



NOTES ON THE DISTRIBUTION AND STATUS OF *TANOUSIA ZRMANJAE* (BRUSINA, 1866) (GASTROPODA: TRUNCATELLOIDEA: HYDROBIIDAE)

LUBOŠ BERAN

Nature Conservation Agency of the Czech Republic, Regional Office Kokořínsko – Máchův kraj Protected Landscape Area Administration, Česká 149, CZ - 276 01 Mělník, Czech Republic
(e-mail: lubos.beran@nature.cz)

ABSTRACT: *Tanousia zrmanjae* is probably the last surviving species of *Tanousia*; fossil species of the genus are known from interglacial deposits in many countries. During a detailed inventory of the Zrmanja River the occurrence of live specimens of *T. zrmanjae* was confirmed at only two sites in the middle section of the river while empty shells were found at another 10 sites, also in the middle river section, between the Jankovica Buk waterfalls and the Visoki Buk waterfalls near the confluence of the Zrmanja and Krupa rivers. The recent occurrence is probably limited to a few sites and thus *T. zrmanjae* should still be regarded as critically endangered.

KEY WORDS: *Tanousia zrmanjae*, endangered species, distribution, habitats

INTRODUCTION

Tanousia zrmanjae (Brusina, 1866) (Fig. 1) was described from the Zrmanja River in Croatia. This river was regarded as one of the hot spots of freshwater gastropod fauna (STRONG et al. 2008). Recently, a population of this species was found during a faunistic survey of the Zrmanja River (BERAN 2011). Fossil *Tanousia*, represented by several species, are known from Denmark (MADSEN & NORDMANN 1901), England (SCHLICKUM 1974, PREECE 1990, 2001), the Netherlands (MEIJER 1989, GITTENBERGER et al. 1998, GLÖER 2002), France (SCHLICKUM 1974), Hungary (ROTH 1881, BRUSINA 1902), Ukraine (ANDRUSOV 1890, KONDRASHOV 2007), Romania (HERBICH & NEUMAYR 1875, JEKELIUS 1932, 1944), Italy (ESU &

KOTSAKIS 1996, ESU & GIANOLLA 2007, ESU 2008), and Greece (SCHÜTT 1976), mostly from interglacial deposits. *T. zrmanjae* is probably the last surviving species of the genus (BERAN et al. 2015). Its occurrence is restricted to the Zrmanja River (RADOMAN 1983). In the IUCN Red List it was classified as Critically Endangered (Possibly Extinct), based on the habitat loss at the type locality, and further surveys were recommended to determine whether the species was still extant (FALNIOWSKI 2011).

The main aim of this paper is to summarise the present distribution, population status and habitat requirements of *T. zrmanjae* in the Zrmanja River and its tributary Krupa River.

MATERIAL AND METHODS

Based on the previous research (BERAN 2011) the freshwater section of the Zrmanja River upstream of the Jankovica Buk waterfalls (upstream of site No. 1, see Fig. 2) was searched for *T. zrmanjae*. Downstream

of the waterfalls the river is brackish and inhabited by different molluscan assemblages (BERAN 2011) without *T. zrmanjae*. The section upstream of the inflow of the Krupa River has a different character and



is inhabited by poor mollusc communities, also without *T. zrmanjae* (BERAN 2011), so the last site studied was downstream of Kaštel Žegarski (site No. 23). The Krupa River was searched from its inflow into the Zrmanja River to the Kudin most bridge south-east of Golubić (site No. 27).

Fieldwork was conducted in the summers of 2012 to 2016. Some sites were visited more than once and sites with living populations were inspected more often.

Sampling by washing vegetation or sediments on a metal sieve (diameter 20 cm, mesh size 0.8 mm) was combined with searching the surface of stones, wood and artificial materials (e.g. plastic bags and bottles) and diving (snorkelling) in the deeper parts of the river. The search at each site ranged from 45 to 60 minutes. Where live snails were found, an area of 10×20 cm with their occurrence was chosen and the individuals were counted. The small size of the sampling area was due to two facts. The first was the rarity of the species in general, the second was the limited occurrence on the edges of individual rocks, on the sediment between rocks and stones etc. The density was not recalculated per 1 m^2 , because it would be misleading.

