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The distribution of *Microcondylaea bonellii* (Bivalvia: Unionidae) in Slovenia

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Abstract. The freshwater bivalve *Microcondylaea bonellii* is classified as Vulnerable according to the last IUCN Red List assessment and also listed in Annex V of the Habitats Directive. According to more than one hundred years old data, the species was present in Slovenia in a restricted section of the Vipava River and its tributary the Lijak Stream, which is also the species' type location. We surveyed all previously known as well as new potential localities for *M. bonellii*. Live mussels were found only in the lower part of the Vipava River, but not in the Lijak Stream. Nevertheless, the population in Slovenia is isolated from other populations and restricted only to 16 km of the Vipava River. Unfortunately, key sections of the Vipava River have been subjected to habitat destruction in the past and are threatened by ongoing engineering works and developments. Thus the legislation should be taken into strict consideration immediately if we want to preserve this protected species and its habitat.

Key words: *Microcondylaea bonellii*, distribution, type locality, Vipava River, Slovenia, the Habitats Directive

Izvleček. Razširjenost rečne enozobke (*Microcondylaea bonellii*; Bivalvia: Unionidae) v Sloveniji – Rečna enozobka je kot ranljiva vrsta uvrščena na Rdeči seznam IUCN in na Prilogo V Direktive o habitatih. Glede na več kot sto let stare podatke je vrsta živela na omejenem odseku reke Vipave in v njenem pritoku Lijaku, ki je hkrati tudi tipsko najdišče te vrste. Na terenu sva rečno enozobko iskala na vseh predhodno znanih, hkrati pa tudi na novih potencialnih nahajališčih. Žive školjke sva našla le v spodnjem delu reke Vipave, ne pa tudi v potoku Lijaku. Slovenska populacija je izolirana od drugih populacij, njen habitat pa je omejen le na 16 km dolgi odsek reke Vipave. Ta je bila v preteklosti izpostavljena posegom, ki so vodili v preoblikovanje habitata, vodnogospodarska dela pa potekajo še naprej. Zato bi bilo treba nujno začeti upoštevati obstoječo zakonodajo, če želimo ohraniti to zavarovano vrsto in njen habitat.

Ključne besede: *Microcondylaea bonellii*, rečna enozobka, tipsko najdišče, razširjenost, reka Vipava, Slovenija, Direktiva o habitatih

Introduction

Freshwater bivalves of the order Unionida, also known as freshwater mussels, are represented in Europe by at least 16 recognized species with several subspecies grouped into two families Margaritiferidae and Unionidae (Cuttelod et al. 2011, Lopes-Lima et al. 2017). Some species are widely distributed, while others have a relatively limited range. *Microcondylaea bonellii* (A. Ferussac, 1827) (= *M. compressa* Menke, 1828) is restricted to southern Europe and has been recorded from the Italian Peninsula to the Adriatic drainages of the Balkans (Lopes-Lima et al. 2017). Most of the populations of *M. bonellii* are restricted to the Po River Basin in Italy, where it is present in a few tributaries of the Po River (Lopes-Lima et al. 2017), with no more than 30 known locations (Oliverio et al. 2016). Isolated populations have also been recorded in the Soča (= Isonzo) River Basin in Italy (Nagel & Hoffmeister 1986, Cencetti & Castagnolo 1997, Nagel et al. 2007) and in the Mirna River on the Istrian Peninsula in Croatia (Fischer 1999, Fischer & Reischütz 1999, Reischütz & Reischütz 2002, Mrkvicka 2018). In the last ten years new populations have been discovered in Albania (Reischütz et al. 2008, 2014). It is considered to be extinct in Switzerland (Rüetschi et al. 2012).

In Slovenia, *M. bonellii* has been found in the Soča's tributary, the Vipava River (Erjavec 1877, Kobelt 1884, Gallenstein 1889, 1894, Reischütz & Reischütz 2002), and in its tributary, the Lijak Stream (Rossmässler 1835, Erjavec 1877, Kobelt 1884, Gallenstein 1889, 1894, Reischütz & Reischütz 2002), which is also the type location (Rossmässler 1835). The lectotype specimen is housed at the Naturmuseum Senckenberg Frankfurt am Main (Zilch 1967). The Vipava River and Lijak Stream are also mentioned in many recent Slovenian (Bole 1969, 1992, Velkovrh 2003, Slapnik 2013, Govedič 2017) and international papers (Fischer 1999, Fischer & Reischütz 1999, Bössneck 2002, Nagel et al. 2007, Rüetschi et al. 2012, Lapini et al. 2013) without any definitive proof that the species is still present in the year of publication. Only Reischütz & Reischütz (2002) confirmed its presence in the Vipava River and found empty shells in the Lijak Stream.

