

New records of *Corbicula* clams in French rivers

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Abstract

The aim of this paper is to present new data and review the current distribution of *Corbicula* spp. in France. Three morphotypes were recorded during the study - "round form", "light R form" and "saddle form". During April 2009, *Corbicula* spp. were found in several watercourses in France, including three rivers (Canal de la Somme, Oise and Vilaine) where the taxa were not previously reported. In addition, this is the first report of form S in the River Seine and, the first record of the "light R form" in the River Gard. Molluscs of the genus *Corbicula* are considered to be a well established alien species in large rivers.

Key words: Molluscs, Bivalves, *Corbicula*, alien species, France

Introduction

Freshwater biodiversity is threatened by several mechanisms among which habitat loss and the introduction of non indigenous species are the two most important (Nepveu and Saint-Mexent 2002). Aquatic invasive species are of particular interest because of the major impact they have on both ecosystems and industrial installations. Currently, the invasion rate in French aquatic ecosystems, all functional groups taken into account, follows an exponential curve which indicates an acceleration of the phenomenon during the last decades (Devin et al. 2005). However, this acceleration could be an artefact, owing to the growing interest for the biology of invasions. In 2005, 43 freshwater non-indigenous species of macro-invertebrates were reported in France (Devin et al. 2005). Among them, molluscs of the genus *Corbicula* (Megerle Von Mühlfeld 1811) are one of the most successful groups and are of particular concern (Devin et al. 2005). *Corbicula* is a benthic filter-feeder and has multiple ecological impacts: e.g. competition with native bivalves or phytoplankton decline (Aldridge and Müller 2001; Hakenkamp et al. 2001; Schmidlin and Baur 2007). It is also considered as a biofouling organism (Swinnen et al. 1998). The aim of this paper is to give an overview of the current distribution of *Corbicula* in France, which includes new data.

The modern native range of the genus *Corbicula* includes South of Asia, the Middle East, Australia and Africa but fossils have been recorded in Europe, North America and Japan (reviewed in Araujo et al. 1993).

The first record of *Corbicula* outside its current original range was in 1924 in North America (British Columbia), it then rapidly spread across the country (McMahon 1982). The genus was first reported in South America around 1970 (Ituarte 1994). In Western Europe, *Corbicula* was then detected in 1980 in France, in the River Dordogne. That same year it was also observed in the Tagus estuary in Portugal (Mouthon 1981). Since then its European distribution has further extended (Hubenov 2001; Popa and Popa 2006; Morais et al. 2009).

Two main morphotypes are typically found in Europe. Here we refer to morphotypes R ("round form") and S ("saddle form") (Mouthon 2000; Pfenninger et al. 2002) that have usually been respectively identified as *C. fluminea* and *C. fluminalis*. However, this nomenclature does not satisfactorily reflect the taxonomic situation in the genus *Corbicula* in Western Europe (Renard et al. 2000; Pfenninger et al. 2002). The shell surface of forms R and S has well-marked concentric ridges that are more closely spaced and thinner in form S than in form R (Figure 1). Form R is round and broad, while form S is narrow. Generally, form R reaches larger sizes

than form S (Swinnen et al. 1998). In form R the internal shell colour is white sometimes interspersed with purple marks while in form S it is deep purple (Figure 1). Additionally, a third, light-coloured form (“light R form”, hereby named Rlc), was reported in the Haut-Rhône (Mouthon 2000). The Rlc form is morphometrically similar to form R, but the outer shell surface has a lighter colour. Moreover the inner shell surface is yellow-white with less purple marks (Figure 1) (Mouthon 2000).

The current distribution of taxa belonging to the genus *Corbicula* in French rivers is presented in Table 1. The present paper reports the recent discovery of *Corbicula* morphotypes R, Rlc and S in five rivers in France where they were never recorded previously (Table 1, Figure 2).

Materials and methods

In April and July 2009, we conducted a sampling survey of *Corbicula* species in 18 rivers distributed in six French watersheds. Living specimens of *Corbicula* were collected by wading the bottom of the rivers with a handnet. We examined the morphology in order to classify each individual as form R, form Rlc or form S (Pfenninger et al. 2002).