Fig. 1. Shell of *Tanousia zrmanjae*. Actual size 3.91×2.43 mm. Photo: MICHAL HORSÁK

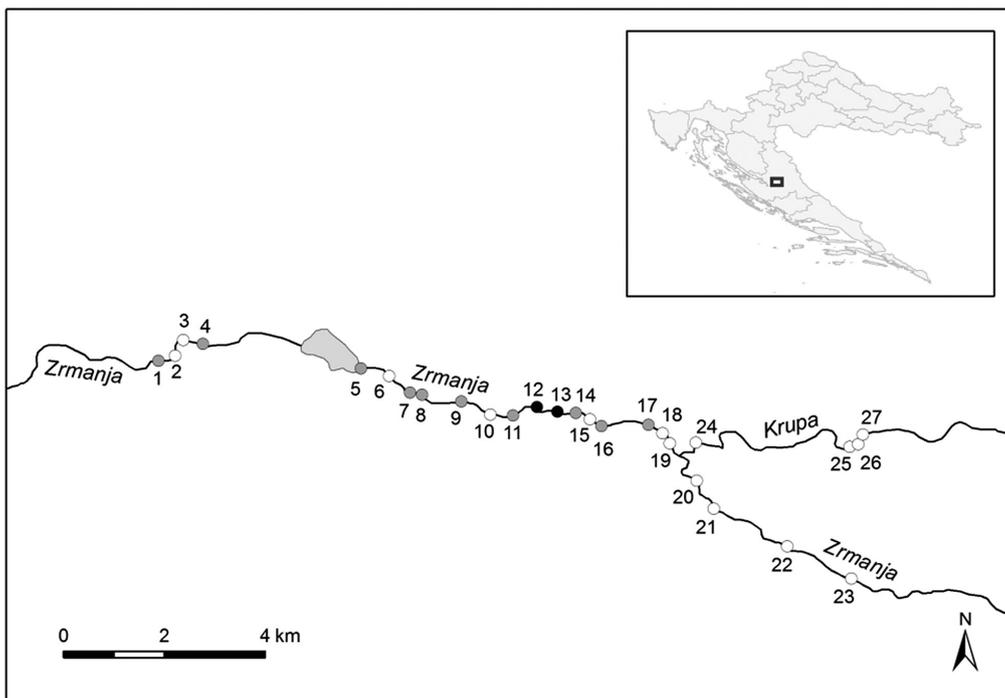


Fig. 2. Map of the Zrmanja River with collection sites. Black points – living populations of *T. zrmanjae*; grey points – empty shells; white points – no record of live snails or shells. Drawings: HELENA MEDKOVÁ

RESULTS

DISTRIBUTION

Twenty seven sites were examined during the survey (Fig. 2, Appendix 1). The occurrence of live *T. zrmanjae* was confirmed at only two of them, both located in the middle section of the Zrmanja River: No. 12 (Fig. 3) and No. 13. Empty shells were found at ten sites, also only in the middle section between the Jankovica Buk waterfalls and the Visoki Buk waterfalls, near the confluence of the Zrmanja and Krupa rivers (Figs 4, 5). Only few empty shells were found at each particular site. Neither live specimens nor shells were recorded in the Krupa River or in the section of the Zrmanja upstream of the Visoki Buk waterfalls. At sites No. 1, 7, 8 and 14 relatively fresh shells were found while only old or subfossil shells were recorded at other sites (4, 5, 9, 11, 16, 17, see Fig. 2, Appendix 1).

