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Cobitis ohridana and *Barbatula zetensis* in the River Morača Basin, Montenegro: distribution, Habitat, Population Structure and Conservation Needs

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In this paper, we report on the distribution, habitat, population structure and conservation needs of *Cobitis ohridana* and *Barbatula zetensis* in the basin of the River Morača in Montenegro. Our data show both species to be mainly distributed in the lower stretch of the main river and some tributaries in lowland habitats. *Cobitis ohridana* preferred more shallow water with a higher abundance of filamentous algae, while *Barbatula zetensis* was more numerous in slightly deeper water with more stones as a bottom substrate. Slight differences in the habitat preference were also observed between juveniles and adults in both species. Although both species are abundant in suited habitat, they have a small distribution area in the Morača basin due to the natural rarity of the habitat. According to our data, they are not endangered.

Key words: Balitoridae, Cobitidae, Mediterranean, conservation, habitat preferences, outecology.

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The River Morača is the main tributary of Lake Skadar, together with the Drim River and Lake Ohrid forming one of the major water basins in the northern Mediterranean (BIANCO 1990). This independent basin is well known to house several endemic fish species and to have a unique ichthyocoenosis (MARIC 1995; ŠORIĆ 1990). From the Morača-Skadar system, three species of loach fish were listed, namely *Cobitis ohridana* KARAMAN, *Barbatula sturanyi* (STEINDACHNER) and *B. zetensis* (ŠORIĆ), but little information about these fishes is available (MARIC 1995). The former two species were originally described from Lake Ohrid and were later assumed to occur in the whole Drim-Skadar-Ohrid system, while *B. zetensis* was described from the Zeta River, the main tributary of the River Morača. While working on a project on the situation of freshwater fishes in the Morača basin in Montenegro, we had the opportunity to investigate the distribution, habitat, population structure and conservation needs of loaches in the Morača basin.

Material and Methods

Fishes were caught at 12 localities in the Morača basin using a portable electroshocker (500 V, 4 A, pulsed D.C.) and a hand net of 60 cm width (4 mm mesh size). Upon occurrence, loaches were counted

