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First record of the North American amphipod *Melita nitida* Smith, 1873 in Polish coastal waters

by

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Abstract

The present paper reports the first observation of the North American amphipod *Melita nitida* Smith, 1873 in the Gulf of Gdańsk (the southern Baltic Sea, Poland). In 2014, 13 adult specimens, including 3 males, were collected in the Port of Gdynia, which is located in the western part of this waterbody.

Key words: non-indigenous species, introduced species, Melitidae, Gulf of Gdańsk, southern Baltic Sea

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Introduction

The human-mediated introductions of non-indigenous marine species to regions outside their natural occurrence range are nowadays recognized as a problem of global concern because of the unexpected and usually negative environmental consequences caused by these species (Olenin & Leppäkoski 1999; Chandra & Gerhardt 2008). Ecosystems most vulnerable to biological invasions are coastal seas and estuaries which offer newcomers favorable living conditions (Wolff 1999; Leppäkoski & Olenin 2000; Preisler et al. 2009). The Baltic Sea – also called "the sea of invaders" (Leppäkoski et al. 2002) is a typical example, where up to now 132 introduced and cryptogenic species have been recorded (AquaNIS 2015). More than 20% of them are Malacostraca, mostly represented by amphipods native to various regions, e.g. Ponto-Caspian, Atlantic or Pacific (HELCOM 2013; AquaNIS 2015). In addition to the species-rich family Gammaridae, amphipods introduced to the Baltic Sea encompass also representatives of the families Corophiidae, Talitridae and Melitidae. The latter family includes the species *Melita nitida* Smith, 1873 native to the Atlantic coast of North America. In 2010, this amphipod was found in the westernmost part of the Baltic Sea (Kiel Canal, Germany), but re-identification of the material from the previous surveys showed that *M. nitida* was present in these waters at least since 2008 (Reichert & Beermann 2011). So far, this species was reported by Lackschewitz et al. (2014) from the south-western Baltic Sea (Mecklenburg Bay), but without any details. In this paper we report, for the first time, the presence of *M. nitida* in the southern Baltic Sea (the Gulf of Gdańsk, Poland).

Materials and Methods

Sampling took place in the Port of Gdynia (54°32'107" N, 18°31'781" E) located in the eastern part of the Gulf of Gdańsk (the southern Baltic Sea). Traps ($n = 3$) consisting of a plastic crate (30 × 30 × 30 cm) filled with empty oyster shells (Fowler et al. 2013) were used to collect mobile epifauna. They were deployed in 2014 from June to July (8 weeks) at a depth of less than 10 m. The water temperature varied between 10.5 and 19.1°C, whereas salinity was 7 PSU. Sampled specimens were fixed in 4% formaldehyde, transferred to the laboratory and determined to the species level based on the characteristics given by Bousfield (1973), Chapman (1988) and Jarrett & Bousfield (1996). Specimens were deposited in the RBINS Marine Taxonomic Reference Centre in Ostend.

Results

Among 79 amphipods collected in 2014, 13 were identified as *M. nitida* (Fig. 1), a species hitherto not recorded in the Polish waters. The sample contained 3 adult males. Species identification was done based on the following features: (1) absence of the dorsal teeth on the first urosome segment and the presence of a group of dorsolateral spines on either side of the second urosome segment (Fig. 2A) and (2) the shape of the male gnathopod 2 (Fig. 2B).

Discussion

Melita nitida Smith, 1873 is native to the Atlantic coast of North America (Bousfield 1973). The species was introduced through human activities, first to the northeast Pacific (Chapman, 1988) and then to European waters (Faasse & van Moorsel 2003). The first documented finding in Europe dates back to 1996 when *Melita* specimens were collected at Doel (the Belgian part of the Western Scheldt) on October 15th, but at that time the taxon was identified as native *Melita palmata* (Ysebaert et al. 2000). However, re-identification of the material showed that the specimens were actually *M. nitida* (VLIZ Alien Species Consortium 2011). Up to now, the species has been recorded from estuaries and ports of the North and Baltic Seas, in Belgium, the Netherlands, Germany and Poland as well as of the Atlantic Ocean (Bay of Biscay), in France (Fig. 3). Regarding vectors responsible for the introduction of *M. nitida* to European waters, the most likely ones are fouling on ship hulls or international oyster transports (Heiman et al. 2008; Reichert & Beermann 2011; Gouillieux et al. 2016). The identification of *M. nitida* may pose some difficulties due to the intraspecific morphological variations as well as nuances in taxonomic characters which allow to distinguish this species from the other American amphipods in the so-called "*Melita nitida* complex" (Chapman 1988; Jarrett & Bousfield 1996; Faasse & van Moorsel 2003; Reichert & Beermann 2011). In its introduced range in Europe, the species may be misidentified when using European identification literature, e.g. Lincoln (1979), and indeed in the past it has been identified as native *Melita palmata* (see Ysebaert et al. 2000) and *Melita pellucida*, now *Allomelita pellucida* (see BioConsult 2009). However, the presence of the group of dorsolateral spines on the second urosome segment is characteristic of *M. nitida* (Faasse & van Moorsel 2003).

