

First report of the oriental shrimp *Palaemon macrodactylus* Rathbun, 1902 (Decapoda, Caridea, Palaemonidae) from German waters

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Abstract The native East Asian shrimp *Palaemon macrodactylus* has become a common inhabitant of estuaries along the Pacific coast of North America. More recently (documented since 1999), the species has also been colonising European waters and has been reported from Spain, England, Belgium and the Netherlands. In this study, we present a chronology of the reported introductions of this species and provide the first detailed report of its occurrence in German waters. *P. macrodactylus* was found in the Geeste river mouth (Weser Estuary) as well as in Hooksiel, north of Wilhelmshaven between 2004 and 2005. We assume its presence in other estuarine habitats of the North Sea and predict its introduction into the Baltic Sea.

Keywords *Palaemon macrodactylus* · Oriental shrimp · New record · German waters · Invasive species

Introduction

Palaemon macrodactylus is a shrimp originating from estuaries in South East Asia. It was described from

Japan (Rathbun 1902), but its distribution also includes Korea and the north coast of China (Newman 1963). It is a very resistant species, withstanding wide ranges of temperature and salinity (Newman 1963; Siegfried 1980).

The first records from outside the species' original distribution were from San Francisco Bay, California, in 1957 (Newman 1963) and from Newcastle, southeast Australia (Buckworth 1979; Holthuis 1980). Nowadays, it is a very common species along the northwestern coast of America, where it is called "oriental shrimp".

In Europe, the first specimens of *P. macrodactylus* were collected in the Guadalquivir Estuary (Cuesta et al. 2004) in the course of an ongoing project that started in May 1997. A re-examination of the collected samples allows to date back the first presence of the species *P. macrodactylus* in the Guadalquivir Estuary to January 1999 (instead of May 1999, cf. Cuesta et al. 2004), when two adult females of 11.8 and 10.5 mm of cephalothorax length were collected. To determine the distribution range of this species near the Guadalquivir Estuary, samplings in other estuaries of the Gulf of Cádiz were carried out in April 2004. These confirmed the establishment of populations of this species in the unconnected Guadalete, San Pedro and Salado rivers (Cuesta et al. 2004). At present, this species is more abundant in the Guadalquivir Estuary (46% of all Palaemonidae collected) than the native shrimp *Palaemon longirostris* H. Milne-Edwards, 1837 (40%).

Later, *P. macrodactylus* was also found in northern European waters, precisely in the Orwell Estuary, Suffolk, UK (Ashelby et al. 2004) in December 2001, and in some places of the coasts of Belgium and The Netherlands between the end of July and October 2004

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(d'Udekem d'Acoz et al. 2005). Subsequent catches and records provided evidence for the stability of the Orwell population (Ashelby et al. 2004). Among shrimps collected on 27 November 1999 in the estuary of the Westerschelde (Walsoorden, Holland), d'Udekem d'Acoz et al. (2005) also identified some specimens as *P. macrodactylus*, giving evidence that this invasive species has already been present in the North Sea for a number of years.

Methods

In July 2004, a sampling campaign took place in the Weser and Elbe estuaries, in the frame of a German–Spanish bilateral project (Acciones Integradas-DAAD) of the Instituto de Ciencias Marinas de Andalucía (CSIC, Spain) and the Universität Regensburg (Germany). The aim of this project is a population genetic comparison of selected species of caridean shrimps from southern and northern Europe. The samples were taken on 5 July 2004 with crab traps in the yacht jetty of the Geeste river mouth in the Weser

Estuary (Bremerhaven), and on 16 August 2005 in Hooksiel, north of Wilhelmshaven.

Two specimens of *P. macrodactylus* have been deposited at the Senckenberg Museum und Forschungsinstitut, Frankfurt, under accession number SMF 30987.

Results and discussion

On 5 July 2004, several *P. longirostris* and 19 (17 males and 2 female) *P. macrodactylus* were collected from the Geeste river mouth. These catches represent the first record of the latter species from German waters.

In the second sampling period, on 16 August 2005, two additional specimens of *P. macrodactylus* (one male and one female) were collected from Hooksiel.

These findings indicate that *P. macrodactylus* is expanding into this part of the North Sea, and we assume the species' presence in other unsampled localities. Due to its preference for brackish waters, it is likely that this alien species will be found in the Kiel-Canal (Nord–Ostsee canal) and will invade the Baltic Sea in the near future.