Freshwater mussels, particularly Unionidae and Margaritiferidae, rank among the most endangered organisms in freshwater ecosystems and have experienced a global decline in species richness, distribution and abundance (Lopes-Lima et al. 2017). *M. bonellii* has undergone a serious decline (Nagel et al. 2007). Until the beginning of the last century it was considered relatively abundant. As in many other freshwater mussel species, the drastic decline of this species is probably due to human impacts, among which habitat destruction and water pollution are the most important factors. Using the last IUCN Red List assessment, *M. bonellii* is recognized as Vulnerable (Albrecht et al. 2011). It has been assessed as Vulnerable in the European Red List of non-marine Molluscs (Cuttelod et al. 2011). *M. bonellii* is also listed under the name *M. compressa* in Annex V of the Habitats Directive (OJ 1992) and protected under the Bern Convention (Appendix III - Protected fauna species). In Slovenia, both the species and their habitats are protected (Ur. l. RS 2004). After adoption of the Habitats Directive in 1992, intensive research activity on species of conservation concern was spurred in many European countries. However, the emphasis was on Annex II and some Annex IV species but unfortunately not for Annex V species. Therefore a knowledge gap has arisen for the ecology and even the basic distribution of many species, also for *M. bonellii.*

Even the host fishes for *M. bonellii* glochidia remain unclear (Nagel et al. 2007, Lopes Lima et al. 2017).

No research and monitoring of most Annex V species in Slovenia has been carried out and, in turn, no new data have been collected so far. The ongoing unknown status (XX) of *M. bonellii* was reported under Article 17 of the Habitats Directive in 2007 and 2013 (ZRSVN 2007, 2013). Article 11 of the Habitats Directive requires Member States to monitor the habitats and species listed in the Annexes (habitats in the Annex I and species in the Annexes II, IV and V), while Article 17 requires a report to be sent to the European Commission every 6 years. As there are no published and up-to-date data on the species in Slovenia and old literature is commonly overlooked, there is also a gap in the distribution maps in the last review of European Unionidae (Lopes-Lima et al. 2017). At the same time, many recent papers about *M. bonellii* just mention its presence in Slovenia (Fischer 1999, Fischer & Reischütz 1999, Bössneck 2002, Nagel et al. 2007, Rüetschi et al. 2012, Lapini et al. 2013), but none of them bring new data or proof that this species is still present in Slovenia.

In this paper we present recent data on the distribution of *M. bonellii* in Slovenia.

Materials and methods

The Vipava River is a 49 km long left tributary of the Soča River, with its mouth in the northern Adriatic Sea. The Vipava River spring system is located at an elevation of 98 m a.s.l. in Vipava town in the western foothills of the Nanos massive. It drains a 598 km^2 catchment (Brenčič 2013, Monegato et al. 2015). In Miren, the Vipava River leaves Slovenia and enters Italy, where it discharges into the Soča River after 5 km, at an elevation of 30 m. The average discharge in Miren is 16.5 m^3/s, the minimum can be less than 2 m^3/s and the maximum 341 m^3/s (Brenčič 2013). At Miren it reaches a width of 30 m. The Vipava River has a Dinaric pluvio-nival regime, in which spring and autumn peaks are fairly similar, while differences between winter highs and summer lows are pronounced (Pavlič & Brenčič 2010). The Vipava River spring is a typical karst, water-rich spring, with a stable average water temperature of 9.5°C which oscillates between 8.5°C and 10°C (Pavlič & Brenčič 2010). In Miren, water temperatures rarely fall below 4°C in the winter and can reach up to 26°C in the summer. Close to Renče, the Lijak Stream flows into the Vipava River. The maximum discharge close to the confluence with the Vipava River is 70 m^3/s and 2 m^3/s on average. Water temperature in the Lijak Stream rises up to 20°C in the summer and falls below 4°C in the winter.

Bivalve surveys were conducted between 2007 and 2018 during low water levels. In total, 23 localities were surveyed. Three of these localities were revisited (Tab. 1). Localities were selected, based on the known and predicted distribution of the species. We surveyed shallow water patches to a maximum water depth of 1 m. We combined methods of hand collection, hand netting and the use of surface bathiscope. To spot mussels or their siphons, especially on the gravel sediment, a surface bathiscope was used, while hand netting was performed only in fine river sediments. We also systematically searched for empty shells at gravel bars. As our focus was only the distribution and not quantitative surveys of *M. bonellii*, we didn't use methods for searching completely buried mussels, especially small ones. Consequently the results are presented as presence-absence only.

