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Short Communication

New records of the amphipods *Gammarus tigrinus* Sexton, 1939 and *Pontogammarus robustoides* G.O. Sars, 1894 in Latvian waters of the Baltic Sea

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Abstract

The paper presents recent records of the North-American amphipod *Gammarus tigrinus* and the Ponto-Caspian amphipod *Pontogammarus robustoides* in Latvian territorial waters of the Baltic Sea. *P. robustoides* was found for the first time in shallow waters of the Gulf of Riga near Jurmala City in June 2009. During field surveys of 2011–2012, *P. robustoides* and another invader, the North-American amphipod *G. tigrinus* (detected earlier in Estonian part of the Gulf), were recorded in different sites of the Latvian waters of the Gulf of Riga and in the coastal Lake Liepaja. Abundance ranged between 1–70 ind./m^2 for *P. robustoides* and 5–100 ind./m^2 for *G. tigrinus,* suggesting they potential role in the functioning of the benthic community in near future.

Key words: gammarid amphipods; invasive species; distribution; establishment; abundance; Gulf of Riga; coastal

Introduction

Lately, the number of non-indigenous invertebrates has increased worldwide, resulting in fauna mixing and structural changes of aquatic communities (Leppäkoski et al. 2002). The Gulf of Riga is the trans-border area between Latvia and Estonia. The southern area (i.e., near Riga City and its suburbs) has environmental issues due to intensive and long-term development of major holiday resorts. The main environmental problems in the Gulf of Riga caused by humans include eutrophication, harmful algal blooms, toxic pollution and presence of invasive species. The substantial maritime traffic (both cargo ships and leisure boats), exchanging ballast water in the sea and fish stocking are important sources of transfer of non-native species to this region.

In the last few decades, at least 14 non-native macrobenthic invertebrate species have been recorded in the Gulf of Riga, including: the hydroid *Cordylophora caspia* Pallas, 1771; the polychaetes *Marenzelleria viridis* Verrill, 1873 and *M. neglecta* Sikorski and Bick, 2004; the molluscs *Mya arenaria* Linnaeus, 1758, *Dreissena polymorpha* Pallas, 1771, and *Potamopyrgus antipodarum* J.E. Gray, 1843; a barnacle *Balanus improvisus* Darwin, 1854; the crabs *Eriocheir sinensis* H. Milne Edwards, 1853 and *Rhithropanopeus harrisi* Gould, 1841; a shrimp *Palaemon elegans* Rathke, 1837, the mysids *Paramysis intermedia* Czerniavsky, 1882 and *Hemimysis anomala* G. O. Sars, 1907; and the amphipods *Pontogammarus robustoides* G.O. Sars, 1894 and *Gammarus tigrinus* Sexton, 1939 (Ojaveer 1995; Leppäkoski et al. 2002; Herkül and Kotta 2007; Blank et al. 2008; Herkül et al.2009; Kotta and Kotta, 2010; Kalinkina and Berezina, 2010; Kotta et al. 2010, 2011; Kotta and Kuprijanov 2012).

The goal of this study was to document the presence of alien amphipods in Latvian waters of the Gulf of Riga and to estimate their abundance and current distribution. We predicted the presence in the communities of this Gulf of at

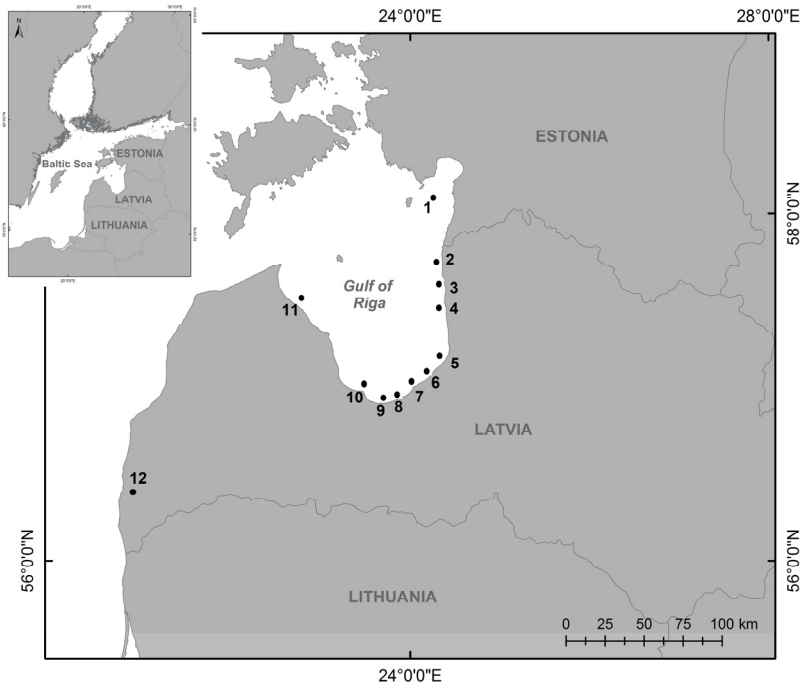

Figure 1. Map of the Gulf of Riga with sites of amphipod records in 2011-2012. 1 - Pärnu Bay, 2 - Ainaži, Randu meadows, 3 - Salacgrīva, 4 - Vitrupe, 5 - Lilaste, 6 - Garciems, 7 - Vecāķi, 8 - Bolderāja, 9 – Jurmala, 10 - Ragciems, 11 - Kaltene, 12 - Lake Liepaja.