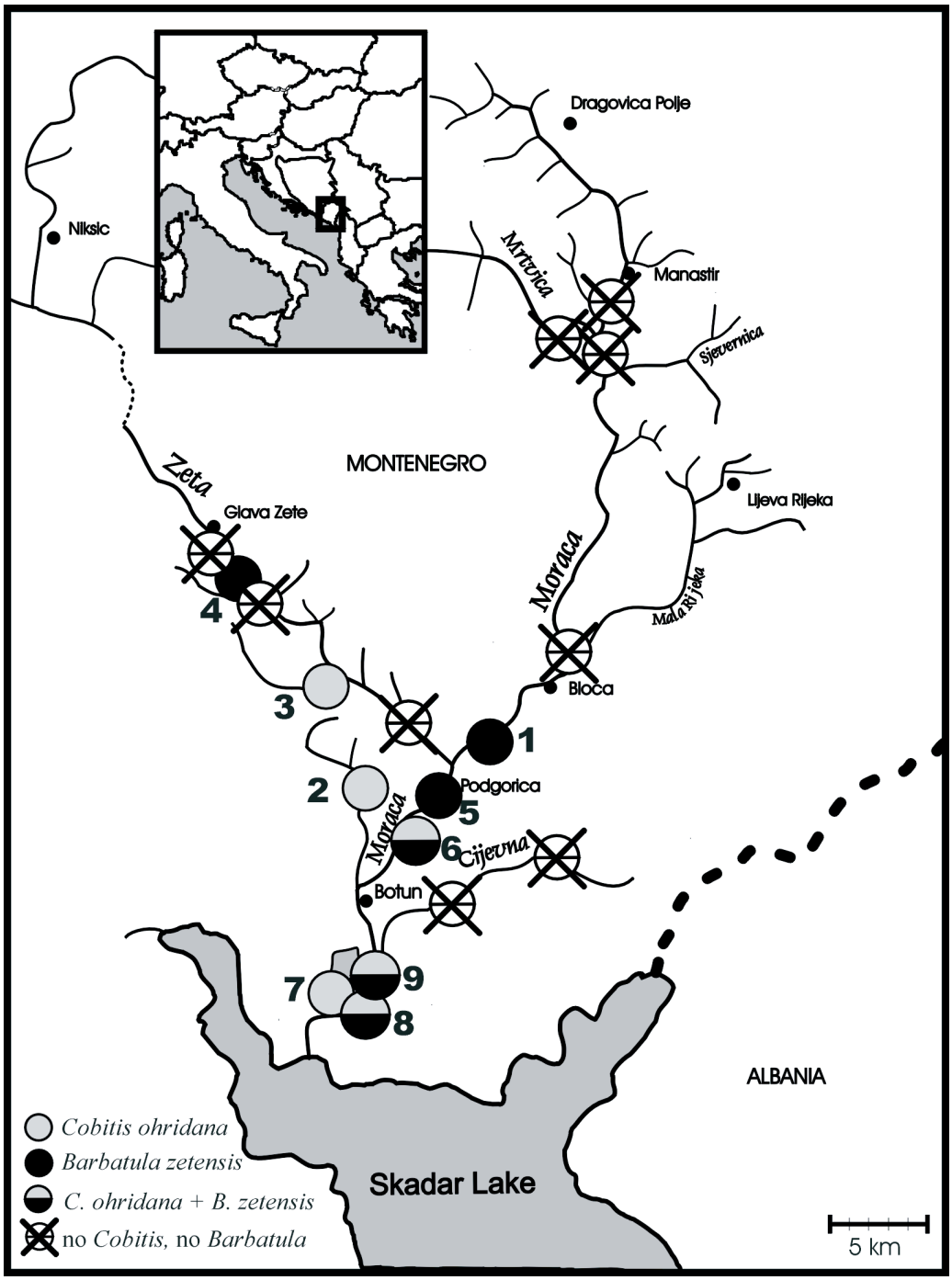

Fig. 1. Map of the River Morača system in Montenegro with the sampled localities

and measured to the nearest mm TL. In adult specimens of *C. ohridana* the sex was determined by checking the presence of a lamina circularis on the base of the second pectoral fin ray. Specimens of *C. ohridana* smaller than 38 mm total length (the minimum length for the occurrence of a lamina circularis) were taken as juvenile. In *B. zetensis*, specimens of the first age class (27-49 mm total length) were considered as juvenile. The habitat was characterized by the following parameters: river width, river depth, type of bottom substrate, current speed and type of vegetation present.

For a finer analysis of the habitat of the loaches, 12 transects of hand net catching were carried out in the shallow parts of the river section at locality 8. Locality 8 was most suitable for such a quantitative investigation because (I) both loach species occurred here, (II) population density was high enough to obtain a sufficient amount of fish, and (III) habitat diversity was large enough to promote

a habitat choice by the fish. The transects were straight, 13 to 15 m long, parallel to the shoreline and ensured a quantitative catch of occurring loaches. Each four transects were arranged parallel to each other in different water depth and distance from the shore. In total, three groups of replicates were carried out. For each transect, the environmental parameters depth, distance from shore, bottom substrate and vegetation were recorded. Pearson correlation coefficient was used to analyse the relationship between environmental parameters and loaches abundance.

The loaches caught in locality 8 were used for an analysis of length-frequencies, length-weight relationship and for calculation of the von-Bertalanffy growth model. The age of each specimen was determined from body scales. For this, scales from the right body side under the dorsal fin were scratched from the fish, distributed on an objective slide in a drop of ethanol and after drying embedded in DPX mount under a cover glass. The number of annuli rings was estimated at magnification 40 x.

Results

The authors found *B. zetensis* only in the lower and middle stretch of the River Morača and in the Zeta River, but not in other tributaries of the River Morača (Fig. 1). In contrast, *C. ohridana* was present not only in the lower Morača but also in two of its tributaries, and a tributary of the Zeta River. The habitat parameters of the localities with occurrence of loaches and the co-occurring fish species are given in Table 1. Most specimens of *B. zetensis* were caught in less vegetated area with the highest current speed and most gravel at the bottom, while *C. ohridana* was most common in shallow waters with a dense growth of filamentous algae. In both species, there was a tendency for the adult fish to occur in deeper water than the juveniles.

