus phoxinus</i> (18), <i>Leuciscus cephalus</i> (9), <i>Alburnus alburnus</i> (1), <i>Telestes montenegrinus</i> (4), <i>Pachychilón pictum</i> (7), <i>Rutilus sp.</i> , <i>Chondrostoma nasus</i> , <i>Barbatula zetensis</i> , <i>Cobitis ohridana</i> , <i>Gasterosteus aculeatus</i> (1), <i>Salmo trutta</i> , <i>Anguilla anguilla</i> (1), <i>Lethenteron zanandreae</i> (1)
4. mouth of the river Sušica into the Zeta River (1)	N 42°30'50.9" E 19°10'22"	8; up to 1.8	stagnant	silt with gravel and small stones	scattered macrophytes, floating leaves of <i>Nymphaea</i>	<i>Cobitis ohridana</i> (3), <i>Pomatoschistus sp.</i> (3), <i>Phoxinus phoxinus</i> (2), <i>Leuciscus cephalus</i> (4), <i>Barbus rebeli</i> (6)
5. River Morača in village Golubovci (1)**	N 42°18'55.3" E 19°12'03.5"	40-150; up to 3, pools on the bank	0.1 - 0.6	gravel covered by fine sediment	dense filamentous algae	<i>Barbatula zetensis</i> , <i>Cobitis ohridana</i> , <i>Pomatoschistus sp.</i> , <i>Kripowitschia croatica</i> , <i>Barbus rebeli</i> , <i>Phoxinus phoxinus</i> , <i>Leuciscus cephalus</i> , <i>Cyprinus carpio</i> , <i>Salaria fluviatilis</i> , <i>Lethenteron zanandreae</i>



**Fig. 2.** A detailed map of the Morača River drainage. Full circles indicate sampled localities. The sites with occurrence of *Gobio gobio* are numbered. The numbers correspond to numbers in Table 1.

**Table 2.** Genetic variability at 20 loci in population of the *Gobio gobio* from the River Zeta (Montenegro) and rivulet Haná (Czech Republic) (standard errors are given in parentheses)

Locality	% of polymorphic loci P	Mean aleles/locus A.D.	Mean expected $H_e$	Heterozygosity observed $H_o$
River Zeta	10	1.03 (0.18)	0.028 (0.085)	0.033 (0.103)
Rivulet Haná	23.5	1.50 (0.20)	0.121 (0.052)	0.131 (0.056)

from the Zeta River were examined for allozyme patterns by electrophoresis. The classical method (Lusková et al. 1997, Šlechťová et al. 2000) on starch gels using liver and muscle tissue homogenates was used. 14 protein systems by specific enzyme staining were detected. Basic statistics were performed using Genetix software. The values obtained for the population of *Gobio gobio* from the rivulet Haná (Danube basin, Czech Republic) were used for comparison.

## Results

*G. gobio* occurrence was recorded at five of the 20 localities investigated within the Morača River system (Fig.1, No. 1 to 5). This species was not found in the rivers Cijevna, Mrtvica and Sitnica. In the River Morača, it was found at only one locality in the lower part of the river. The single specimen, in this case juvenile, was caught in a pit on the bank formed by gravel mining. Gudgeon occurred mainly in the Zeta River where the species was caught at four out of five sites studied, but still in very low numbers. Gudgeon represented from 2 to 8.5 % of all fishes caught at these localities. In total, 15 specimens were caught in this river (see Table 1), with total lengths ranging from 48 to 145 mm. Of 12 specimens, in which the number of scales on the lateral line was counted, seven had 40 and five had 39 scales (mean 39.58). The main characteristics of the localities where gudgeon occurred, together with the fish species composition are presented in Table 1.

By specific staining in 14 enzyme protein systems, 20 loci were found. The following 18 loci were monomorphic: *LDH-A\** (100); *LDH-B\** (100); *sAAT\** (100); *mAAT-1\** (100); *mAAT-2\** (100); *sMDH-A\** (100); *sMDH-B\** (100); *mMDH\** (100); *PGM-1\** (100); *mIDHP\** (100); *GPI-A\** (100); *AK\** (100); *6PGDH\** (100); *ADH\** (100); *MPI\**(100); *sMDHP-1\** (075); *GPI-2\** (175); *CK\** (120). Heterozygosity was found in two individuals, one having *G3PDH-2\** enzyme with alleles 080 and 100, and the other *SOD\** alleles 072 and 100. Estimates of observed ( $H_o$ ) and expected heterozygosity ( $H_e$ ), percentages of polymorphic loci (P) and allele numbers per locus (A.D.) at samples from the River Zeta in comparison to samples from the rivulet Haná (Czech Republic, Morava River basin) are given in the Table 2. All alleles found in individuals from the River Zeta are also present in *Gobio gobio* from the Czech Republic and Slovakia (Šlechťová et al. 2005).