Table 1. List of survey locations, where *Microcondylaea bonellii* was searched for in Slovenia in the years 2007–2018. Letters in Sampling refer to: MG (Marijan Govedič), TBG (Teja Bizjak Govedič), PV (Peter Valič). Signs in the column *M. bonellii* refer to: x – live mussels, o – empty shells.

Tabela 1. Seznam lokacij vzorčenja rečne enozobke (*M. bonellii*) v letih 2007–2018 v Sloveniji. Razlaga kratic v stolpcu Vzorčenje: MG (Marijan Govedič), TBG (Teja Bizjak Govedič), PV (Peter Valič). Razlaga kratic v stolpcu *M. bonellii*: x – žive školjke, o – prazne lupine.

ID number /Zap. številka	**Locality/Lokacija**	**Gauss-Krüger coordinates/ Gauss-Krügerjeve koordinate**		**Date/ Datum**	**Sampling/ Vzorčenje**	**Survey method/ Metoda vzorčenja**		***M. bonellii***
		X	**Y**			**water/ voda**	**gravel bar/ prodišče**	
1	The Vipava River before national border	391124	83585	12. 8. 2016	MG, TBG, PV	x	x	x, o
2	The Vipava River close to national border East from Rupa village	391224	83978	13. 8. 2018	MG, TBG		x	o
3	The Vipava River downstream the bridge in the town of Miren	392360	84242	27. 5. 2015	MG		x	o
4	The Vipava River 50 m downstream from mouth of the Vrtojbica Stream	392819	84466	13. 8. 2018	MG, TBG	x	x	x, o
5	The Vipava River downstream the weir at village Pod Otokom	392926	84340	22. 7. 2018	MG, TBG	x		x, o
6	The Vipava River 200 m Northeast from Miren Castle downstream the weir Pri Selu	392242	83247	26. 5. 2018 20. 6. 2018	MG, TBG	x		x
7	The Vipava River downstream weir at Dolnji Konec	393857	83787	20. 7. 2018	MG, TBG	x		x
8	The Vipava River 400 m downstream from the bridge of the bypass of Renče town	396505	83799	13. 8. 2018	MG, TBG	x		x, o
9	The Vipava River at the mouth of the Oševljek Stream	397872	83649	20. 6. 2018	MG, TBG	x	x	x
10	The Vipava River under the bridge North from Gradišče above Prvačina	399859	84025	20. 7. 2018	MG, TBG, PV	x	x	x
11	The Vipava River downstream the weir of Gradišče hydropower plant	400851	83032	1. 6. 2015	MG		x	
12	The Vipava River under the bridge on the road Zalošče-Dornberk	402852	83540	30. 8. 2016	MG	x	x	

ID number /Zap. številka	Locality/Lokacija	Gauss-Krüger coordinates/ Gauss-Krügerjeve koordinate X	Y	Date/ Datum	Sampling/ Vzorčenje	Survey method/ Metoda vzorčenja: water/ voda	gravel bar/ prodišče	*M. bonellii*
13	The Vipava River between former weir and railway bridge East from settlement Tabor	402795	82652	13. 8. 2018	MG, TBG	x	x	
14	The Lijak Stream at ARSO water measuring station	398193	84781	4. 6. 2015 20. 6. 2018 13. 8. 2018	MG	x		
15	The Lijak Stream between weir and railway bridge	398261	84887	13. 8. 2018	MG, TBG	x		
16	The Lijak Stream under the highway viaduct	399726	86765	26. 5. 2018	MG, TBG	x		
17	The Lijak Stream at the hunting observatory Northwest from crossroad towards the poultry	399922	88717	26. 5. 2018	MG, TBG	x		
18	The Lijak Stream under the bridge on the road Nova Gorica-Ajdovščina	400125	90102	16. 4. 2015	MG	x	x	
19	SE part of the Vogršček reservoir	403349	85271	12. 8. 2016	MG, TBG, PV		x	
20	The Vrtojbica Stream West from the bridge to the house address Vipavska cesta 90 in Rožna dolina settlement	396527	89194	3. 6. 2015 24. 6. 2016	MG	x		
21	The Pevnica Stream close to Podsabotin village	393227	94189	22. 7. 2018	MG, TBG	x		
22	The Briša Stream close to Vipolže village	387557	92684	22. 7. 2018	MG, TBG	x		
23	The Stream Oblenč close to Medana village	386554	94238	22. 7. 2018	MG, TBG	x		

Identification of mussels is unambiguous. *M. bonellii* has a unique shell shape which does not resemble any of the other species present in the Adriatic basin of Slovenia. It has a weakly developed cardinal tooth in each valve compared to the genus *Anodonta*, which is without teeth and *Unio* with well-developed teeth. *M. bonellii* is characterized by its tree-like (»arboriform«) siphonal papillae – all other European Unionidae have undivided papillae (Mrkvicka 2018). This characteristic allows the identification of mussels on underwater photos, especially on web photo forums.

