

Rapid Communication

First record of *Chelicorophium curvispinum* (G.O. Sars, 1895) from Lake Mälaren, SE Sweden

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Abstract

The Ponto-Caspian amphipod *Chelicorophium curvispinum* (G.O. Sars, 1895) was first recorded in the Baltic Sea catchment area in the early 20th century. Since then the species has considerably extended its distribution. Here, we present the first record of the invasive amphipod in Sweden (Drottingholm, Lake Mälaren, SE Sweden). It is plausible that *C. curvispinum* was initially introduced via shipping to the brackish waters of the Stockholm Archipelago. National ferry traffic may have provided a subsequent means of transport for this species from Stockholm centrum to Lake Mälaren.

Key words: invasive species, Ponto-Caspian, shipping, amphipod, Baltic Sea, Stockholm archipelago

Introduction

Chelicorophium curvispinum (G.O. Sars, 1895) is a tube dwelling amphipod native to fresh and brackish waterbodies of the Ponto-Caspian region. However, this species has exploited European river systems and man-made canals to expand its distribution, which currently includes Belarus, Belgium, Bosnia-Herzegovina, Croatia, Estonia, France, Germany, Hungary, Ireland, Lithuania, Netherlands, Poland, Romania, Russia, Serbia, UK and Ukraine (CABI 2017). *Chelicorophium curvispinum* had reached the southern parts of the Baltic Sea drainage area and brackish lagoons by the beginning of the 20th century (e.g. Bij de Vaate et al. 2002). First records of *C. curvispinum* in the northern Baltic Sea were reported in the 1920's from Curonian Lagoon, Lithuania (Szidat 1926), in 2005 from Narva Bay, Estonia (Herkül and Kotta 2007), from the easternmost parts of the Gulf of Finland, Luga Bay, Russia in 2006

(Malyavin et al. 2008) and from Lake Ladoga, Russia in 2009 (Kurashov et al. 2010). Here, we report the first record of *C. curvispinum* in Sweden and discuss the possible route of introduction.

Material and methods

In May 2017, during a marine archaeological survey conducted in Drottingholm Bay, Lake Mälaren, Sweden (59°19.456'N; 17°53.656'E WGS84), seven individuals of an unknown Corophiidae species were collected from wood samples retrieved from a wooden structure at a depth of ~13 meters, (Figure 1). Tube structures typical to tube dwelling species of corophiids were clearly visible on the wood samples, and animals were crawling outside the tubes when the wood samples were brought to the surface (Figure 2). The specimens were stored in 70% alcohol and transported to the Department of Environmental Sciences, University of Helsinki, Finland for identification.