Due to the fact that the majority of new introductions to marine waters are vessel-mediated, ports

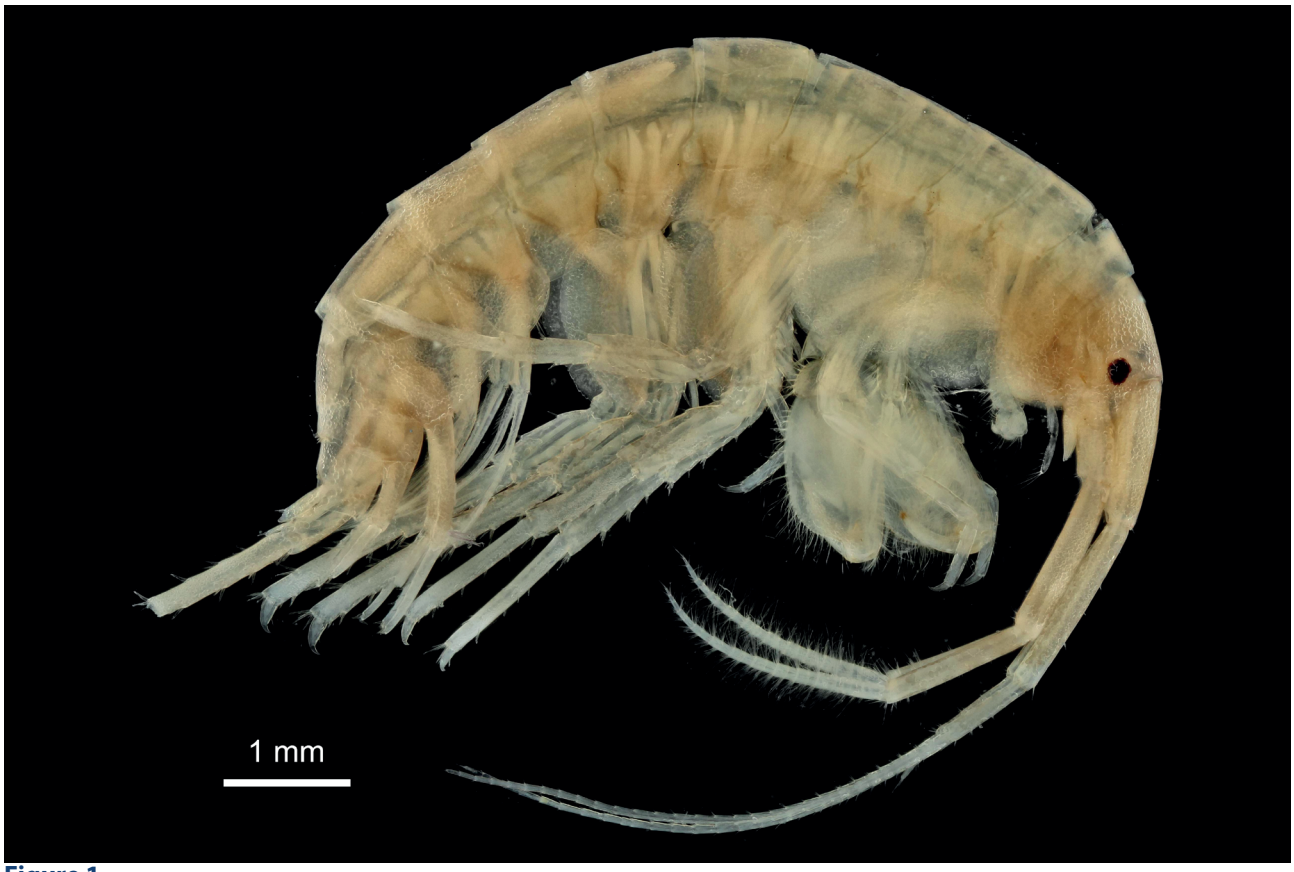

Figure 1

Adult male specimen of *M. nitida* Smith, 1873 collected from the Gulf of Gdańsk in 2014 (Photograph: C. d'Udekem d'Acoz and F. Kerckhof, RBINS)

