

Non-native shrimps in Polish coastal waters: first record of *Palaemon longirostris* H. Milne Edwards, 1837 and new sites for *P. macrodactylus* Rathbun, 1902

Katarzyna Spich*, Bartosz Witalis, Sławomira Gromisz, Lena Szymanek, Adam Woźniczka

Abstract

Two non-indigenous species of shrimps (*Palaemon longirostris* and *Palaemon macrodactylus*) were recorded in the Gulf of Gdańsk (Baltic Sea) during surveys of macrozoobenthos. Three individuals of *Palaemon longirostris* were found in the port of Gdynia in July 2018, and two more outside the port, in the Outer Puck Bay and the Puck Lagoon in September 2019. *Palaemon macrodactylus* introduced to Polish waters, was recorded in the ports of Gdynia and Gdańsk in June 2021. Of the 25 *P. macrodactylus* individuals, 8 were ovigerous females. This article aims to record the first appearance of *P. longirostris* in 2018 and confirm the occurrence of *P. longirostris* and *P. macrodactylus* in the Gulf of Gdańsk in the years that followed.

Keywords

Palaemon longirostris; *Palaemon macrodactylus*; Non-native species; Gulf of Gdańsk; Southern Baltic Sea

Department of Fisheries Oceanography and Marine Ecology, National Marine Fisheries Research Institute, Kołłątaja 1, 81–332 Gdynia, Poland

*Correspondence: kspich@mir.gdynia.pl (K. Spich)

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Among shrimps inhabiting the Baltic Sea, five species of the genus *Palaemon* can presently be identified. *Palaemon adspersus* and *Palaemon varians* are native to the Baltic Sea, whereas *Palaemon elegans*, *Palaemon macrodactylus* and *Palaemon longirostris* are recognized as alien species. Two of them (*P. macrodactylus* and *P. longirostris*) have been introduced relatively recently to the ecosystem of the Baltic Sea and have become the subject of recent research (AquaNIS. Editorial Board, 2015; Grabowski, 2006; Jażdżewski and Grabowski, 2011; OBIS, April 2024).

Palaemon longirostris is an euryhaline species (Campbell and Jones, 1990), which inhabits both fresh and brackish water (Zettler, 2002), and that is why it is commonly found in estuaries or reservoirs with low salinity. The native areas of *P. longirostris* occurrence are the western British Isles, through France, Spain, Portugal to Morocco locates along the Atlantic coast (Taybi et al., 2021; González-Ortegón et al., 2010; Béguer et al., 2012; Cartaxana, 1994). Its appearance was also recorded in the Black Sea (Sezgin et al., 2007) and in the Baltic Sea. Its presence in the Baltic Sea was first found in 1999 on the German coast in the region of Mecklenburg-Western Pomerania (Zettler, 2002). In some parts of Europe *P. longirostris* is a species of direct and indirect importance for fisheries. On the one hand, it accounts for a significant part of landings e.g.

in France, and on the other hand is a vital food source for commercially caught fish (Béguer et al., 2012). This shrimp lives about 1.5 years and can close its entire life cycle within one estuary (Gurney, 1923; González-Ortegón et al., 2010). Salinity tolerance by *P. longirostris* ranges from 0 to 43 PSU (Campbell and Jones, 1990). Hydrological conditions, such as temperature and salinity, play a significant role in its reproduction. Along with latitude increases, reproduction is limited to periods when the water temperature is higher, usually beginning in spring and lasting until autumn (Béguer et al., 2012). Ovigerous females show their presence at low salinity, which can favour eggs hatch (Béguer et al., 2010, 2012). *P. longirostris* mainly feeds on copepods, epiphytes, and detritus (Mouny et al., 1998; González-Ortegón et al., 2010).

The native region of *Palaemon macrodactylus* occurrence is the north-western Pacific Ocean (d'Udekem d'Akóz et al., 2005). This species was brought to the shores of the USA in the 1950s (Newman et al., 1963), but its presence has also been recorded off the Atlantic coast of Europe (Ashelby et al., 2004; Cuesta et al., 2004), as well as in brackish Lake Varna (St. Raykov et al., 2010). In 2014, prawns of *Palaemon macrodactylus* were caught in the mouth of the Wisła Śmiała River feeding the Gulf of Gdańsk (southern Baltic Sea) (Janas and Tutak, 2014) but since

then no further information on this topic has appeared.