In the analysis of the microhabitat in locality 8, the density of *C. ohridana* ranged from 11 to 449 Ind/100m^2, while the density of *B. zetensis* varied between 0 and 295 Ind/100m^2 (Table 2). No significant correlation between the abundance of *B. zetensis* and any habitat parameter was found (Table 3). On the other hand, the abundance of *C. ohridana* was significantly correlated to all four analysed habitat parameters.

In locality 8, the largest female *C. ohridana* measured 75 mm of total length, the largest male 46 mm (Fig. 2). The maximum age observed for females was 3.5 years; for the oldest male it was 1.5 years. According to the von-Bertalanffy model, the theoretical maximum length of females is 89.5 mm. Males can reach sexual maturity (presence of Canestrini's scale) at a minimum length of 38 mm. In locality 4, slightly larger specimens than in locality 8 were caught, the largest female measured 83 mm, the largest male 66 mm (data not shown). The overall sex ratio (combining specimens from all localities) was 1 male: 2.8 females. The largest specimen of *B. zetensis* had a length of 84 mm TL (Fig. 3). The theoretical maximum length of this population was estimated to be 117 mm.

Discussion

In our investigation we found *B. zetensis* and *C. ohridana* in the Morača system, but failed to find *B. sturanyi*. This is most likely due to the very recent description of *B. zetensis* (ŠORIĆ 2000) and general difficulties with the taxonomic agreement in loaches. Since it seems unlikely that one species of *Barbatula* recently replaced another in all sampled localities, we tentatively consider former records of *Barbatula* to refer to *B. zetensis*. Within the Morača system, records of *Barbatula* came from the lower course of the River Morača, its main tributary, the Zeta River, and Lake Skadar (MARIC 1995; ŠORIĆ 1990).
C. ohridana was originally described from Lake Ohrid and later assumed to be distributed through out the whole Skadar-Drim-Ohrid system. Similar to *B. zetensis*, it was recorded within the Morača system from the lower course of the River Morača, its main tributary, the Zeta River, and Lake Skadar (MARIC 1995; ŠORIĆ 1990).

Both species were mainly found in localities with lowland characteristics. These localities strongly contrasted with the cold-mountainous character of the localities in the upper stretch of the Morača and its tributaries. Most of the Morača basin is a typical salmonid habitat with very high current velocity (up to 2.5 m s^{-1}), cold water (max. 17^{o}C) and a gravel to rocky bottom. That is why we assume the distribution of habitat to be responsible for the observed pattern of occurrence of *C. ohridana* and *B. zetensis* in the River Morača basin. Therefore, the distribution of both species seems to represent a natural situation.

C. ohridana was more closely bound to the lowland habitats than *B. zetensis*, as *C. ohridana* did not occur in localities without a sand fraction in the bottom substrate and submerged vegetation. Similar habitat requirements were reported for other *Cobitis* species (RITTERBUSCH & BOHLEN 2000; SLAVÍK *et al.* 2000). In contrast, the habitat requirements of *B. zetensis* include a gravel fraction, but not necessarily vegetation. Due to these general differences in habitat between the two loach species, little interspecific competition is to be expected. The broadness of the correlation between abundance and habitat parameter in *C. ohridana*

Table 1

Habitat characteristics and a list of occurring fish species in nine localities in the Morača system with occurrence of loaches. The numbers of the localities correspond to the numbers in Figure 1