All bivalves were measured (length, height and width) by using vernier caliper which is accurate to the nearest 0.1 mm. Living bivalves were immediately returned to their habitat, whereas empty shells were taken from the spot and are stored in the authors' private collection. Bivalves were surveyed in accordance with a licence (35603-3/2010-4) issued by the Slovenian Environment Agency of the Ministry of the Environment and Spatial Planning of the Republic of Slovenia to the Centre for Cartography of Fauna and Flora (CKFF).

The range of water quality variables are measured by national authorities (Slovenian Environment Agency – ARSO) within a national monitoring program. We gathered data for Miren, town close to the Italian border, for the period 2007 to 2017 (ARSO 2018; Tab. 2).

Results

Live mussels or empty shells were found at all survey sites in the Vipava River downstream from the Gradišče hydropower plant (Tab. 1: ID 1-10, Fig. 1). At all positive sites for *M. bonellii* we also found live *Unio elongatulus* C. Pfeiffer, 1825. In the Lijak Stream, no live mussels or empty shells of *M. bonellii* were found at any of the survey sites (Tab. 1: ID 14–18, Fig. 1). Altogether, 169 live mussels were found and 287 empty shells collected.

The mean length of live bivalves was 79.3 mm (min-max: 57.7–95.1 mm), the mean length of empty shells 75.6 mm (min-max: 31.3–95.1 mm) (Fig. 2).

Table 2. Physical and chemical water quality parameters of the Vipava River at Miren (ARSO 2018).
Tabela 2. Fizikalni in kemijski parametri kvalitete vode reke Vipave na merilnem mestu v naselju Miren (ARSO 2018).

Parameter	Unit / Enota	Mean (min-max) / Povprečje (min-max)	Number of measurements / Št. meritev	Number of measurements above detection limit / Št. meritev nad mejo detekcije	Detection limit / Meja detekcije
pH		8.2 (7.6–8.6)	60	60	
Specific conductance / Električna prevodnost	µS/cm	356 (296–466)	60	60	
Dissolved oxygen / Raztopljeni kisik	mg O_2/l	9.6 (6.2–14.3)	60	60	
Saturation of dissolved oxygen / Nasičenost	%	93 (65–130)	60	60	
Chemical Oxygen Demand (COD) / Kemijska potreba po kisiku (KPK)	mg O_2/l	6.8 (5–9)	52	12	5
Biological Oxygen Demand (BOD) / Biološka potreba po kisiku (BPK)	mg O_2/l	1.3 (0.5–2.9)	52	51	0.5
Dissolved Organic Carbon (DOC) / Celotni raztopljeni organski ogljik	mg C/l	1.3 (0.6–2.8)	28	28	
Total Nitrogen (TN) / Skupni dušik	mg N/l	1.80 (1.01–3.01)	52	52	
Ammonia / Amonijak	mg NH_3/l	0.005 (0.003–0.01)	44	17	0.003
Unionized ammonium / Amonij	mg NH_4^+/l	0.093 (0.014–0.3)	52	49	0.013
Nitrite / Nitrit	mg NO_2/l	0.059 (0.013–0.172)	52	51	0.007
Nitrate / Nitrat	mg NO_3/l	6.6 (4.4–11)	52	52	
Total phosphorus / Celotni fosfor	mg PO_4/l	0.16 (0.04–0.43)	52	52	
Orthophosphates / Ortofosfati	mg PO_4/l	0.062 (0.031–0.132)	52	35	0.031
Calcium / Kalcij	mg/l	60.8 (46–83)	52	52	