In this article, we report the first record of *P. longirostris* occurrence and new sites of *P. macrodactylus* presence in Polish coastal waters. The sites sampled in 2018–2021 were located within the coastal area of the Gulf of Gdańsk (southern Baltic Sea): i.e. Ports of Gdynia, Gdańsk, Puck, Hel, Outer Puck Bay and the Puck Lagoon. The coordinates of sampling stations, dates and depths of material collection are included in Table 1. The shrimp samples were collected during three different studies, hence the different sampling techniques were used.

In 2018, the Gdynia Port survey for detecting non-indigenous species (HELCOM, OSPAR, 2015) was conducted and hard bottom macrozoobenthos was sampled using the fouling plate sets and hydrobiological scraper. The triplicate fouling plates sets at three different sites within a Gdynia Port with three repetitions at one site (at 15 m distance from each other). They were exposed during the spring bloom (April) and collected for analysis during the summer maximum (August) along with scraped samples. In 2019, soft bottom macrozoobenthos was sampled with van Veen grab (0.1 m²) at 15 stations located in both Outer Puck Bay and Puck Lagoon (for geographical names see: Cyberski, 1993; Nowacki, 1993), with three replicates at each station. In 2021, mobile macrozoobenthos was collected using 3 types of traps: i) commercial Fukui-designed crab traps with a locally fish *Sprattus sprattus* as the bait (HELCOM, OSPAR, 2015), ii) habitat traps (baskets filled with pots and PVC tubes of two diameters 3 and 4 cm and biological filter media used as an attachment for the bait in the basket; as recommended by HELCOM, OSPAR, 2015; Figure 1), and iii) self-designed habitat traps in the form of perforated PVC tube with funnel-shaped ends allowing the organisms to enter, but not to escape (Figure 2). Triplicate traps were installed at three sites at each location in Ports of Gdynia, Gdańsk, Puck, and Hel.

All collected shrimps were preserved with a buffered 4% formaldehyde solution and the taxonomic identification to the species level was performed in a laboratory on land using a stereomicroscope (NIKON1500) with magnification up to 112.5x. The length of the shrimp was measured to the nearest 0.01 mm using a digital image analysis system and NIS ELEMENTS software. *P. longirostris* and *P. macrodactylus* were identified based on features given by González-Ortegón et al. (2010) and Janas and Tutak (2014).

At all sampling sites, a mix of *Palaemon* species occurred. Among them, *P. elegans* is the most common and abundant shrimp species in the Gulf of Gdańsk area (pers. observation of the authors), usually dominating and sometimes co-occurring with native *P. adspersus*. Both *P. longirostris* and *P. macrodactylus* were identified in these mixed *Palaemon* samples.

Of the three individuals of *P. longirostris* were found in the Gdynia Port in 2018, two were captured with a hydro-



Figure 1. Habitat traps – baskets filled with pots and PVC tubes and biological filter media used as an attachment for the bait in the basket.

biological scraper, whereas one was found on the colonization plate. Their mean total body length was 39.91 ± 1.48 mm ($\pm$ standard deviation). A year later, in the open waters of the Outer Puck Bay and Puck Lagoon, two more specimens were found with a mean length of 41.51 ± 0.23 mm. Bodies of collected individuals were almost colourless, translucent or with blue-grey pigmentation. The pigmented specimens had a slightly orange or red transverse reticulation on the carapace and abdomen. The rostrum was straight or very slightly up-curved with 7 to 9 dorsal teeth and 3 or 4 (rarely 5) ventral teeth. The ventral margin of the rostrum was with a single row of setae. Two of the dorsal teeth were located behind the posterior edge of the orbit (Figure 3A). The shorter ramus of the outer flagellum of the antennule was fused to the longer one for approximately 30% of its length (Figure 3B). The anterolateral spine of the basal segment of the antennule spans about half the length of the second segment. The mandibular palp consisted of three segments (Figure 3C). The carpus

Table 1. Sampling location characteristic and an overview of results.