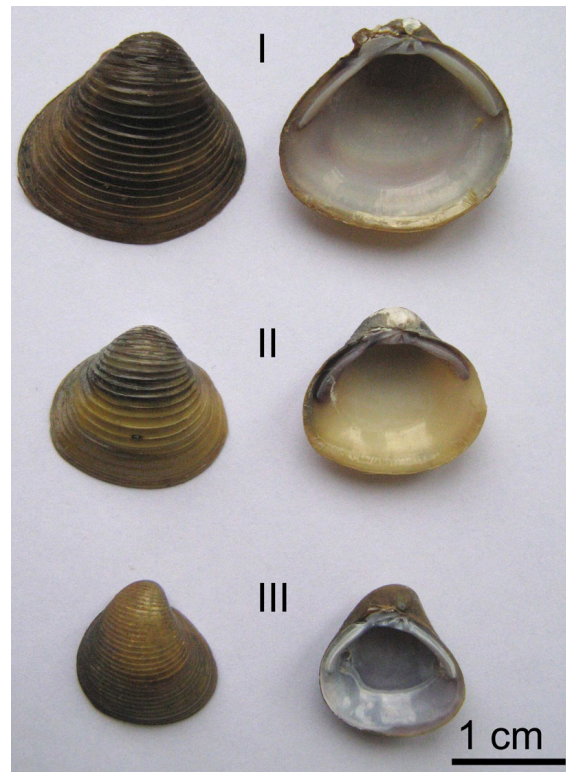


Figure 1. External views of the shells of *Corbicula* form R (I), form Rlc (II) and form S (III). Photograph by Lise-Marie Pigneur.

Figure 2. Hydrological map of France showing previous and new records of *Corbicula* in French rivers. The new records are in red. Rivers sampled in this study are indicated in bold with the coloured circles referring to the presence of each form: form R in blue, form Rlc in red and form S in green.

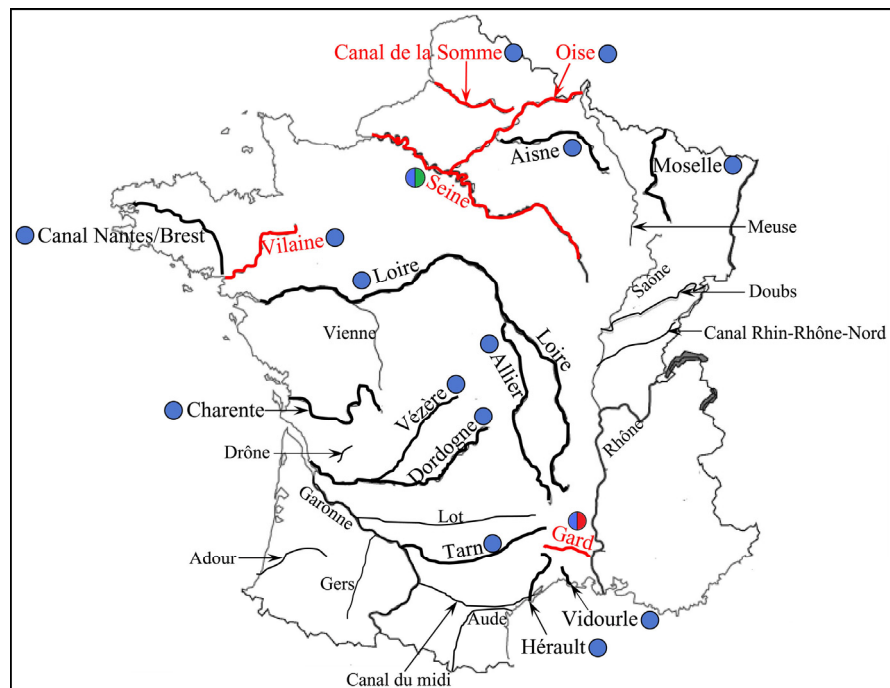


Table 1. The invasion of *Corbicula* spp. in French large rivers and canals. The underlined locations present the new records of *Corbicula* in France. The morphotypes recorded in our samples are indicated.