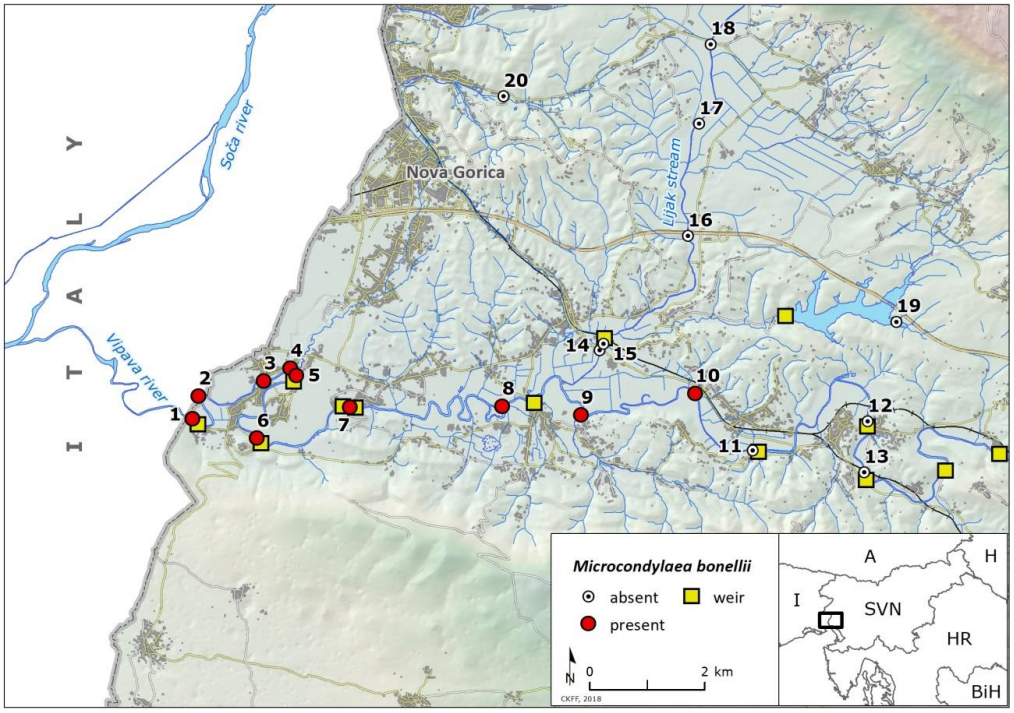

Figure 1. Locations of *M. bonellii* in the Vipava River in Slovenia and higher weirs in this sections (numbers on Fig. 1 correspond to ID Numbers in Tab. 1).
Slika 1. Najdišča rečne enozobke (*M. bonellii*) v reki Vipavi v Sloveniji z označbo večjih jezov (številke na sliki so enake zaporednim številkam v Tab. 1).

In the Prvačina and Renče area we were able to survey the Vipava River from bank to bank (20 m width), as well as its central part, where water was up to 1 m deep at low discharge rates. *M. bonellii* and *U. elongatulus* were present only in a 1.5 m strip from the bank with the low but present water current. Bivalves were buried in fine sand and gravel up to 1 cm diameter. In the central part, where water current was higher and consequently larger fractions of gravel were present, we didn't find any mussel of either species. Compared to *U. elongatulus*, *M. bonellii* was totally buried into the sediment and thus only siphonal openings were visible.

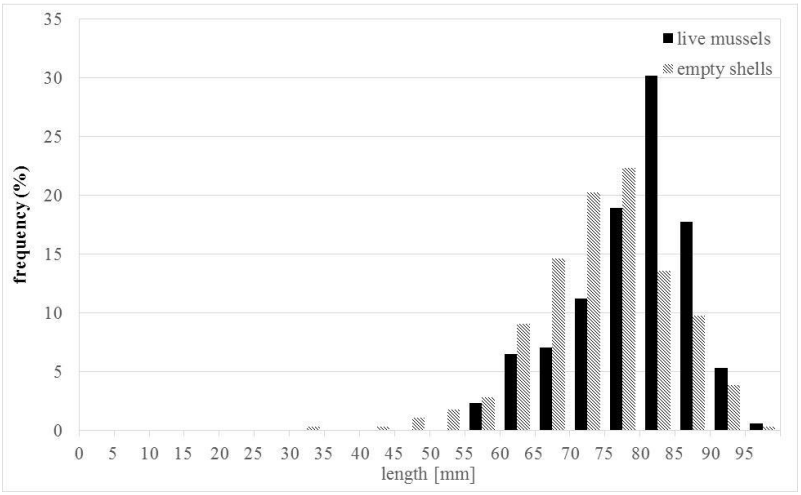

Figure 2. Length frequency distribution of *M. bonellii* in the Vipava River in Slovenia.
Slika 2. Frekvenčna distribucija dolžine lupin pri rečni enozobki (*M. bonellii)* iz reke Vipave v Sloveniji.

In the Miren area, we were only able to survey a 5 m strip from the bank due to deep water in the main river channel. In a patch, where a living *M. bonellii* was found, evident water current was observed. Bivalves were buried between stones of the same size as was their own. Right next to the riverbank in fine sand with low flow, *M. bonellii* was very rarely recorded, while *U. elongatulus* prevailed. This was the opposite of the survey results for the Prvačina and Renče areas.