## Discussion

One of the main factors influencing the distribution of gudgeon in the Morača River drainage is most probably the much more diversified substratum, providing more suitable microhabitats for this species in the Zeta River in comparison with the Morača River and its other inflows. In the Zeta, the bed was very variable, even on a local scale, and was composed of stones, gravel of different sizes, and sand. Aquatic macrophytes were abundant and submerged trunks and branches of trees, as well as other wooden debris, were plentiful; banks were indented and undercut. In contrast, the bottom of the Morača was uniform, with small stones and pebbles. Finer sediment and vegetation, composed solely of filamentous algae, were found only in the lowest part of the river below Podgorica.

Several subspecies of *Gobio gobio* have been described from the Ohrid-Drim-Skadar system: *Gobio gobio ohridanus* Karaman, 1924 from Ohrid Lake, *Gobio gobio skadarensis* Karaman, 1936 from Skadar Lake, and *Gobio gobio albanicus* Oliva, 1961 from the River Kir in Albania. However, comparative morphological and meristic analyses have shown that

all gudgeon populations within the Ohrid-Drim-Skadar system are conspecific (Grupče & Dimovski 1975, Šorić & Ilić 1988). The small differences between populations within the system do not exceed the range of interpopulation variability and could be caused by different ecological conditions at each locality (Šorić 1990). According to Grupče & Dimovski (1975), Šorić & Ilić (1988), and Bănărescu et al. (1999) the Ohrid-Drim-Skadar system is inhabited by *Gobio gobio ohridanus* Karaman, 1924. In contrast, Vinciguerra (1933) described the specimens from Skadar Lake as identical to the nominotypical form of *Gobio gobio*. Kottelat (1997) too did not recognize *Gobio gobio ohridanus* to be a valid taxon. The results of our allozyme analyses support the opinion of Kottelat (1997) that gudgeon from the system Ohrid-Drim-Skadar is not a valid taxon and that the name *Gobio gobio ohridanus* is a junior synonym of *Gobio gobio gobio* (Linnaeus, 1758).

The main difference between gudgeon populations from the Ohrid-Drim-Skadar system and other European sites is the lower number of scales in the lateral line, varying from 33 to 43, with an average of 38–39 (Karaman 1924, 1936, Oliva 1950, 1961, Ivanović 1973, Grupče & Dimovski 1975, Šorić & Ilić 1988). The number of scales on the lateral line of gudgeon from Skadar Lake ranged from 33 to 41 (mean 38.5) (Ivanović 1973). The number of scales on the lateral line in specimens from the Morača River drainage now studied falls in the range reported for gudgeon populations from the Ohrid-Drim-Skadar system, although the mean number is slightly higher (39.58).

Lower number of scales in the lateral line of gudgeon from the Ohrid-Drim-Skadar system in comparison with other European sites (average usually more than 40; Bănărescu et al. 1999) could be an effect of clinal variability, the southern populations of widespread species having fewer lateral line scales (Holčík & Jedlička 1994). Thus, the number of lateral line scales could not be used as a taxonomic criterion in variable species with continuous distribution such is the case of common gudgeon.

Gudgeon probably reached the Ohrid-Drim-Skadar system from the Danube system by river capture of those two systems in the area of Kosovo (Karaman 1971). River capture is known to be an important process for dispersion of freshwater fishes (Bănărescu 1989, Economidis & Bănărescu 1991, Durand et al. 1999, Tsigenopoulos & Berrebi 2000). A Dalmatian route of dispersion (Economidis & Nalbant 1996) is not probable, because *Gobio gobio* does not occur in rivers of the Dalmatian coast (Mrakovčić et al. 1995).

Recent distribution of common gudgeon in the eastern and southern Adriatic Sea drainage is not restricted only to the Ohrid-Drim-Skadar system, as has been stated in the latest revision of Bănărescu et al. (1999). This species is distributed more widely in the whole Albanian ichthyogeographic district (*sensu* Bianco 1990). It has also been reported in other Albanian rivers, the Mat (Rakaj 1995), Skumbini (Cakë & Miho 1999) and Vjose (Ahnel & Elvira 1991) and the occurrence of *G. gobio* in these rivers was confirmed in summer 2004 (Šanda, unpublished data). Taxonomic status of Albanian populations and their relationships to populations from the Ohrid-Drim-Skadar are under investigation at the present time.