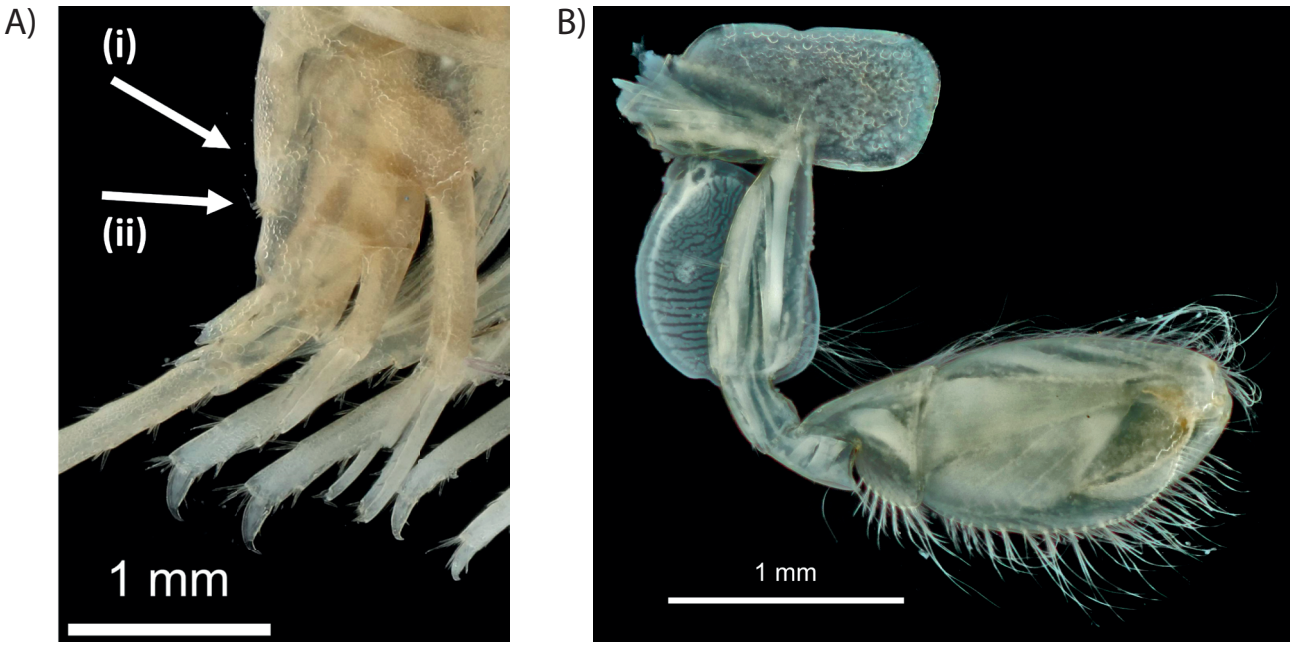

Figure 2

Taxonomic features used for identification of *M. nitida*: (A) the first urosome segment (i) and dorsolateral spines on the second urosome segment (ii), (B) second male gnathopod (Photograph: C. d'Udekem d'Acoz and F. Kerckhof, RBINS)