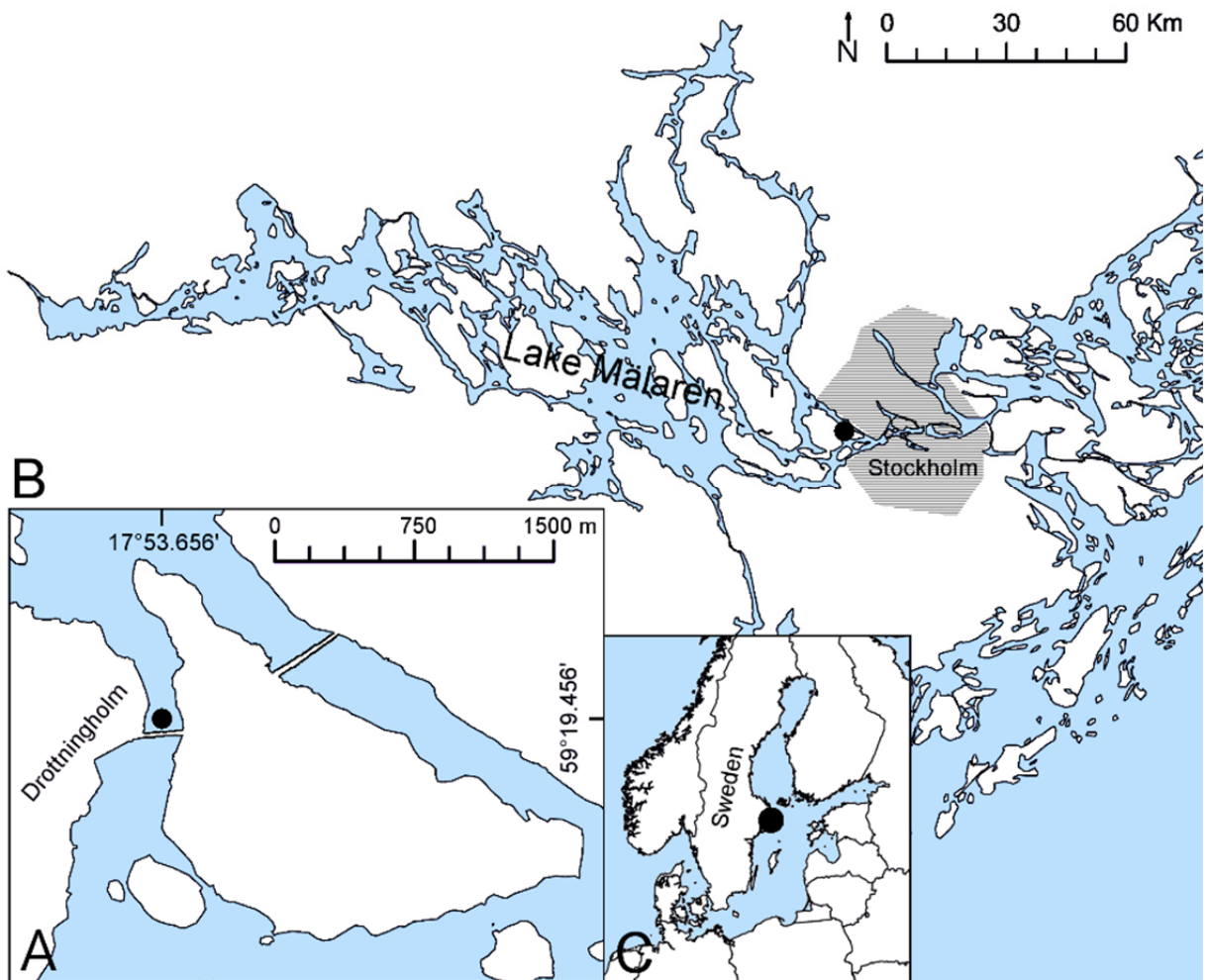


Figure 1. The sampling site is denoted by filled circles. The map data (Open Database Licence 1.0) was retrieved from OpenStreetMap Foundation GIS database (<http://www.geofabrik.de>). **A:** The location of the sampling site, **B:** The location of Lake Mälaren and approximate area of greater Stockholm (gray area) and **C:** The Baltic Sea.

The unknown Corophiidae was initially inspected and body length measured under a binocular microscope. One specimen was also dissected, mounted on temporary slides with glycerol and further inspected under a compound microscope for species determination and illustration. The original descriptions and later taxonomic study by Cărăușu (1943) and the latest revisionary work by Bousfield and Hoover (1997) were used in identification.

Results

The short rostrum, separate urosomal somites, laterally inserted uropod 1 and spinose rami of uropods 1 and 2, small antennal cone, not elongated maxilliped palp segment 2, and other characters clearly attributed the

species to the genus *Chelicorophium* Bousfield and Hoover, 1997. Presence of both median and small distal processes on antenna 2 segment 5, four posterior claw-like spines on dactylus of gnathopod 2, nearly bare anterior margin of pereopods 3 and 4 basis, spinose outer margin of uropod 1 peduncle and both margins of outer ramus, and bare inner margin of uropod 2 inner ramus indicated that the specimens belong to *C. curvispinum* (Figure 3). However, there are some differences from the original description and figures of G.O. Sars (1895). He did not mention the presence of distal process on antenna 2 segment 5, nor that the uropod 2 peduncle was devoid of outer spines. Study of the type and other material from the Caspian Sea is necessary to resolve the importance of these differences.



Figure 2. Amphipod tubes (denoted by white circles) and amphipods on a wood sample retrieved from the Drottningholm wreck. Photograph by Eveliina Salo.