Description	Date of collecting	Width and depth	Bottom substrate	Current speed	Vegetation	Fish species found
Loc. 1: mainstream Morača at Smokovac	July 2002	About 40 m width, pools up to 2 deep	Rapids and main rim with stones and rocks, shallows with gravel	On shallows about 0.4 m s^{-1}	No vegetation	*Alburnoides bipunctatus,* ***Barbatula zetensis****, Barbus rebeli, Phoxinus phoxinus, Salaria fluviatilis, Salmo* spec.*, Telestes montenegrinus*
Loc. 2: Sitnica River	July 2002	About 10 m width, up to 1 m deep	Silt bottom with sand and few gravel	About 0.25 m s^{-1}	Dense submerse vegetation covered by filamentous algae	***Cobitis ohridana****, Leuciscus cabeda*
Loc. 3: Sušice River	July 2002	About 20 m width, up to 1.8 m deep	Silt bottom with sand and few gravel	About 0.25 m s^{-1}	Scattered submerse vegetation and floating leaves of *Nymphea*	*Barbus rebeli*, ***Cobitis ohridana****, Leuciscus cabeda*, *Knipowitschia* spec.
Loc. 4: River Zeta under Glava Zete	September 2002	About 15 m width, up to 3 m deep	Bottom partly sandy, partly stony	About 0.5 m s^{-1}	Moss on some stones	*Anguilla anguilla****, Barbatula zetensis****, Barbus rebeli, Gasterosteus gymnurus, Gobio gobio,* unidentified Ammocoetes larvae*, Leuciscus cabeda, Pachychilon pictum, Phoxinus phoxinus, Salmo* spec.*, Telestes montenegrinus*
Loc. 5: mainstream Morača at Podgorica	September 2002	About 40 m width, pools up to 2,5 m deep	Rapids and main rim with stones and rocks, shallows with gravel	About 0.5 m s^{-1}	Dense filamentous algae on the gravel	***Barbatula zetensis*** (no regular collecting point, therefore no other fishes caught here)
Loc. 6: mainstream Morača below Podgorica	September 2002	About 40 m width, pools up to 2,5 m deep	Rapids and main rim with stones and rocks, shallows with gravel	About 0.5 m s^{-1}	Dense filamentous algae on the gravel	***Barbatula zetensis****, Barbus rebeli,* ***Cobitis ohridana,*** *Gasterosteus gymnurus, Leuciscus cabeda, Pachychilon pictum, Phoxinus phoxinus, Telestes montenegrinus*
Loc. 7: effluent of lake Malo Blato	July 2002	About 20 m width, up to 3 m deep	Silt bottom with sand and few gravel	About 0.5 m s^{-1}	Scare to dense stands of *Pomatogeton*	***Cobitis ohridana****, Carassius 'gibelio', Leuciscus cabeda, Knipowitschia* spec.*, Rhodeus amarus, Rutilus ohridanus, Salaria fluviatilis*
Loc. 8: mainstream Morača at Golubovci	July 2002	About 40 m width, main rim up to 2 m deep	Silt bottom with sand and gravel	In shallows 0.1 m s^{-1}, in main rim 0.6 m s^{-1}	Scattered to dense filamentous algae on the bottom	***Barbatula zetensis****, Barbus rebeli,* ***Cobitis ohridana,*** *Cyprinus carpio, Gasterosteus gymnurus, Leuciscus cabeda, Knipowitschia* spec.*, Phoxinus phoxinus, Rutilus ohridanus, Salaria fluviatilis*
Loc. 9: mainstream Morača at Golubovci	Septemb er 2002	About 100 m width, main rim up to 3 m deep	Silt bottom with sand and gravel	In shallows 0.1 m s^{-1}, in main rim 0.6 m s^{-1}	Scattered to dense filamentous algae on the bottom	*Alburnus scoranza,* ***Barbatula zetensis****, Barbus rebeli,* ***Cobitis ohridana,*** *Carassius 'gibelio', Gasterosteus gymnurus, Leuciscus cabeda, Knipowitschia* spec.*, Pachychilon pictum, Pseudorasbora parva, Rutilus spec., Telestes montenegrinus*

Table 2

Environmental parameters and abundance of loaches on locality 8 (Morača at Golubovci)

Transect number	Length (m)	Distance from shore (m)	Depth (cm)	Thickness of algae layer (cm)	Coverage by algae (%)	Abundance *C. ohridana* (Ind/100m^2)	Abundance *Barbatula* (Ind/100m^2)
A 1	15	2.5	15	4	100	67	11
A 2	15	5	35	4	60	22	67
A 3	15	7.5	50	2	70	67	11
A 4	15	12	80	2	35	11	11
B 1	14	2.5	15	10	100	250	0
B 2	14	5	27	9	100	238	48
B 3	14	7.5	40	3	50	48	202
B 4	14	10	80	2	40	24	12
C 1	13	0.5	13	13	100	449	0
C 2	13	5	32	10	100	218	295
C 3	13	7	50	2	25	77	167
C 4	13	10	70	2	25	103	128