POPULATION STATUS

Live specimens were found only at two sites while empty fresh or old (subfossil) shells were found at

another 10 sites. Live specimens at site No. 13 were found in 2010 (site No. 8 in BERAN 2011) and their occurrence was confirmed during all subsequent visits (2012, 2014, 2016, Appendix 1). The maximum density was estimated at about 8 specimens/200 cm² and no significant changes in the population density were observed during these visits. Live specimens at site No. 12 were found in 2012. The maximum density at that site was estimated at about 15 specimens/200 cm² in 2012, fewer specimens were found in 2013 and only few in 2014; no live snails were observed in 2016. The occurrence at both sites was limited to a discontinuous area of a few square metres.

HABITAT REQUIREMENTS

Live specimens were recorded at depths ranging from ca. 0.2 m to 4.5 m. Both sites with live specimens had a similar habitat – sediment on steep and rocky banks in calm parts downstream of cascades or small waterfalls (Fig. 3).



Fig. 3. Zrmanja River at site No. 12. Specimens of *T. zrmanjae* were found at a spot corresponding to the centre of this photo under a small rock. Photo: LUBOŠ BERAN



Fig. 4. Zrmanja River at site No. 1, upstream of the Jankovica Buk waterfalls. Fresh shells were found upstream of the waterfalls. This part is isolated by the dam reservoir situated upstream and flows slowly without waterfalls or cascades. Photo: LUBOŠ BERAN



Fig. 5. Zrmanja River at site No. 7, downstream of the Berberov Buk waterfalls. Photo: LUBOŠ BERAN



DISCUSSION

The survey confirmed that the species inhabited only the freshwater part of the Zrmanja River, ca. 9 km long and disrupted by a dam reservoir. The occurrence of this freshwater species downstream of the Jankovica Buk waterfalls in the brackish river section is excluded. Neither live specimens nor shells were found upstream of the confluence of the Krupa and Zrmanja rivers despite the thorough search in the adjacent sections of both rivers (Fig. 2). Likewise, the earlier survey failed to reveal *T. zrmanjae* upstream of the confluence (BERAN 2011).

The living population was found only in the middle section of the Zrmanja, with small waterfalls and cascades and alternating slow- and fast-flowing parts. It is questionable whether *T. zrmanjae* occurs at those two sites only, because relatively fresh shells were found also in other sections of the river.

A probable extinction or at least a significant decline of the species at one of the two known sites mentioned above was observed during this survey. The reason is still unknown. The site and its surroundings showed no visible changes. No data on water quality were available, but both sites are very close to each other; the river is also used as an important source of drinking water and no significant changes in land use of the Zrmanja River basin were recorded. The site will be monitored in the following years.

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Appendix 1

List of collecting sites on the Zrmanja and Krupa rivers

Site no.	Geographical coordinates	Site description, date of investigation	Number of live specimens (s) or empty fresh (fs) and empty old shells (os)
1	44°12'10.6"N 15°43'19.5"E	Zrmanja River upstream of Jankovica Buk waterfalls, 16.8.2013, 28.6.2015	16.8.2013: 11 os, 1 fs; 28.6.2015: 4 os
2	44°12'13.8"N 15°43'30.2"E	Zrmanja River ca. 400 m upstream of Jankovica Buk waterfalls, 28.6.2015	–
3	44°12'23.8"N 15°43'35.2"E	Zrmanja River near the ruin of St. Obrovac castle by the destroyed hydroelectric power station, 30.6.2015	–
4	44°12'21.4"N 15°43'47.9"E	Zrmanja River ca. 200 m upstream of the destroyed hydroelectric power station, 30.6.2015	1 os
5	44°12'05.6"N 15°45'29.4"E	left arm of Zrmanja River at its inflow into the dam reservoir (former Šupkov Buk waterfalls), 29.6.2015	3 os
6	44°12'00.7"N 15°45'47.4"E	right arm of Zrmanja River near its inflow into the dam reservoir by a small bridge near the inflow of Dobarnica Brook (former Devica Buk waterfalls), 29.6.2015	–
7	44°11'50.0"N 15°46'00.1"E	Zrmanja River downstream of Berberov Buk waterfalls, 3.7.2014, 7.7.2016	3.7.2014: 3 os, 1 fs; 7.7.2016: 2 os
8	44°11'48.5"N 15°46'08.7"E	Zrmanja River upstream of Berberov Buk waterfalls near Berberi, 2.8.2012, 1.7.2015, 3.7.2016	2.8.2012: 2 os; 1.7.2015: 3 os, 1 fs; 3.7.2016: –
9	44°11'44.2"N 15°46'33.9"E	Zrmanja River ca. 400 m upstream of the bridge in Berberi, 4.7.2014	1 os
10	44°11'35.7"N 15°46'52.5"E	Zrmanja River ca. 700 m upstream of the bridge in Berberi, 1.7.2015	–
11	44°11'35.0"N 15°47'07.2"E	Zrmanja River downstream of waterfalls, 14.8.2013, 3.7.2016	14.8.2013: 1 os; 3.7.2016: –



