

## Aquatic Invasions Records

## Range expansion of the quagga mussel *Dreissena rostriformis bugensis* (Andrusov, 1897) in Western Europe: first observation from France

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Received: 28 April 2011 / Accepted: 21 June 2011 / Published online: 24 June 2011

### Abstract

After the quagga mussel was found for the first time in Western Europe in 2006, upstream migration in the River Rhine was observed. Navigation is expected to be an important vector for range expansion in this river. It was only a matter of time before the colonization of the navigable international River Moselle (a tributary of the River Rhine), which rises in France. The species was found in March 2011 at three locations in the French section of the river.

**Key words:** Moselle, Rhine, introduction, navigation

### Introduction

The quagga mussel, *Dreissena rostriformis bugensis* (Andrusov, 1897), started range expansion in the 1930s from its native range, the Dniepr delta (Son 2007), facilitated by interconnection of river basins in the former Soviet Union and navigation in constructed waterways (Orlova et al 2004). In 2004 the species was observed for the first time in Eastern Europe, in the lower River Danube, where the population expanded in an upstream direction (Micu and Telembici 2004; Popa and Popa 2006). The first observation in Western Europe was made in 2006 in the Hollandsch Diep, a river stretch in the Rhine delta, The Netherlands, as a result of successful colonization in approximately 2004 (Molloy et al. 2007). In the River Rhine as well as in the River Meuse, range expansion in an upstream direction was subsequently observed (Haybach and Christmann 2009; Van der Velde and Platvoet 2007). In 2007, the species was found in the River Main, an upstream tributary of the River Rhine (Van der Velde and Platvoet 2007). Mayer et al. (2009) demonstrated that navigation must be an important vector for this upstream expansion. Since the River Moselle, a tributary of the River Rhine, is a navigation route from Germany to

France, it was only a question of time before the introduction of the quagga mussel in the latter country.

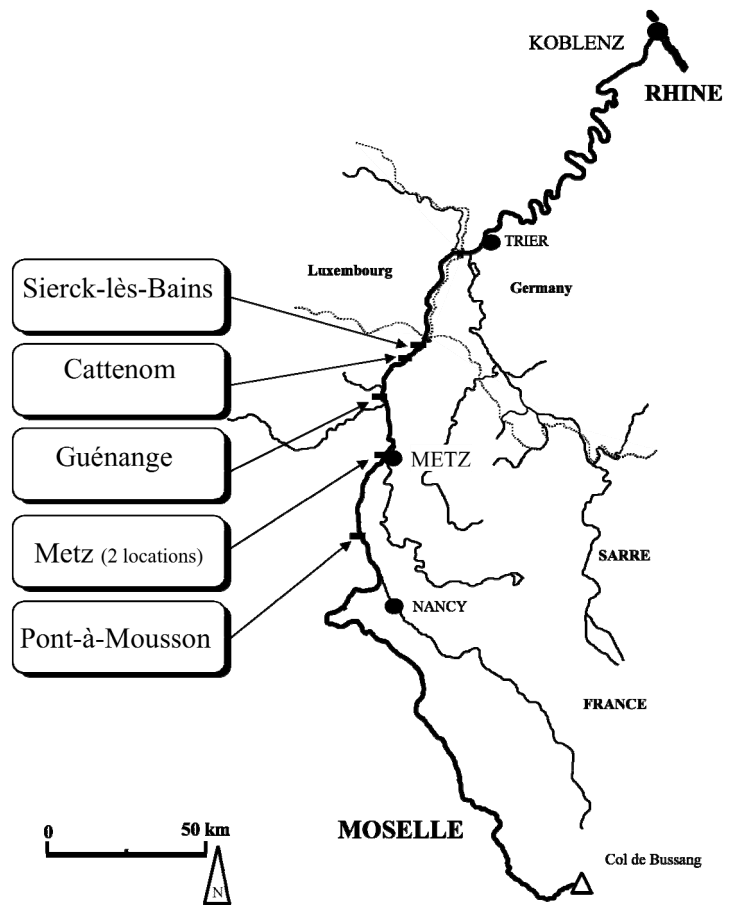
### Material and methods

In order to check whether the quagga mussel had reached France through the river Moselle, dreissenids were sampled at six locations in the French section of that river between March 9 and April 1, 2011 (Table 1; Figure 1). The mussels were cut from riprap in the littoral zone, which was picked up manually from a depth of 0.2–0.7 m. All mussels collected had their shell lengths measured to the nearest mm. Since the dreissenid density was relatively low at these locations, 46–278 specimens only per location were collected.