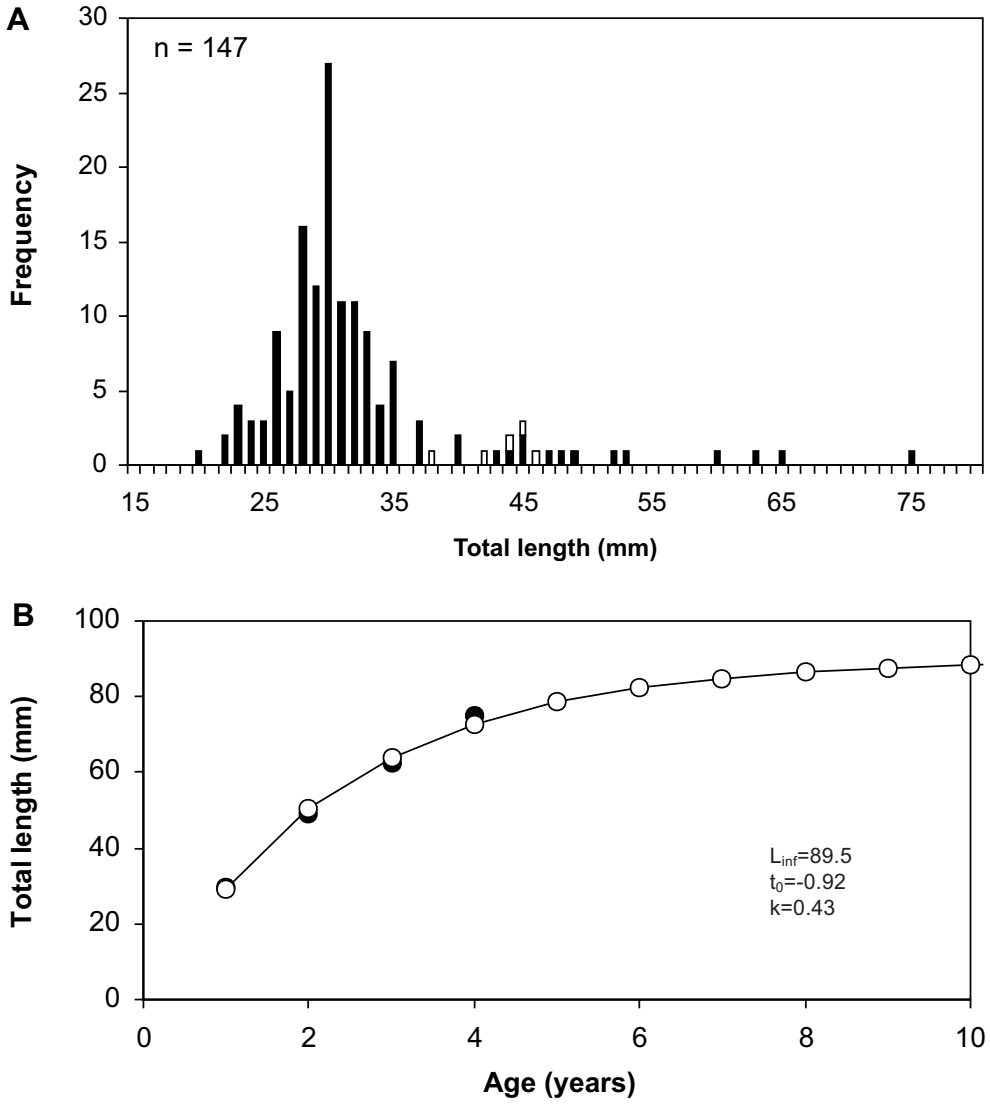

Fig. 2. Population structure of *C. ohridana* at locality 8 (main Morača at Golubovci). (A) length-frequency distribution; black bars indicate juvenile and female fish, white bars indicate males, (B) von-Bertalanffy model of growth; black dots indicate the observed values, white dot the estimated values.