Appendix 1. continued

12	44°11'40.7"N 15°47'22.3"E	Zrmanja River near Dramotići upstream and downstream of small waterfalls, 30.7.2012, 11.8.2013, 29.6.2014, 9.7.2016	30.7.2012: 35 s (14 s/200 cm ²); 11.8.2013: 12 s; 29.6.2014: 5 s; 9.7.2016: 2 fs
13	44°11'37.7"N 15°47'35.6"E	Zrmanja River downstream of waterfalls (left bank downstream of waterfalls at a big rock), 5.7.2012, 29.6.2014, 6.7.2016	5.7.2012: 15 s; 29.6.2014: 28 s (8 s/200 cm ²); 6.7.2016: 24 s (7 s/200 cm ²)
14	44°11'36.8"N 15°47'47.4"E	Zrmanja River between two waterfalls, 5.7.2016	2 os, 1 fs
15	44°11'32.6"N 15°47'56.5"E	Zrmanja River ca. 1,300 m downstream of Visoki Buk waterfalls near small rapids, 11.8.2013	–
16	44°11'28.2"N 15°48'03.9"E	Zrmanja River near a small island, 6.7.2016	2 os
17	44°11'29.1"N 15°48'34.1"E	Zrmanja River ca. 900 m downstream of Visoki Buk waterfalls at a rock in the shape of four-sided pyramid, 11.8.2013	1 os
18	44°11'23.7"N 15°48'43.0"E	Zrmanja River downstream of Visoki Buk waterfalls, 14.8.2013	–
19	44°11'16.9"N 15°48'47.7"E	Zrmanja River upstream of Visoki Buk waterfalls, 14.8.2013	–
20	44°10'52.9"N 15°49'04.9"E	Zrmanja River ca. 750 m upstream of the inflow of the Krupa River, 2.7.2015	–
21	44°10'34.7"N 15°49'15.9"E	Zrmanja River next to a big rock ca. 5 km downstream of the bridge in Kaštěl Žegarski, 2.7.2015	–
22	44°10'10.3"N 15°50'03.1"E	Zrmanja River ca. 3 km downstream of the bridge in Kaštěl Žegarski, 2.7.2015	–
23	44°09'49.4"N 15°50'44.4"E	Zrmanja River ca. 700 m downstream of the bridge in Kaštěl Žegarski, 5.7.2014	–
24	44°11'17.5"N 15°49'04.6"E	Krupa River ca. 450 m upstream of its inflow into the Zrmanja River, 2.7.2015	–
25	44°11'14.8"N 15°50'43.1"E	Krupa River below waterfalls downstream of the Kudin most bridge, 2.7.2014	–
26	44°11'16.5"N 15°50'48.6"E	Krupa River between the Kudin most bridge and waterfalls upstream of the bridge, 2.7.2014	–
27	44°11'22.7"N 15°50'51.7"E	Krupa River above travertine cascades ca. 200 m upstream of the Kudin most bridge, 2.7.2014	–
