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THREATENED FISHES OF THE WORLD: *Orsinogobius croaticus* (Mrakovčić, Kerovec, Mišetić and Schneider, 1996) (Teleostei: Gobiidae)

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ABSTRACT

Orsinogobius croaticus is a freshwater fish with a small and limited distribution range in the Adriatic basin in Croatia and Bosnia-Herzegovina, where it inhabits cold karstic rivers and springs. The main threats to its populations include habitat fragmentation, declining habitat quality and the introduction of alien species. Conservation recommendations are proposed to improve effective habitat preservation and to expand the knowledge about this species.

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SYNONYMS

None

COMMON NAMES

Vrgoračka gobica (Cro)
Neretva dwarf goby (Engl)

TAXONIMIC NOTES

This species was originally described as *Knipowitschia punctatissima croatica*. It has been transferred to the genus *Orsinogobius*, as *O. croaticus*, by Geiger et al. (2014).

GEOGRAPHIC RANGE INFORMATION

Orsinogobius croaticus (Fig. 1) is endemic to the Adriatic basin in Croatia and Bosnia-Herzegovina. It is found in karst rivers and slow-flowing streams and in clear oligotrophic lakes, occasionally in brackish lakes connected with the Adriatic Sea.

POPULATIONS

Two subpopulations are known to inhabit five core distribution areas (Figure 2). The first subpopulation is found in the (1) Matica River, (2) Rastočko Polje field and (3) Baćina Lakes, all in Croatia (Mrakovčić et al., 2006; Zanella, 2007), and the second inhabits the (4) Norin River and (5)

Fig 1. Male (A) and female (B) *Orsinogobius croaticus* (photo by Perica Mustafić, June 2006)

lower Neretva drainage catchments in Croatia and Bosnia-Herzegovina, including the Trebižat River, Bregava River and Hutovo Blato wetland (Mrakovčić et al., 2006; Šanda and Kovačić, 2009) (Table 1). It should be noted that no individuals have been recorded in Modro Oko Lake since 1997, and it is believed that prior reports were the result of incidental translocation via subterranean water flows from the Neretva River.

Mrakovčić et al. (2006) list *O. croaticus* as critically endangered (CR) in Croatia due to declining abundance, continued diminishing of the distribution range, declining habitat quality and a strong impact from alien species (criteria: A1ace). It has been included in the IUCN Red List as vulnerable (VU) since 1996 (IUCN, 1996). Detailed quantitative studies on these subpopulations are needed so as to ascertain the existence, actual abundance and stability of subpopulations.

Table 1. List of locations where *O. croaticus* was found in Croatia and Bosnia-Herzegovina, with core areas and their associated area of occupancy (AOO)

	Locations	Core area	AOO (km^2)	References
1.	Bregava River	Neretva River (B-H)	24	*Šanda and Kovačić, (2009)*
2.	Trebižat River (Teskera)			
3.	Trebižat River (Kravica waterfalls)			
4.	channel in Hutovo Blato wetland			
5.	Metković City	Neretva River (Croatia)	20	*Mrakovčić et al., (1996, 2006); Crivelli, (2006); Kottelat and Freyhof, (2007); Čaleta et al., (2015)*
6.	Modro Oko Lake			
7.	Mlinište village			
8.	Norin River	Norin River	4	*Mrakovčić et al., (1996, 2006)*
9.	Baćina Lakes	Baćina Lakes	8	*Mrakovčić et al., (1996, 2006); Crivelli, (2006); Kottelat and Freyhof, (2007)*
10.	near Brečići village	Matica River (Polje Jezero field)	20	*Mrakovčić et al., (1996, 2006); Miller, (2004); Crivelli, (2006); Kottelat and Freyhof, (2007); Zanella, (2007); Čaleta et al., (2015)*
11.	Krotuša field			
12.	near Crni Hum			
13.	Stinjevac spring			
14.	Vučija spring			
15.	Vrgorac city	Matica River (Rastočko Polje field)	4	*Šanda and Kovačić, (2009)*