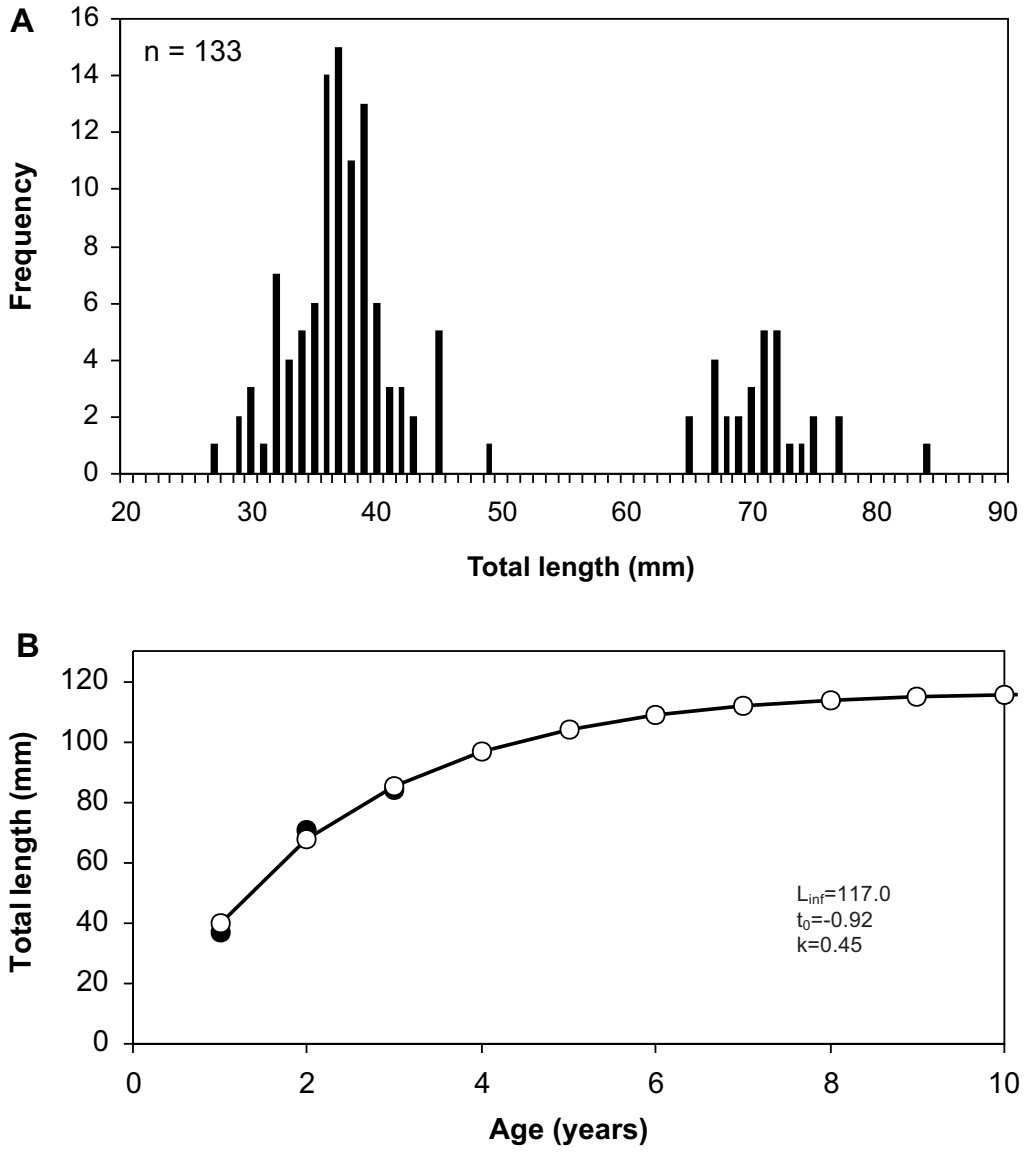

Fig. 3. Population structure of *B. zetensis* at locality 8 (main Morača at Golubovci). (A) length-frequency distribution, (B) von-Bertalanffy model of growth; black dots indicate the observed values, white dot the estimated values.