#### Acknowledgement

We are thankful to all who helped us during the fieldwork, especially to Lubomír Piálek. Our thanks are due to Peter J. Miller for his constructive comments on the manuscript. This work was supported by the BP Conservation Programme (project Survey of Endangered Fish Species of the Morača River System), Czech

Ministry of Culture (project MKOCEZF0201), Grant Agency of the Academy of Sciences of the Czech Republic (project IAA6045005) and the Fisheries Society of the British Isles (research grant Diversity and Phylogenetic Relationships of Albanian Freshwater Gobies).

## LITERATURE

- AHNELT H. & ELVIRA B. 1991: Eine Kollektion von Meeres- und Süßwasserfischen der Österreichischen Adria-Tiefsee-Expedition 1894. *Ann. Naturhist. Mus. Wien* 92B: 1–13.
- BĂNĂRESCU P. M. 1989: Vicariant patterns and dispersal in European freshwater fishes. *Spixiana* 12 (1): 91–103.
- BĂNĂRESCU P. M. 1992: Zoogeography of Freshwaters. Vol. 2. Distribution and dispersal of freshwater animals in North America and Eurasia. *AULA-Verlag, Wiesbaden*, p. 517–1091.
- BĂNĂRESCU P. M., ŠORIĆ V. & ECONOMIDIS P. S. 1999: *Gobio gobio* (Linnaeus, 1758). In: Bănărescu P. M. (ed.), *The Freshwater Fishes of Europe*. Vol. 5/I. Cyprinidae 2/I. *Rhodeus* to *Capoeta*. *Aula-Verlag, Wiebelsheim*: 81–134
- BEETON A. M. 1981: Physical conditions of Lake Skadar and its basin: general introduction.. In: Karaman G. & Beeton A.M. (eds), *The biota and limnology of Lake Skadar*. *Podgorica*: 15–17
- BIANCO P. G. 1990: Potential role of the palaeohistory of the Mediterranean and Paratethys basins on the early dispersal of Euro-Mediterranean freshwater fishes. *Ichtyol. Explor. Freshwaters* 1 (2): 167–184.
- CAKE A & MIHO A. 1999: Ihtiofauna e lumit Shkumbini (Veshtrim ekologjik). (Ichthyofauna of the River Shkumbini (Ecological point of view)). *Tirana*, 79 pp (in Albanian with English summary).
- DRECUN D., KNEŽEVIĆ B., FILIPOVIĆ S., PETKOVIĆ S., PETKOVIĆ S. & NEDIĆ D. 1985: Biološko-ribarstvena istraživanja rijeka Morače, njenih pritoka i Rikavačkog jezera. (Biological and ichthyological investigations of the River Morača, its tributaries and the Rikavačko Lake). *Podgorica*, 92 pp. (in Serbian with English summary).
- DURAND J. D., TEMPLETON A. R., GUINAND B., IMSIRIDOU A. & BOUVET Y. 1999: Nested clade analyses of the chub, *Leuciscus cephalus* (Teleostei, Cyprinidae), in Greece: Implications for Balkan Peninsula Biogeography. *Molecular Phylogenetics and Evolution* 13: 566–580.
- ECONOMIDIS P. S. & BĂNĂRESCU P. M. 1991: The distribution and origins of freshwater fishes in the Balkan Peninsula, especially in Greece. *Inter. Rev. Ges. Hydrobiol.* 76 (2): 257–283.
- ECONOMIDIS P. S. & NALBANT T. T. 1996: A study of the loaches of the genera *Cobitis* and *Sabanejewia* (Pisces, Cobitidae) of Greece, with description of six new taxa. *Trav. Mus. natl. Hist. nat. «Grigore Antipa»* 36: 295–347.
- GRUPČE R. & DIMOVSKI A. 1975: Morfološko-sistematski proučavanja vrz rodot *Gobio* (Pisces, Cyprinidae) vo Makedonija II. *Gobio gobio ohridanus* Kar. od Ohridskoto i Skadarskoto ezera (Morphological and systematic investigation of the genus *Gobio* (Pisces, Cyprinidae) in Macedonia II. *Gobio gobio ohridanus* Kar. from lakes Ohrid and Skadar). *Acta Musei Macedonici Scientarium Naturalium* 14 (6): 145–169 (in Macedonian with French summary).
- HOLČÍK J. & JEDLIČKA L. 1994: Geographical variation of some taxonomically important characters in fishes: the case of the bitterling *Rhodeus sericeus*. *Environ. Biol. Fish.* 41: 147–170.
- IVANOVIĆ B. M. 1973: Ichthyofauna of Skadar Lake. *Institution for biological and medical research in Montenegro, Biological Station, Podgorica*, 146 pp.
- KARAMAN S. 1924: Pisces Macedoniae. *Split*, 90 pp.
- KARAMAN S. 1936: 10. prilog poznavanju slatkodvodnih riba Jugoslavije (10<sup>th</sup> contribution to the knowledge of the freshwater fishes of Yugoslavia). *Glasnik Skopskog Naučnog Društva* 17: 55–64 (in Serbian with German summary).
- KARAMAN M. 1971: Zoogeografski odnosi Prespanskog i Ohridskog jezera. (Zoogeographical relationships of lakes Prespa and Ohrid). *Izdanija, Zavod za ribarstvo na SR Makedonija* 4 (5): 1–21 (in Serbian with German summary).
- KOTTELAT M. 1997: European freshwater fishes. *Biologia (Bratislava)* 52, Supplement 5: 1–271.
- LUSKOVÁ V., ŠLECHTOVÁ V., POVŽ M., ŠLECHTA V. & LUSK S. 1997: Genetic variability of *Chondrostoma nasus* populations in rivers of the Black Sea and the Baltic Sea drainage systems. *Folia Zool.* 46 (Suppl. 1): 27–36.