least two amphipods (*P. robustoides, G. tigrinus*) that were discovered recently in the Gulf of Riga (Berezina and Kalinkina 2010; Herkül and Kotta 2007). Surveys of the bottom communities in the south-eastern part of the Gulf of Riga and the Latvian coast of the Baltic Sea were started during the Latvian-Russian collaborative program BEAST (project BONUS+Programme 2009-2011) aimed at determining the most sensitive indicators among amphipods for the control of hazardous substances in the Baltic Sea. In 2012, sampling was conducted along whole Latvian coast of the Gulf of Riga in the frame of the European Social Fund project HYDROTOX.

Study area and sampling method

The Gulf of Riga (18 100 km^2) is a large shallow bay (maximum depth of 62 m) in the eastern part of the Baltic Sea. During spring, surface-water salinity varies between 0.5 and 2.0 PSU while bottom water salinity (i.e., in the Irbe Strait) reaches up to 7.7 PSU (Ojaveer 1995). The relatively low salinity of the Gulf of Riga is the result of high freshwater inflow from the rivers Daugava, Lielupe, Gauja, and Salaca.

Zoobenthos were sampled during field survey several times in a year, during summer, autumn and winter of 2011 and 2012 mostly from the littoral area (0-1 m) at 11 sites of the Gulf of Riga and one site at the Baltic Sea coast, from deep water stations (10 m depth) of the Pärnu Bay as well as from the Lake Liepaja (Figure 1). All sampling dates, coordinates and names of mentioned sites are illustrated in the Table 1 and 2. To record new sites of amphipod species distribution, macrobenthic organisms were collected by means of a Mini-Surber Sampler (500 µm mesh).

The samples were conserved by 4% formaldehyde and transported to the laboratory. Amphipods were identified and their abundance was expressed as number/m^2.

Results and discussion

During the field survey of 2011-2012, the presence of amphipods *Pontogammarus robustoides* and *Gammarus tigrinus* was confirmed in several new locations of the Gulf of Riga (Table 1 and 2). In 2011 both species were found in the shallowest areas of the Gulf, where earlier

Table 1. New record of *Pontogammarus robustoides* of the Gulf of Riga.

Site No.	Location (site name)	Record coordinates		Record date	Number collected (ind./m^2)
		Latitude, °N	Longitude, °E		
2	Ainaži, Randu	57°49'33"	24°19'58"	01.10.2011 - 04.06.2012	5-10
3	Salacgrīva	57°44'12"	24°20'38"	04.06.2012	8
4	Vitrupe	57°38'34"	24°22'08"	04.06.2012	11
5	Lilaste	57°11'38"	24°20'01"	04.06.2012	10
6	Garciems	57°06'55"	24°11'25"	04.06.2012	19
7	Vecāķi	57°04'54"	24°06'21"	05-09.2011-04.06.2012	100-6
8	Bolderāja	57°01'14"	23°57'55"	04.06.2012	1
9	Jurmala	56°57'54"	23°33'36"	15.06.2011 - 04.06.2012	10-6
11	Kaltene	57°27'34"	22°53'09"	04.06.2012	10

Table 2. Records of *Gammarus tigrinus* in Latvian waters of the Baltic Sea and the Gulf of Riga.

Site No.	Location	Record coordinates		Record date	Number collected (ind./m^2)
		Latitude,°N	Longitude,°E		
1	Pärnu Bay	58°07'51"	24°10'58"	14.01.2012	40
				07.08.2012	70
2	Ainaži, Randu	57°49'33"	24°19'58"	01.10.2011	2
9	Jurmala	56°58'13"	23°45'13"	15.06.2011	5
10	Ragciems	57°01'44"	23°29'47"	04.06.2012	1
12	Lake Liepaja	56°30'56"	21°02'39"	07.06.2011	50

(before 2000s) the Baltic *Gammarus* species were commonly recorded. From eighteen observed sites in 2012 in the littoral areas, *P. robustoides* and *G. tigrinus* were found at more than 50% places (Tables 1, 2). During January and August 2012, *G. tigrinus* was also found in deep water stations of the Pärnu Bay (in 10 m depth) where the Baltic corophiid *Corophium volutator* was detected as well.