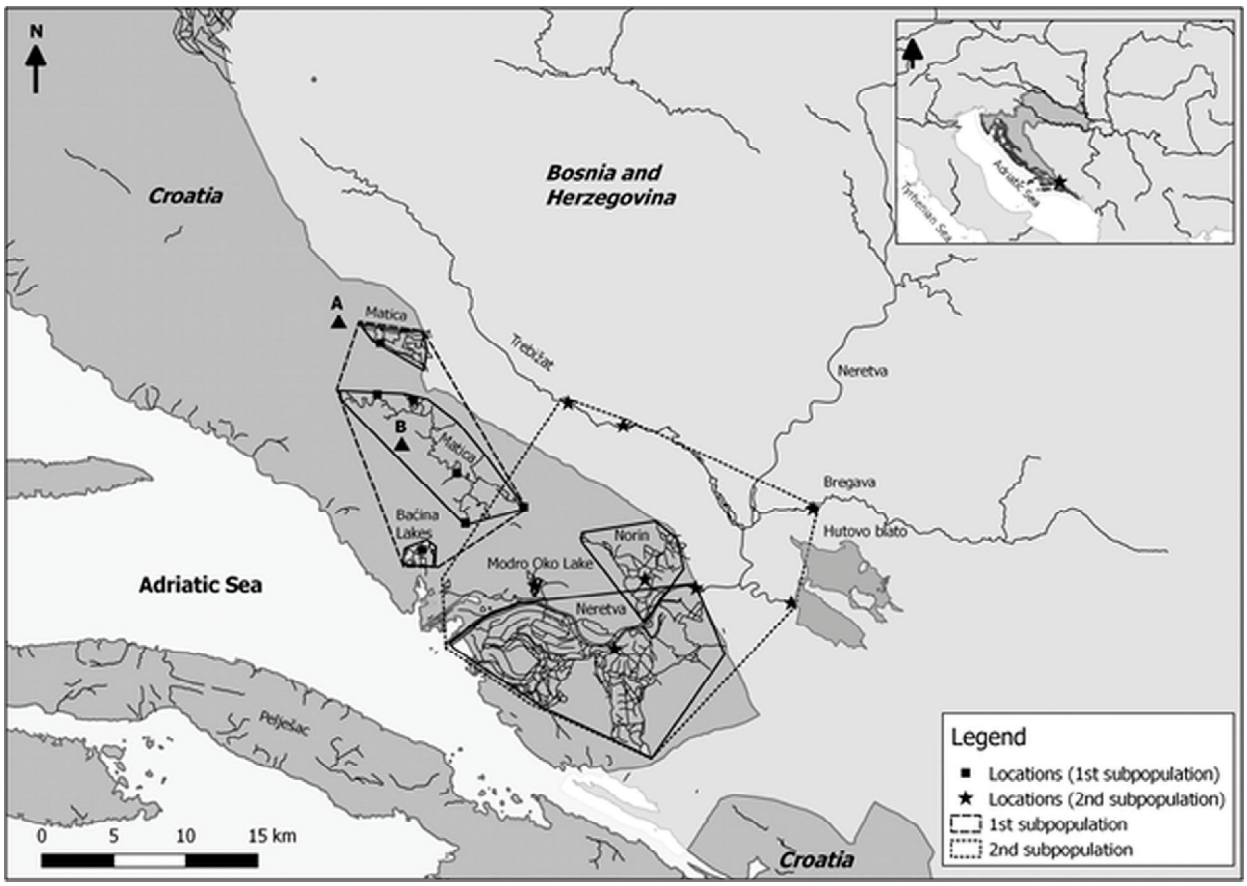

Fig 2. Geographical distribution of *Orsinogobius croaticus*

HABITAT AND ECOLOGY

Orsinogobius croaticus is a benthic freshwater species that occupies sandy bottoms with occasional stones and pebbles in clear karst rivers, slow-flowing streams and oligotrophic lakes. Occasionally, it can be found in brackish lakes (Bačina). Saline springs (i.e. Mindel) result in increased salinity in some parts of the lakes (i.e. Očuša Lake), which may reach 5‰. This species inhabits cold oligotrophic karst watercourses with a mean annual water temperature between 9.7 and 19.3°C. The mean annual saturated oxygen level at all locations was 80% (with the exception of the Butina spring where autumn/winter levels dropped to 71%) (Zanella, 2007). During winter and early spring, it inhabits small rivers and streams, but in summer when the rivers may completely dry out, it is assumed to retract underground, surviving in small ponds and refuges (Miller, 2004; Mrakovčić et al., 2006; Zanella, 2007). An example is the Matica River, a typical karst river with prominent seasonal fluctuations in the water regime. Sexually mature individuals appear in larger numbers only in the winter, when springs are full and rainwaters torrential. Spawning begins in February and March. Following spawning, adult individuals are less common in a watercourse and they are more difficult to capture, as confirmed by field studies. This is also true for other endemic species inhabiting seasonal karst watercourses and springs in Croatia (genera *Telestes, Delminichthys, Squalius*) (Miller, 2004; Mrakovčić et al., 2006; Kottelat and Freyhof, 2007). No data are available on migration patterns.

BIOLOGY

Orsinogobius croaticus is a small goby reaching up to 60 mm TL and has a life span of less than two years. Sexual maturity in both males and females is achieved at about 40-45 mm TL, spawning occurs after the first winter (Kottelat and Freyhof, 2007; Zanella, 2007). The extended spawning season lasts from March to November, with the highest intensity between April and September (Zanella et al., 2011). During spawning, males produce drumming sounds (Zanella, 2007). It is assumed that *O. croaticus* is a multiple spawner, capable of producing several batches of eggs in a single reproductive season (Zanella et al., 2011), with a