- MARIĆ D. 1995: Endemic fish species of Montenegro. *Biological Conservation* 72 (2): 187–194.
- MARTINOVIĆ-VITANOVIĆ V. & KALAFATIĆ V. 1995: [Basic hydrogeological characteristics of Yugoslavian freshwaters]. In Stevanović V & Vasić V. (eds), Biodiverzitet Jugoslavije. *Ecolibri, Biološki Fakultet, Beograd* 97–115 (in Serbian).
- MRAKOVČIĆ M, MIŠETIĆ S. & POVŽ M. 1995: Status of freshwater fish in Croatian Adriatic river systems. *Biological Conservation* 72 (2): 179–185.
- OLIVA O. 1950: Notes on collection of fishes obtained by professor J. Komárek in Macedonia (Yugoslavia). A. Cyprinidae. *Věst. Čs. zool. spol.* 14: 229–262.
- OLIVA O. 1961: Bemerkungen über einige Fischarten aus Albanien. *Věst. Čs. zool. spol.* 25: 39–54.
- RAKAJ N. 1995: [Fishes of Albania]. *Shtëpia Botuese "Libri Universitar", Tirana, 700 pp.* (in Albanian).
- ŠLECHTOVÁ V., LUSKOVÁ V., ŠLECHTA V., HALAČKA K., LUSK S. & KOŠČO J. 2005: Intraspecific allozyme diversity of *Gobio gobio* in Czech and Slovak rivers. *Folia Zool.* 54 (Suppl.1): 25–32.
- ŠLECHTOVÁ V., LUSKOVÁ V., ŠLECHTA V., LUSK S., HALAČKA K. & BOHLEN J. 2000: Genetic differentiation of the two hybrid diploid-polyploid complexes of spined loach, genus *Cobitis* (Cobitidae), in Czech Republic, involving *C. taenia*, *C. elongatoides*, and *C. spp.*: Allozyme interpopulation and interspecific differences. *Folia Zool.* 49 (Suppl. 1): 67–78.
- ŠORIĆ V. 1990: Ichthyofauna of the Ohrid-Drim-Skadar system. *Ichthyologia* 22 (1): 31–43.
- ŠORIĆ V. & ILIĆ K. R. 1988: Vrste roda *Gobio*. II. – *Gobio gobio ohridanus* u jadranskom, Ohrid-Drim-Skadar sistemu i *Gobio gobio obtusirostris* u crnomorskom i egejskom sistemu (Species of the genus *Gobio* II. – *Gobio gobio ohridanus* in the Adriatic, Ohrid-Drim-Skadar system and *Gobio gobio obtusirostris* in the Black Sea and Aegean systems). *Ichthyologia* 20 (1): 47–60 (in Serbian with English summary).
- TSIGENOPOULOS C. S. & BERREBI P. 2000: Molecular phylogeny of north Mediterranean freshwater barbs (genus *Barbus*: Cyprinidae) inferred from cytochrome b sequences: Biogeographic and systematic implications. *Molecular Phylogenetics and Evolution* 14 (2): 165–179.
- VINCIGUERRA D. 1933: Pesci di Albania raccolti dal Dr. Pietro Parenzan nel 1930. *Annali del Museo Civico di Storia Naturale di Genova* 56: 303–310.