Location (Basin /River) and <i>Corbicula</i> form	Record coordinates		Record date	Previous record references
	Latitude	Longitude		
Artois-Picardie				
<u>Canal de la Somme (first record of form R)</u>	49°55'243"N	2°44'499"E	5 April 2009	Present study
Seine-Normandie				
Aisne (form R)	49°25'588"N	2°51'168"E	5 April 2009	Mouthon 2000
<u>Oise (first record of form R)</u>	49°24'521"N	2°48'278"E	5 April 2009	Present study
<u>Seine (first record of form S)</u>	NA	NA	6 April 2009	Chevallier 2000 & present study
Loire-Bretagne				
Allier (form R)	46°33'456"N	3°19'586"E	18 April 2009	Vrignaud 2007
Canal Nantes-Brest (form R)	47°26'723"N	1°33'957"W	11 April 2009	Mouthon 2000
Loire (form R)	46°07'351"N	4°05'866"E	18 April 2009	Gruet 1992
<u>Vilaine (first record of form R)</u>	47°35'925"N	2°05'865"W	11 April 2009	Present study
Adour-Garonne				
Adour			No sampling	Fontan and Meny 1995
Canal du Midi			No sampling	Girardi 1989-1990
Canal latéral de la Garonne			No sampling	Dubois 1995
Charente (form R)	45°43'650"N	0°35'112"W	12 April 2009	Chevallier 2000
Dordogne (form R)	44°49'397"N	0°06'599"W	12 April 2009	Mouthon 1981
Drone			No sampling	Fontan and Meny 1995
Gers			No sampling	Fontan and Meny 1995
Garonne			No sampling	Fontan and Meny 1995
Lot			No sampling	Fontan and Meny 1995
Tarn (form R)	44°05'993"N	1°04'664"E	13 April 2009	Chevallier 2000
Vézère (form R)	45°00'696"N	1°05'278"E	28 July 2009	Fontan and Meny 1995
Vienne				Brancotte and Vincent 2002
Rhône-Méditerranée-Corse				
Aude			No sampling	Chevallier 2000
Doubs			No sampling	Mouthon 2007
<u>Gard (form R- first record of form R1c)</u>	43°57'247"N	4°16'197"E	16 April 2009	Girardi 1989-1990 &
	43°51'266"N	4°36'484"E	17 April 2009	present study
Hérault (form R)	43°42'345"N	3°33'483"E	15 April 2009	Mouthon 2000
Rhône			No sampling	Khalanski 1997
Saône			No sampling	Mouthon 2000
Vidourle (form R)	43°41'532"N	4°09'830"E	16 April 2009	Chevallier 2000
Rhin-Meuse				
Canal Rhin-Rhône-Nord à Mulhouse			No sampling	Nagel 1997
Meuse			No sampling	Swinnen et al. 1998
Moselle (form R)	48°49'506"N	6°06'50"E	19 April 2009	Bachmann et al. 1997

Results and discussion

On the 18 prospected rivers, one was not accessible (River Garonne) due to adverse hydrological conditions. Moreover no *Corbicula* individuals were found in the tidal River Léguer in Lannion (not shown on the map). Form R was found in all 16 remaining rivers (see Table 1 - rivers with record date April or July 2009). Form S was found in the River Seine exclusively. In addition, we found at least two individuals of form Rlc in the River Gard where they occur in sympatry with form R. We highlight here the broad distribution of form R while forms S and Rlc seem restricted. However our survey underestimates the occurrence of form S, which was found for example in the rivers Moselle and Allier in previous studies (Bachmann et al. 1997; Vrignaud 2007).

This is the first record of *Corbicula* (form R) in the Somme canal and therefore in the “Picardie” region. It is also the first record of *Corbicula* (form R) in the rivers Oise (region Seine-Normandie) and Vilaine (region Loire-Bretagne) and consequently the first observation of *Corbicula* clams in the Brittany region (“Bretagne”) (Table 1, Figure 2). *Corbicula* form R was previously detected in the River Seine in 2000 (Mouthon 2000) and the presence of form S in this river has been suggested in a report by bij de Vaate et al. (2007). Here, we confirm the first official record of *Corbicula* form S in the River Seine in France. Moreover, we report the first record of form Rlc in the River Gard (Table 1, Figure 2).

These results confirm the widespread invasion of *Corbicula* into all main French basins, especially in large lowland rivers. This rapid dispersal of *Corbicula* in France is not surprising because the French basins are highly interconnected by a large number of canals which facilitate the progression of *Corbicula* spp. More specifically, the presence of the clams in the River Oise may be explained by the existence of the Aisne-Oise canal which allows the migration of these molluscs from the Aisne to the Oise. The presence of *Corbicula* clams in the River Aisne was first recorded in 2000 (Mouthon 2000). The Somme canal intersects with the River Aisne and therefore this connection probably allowed their passage from the Aisne to the Somme. The river Vilaine flows directly into the Atlantic Ocean, but is connected to the River Tarn by the Ille-et-Rance canal and by the River

Rance, which were probably the dispersal routes of *Corbicula* to the River Vilaine.

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