Pontogammarus robustoides (Figure 2) has been recorded in 1999-2005 as an established component in the lower reaches or mouths of Latvian rivers flowing into the Baltic Sea (Grudule et al. 2007)**.** In June 2009, it was found in the Gulf of Riga near Jurmala City in sandy littoral habitats (Kalinkina and Berezina 2010). It was the first recorded report of *P. robustoides* in Latvian coastal areas of the Gulf. There is an unpublished record of this species from the same location from July 2000 (J. Ironside, personal communication). This suggests that *P. robustoides* has been present in the Jurmala district since at least 2000.

The original distribution of this Ponto-Caspian amphipod includes: the brackish and freshwater bays of the Black Sea, the Azov Sea and the Caspian Sea; coastal lakes; lagoons, lower courses and estuaries of major rivers (e.g., Volga, Don, Bug, Dnepr, Dniester, Danube, Prut, Terek, Kura, Kuban, etc.); as well as the lakes near Marmara Sea (Kalinkina and Berezina 2010). The invasion history of this species in the southern Baltic Sea basin begins in 1960 when it was introduced from the Black Sea basin to the Kaunas Reservoir (Neman River) and subsequently further north in Lithuania, Latvia and Russia (Leningrad province). By the end of 20th century, *P. robustoides* had spread in the estuaries and along the course of several large rivers (e.g., Vistula, Oder/Odra, Neman/ Nemunas), and also it penetrated several lakes and reservoirs within their basins (Rudolph 1997, Zettler 1998, Arbačiauskas 2002, 2008, Jażdżewski and Konopacka 2002; Wawrzyniak and Gruszka 2005; Ezhova et al. 2005). During the last few decades it was recorded in the eastern part of the Gulf of Finland, specifically in the estuary of the River Neva (Berezina and Panov 2003) and along Estonian coast in Narva Bay (1999) (Herkül et al. 2009).

Gammarus tigrinus (Figure 3) is a species native to the Atlantic seaboard of North America and introduced into Northern Ireland (known from 1931) presumably transported by ballast waters (Hynes 1955). It was firstly found in Great Britain in 1939 (Sexton and Cooper 1939).

Figure 2. General view of the amphipod *Pontogammarus robustoides* Sars, 1894, collected from the Vecāķi, Gulf of Riga. Photograph by E. Strode.

Figure 3. General view of the amphipod *Gammarus tigrinus* Sexton, 1939, from the Gulf of Riga near Jurmala. Photograph by E. Strode.

G. tigrinus became wide-spread in continental European waters after intentional introductions (as food for fish) from England to the River Werra, Germany, in 1957 (Schmitz 1960) and from Northern Ireland to the Lake Ijsselmeer, The Netherlands, in 1960 (Nijssen and Stock 1966).

Since its first discovery in 2003, *G. tigrinus* has been recorded frequently in the Estonian coastal areas of the northern Gulf of Riga (Kõiguste Bay) (Herkül and Kotta 2007). Until now, *G. tigrinus* had not been reported in the Latvian part of the Gulf of Riga when it was recorded as an abundant species in several sites of the Gulf of Riga and Lake Liepaja (Table 2).

In 1975, the species was found in the Baltic Sea, Schlei Fjord (Bulnheim 1976). In 1992 it was recorded in the Peenestrom and the Achterwasser - the River Odra estuary (Rudolph 1994). However, Wydrowska-Wawrzyniak and Gruszka (2005) showed that *G. tigrinus* was already present in the estuary - in the Szczecin Lagoon in 1988. Soon, it spread along the entire Baltic Sea shore of north-eastern Germany (Zettler 2001) and north-western Poland (Gruszka 1999; Jażdżewski and Konopacka 2000). During the next decade, the species reached Puck Bay (Szaniawska et al. 2003) and the Vistula Lagoon (Jażdżewski et al. 2002; Ezhova et al. 2005). At the Finnish coast of the Gulf of Finland, this gammarid was found in 2003 (Pienimäki et al. 2004) and later, in 2005, it was recorded in the eastern-most part of the Baltic Sea (the River Neva estuary, Berezina 2007).

Abundance of amphipods *P. robustoides* and *G. tigrinus* in our sampling sites was relatively high (Tables 1 and 2). It varied between 1-70 ind./m^2 in the case of *P. robustoides* and 5-100 ind./m^2 in the case of *G. tigrinus*, which suggests they have become an important component of the benthic community of the Gulf of Riga. Both species are key components of benthic communities in freshwater and brackish water areas where they feed upon small planktonic and benthic invertebrates (Arbačiauskas and Gumuliauskaite 2007; Berezina et al. 2011). The selective predation of invasive amphipods on native invertebrates is considered to be the main mechanism explaining the replacement of previously co-existing species and shifts in density of native invertebrates (e.g., Dick et al. 2002). As a rule, their predation pressure depends on abundance and availability of prey in particular habitats and can change seasonally. Further investigations of the distribution, reproductive success and ecological significance of these two non-native species in the Gulf of Riga are needed in order to estimate quantitatively their role in the structure and functioning of the benthic communities in Latvian waters.

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