### Results and discussion

In total, 1,110 dreissenids were sampled at the six sampling locations along the French section of the river Moselle, of which seven specimens were quagga mussels. They were found at the locations Sierck-lès-Bains, Cattenom, and Guénange (Table 1). Their shell lengths ranged from 7 to 27 mm (Table 2). The discovery of a 27 mm specimen, indicated a number of

**Figure 1.** Sampling locations in the French section of the River Moselle.



**Table 1.** Sampling locations, sampling date, and the number of zebra (*D.p.*) and quagga mussels (*D.r.b.*) found in the River Moselle.

Location	Coordinates		River bank	Sampling date	<i>D.p.</i>	<i>D.r.b.</i>
Sierck les Bains	49°26'36.68" N	6°21'07.27" E	Right	9-3-2011	167	3
Cattenom	49°23'44.03" N	6°15'12.37" E	Left	9-3-2011	226	3
Guénange	49°17'40.27" N	6°10'46.07" E	Right	9-3-2011	45	1
Metz	49°07'24.94" N	6°10'06.31" E	Right	10-3-2011	200	0
Metz-Saulcy	49°07'06.70" N	6°09'40.91" E	Right	1-4-2011	278	0
Pont-à-Mousson	48°54'38.18" N	6°03'07.15" E	Right	1-4-2011	187	0

possibilities for range expansion including arrival as a larva or juvenile in 2008 or possibly later when transported by navigation as an adult, suggesting jump dispersal (Mayer et al. 2009). Based on their shell length the other specimens must have arrived in 2010. These arrival estimates are based on growth data of zebra

mussels in the River Rhine (Smit et al. 1992). Although Molloy et al. (2007) suggested that range expansion into the Rhine basin took place via the River Danube and the Main-Danube canal, connecting both river basins, Bij de Vaate (2010) concluded that the introduction in the Rhine delta was the result of ballast water

**Table 2.** Number per length class of dreissenids in the samples (SL = shell length; *D.p.* = zebra mussel; *D.r.b.* = quagga mussel).

SL (mm)	Sierck-lès-Bains		Cattenom		Guénange		Metz	Metz-Saulcy	Pont-à-Mousson
	<i>D.p.</i>	<i>D.r.b.</i>	<i>D.p.</i>	<i>D.r.b.</i>	<i>D.p.</i>	<i>D.r.b.</i>	<i>D.p.</i>	<i>D.p.</i>	<i>D.p.</i>
1									
2			2					2	
3			1				2	2	
4			2				1	1	
5	2		1				2	3	1
6	4		0		2		4	7	3
7	10		6	1	1		1	12	10
8	5		8	1	0		7	17	13
9	1	1	11	1	1		8	11	10
10	3		15		1		19	10	14
11	5		27		2		32	9	5
12	11		31		7		36	8	6
13	12	1	38		4		34	19	9
14	24		49		3	1	20	18	24
15	20		23		8		11	33	20
16	18		6		3		14	47	21
17	11		4		5		5	32	19
18	27		2		2		2	28	16
19	6				5		2	9	12
20	6				0			6	3
21	2				1			1	1
22								2	
23								1	
24									
25									
26									
27		1							

transport by sea-going freighters. From there, quagga mussels were transported by inland navigation. On the other hand, the same vector could be used by the species to jump from the Danube basin into the Rhine basin. Imo et al. (2010) reported one quagga mussel specimen in a sample from the River Main, following genetic re-examination of dreissenids collected in 2005, which could indicate jump dispersal either from the Rhine delta or the River Danube. However, with the results of their genetic analyses they were not able to discriminate between the German, North American or southeast Danube origin of quagga mussel populations.

After initial colonization, the quagga mussel is able to dominate the dreissenid community within a few years (e.g. Mills et al. 1999; Orlova et al. 2004; Wilson et al. 2006; Nalepa et al. 2009). For example, Orlova et al. (2004) observed an increase of the contribution of quagga mussels in the dreissenid community in the Volga delta being 4% in 1994, 24% in 1995, 32% in 1996, and 96% in 2000. Bij de Vaate

(unpublished results) found an even more rapid increase in the southern part of Lake IJsselmeer: from an absence in 2006, 1% in 2007, 49% in 2008, 61% in 2009 to 88% in 2010 (samples taken in October each year). Based on these data, dominance of quagga mussels in the River Moselle dreissenid community is expected within a few years.

### Acknowledgements

Frances Lucy is acknowledged for her constructive comments and suggestions to improve the manuscript.

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