First record of the invasive Ponto-Caspian amphipod Pontogammarus robustoides G.O. Sars, 1894 from Lake Ladoga, Russia

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Abstract

The invasive amphipod Pontogammarus robustoides G.O. Sars, 1894 was first recorded in Lake Ladoga in August 2006 during an expedition by the Institute of Limnology Russian Academy of Sciences to investigate the lake’s littoral zone. The species was found associated with another alien amphipod, Gmelinoides fasciatus, in a shallow littoral area of the Volkhov Bay. The biomass of the two amphipod species was 25.2% and 15%, respectively of the total macrobenthos, with 1456 and 864 mg WW m⁻². The appearance of P. robustoides in Lake Ladoga is of great concern as this new invader may alter the ecological balance in the littoral zone of the largest European lake.

Key words: biological invasions, alien Amphipoda, Pontogammarus robustoides, first record, Lake Ladoga

Invasions of alien species, including Ponto-Caspian amphipods, into aquatic ecosystems of the Gulf of Finland basin are of high concern and scientific interest as they may induce drastic ecological change and may even cause economic loss (Panov et al. 1999; Leppäkoski et al. 2002; Panov et al. 2002). Lake Ladoga, the largest European lake, has still been steady enough to invasions of species which have already shown their high invasive potential. Thus, although 25 alien species are now established in the eastern Gulf of Finland and in Neva Bay (Panov et al. 2003; Berezina and Panov 2003; Orlova et al. 2006; Berezina et al. 2007), many of which could theoretically penetrate into Lake Ladoga, only two have been found in this waterbody. They are invasive crustaceans: the Baikalian amphipod Gmelinoides fasciatus (Stebbing, 1899) and the Chinese mitten crab Eriocheir sinensis H. Milne-Edwards, 1853 (Panov 1996, 2006). The former species has successfully naturalized in the lake; moreover, G. fasciatus has in fact established as a dominant species in littoral benthic communities (Panov and Berezina 2002; Kurashov et al. 2006) and has penetrated into Neva Bay of the eastern Gulf of Finland (Panov and Berezina 2002).

The Ponto-Caspian amphipod Pontogammarus robustoides G.O. Sars, 1894 is widespread in the Baltic Sea basin. This alien species dwells in the inland waters of Poland (Jazdzewski and Konopacka 2000; Grabowski et al. 2006), Lithuania (Arbačiauskas 2002, 2005), and Germany (Martens et al. 1999). It also occurs in the eastern part of Gulf of Finland and in the Neva Estuary, where it was first detected in 1999 (Berezina and Panov 2003).

On August 5, 2006, during expedition of the Institute of Limnology Russian Academy of Sciences, a benthic sample was collected in littoral zone of the Volkov Bay, to the west of the River Volkov inflow (60°07.680’N, 32°19.217’E) (Figure 1), at depth of 0.3 m, using Panov and Pavlov’s (1986) tube sampler with a cross-section area of 0.125 m². The sample was sieved with a 0.125 mm mesh and preserved in 4-5% formaldehyde. The invertebrates were sorted and preserved in 70% ethanol.
Table 1. Density (N, ind m$^{-2}$) and biomass (B, mg WW m$^{-2}$) of macrobenthos in Volkhov Bay, Lake Ladoga (St.4; 60°07.680’ N, 32°19.217’ E; 5 August 2006).

<table>
<thead>
<tr>
<th>Invertebrate group</th>
<th>N</th>
<th>% N</th>
<th>B</th>
<th>%B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oligochaeta (class)</td>
<td>1704</td>
<td>19.6</td>
<td>552</td>
<td>9.6</td>
</tr>
<tr>
<td>Bivalvia (class)</td>
<td>88</td>
<td>1.0</td>
<td>600</td>
<td>10.4</td>
</tr>
<tr>
<td>Amphipoda (order):</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gmelinoides fasciatus</td>
<td>560</td>
<td>6.4</td>
<td>1456</td>
<td>25.2</td>
</tr>
<tr>
<td>Pontogammarus robustoides</td>
<td>24</td>
<td>0.3</td>
<td>864</td>
<td>15.0</td>
</tr>
<tr>
<td>Ephemeroptera (order)</td>
<td>8</td>
<td>0.1</td>
<td>4</td>
<td>0.1</td>
</tr>
<tr>
<td>Trichoptera (order)</td>
<td>8</td>
<td>0.1</td>
<td>16</td>
<td>0.3</td>
</tr>
<tr>
<td>Chironomidae (family)</td>
<td>6312</td>
<td>72.5</td>
<td>2280</td>
<td>39.5</td>
</tr>
<tr>
<td>Mermithidae (family)</td>
<td>8</td>
<td>0.1</td>
<td>4</td>
<td>0.1</td>
</tr>
<tr>
<td>TOTAL</td>
<td>8712</td>
<td>-</td>
<td>5776</td>
<td>-</td>
</tr>
</tbody>
</table>

Figure 1. Location of Pontogammarus robustoides first confirmed record in Lake Ladoga (Volkhov Bay, St.4).