Sampling location	Latitude N Longitude E	Sampling date	Bottom depth (m)	Salinity (PSU)	Species	n	Length (mm)	♀
Gdynia Port	54.52922 18.55968	07.08.2018	8.5	6.9	<i>P. longirostris</i>	3	38.97–41.62	–
Puck Lagoon	54.62030 18.54890	24.09.2019	8.7	7.44	<i>P. longirostris</i>	1	41.67	–
Outer Puck Bay	54.73690 18.43500	28.09.2019	4.4	7.37	<i>P. longirostris</i>	1	41.35	–
Gdańsk Port	54.40464 18.66383	03.07.2021	11.0	7.0	<i>P. macrodactylus</i>	2	33.51–39.54	1
Gdańsk Port	54.38279 18.65810	03.07.2021	3.5	7.0	<i>P. macrodactylus</i>	9	32.86–47.29	4
Gdańsk Port	54.38466 18.67241	03.07.2021	11.0	6.8	–	–	–	–
Gdynia Port	54.54142 18.51250	26.06.2021	10.0	7.1	<i>P. macrodactylus</i>	10	26.56–41.91	1
Gdynia Port	54.53456 18.52732	13.07.2021	10.0	7.1	<i>P. macrodactylus</i>	4	34.75–41.80	2
Puck Port	54.72332 18.41063	30.06.2021	3.3	7.3	–	–	–	–
Hel Port	54.60225 18.80135	30.06.2021	3.5	7.5	–	–	–	–

**Figure 2.** Self-designed habitat trap in the form of perforated PVC pipe (A); funnel-shaped ends allowing the organisms to enter, but not to escape (B).

of the second pereopod was equal to or slightly longer than the merus, and the finger of chela was 0.7 times longer than the palm (Figure 3D). There is a protuberance just above the posterolateral margin spine of the sixth abdominal

segment (Figure 3E) (González-Ortegón et al., 2010).

Palaemon macrodactylus was found in two seaports (Gdańsk and Gdynia) out of four monitored in summer 2021 (Table 1). Shrimps were mostly caught with the habitat trap (11 individuals in the Gdańsk Port, 8 in the Gdynia Port); five individuals were caught using a PVC tube (4 in the Gdynia Port and 1 in the Gdańsk Port). Eight out of 25 *Palaemon macrodactylus* individuals with mean body length in the range of 35.75 ± 5.78 mm, were ovigerous females. Interestingly, the lowest effectiveness was shown by Fukui trap, recommended by HELCOM and OSPAR (2015) as only one individual was caught in the Gdynia Port. Our observation brought us to the conclusion that habitat trap (box type) was the most effective gear applied during our studies, especially with a lot of bait and filling debris, which create shelter for mobile organisms, but they are also a trap preventing their escape during pulling out of the water. We are of the opinion that covering the habitat trap or any other applied gear to sample shrimps in a coastal area of the Baltic Sea, prior to its (their) pulling up, could have enhanced the effectiveness of the gear expressed in a number of individuals.

Ecological meaning of the introduction of new alien shrimp species to the Polish coastal waters is ambiguous and difficult to predict. Condition and fecundity of shrimps are related to the ontogenesis overlap with favourable environmental conditions, like temperature, salinity, food availability or predator presence (Béguet et al., 2010; Jacobson et al., 2019; Matern et al., 2021; Mustamäki et al., 2014). Studies carried out in regions beyond the Baltic Sea showed that the presence of ovigerous females of