Discussion

We confirmed the presence of *M. bonellii* in the Vipava River main channel downstream of the Gradišče hydropower plant. 120 years ago, Gallenstein (1894) wondered whether the species really does occur further upstream of the confluence with the Lijak Stream. He concluded that more detailed research was required. We were able to find it close to Prvačina town, 3 km upstream from the confluence of the Lijak Stream, 2 km downstream from the Gradišče hydropower plant. Live mussels were also observed in the Italian part of the Vipava River (Reischütz & Reischütz 2002, Lapini et al. 2013). In the Lijak Stream, dozens of living *U. elongatulus* were found, but no living *M. bonellii*. Neither did we find any empty shells, although they had been found by Reischütz & Reischütz (2002). The downstream section of the Lijak Stream was very difficult to survey due to its steep river banks and deep water. In the Vipava River basin, the species' range is limited to 20 km of the Vipava River from the Gradišče hydropower plant downstream to its confluence with the Soča River, 16 km of those in Slovenia. The hydropower plant was built in 1922 (Brenčič 2013) and is poorly or even totally impassable for upstream fish migration. Thus it has probably been limiting the upstream distribution of *M. bonellii* for already a century. Additionally, small weirs were built

on the Vipava River for mills and sawmills. Today at least 4 weirs over 1.5 m in height exist in the Vipava River downstream from Gradišče. All weirs are poorly or even totally impassable for fishes. Consequently the habitat of *M. bonellii* and probably populations are fragmented. Oxbow lakes of the Vipava River, where Erjavec (1877) found the species, weren't surveyed, since most of them don't exist anymore. Although bivalves can be totally buried into the sediment (Nagel et al. 2007), we believe our results of the species range are representative, since we combined the method of surveying both live mussels and empty shells. Correspondingly we also found *U. elongatulus* at some locations where *M. bonellii* was not present. We can conclude that the range of *M. bonellii* in the Vipava River is similar to the previously described situation. The statement by Reischütz & Reischütz (2002) that *M. bonellii* is extinct in the Lijak Stream needs further focused research. In streams where mussels might be present in very low densities, other methods (e.g. sieving sediment) on more patches should be performed.

The population in the Vipava River and the population in the Versa Stream are the only two populations of *M. bonellii* in the Soča River basin, both already mentioned in Gallenstein (1894). Both populations are isolated from each other, since there are no records that *M. bonellii* lives in the Soča River. In the Versa Stream 12 km West from Nova Gorica, *M. bonellii* was rediscovered in 1984 and was then the first live record of this bivalve in Northern Italy since 1930 (Nagel & Hoffmeister 1986). In the upper regulated section of the Birša Stream (Slovenian name for the Versa Stream) in Slovenia, no mussels were found. The Birša Stream partly dries up before the national border and shows signs of excessive nutrient intake. At the bottom of the stream fine sediments are present as a result of runoff from adjacent agriculture areas, with the signs of anoxia. South of Slovenia, the first known population of *M. bonellii* lives in the Mirna River on the Istrian Peninsula in Croatia (Fischer 1999, Fischer & Reischütz 1999, Mrkvicka 2018). The IUCN range map (Albrecht et al. 2011) shows a totally inaccurate range in the region. The Vipava River in Slovenia, the Versa Stream in Italy and the Mirna River in Croatia are excluded, while the Dragonja and Reka River basin are included as an area of distribution (Albrecht et al. 2011). Consequently, references which use IUCN range maps are incorrect (e.g. Darwall et al. 2014). There is no evidence that this species is present in the catchment area of the Dragonja and the Reka Rivers in Slovenia. A record for the Reka River from Slapnik (2005) is doubtful and should be omitted, as Slapnik (2013) mentioned the species' distribution only for the Vipava River basin. In addition, our findings of individual bivalves from the genus *Anodonta* in the Reka River (Govedič, unpublished), which is not mentioned in Slapnik (2005), is another reason to omit the record from the Reka River.

The drastic decline of *M. bonellii* in Europe is probably caused by human impacts, among which habitat destruction and water pollution are the most important factors (Nagel et al. 2007). Nitrogen compounds, particularly ammonia, and temperature are suspected major stressors for these aquatic organisms (Beggel et al. 2017). Studies from Central Europe have shown a relationship between the impaired population status of threatened freshwater mussel species and elevated nitrate (NO_3) concentrations in running waters (Douda 2010). The quality of water in the Vipava River entirely depends on its catchment area. Thus the protection of *M. bonellii* in the Vipava River entirely depends on Slovenia since the complete catchment area is geographically within the country. Most of the flood plain of the Vipava River is used for intensive agricultural purposes. After World War II, the Vipava Valley was subjected to extensive agromeliorations and regulation of tributaries (Brenčič 2013). Before, mostly

