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## Quagga mussels *Dreissena rostriformis bugensis* (Andrusov, 1897) in the Main River (Germany)

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### Abstract

The first record of the quagga mussel *Dreissena rostriformis bugensis* (Andrusov, 1897) in Germany is described. This species has expanded its distribution area in Europe at a slower rate than the zebra mussel *Dreissena polymorpha* (Pallas, 1771). Recent records from the Danube in Romania and from an enclosed Rhine-Meuse estuary in The Netherlands, suggest that the Main-Danube canal and River Rhine have functioned as the dispersal pathway of the quagga mussel to The Netherlands. The record of this species in the River Main supports this hypothesis.

*Key words:* Quagga mussel, *Dreissena rostriformis bugensis*, invasive species, Germany, Main-Danube canal

The quagga mussel *Dreissena rostriformis bugensis* (Andrusov, 1897) was until early twenty-first century a slower invader than the zebra mussel *Dreissena polymorpha* (Pallas, 1771). Both mussel species originate from the Ponto-Caspian area. The original native range of the quagga mussel is the Lower Dniepr River and Southern Bug River (Son 2007). Over the last few decades, however, the quagga mussel has considerably extended its range in Russia (Orlova et al. 2003, 2004). It reached the River Volga via the Don River and Volga-Don canal (Zhulidov et al. 2004, 2005). Furthermore, it invaded the Great Lakes area of North America probably simultaneous with the zebra mussel (1987), most likely as larvae via ballast water discharge. The quagga mussel was recognized

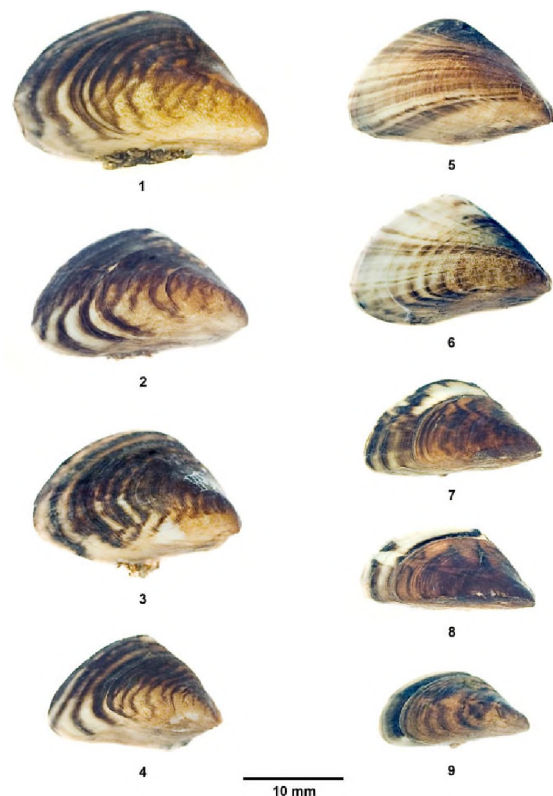
for the first time in the Great Lakes in 1991 (Spidle et al. 1994). *D. rostriformis bugensis* seems to have an ecology similar to *D. polymorpha*, but often colonizes deeper water than *D. polymorpha* (Orlova et al. 2005). However, it is known that at places where *D. polymorpha* occurs and *D. rostriformis bugensis* becomes established the latter outcompetes slowly the first species (Orlova et al. 2004). Zhulidov et al. (2004) mentions some characteristics of *D. rostriformis bugensis* which seems to be important in this process, viz. a better ability than *D. polymorpha* to cope with low food conditions and high temperatures.

Recently, *D. rostriformis bugensis* was recorded by Micu and Telembici (2004) and Popa and Popa (2006) from the Danube,