high variability in fecundity. Zanella (2007) determined three types of nests: (i) in naturally occurring round-shaped crevices in rocks, (ii) dug out openings in the substrate under rocks, and (iii) dug out holes in sandy and silty substrates. On gravelly substrates, where there is no natural shelter, it digs out oval-shaped openings to form nests, making this species more opportunistic than species of the genus *Knipowitschia* (i.e. *K. longicaudata* and *K. panizzae* which require shells or rocks to build nests). After the female lays eggs on the upper surface of the nest, the male aggressively guards the eggs and ventilates them by fanning with the caudal and pectoral fins (Kottelat and Freyhof, 2007; Zanella et al., 2011). *Orsinogobius croaticus* is an opportunistic carnivorous species, feeding on small aquatic invertebrates, mostly chironomid larvae and amphipods (Zanella, 2007).

THREATS

The major threats to *O. croaticus* populations are alien species and anthropogenic impacts, primarily caused by habitat fragmentation and declining habitat quality (Mrakovčić et al., 2006). Since the species is stenoendemic and may spend a part of its life underground, it is vulnerable to water pollution and eutrophication (Crivelli, 2006).

Direct threats within the species distribution range include:

I. Watercourse reclamation has the largest impact throughout Rastočko Polje field, which has been largely altered for agriculture. The Matica River has been connected with the Mlada River via a canal for irrigation purposes. In combination with the porous karst substrate, this has increased the likelihood for the inflow of pollutants into ground water.

II. Polje Jezero field is also affected by strong anthropogenic impacts. Intensive road construction works have taken place here recently and resulted in the widespread removal of deciduous vegetation and concrete reinforcement of river banks. Illegal fishing using minnow traps to capture indigenous ichthyofauna occurs throughout the Matica River. A main freeway lies in the vicinity.

III. The Neretva: the delta is a mosaic of diverse aquatic habitats (delta, lagoons, brackish habitats, canal networks, springs and streams, lakes). Anthropogenic pressure is high, particularly in the form of expansion of agricultural areas and changes of the water regime in floodplain areas. Neighbouring towns create a high pollution load on the river. The entire delta region is highly fragmented by the construction of roads and railways. Translocated and introduced alien species are a direct threat.

IV. Agricultural activities in the surrounding area have a negative impact on Baćina Lakes, primarily since various pollutants (mineral fertilisers, herbicides, heavy metals) drain directly into the lakes due to the karst character of the fields.

V. An additional problem is excessive fishing using all available gear and the lack of adequate controls. However, it is unclear if fishing leads to population depression.