meadows and pastures existed along the Vipava River, which were regularly flooded. The increasing intensification of agriculture in the Vipava Valley can lead to elevated concentrations of nitrogen in the water and, due to the use of phytopharmaceuticals, also some other chemicals. The Vipava River receives all wastewater from the entire valley. There is a population of at least 65,000 inhabitants in the wider drainage area (Kladnik 2013). The probability of accidental pollution incidents increased after the change of discharge from the waste water treatment plant of the town of Nova Gorica, which had been redirected a few years ago to the Vrtojbica Stream (a tributary of the Vipava River upstream from Miren). There is no information on water quality requirements for *M. bonellii* habitat, so we can't compare the results of water quality of the Vipava River at Miren with others studies. Average concentrations of nitrate (6.6 mg/L NO_3) in the Vipava River that corresponds to 1.5 mg/L of nitrate nitrogen (N-NO_3), is in range of the reported value for high abundance and reproduction of *U. crassus* (Douda 2010, Köhler 2006, Zając et al. 2018, Denic et al. 2014, Zettler & Jueg 2007). There can be some misunderstanding while some research present results as nitrate (NO_3) values (Zając et al. 2018), others (Douda 2010, Denic et al. 2014, Zettler & Jueg 2007) as nitrate nitrogen (N-NO_3). Only Köhler (2006) pays attention to both values. Furthermore, many other chemicals of which impact has not been studied and which are not regularly monitored can have negative effects on bivalves. Knowledge on chemicals that are produced and released to the Lijak Stream from sediments of accumulation in Lake Vogršček is also lacking. Also human activity in Goriška Brda in Slovenia in the catchment area of Versa Stream can potentially affect the quality of water at *M. bonellii* populations downstream in Italy. Goriška Brda is an agricultural region with intensive vineyards and orchards. Population density in Goriška Brda is high (69 inhabitants/km^2) as well (Glavan 2011). Due to the intensification of agriculture in Goriška Brda, special attention on water quality should be paid, as well as on quantity. Especially in summer, the stream should be regularly monitored with the purpose to detect early threats to the *M. bonellii* populations downstream in Italy.

In terms of size structure smaller live mussels are missing. The reason for this is most probably the hand-searching surveying method, which is insufficient for identifying the presence of small mussels. Digging in the substratum to detect small specimens was not performed. The biggest live specimen and empty shell measured 95 mm in length. This is comparable with related studies (max. 91 mm in Bössneck (2002), max. 81 mm in Fischer & Reischütz (1999)). The biggest one ever found measured 102 mm in length (Erjavec 1877). *M. bonellii* can live up to ten years, but negative environmental impacts, specifically water pollution, shorten their life expectancy (Fischer & Reischütz 1999). According to the length structure of *M. bonellii* in the Vipava River they still reach the expected length and age. From the size structure of living specimens and from empty shells in the years 2015 and 2018, we can conclude that they still successfully breed in the Vipava River. But the alarming fact is that we found large amounts of empty shells at Miren, where they were smaller than 65 mm. This size corresponds to the age of 4 years (Nagel & Hoffmeister 1986) and indicates the mortality of mussels before they reach their final size. We don't know what is causing this, but the quality of water should be monitored more thoroughly as is provided under the national monitoring program, especially during summer flow minimums.

The number of specimens we found at each locality is related to the surface of shallow habitat, which was accessible for survey and with time spent for searching. Our goal was not to assess the density of the species, but to confirm its presence. It seems that, as in the Versa Stream, *M. bonellii* in Vipava River also prefers sections with a distinctive flow. In the main flow section of the Versa Stream, 25 mussels/m^2 were observed, but higher densities were also observed in pools and among the roots of plants on shallow banks (Nagel et al. 2007). In the Mirna River, mussels were observed in high densities up to 15 mussels/m^2 in shallow waters of eroded banks with coves and sandy substrate or accumulated fine substrate but not in the straight parts of the riverbed with a stronger current and gravel substrate (Mrkvicka 2018). According to Rüetschi et al. (2012), *M. bonellii* can also live in lakes and in slow flowing streams with sandy banks. Erjavec (1877) found it in oxbow lakes of the Vipava River. Thus it is questionable whether the mussel lives also in deep sections of the Vipava River and its oxbow lakes, according to the fact that it wasn't found in fine sediment next to the riverbank with low flows. Most of the lower part of the Vipava River is between weirs, where water is deep and its riverbanks are steep and consequently inaccessible for conventional survey methods. It would only be possible to check deeper sections of the Vipava River with the help of divers or underwater cameras. Thus the overall population size of *M. bonellii* in Slovenia remains unknown. If mussels prefer only shallow parts with a distinctive flow, then the population will be very patchy scattered as a result of the arrangement of a suitable substrate.