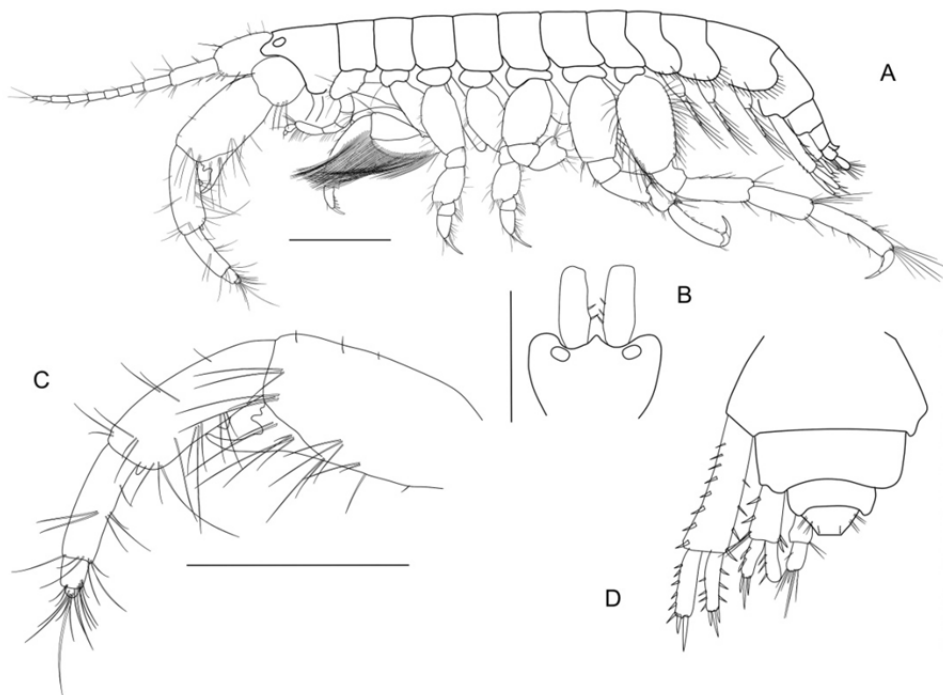


Figure 3. *Chelicorophium curvispinum* from Lake Mälaren, Sweden, female, 4.5 mm. **A**: habitus, **B**: head with antennae 1 segments 1, dorsal view, **C**: antenna 2, lateral view, **D**: urosome with uropods and telson (uropods only from the left side), dorsal view. Scale bar 1 mm. Drawing by Mikhail Daniliya.

Chelicorophium curvispinum were 3.9–5.9 mm in length (average 5.2 mm, SD 0.7 mm). The sample contained both adult females and males. Based on photographs, these non-indigenous amphipods covered the topmost areas of the wooden structures at densities of 500–2000 individuals m⁻². However, no specific abundance assessments were made during the archaeological survey.

Discussion

Here we report the first record of *C. curvispinum* in Scandinavia. This finding is not surprising as this novel Corophiidae is ranked among the most successful invaders in European fresh and brackish waters (CABI 2017). Moreover, *C. curvispinum* is listed in the watchlist of Swedish invasive species (Frammande arter 2012) so its arrival was expected. Currently, the nearest known locations of *C. curvispinum* populations are in Estonia (Herkül and Kotta 2007) and Lithuania (Olenin and Leppäkoski 1999), at an approximate distance of about 500 km from Lake Mälaren.

It is difficult to postulate the actual transport vector for this introduction, but some remarks can be made. Even though *C. curvispinum* has successfully used channels and rivers as invasion corridors (e.g. Bij de Vaate et al. 2002), this amphipod probably arrived in the Stockholm Archipelago area in ship ballast water (Bij de Vaate et al. 2002) and/or as a fouling organism on vessel hulls (Lucy et al. 2004). The Baltic Sea is heavily navigated by fast vessels and ship traffic is regarded as the main vector of dispersal for non-indigenous species in the area (Leppäkoski and Olenin 2000). Both proximate locations of *C. curvispinum* have big ports that are well connected to the Stockholm Archipelago.

Lake Mälaren is connected to Stockholm centrum, which is a brackish water (< 0.33%; Karlsson et al. 2010) seafront in the inner archipelago of Stockholm. The distance between Drottningholm Bay and Stockholm centrum is about 10 km. Stockholm centrum is a busy hub of multiple ports and an extensive network of ferry routes. In addition to leisure crafts, scheduled tourist ferries operate between Stockholm centrum and Drottningholm castle every hour during the summer. Drottningholm pier is located ~100 meters from the site where *C. curvispinum* was retrieved (Figure 1). This clear connection between Drottningholm bay and Stockholm centrum suggests that *C. curvispinum* arrived first to one of numerous international ports in Stockholm and was subsequently transported to Lake Mälaren via small craft.

The environmental characteristics of the sample site accord well with the habitat preference of

C. curvispinum. The strait often has periods of very high current velocity that improves food availability for *C. curvispinum* (van der Brink et al. 1993). The wooden constructions are very suitable substrate for *C. curvispinum* as the species is known to inhabit submerged wood in rivers and streams (Den Hartog et al. 1992; Hoffmann and Hering 2000). Usually, *C. curvispinum* is recorded in relatively shallow waters (< 5 m; Van der Brink et al. 1993; Herkül and Kotta 2007) but our findings suggest that the species can have much wider depth range.

As the population range and density of *C. curvispinum* in Lake Mälaren is currently unknown, it is difficult to predict the environmental consequences of this introduction. *Chelicorophium curvispinum* may potentially outcompete other macroinvertebrate species in the River Rhine (Van der Velde et al. 2000) but as yet there are no data regarding the invertebrate community in our sample site. In addition, large and dense populations (up to 750 000 specimen m⁻²; Van der Brink et al. 1993) may result in clogging and fouling problems. On the other hand, *C. curvispinum* is a suitable food item for many fish species (Van der Brink et al. 1993) and may thus prove to be beneficial for the native fish community.

Although this study provides only a brief glimpse of *C. curvispinum* in Sweden, our finding is yet another example of the high dispersal potential of this species. Hopefully, our paper will trigger more comprehensive research on the dispersal of *C. curvispinum* in Swedish waters. We believe that this novel amphipod species is currently relatively common in Sweden, but determination of its extent is hampered by lack of taxonomic knowledge and poor representation of monitoring sites in potential *C. curvispinum* habitats. In addition, the morphological discrepancies highlighted in this study should be investigated.

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