VI. Melioration and channelling of watercourses to serve agriculture are the greatest threats to the Norin River. The introduction of alien species has negative impacts and poses a direct threat to the fauna of this area. Additional anthropogenic pollution from the nearby Neretva region also has a certain impact on the Norin River.

USE AND TRADES

This species has no direct economic or nutritional value (Zanella, 2007), however it is worth noting that the locals occasionally collect and consume this fish (Mrakovčić et al., 2006). Given the short lifespan of the species and the fact that individuals in surface waters in winter are mostly mature females, this could reflect negatively on the population.

CONSERVATION ACTIONS

Several previous studies have been conducted on the biology, ecology and life history of this goby (Mrakovčić et al., 2006; Zanella, 2007; Zanella et al., 2011). However, detailed knowledge of its genetics and abundance is required. As an endemic species, it is strictly protected pursuant to the Nature Protection Act (*Official Gazette* 144/13), though this protection is inadequate to address the threats the species faces. Its conservation status has been assessed as critically endangered (CR) in the Red Book of Freshwater Fish of Croatia (Mrakovčić et al., 2006). It has been included in the IUCN Red List as vulnerable (VU) in 1996. The species has also been listed as a NATURA 2000 species. All five core areas inhabited by *O. croaticus* are protected NATURA 2000 areas in Croatia, though no protected areas are known from its range in Bosnia-Herzegovina. Furthermore, the Neretva Delta in Croatia is protected under the Ramsar Convention and it is a special ornithological and ichthyological reserve at national level.

Here, alongside Zanella and Kovačić (2014), specific measures for the conservation of this species are proposed:

1. Prevent the reclamation and backfilling of waters, especially groundwater sources (springs Stinjevac and Vučja, Polje Jezero field).
2. Avoid any form of water and habitat pollution,

particularly in the Neretva Delta and its tributaries (Norin River), including areas in the vicinity of large towns.

3. Install wastewater treatment plants to treat possible anthropogenic sources of pollution in the vicinity of the species habitat (particularly for large towns).
4. Limit watercourse regulation (especially amelioration) within the lower Neretva drainages.
5. Strictly prohibit the introduction of alien species (chub, stone moroko, pumpkinseed, black bullhead, pike); where they have already been introduced, regulate population size (Neretva Delta).
6. Prohibit waste disposal near springs (springs Stinjevac and Vučja) in Polje Jezero field.
7. Align the proposed water regulation plan for Polje Jezero field with monitoring and conservation plans for this species.

RATIONALE FOR THE RED LIST ASSESSMENT

Detailed quantitative studies on the long term development of the abundance of *Orsinogobius croaticus* are yet to be set up. However, it is very clear that the populations are declining. This species has a naturally fragmented distribution range, both in Croatia and Bosnia-Herzegovina. At all five known sites, *O. croaticus* is strongly impacted by alien species. As invasive alien species swim freely within the range of the two subpopulations, we recognise these as just two locations based on the threat: "alien species invasion". The total AOO for both subpopulations is calculated at 80 km^2, while the EOO is 574 km^2. Considering that the AOO is less than 500 km^2, and the EOO is less than 5,000 km^2, in line with the IUCN Red List criteria (IUCN, 2012), *O. croaticus* should be listed as endangered (EN). Furthermore, the species is exposed to continuing reductions in habitat quality and meets the criteria B1ab(iii) and B2ab(iii), supporting its listing in this category.

SAŽETAK

UGROŽENE VRSTE RIBA U SVIJETU: *Orsinogobius croaticus* (Mrakovčić, Kerovec, Mišetić and Schneider, 1996) (Teleostei: Gobiidae)

Orsinogobius croaticus je slatkovodna riba s malom i ograničenom rasprostranjenosti u Jadranskom bazenu u Hrvatskoj i Bosni i Hercegovini gdje nastanjuje hladne krške rijeke i izvore. Glavne prijetnje populacijama su fragmentacija staništa, smanjena kakvoća staništa i unošenje stranih vrsta. Predlažu se preporuke zaštite za poboljšanje učinkovitog očuvanja staništa i proširenje znanja o ovoj vrsti.

Ključne riječi: Vrgoračka gobica, fragmentacije, zaštita staništa

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