We still consider *M. bonellii* in Slovenia to be a poorly known and endangered species. New records give the impression that the overall population has increased in the Vipava River, but they are probably only rediscoveries and a confirmation of the former range of the species. Its presence in deeper parts of the Vipava River between weirs should be surveyed as soon as possible as well as in the Lijak Stream. Distribution and population size of the species in the Vipava River remain unknown. Ongoing unknown status (XX) of *M. bonellii* needs to be reported under Article 17 of the Habitats Directive in the next reporting period in 2019. The Vipava River and Lijak Stream underwent large scale habitat destruction in the previous century, but local construction works are still in progress. In order to maintain high flows within the riverbed and to prevent flooding, the habitat is changing because of higher riverbed shear stress during high water discharges. After adoption of the Habitats Directive in 2004, there were few construction interventions in the Vipava River, without confirmation of the species at the site of intervention. Locally eroded banks are replaced by blocks of stone and small locally shallow parts are destroyed. Many suitable habitats and eventually existing mussels' populations were probably destroyed. At least the exact distribution of protected species should have been studied before. In the future all construction works, which can cause the death of mussels or impair their habitat, shouldn't be carried out in the Vipava River or the Lijak Stream. Further comprehensive studies focusing particularly on the ecology and habitat requirements are warranted to better understand the conservation status of the species. Also weirs should be passable for all fish species and not only for spring spawning migrations, also all year around, especially during the development of glochidia and at the end of the parasitic phase of bivalves. Reischütz & Reischütz (2002) evaluated that the conservation status of *M. bonellii* in Slovenia should be altered to CR (Critically Endangered). We fully agree with this assessment, since the existence of the species is limited to 16 km of the highly fragmented Vipava River in Slovenia and is isolated from other populations.

Povzetek

Rečna enozobka (*Microcondylaea bonellii*) je endemit pritokov Jadranskega morja od porečij Pada in Soče prek Istre do severne Grčije. Njeno tipsko najdišče je potok Lijak, pritok reke Vipave v Sloveniji. V Sloveniji je vrsta zavarovana, uvrščena je v Prilogo V Direktive o habitatih, kot ranljiva vrsta pa na svetovni Rdeči seznam IUCN. Predhodni podatki o razširjenosti vrste v Sloveniji so stari več kot 100 let. Takrat je bila vrsta razširjena v potoku Lijak in spodnjem toku reke Vipave.

Školjke in lupine sva iskala na več lokacijah v reki Vipavi in njenih pritokih ter v potokih v Goriških Brdih. Pregledovala sva plitve odseke in prodišča. Školjke sva našla na več lokacijah v reki Vipavi nizvodno od HE Gradišče pri Prvačini, medtem ko je v potoku Lijak ni bilo. Na vseh lokacijah, kjer sva našla rečno enozobko, je bil prisoten tudi podolgovati škržek (*Unio elongatulus)*. Rečne enozobke sva našla v bližini brega na mestih z očitnim tokom, ne pa v srednjem delu struge, kjer so hitrosti vode večje, še posebej ob večjih pretokih. Populacija v Vipavi je omejena na 20 km reke od Gradišča do izliva v Sočo (od tega 16 km v Sloveniji) in je izolirana od edine ostale populacije v porečju Soče v potoku Versa (Birša) v Italiji.

Glede na velikostno strukturo najdenih školjk sklepava, da doživijo pričakovano starost. Koncentracije različnih oblik dušika, izmerjene v reki Vipavi na merilni postaji v Mirnu, za zdaj niso omejujoče za obstoj in razmnoževanje školjk. Sva pa v reki Vipavi pri Mirnu našla številne lupine tudi manjših osebkov, zato bo treba v prihodnje zelo paziti na kemijsko stanje vode v reki Vipavi. Za Vipavsko dolino sta značilna gosta poseljenost in intenzivno kmetijstvo. V reko Vipavo tako s površinskim spiranjem pritečejo onesnažila s kmetijskih površin, hkrati pa se vanjo izlivajo tudi vse odpadne vode, v zadnjih letih prek potoka Vrtojbica tudi iz Centralne čistilne naprave Nova Gorica.

O habitatu školjke v reki Vipavi vemo zelo malo, zato bi bilo treba raziskati, ali je razširjena le v plitvih odsekih, ali morda tudi v globljih, kjer je tok počasen. V Vipavi je habitat rečne enozobke fragmentiran z jezovi, ki so povečini neprehodni za ribe. Ti bi morali biti prehodni tudi v času sproščanja glohidijev iz škrg rib in ne samo v času drstne migracije rib. Varstvo vrste in njenega habitata je pravno že urejeno, le nemudoma je treba začeti upoštevati zakonodajo in se pred vsemi posegi v reko Vipavo prepričati, ali res nimajo vpliva na vrsto.

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