(Table 3) can be explained by the natural dependence among habitat parameters like current speed and bottom substrate. Nevertheless, it became evident that *C. ohridana* was more abundant in shallow, densely vegetated areas with a sand fraction in the bottom substrate and low current speed.

Juvenile fish made up a major part of the population of both species, which indicates a successful

Table 3

Pearson correlation coefficients for abundance of loaches and environmental parameters at locality 8 (Morača at Golubovci)

Abundance	Distance from shore	Depth	Thickness of algae layer	Coverage by algae
C. ohridana	-0.71*	-0.64*	0.93*	0.67*
B. zetensis	0.13	0.03	-0.01	-0.16

* $P<0.05$

recruitment in the locality. Specimens of three (*C. ohridana*) or two (*B. zetensis*) age classes were present, therefore the population structure does not suffer from a lack of age classes, which in *Cobitis* was shown to be connected to disturbances in the suitability of the habitat (RITTERBUSCH & BOHLEN 2000). The presence of several age classes in a pyramidal pattern of frequency (with the youngest age class as the most frequent) is generally taken as an indicator for an undisturbed long-term dynamics of fish populations (JOHNSON 1994). Growth is similar as reported for populations of related species (MARCONATO & RASOTTO 1989; SLAVÍK & RÁB 1995). In contrast, CRIVELLI and LEE (2000) reported an annual, rapidly growing population of *Cobitis meridionalis* from Lake Prespa. In comparison to the findings in other populations of *Cobitis*, this conclusion is rather outstanding and may have been affected by difficulties to estimate the age of *C. meridionalis* together with a disappearance of the species from shallow waters during winter. Such seasonal migratory behaviour was described from Lake Müggelsee in Germany (RITTERBUSCH & BOHLEN 2000). In the Morača basin, the sex ratio of *C. ohridana* was slightly biased towards the females. This is a character that may be caused by a variety of reasons (BOHLEN & RITTERBUSCH 2000). At present, we cannot decide whether the shift in sex ratio was caused by ecological or genetic reasons; further studies to clarify this phenomenon will be undertaken.

Looking on the state of the populations of *C. ohridana* and *B. zetensis* in the light of conservation, the observations from this study have to be looked on in a more general pattern. The distribution of both loach species in the Morača basin goes together with the distribution of suitable lowland habitat. Once a locality has a suitable habitat of considerable size, both species are abundant and show a natural population structure, but due to the natural rarity of suitable habitat, they have a small distribution area in the Morača basin. Both species were most abundant in the lower part of the River Morača. In other localities, only a few specimens were found. This distribution pattern represents the natural situation. Since there is no evidence for a reduction of area of occurrence or population number and since reproduction takes place regularly and abundance was locally high, *C. ohridana* and *B. zetensis* at present do not meet any criterion of threat (IUNC 2000). However, these fish highly depend on the presence of suitable habitat. Once the habitat changes, the loaches will disappear. Two of the five localities that contained loaches were obviously under strong negative impact by human activity: The Sitnica River (Point 2 in Fig. 1) is canalised and highly polluted by rubbish and organic wastewater. Only very few fish were caught in this locality. The River Morača below the city of Podgorice, the capital of Montenegro, with 150000 inhabitants, is strongly affected by agricultural, municipal and industrial wastewater (MARIC 1995). At our sampling localities 8 and 9 at Golubovci (Points 8 and 9 in Fig. 1), intense gravel digging destroyed natural shore vegetation and disturbed the habitat by increasing turbidity and sedimentation. Such massive habitat alterations may easily affect the occurring fishes. Furthermore, *B. zetensis* seems to be endemic to the Morača-Skadar system and more restricted in distribution than *C. ohridana*. Therefore, any alterations that make part of the inhabited area less suitable may easily threaten this species. The only conclusion can be to try to keep the habitats in their most natural stage to ensure a further maintenance of *B. zetensis*, *C. ohridana* and other fish species in the Morača system.

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