The sampling location was overgrown with a sparse association of Phragmites australis (Cav.) with Eleocharis palustris (L.). The substrate consisted of fine sand with decaying reed-stems and other plant remains. The following water characteristics were measured: temperature (24 °C), pH (9.1), conductivity (0.241 mS cm$^{-1}$) and total phosphorus concentration (0.152 mg P l$^{-1}$). Total dissolved salt concentration (TDS, g l$^{-1}$) in water was calculated from conductivity using a conversion factor 0.64 and comprised 0.154 g l$^{-1}$.

In total, only two adult specimens (male and female) and one juvenile individual of P. robustoides were found in the sample (Figure 2). Their body size and wet weight were 18.4, 15.2, 9.9 mm and 61, 37 and 10 WW mg, respectively.

At the investigated site in Volkhov Bay P. robustoides was found together with another amphipod species, G. fasciatus. Among other features, P. robustoides can be easily identified and distinguished from this species and other amphipod species by the armature of urosomal segments (characteristic groups of spines) (Figure 3) (Tsaloikhin 1995).

Table 1 demonstrates a composition and abundance of macrozoobenthos at the investigated site in Volkhov Bay. A total of seven groups of macrobenthos were recorded at this site. Chironomidae and Oligochaeta were dominant in macrobenthic density (72.5% and 19.6% of the total macrofauna). Amphipoda comprised only 6.7% of total macrobenthic number: G. fasciatus – 6.4%, P. robustoides – 0.3% with 560 and 24 ind m$^{-2}$ correspondingly. In contrast, the corresponding biomass shares of these two alien amphipod species were 25.2% and 15%, this indicates the relative importance of invasive Amphipoda (including the new invader P. robustoides) in the littoral benthic communities of Volkhov Bay.

Among the 28 habitats surveyed on the perimeter of Lake Ladoga during the expedition, the new invader P. robustoides was discovered only in Volkhov Bay. At this location water conductivity measured (0.241 mS/cm, corresponding TDS=0.154 g l$^{-1}$) more than twice the maximum values of this parameter at the majority of other investigated littoral stations where conductivity values were within the range of 0.070-0.120 mS/cm (TDS=0.045-0.077 g l$^{-1}$). High total dissolved salt content in Volkhov Bay (up to 0.19 g l$^{-1}$) is caused by the inflowing River Volkov with annual values ranging from 0.086 to 0.306 g l$^{-1}$, whereas average annual TDS values are 0.15-0.16 g l$^{-1}$ (Rumyantsev 2002; Trifonova 2006). This parameter averaged 0.0637 g l$^{-1}$ in the main water body of Lake Ladoga (Raspletina et al. 2002).
Low total dissolved salt concentration seems to be the current reason for *P. robustoides* absence in other areas of the Lake Ladoga littoral zone. This speculation is in accordance with the data on the distribution of *P. robustoides* in Neva Bay, where it was absent in its northern part which had the lowest salt content (TDS=0.042-0.075 g/l, corresponding conductivity 0.066-0.117 mS/cm) due to the strong influence of the Neva River (Berezina et al. 2007).

The invasion pathway of *P. robustoides* to Volkhov Bay is not quite clear. Most probably it penetrated Lake Ladoga through shipping from the eastern part of the Gulf of Finland or Neva Bay (where stable populations of this species exist) as the southern part of the lake is a zone of intensive navigation.

In general, the establishment of a population of *P. robustoides* in Lake Ladoga is an open question, and the fate of this invasive species after its introduction remains uncertain. Nevertheless, the presence of a juvenile specimen in the sample may suggest that the population of *P. robustoides* in Volkhov Bay is able to reproduce.

This species is known to be an aggressive predator altering local invertebrate communities drastically, including other amphipods (Berezina and Panov 2003; Arbačiauskas and Gumuliauskaitė 2007; Berezina 2007; Grabowski et al. 2007a; Gumuliauskaitė and Arbačiauskas 2008). In addition *P. robustoides* is characterised by a very high productive potential (large brood size, high fecundity, early maturation, some repeated generations each year) as well as higher tolerance towards severe environmental conditions (Bacela and Konopacka 2005; Grabowski et al. 2007b).

In conclusion, special attention should be given to monitoring the distribution of *P. robustoides* throughout the littoral zone of Lake Ladoga. Its interactions with local species as well as with the former invader, *G. fasciatus*, should be researched thoroughly as they may alter the composition and functioning of Lake Ladoga littoral biocoenoses.

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