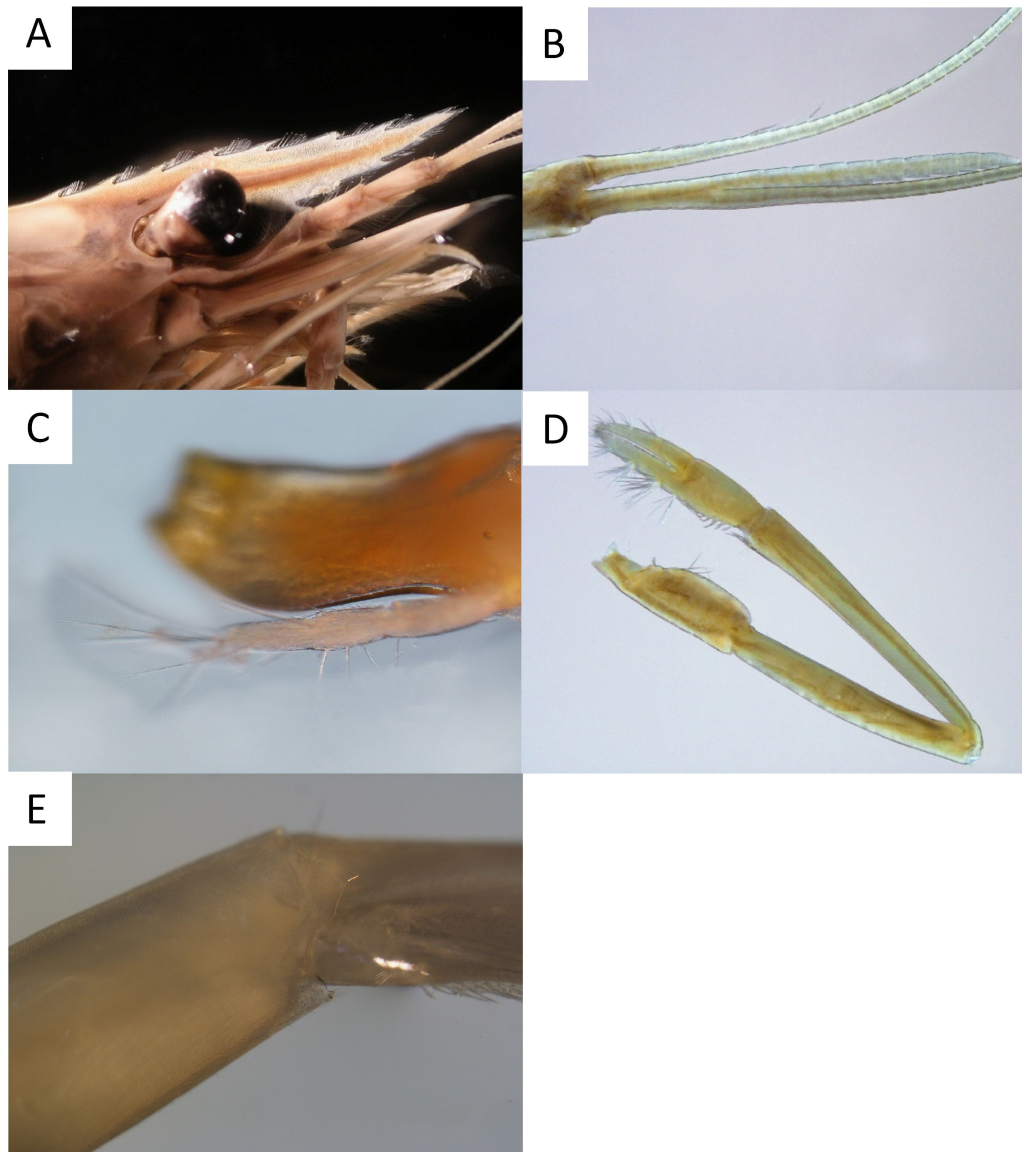


Figure 3. *Palaemon longirostris* rostrum (A), antennule (B), mandibular palp (C), second pereopod (D), sixth abdominal segment (E).

P. longirostris was observed within the temperature range of 11.7–20.7°C and salinity 0–10 PSU (Béguer et al., 2010). Such environmental parameters occur also in the Polish coastal area. Moreover, *P. longirostris* is recognized as a catadromous species which migrates to brackish waters for reproduction (Paula, 1998). Considering the above, it is likely that it could have created a self-sustaining local population in the Polish coastal waters, especially in the water close to the river mouth, since *P. longirostris* favours lower salinity (<6 PSU) for reproduction (Béguer et al., 2010). The presence of new shrimp species in the Polish coastal waters could enhanced local food webs, constituting the prey for coastal fish species e.g. perch (Jacobson et al., 2019; Mustamäki et al., 2014), native black goby

(Matern et al., 2021) or invasive round goby (Matern et al., 2021). On the other hand, it could also compete in terms of food with other shrimp species, but this assumption requires further research (Janas and Barańska, 2008; González-Ortegón et al., 2010).

During our studies, *P. longirostris* and *P. macrodactylus* were found in two large Polish seaports, characterized by intense traffic of ships coming from all over the world. Additionally, *Palaemon macrodactylus* was also recorded in three other Baltic Sea ports located in Sweden (Ystad) and Latvia (Liepaja and Riga in the mouth of the River Daugava) (OBIS, April 2024). This may suggest that shipping is an important pathway in introduction of both species. On the other hand, the first finding of *P. macrodactylus* in the yacht

harbour situated in the mouth of the Wisła Śmiała River feeding the Gulf of Gdańsk (Janas and Tutak, 2014), as well as finding of *P. longirostris* outside the port, in Puck Lagoon may indicate the role of other pathways (e.g. recreational vessels) or vectors in the introduction and spread of these shrimps.

Port infrastructure favours the concentration of marine organisms, which locally affect the food web, but also offers a shelter for mobile species, creating perfect habitats for them. For this reason, seaports should be subject to regular environmental monitoring, with special emphasis on non-indigenous species. Joint Harmonized Procedure for the Contracting Parties of HELCOM and OSPAR on the granting of exemptions under the International Convention for the Control and Management of Ships' Ballast Water and Sediments, Regulation A-4 is a good example of an approach, which allows to detect spreading, or introduction of alien species.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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