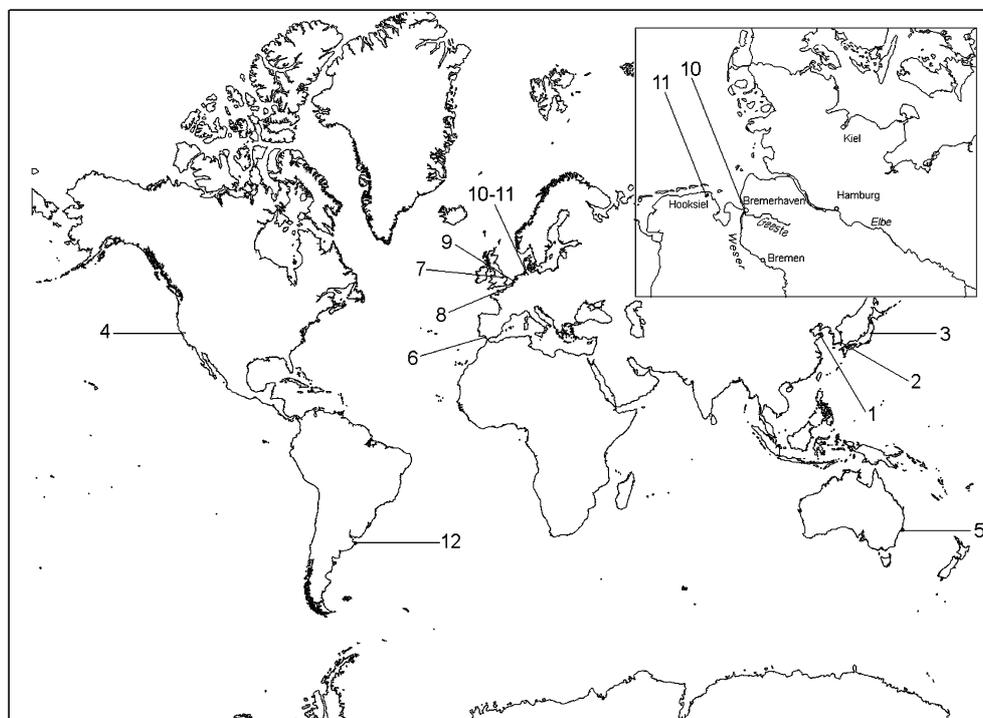


Fig. 1 Worldwide distribution of *Palaemon macrodactylus* Rathbun 1902, and the study area (*inset*). 1 North coast of China (Peitaiho, Tangku, Chefoo and Yangmatao); 2 Korea (Gensan, Jinsen, Pusan); 3 Japan (Aomori, Matsushima, Tokyo Bay, Sagami Bay, Atumi Bay, Nagasaki); 4 Pacific coast of North America (California: Monterey Bay, Los Angeles Harbor, San Francisco Bay; Oregon: Coos Bay); 5 Southwestern Australia

(Gulf St. Vincent, Barker Inlet); 6 Gulf of Cádiz, Spain (Guadaluquivir Estuary, Guadalete Estuary, San Pedro River, Salado River); 7 Orwell Estuary, Suffolk, UK; 8 Yacht harbour of Zeebrugge, Belgium; 9 Westerschelde Estuary and Ijmiden, The Netherlands; 10 mouth of Geeste River, Bremerhaven, Germany; 11 Hooksiel, Germany; 12 Mar del Plata harbour, Argentina

The introduction of *P. macrodactylus* is not only progressing in Europe. In March 2004, specimens of this shrimp have also been collected from Mar del Plata harbour, Argentina. This is the first record for the southwestern Atlantic (Spivak et al. 2006).

Evidently, we are currently witnessing the introduction and expansion of a nektonic estuarine decapod crustacean, originating from the northwest Pacific Ocean, that started invading the coast of Pacific North America and southwest Australia (Indian Ocean), and is now invading two Atlantic regions: the Atlantic coasts of Europe (Spain, UK, Belgium, The Netherlands and Germany) and the eastern coast of South America (Argentina) (Fig. 1).

The way of introduction of *P. macrodactylus* is unclear; the most often used hypothesis in the literature is introduction via ship ballast water, because all localities where this introduced species has been reported are, or are nearby to, large, international harbours. It would be interesting to study the factors enabling an aquatic species to distribute out of its natural range within a few years and almost simultaneously into different and distant parts of the world. This carries the clear signature of an anthropogenic process. It is therefore feasible to presume that any temperate estuary with heavy international ship traffic must be considered a susceptible “hot spot” for invasion by *P. macrodactylus*. In Germany, it is very likely that this species is already present in other areas of the Weser Estuary, as well as in other estuaries such as those of the rivers Elbe, Ems, etc., which are characterized by the presence of important international fluvial harbours.

It is difficult to compare the expansion of *P. macrodactylus* with that of other invasive species, since each has its specific ecological characteristics. However, it resembles the case of the Asian mitten crab, *Eriocheir sinensis* H. Milne-Edwards, 1853, which was recorded for the first time out of its native area in 1912 in Germany, and then spread over North Europe, being known nowadays from Finland, Sweden, Russia, Poland, Czech Republic, The Netherlands, Belgium, France, England, Portugal and Spain. In America, it is known from San Francisco Bay and the Great Lakes, and in the Pacific Ocean it is known punctually in Hawaii (Rudnick et al. 2003).

Estuaries often exhibit a high percentage of exotic species (Reise et al. 1999). A long-term monitoring of estuarine systems can contribute to an early detection of invasive species, thus serving as an early-warning

system. Studies on the vectors and mechanisms of species' introductions can provide the basis for administrative measures to reduce the probability of such introductions. On the other hand, population dynamics data from estuaries can be used to analyse a posteriori the ecological and economic costs caused by introduced species.

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