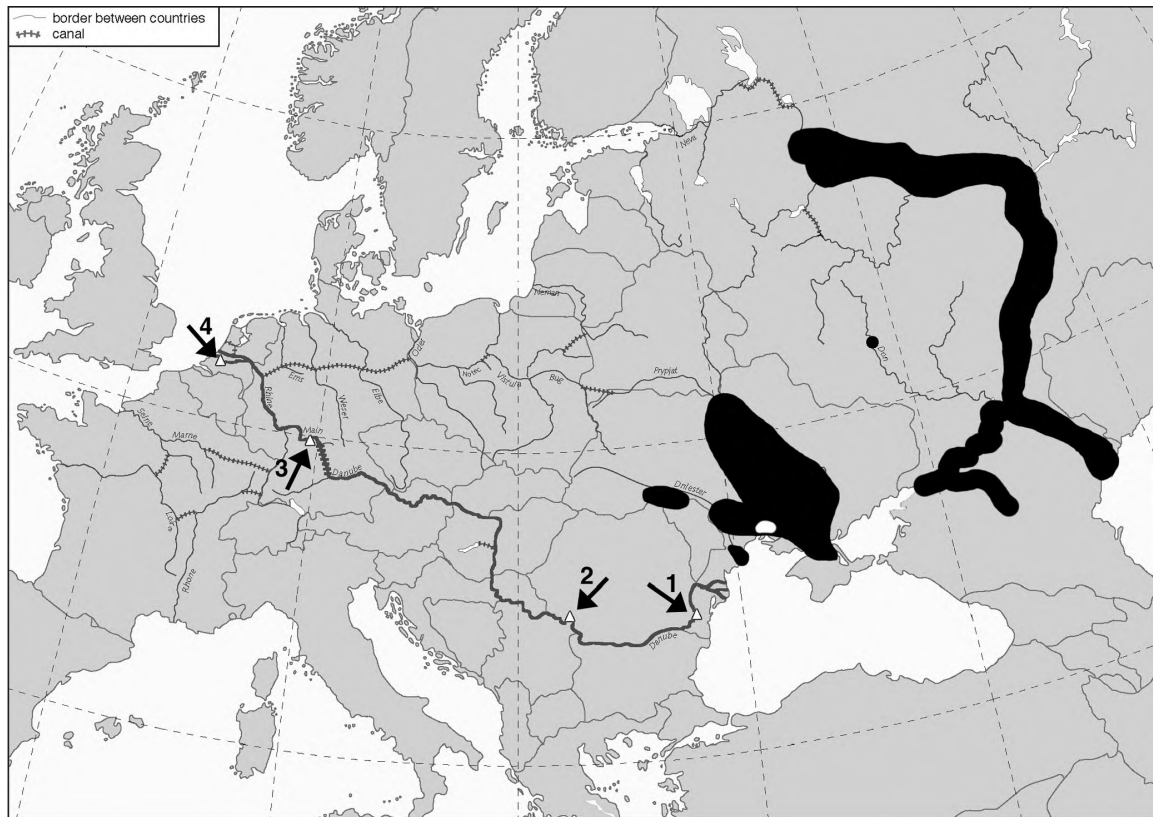
Romania. The neighbourhood of Drobeta Turnu-Severin was considered by these authors the most western recorded occurrence in Europe of this species. However, Molloy et al. (2007) found the species for the first time on the 19th of April 2006 in the Hollands Diep near Willemstad in The Netherlands, where it occurred in relatively low numbers between the zebra mussels (1% were quagga mussels). Molloy et al. (2007) suggested that the quagga mussel entered via the Main-Danube canal, as did so many other Ponto-Caspian invaders (Bij de Vaate et al. 2002). These records in The Netherlands and Romania however, show an enormous geographical distance gap without any records in between. The invasion of quagga mussels in The Netherlands could also be caused by the discharge of ballast water from the Black Sea area in the Rotterdam Port. However, it should be noted that, in the Port of Rotterdam itself we have only sampled zebra mussels thus far.

During a trip to Hungary in 2007 we sampled along the River Main (19th of May), the Main-Danube canal (25th of May), the Danube at various sampling sites (19th and 25th of May) in order to obtain dreissenid mussels for genetic analysis. To our surprise, in the River Main east of Würzburg near Hörblach, we found quagga mussels (*D. rostriformis bugensis*) (13 specimens sampled) on stones up to a depth of 1 m besides zebra mussels (*Dreissena polymorpha*) (26 specimens sampled within half an hour) (Figure 1). During this sampling the River Main showed hardly any flow. Yellow water lilies (*Nuphar lutea* (L.) Smith), showing underwater leaves only, were present. Besides zebra mussels and quagga mussels we found the native snails *Ancylus fluviatilis* (Müller, 1774), *Radix auricularia* (L., 1758) and *Bithynia tentaculata* (L., 1758) on riparian stones at a water depth of 20 to 100 cm. Freshwater sponges were commonly present on dreissenid colonised stones and were even found overgrowing these mussels, in particular *D. polymorpha*. Within the sediment, *Unio tumidus* (Philipsson, 1788) was present together with numerous Asian clams *Corbicula fluminea* (Müller, 1774).

The finding of quagga mussels in the Main makes it very likely that this mussel species took the southern corridor from the mouth of the Danube, upstream to the Main-Danube canal and subsequently colonized downstream in the Main, Rhine and Rhine delta (Figure 2). Because the largest quagga mussel we sampled had a length of 29.8 mm, the Main must certainly have been invaded several years before 2007. We also tried to sample this species from the Main-Danube



**Figure 1.** Quagga mussels (*Dreissena rostriformis bugensis*) (1-6) and Zebra mussels (*Dreissena polymorpha*) (7-9) collected at the same locality in the River Main (Germany). The shells of the Quagga mussels 5 and 6 show an atypical stripe pattern. The largest Quagga mussel on the figure has a length of 25 mm.



**Figure 2.** The distributional expansion of *Dreissena rostriformis bugensis* in Europe. Historical distribution indicated as white spot. Range extensions from 1941 till 2002 black (according to Orlova (2003) and Zhulidov et al. (2004, 2005)). Arrows indicate the most recent records (open triangles), Hollands Diep, The Netherlands (Molloy et al. 2007), Danube, Romania (Popa and Popa 2006) and Main, Germany (this paper), see Annex for coordinates

canal and the Danube. The following localities have been sampled: the Danube west of Regensburg near Kiefenholz (Pfatter), Vilshofen an der Donau west of Passau (stones sampled at 1 m depth); Main-Danube canal at Kelheim, Essing, Hilpoltstein (steep walls scraped by a scrape net to a depth of 3m). However, in spite of our efforts to sample specimens of quagga mussels from the Main-Danube canal as well as the Danube itself, we collected only zebra mussels from these localities.

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#### Annex

##### Recent records of *Dreissena rostriformis bugensis* in Europe

Site No. (Map Ref.)	Location (River, site name, river-kilometer)	Record coordinates		Record date	Number collected	Collector/Reference
		Latitude, °N	Longitude, °E			
1	Danube, Cernavoda, 297	44°19'06"	28°03'91"	March 2004	ca. 500	Dragos Micu/Micu and Telembici 2004
2	Danube, Drobeta Turnu Severin 931	44°40'01"	20°55'19"	23 August 2005	20	Popa and Popa 2006
3	Main, Hörblach	49°47'00"	10°13'00"	19 May 2007	13	Gerard van der Velde and Dirk Platvoet
4	Hollands Diep, Willemstad	51°42'11"	04°28'34"	19 April 2006	ca. 20	Abraham bij de Vaate/Molloy et al. 2007