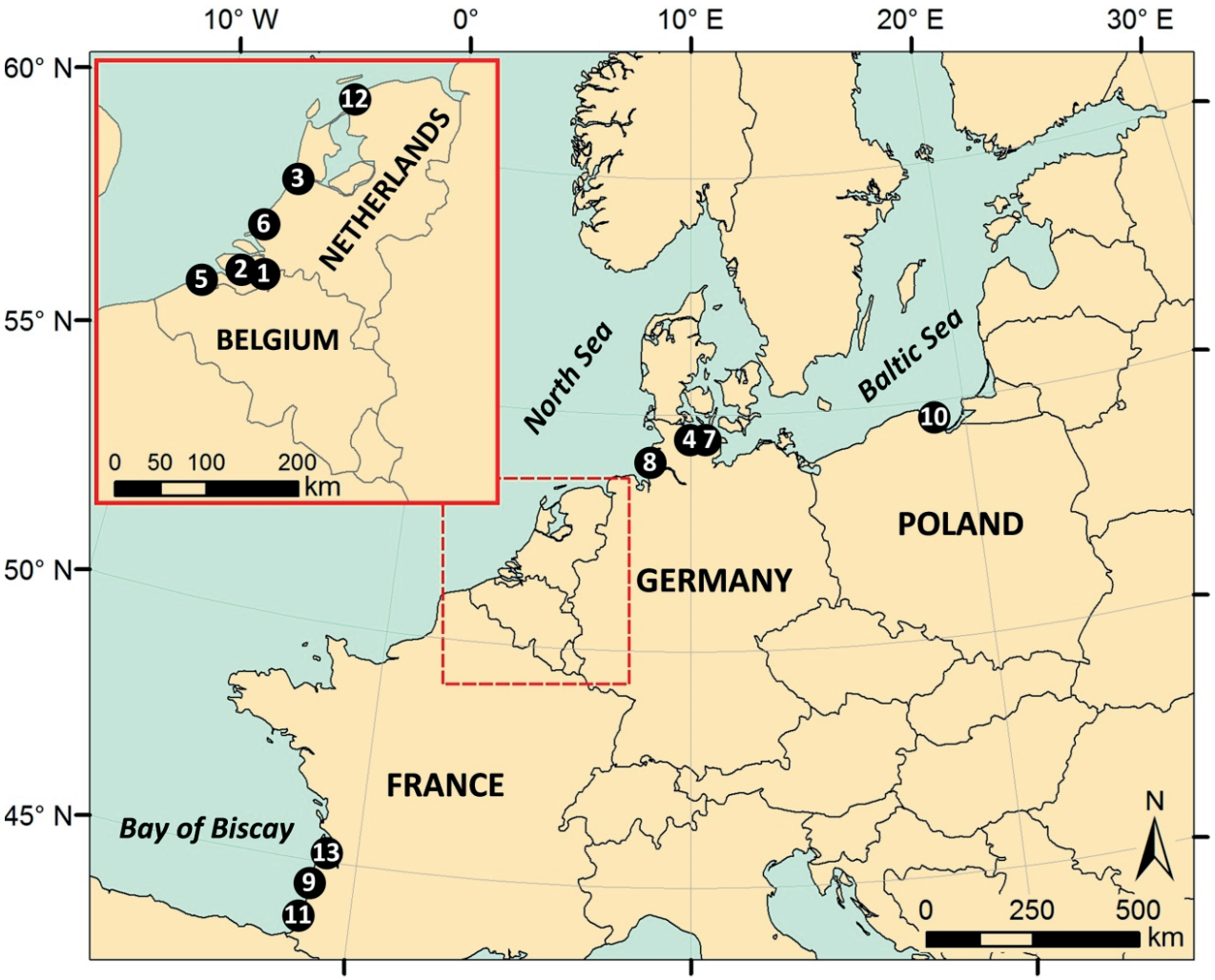

Figure 3

Summary records of *M. nitida* in European coastal waters (chronologically, according to literature and this study; report from Mecklenburg Bay is not included due to lack of detailed data (Lackschewitz et al. 2014)):

1 – 1996, Belgium, Western Scheldt (Ysebaert et al. 2000 – as *M. palmata*), 2 – 1998 and 1999, the Netherlands, Western Scheldt (van Moorsel & Waardenburg 1999 – as *Melita* sp. (Faasse & Moorsel 2003), 3 – 2001 the Netherlands, North Sea Canal, connecting Amsterdam with the North Sea (Munts 2002), 4 – 2008, Germany, Kiel Canal (BioConsult 2009 – as *Melita pellucida*), 5 – 2009, Belgium, harbour of Zeebrugge (Boets et al. 2011), 6 – 2010, the Netherlands, New Waterway, the artificial mouth of the Rhine River connecting Rotterdam with the North Sea (Reichert & Beermann, 2011), 7 – 2010, Germany, Kiel Canal (Reichert & Beermann, 2011), 8 – 2012, Germany, Cuxhaven (Lackschewitz et al. 2014), 9 – 2013, France, Arcachon Bay (Gouillieux et al. 2016), 10 – 2014, Poland, the Gulf of Gdansk, present study, 11 – 2014, France, Hossegor Lake (Gouillieux et al. 2016), 12 – 2014, the Netherlands, Wadden Sea (Gittenberger et al. 2015), 13 – 2016, France, Gironde Estuary (Gouillieux et al. 2016) (Geographic data source: ESRI)

and adjacent regions are often the first regions where introduced species occur (Gollasch et al. 2002; Ojaveer et al. 2014; Lehtiniemi et al. 2015). In Poland, *M. nitida* was found in the Port of Gdynia where numerous vessels, arriving from other ports of the Baltic Sea or the North Sea, discharge ballast water (information on the ship traffic was provided by the Environmental Protection Department, Port of Gdynia Authority SA). These findings allow to conclude that the species was presumably introduced to the Polish coastal waters with commercial maritime transport from the Netherlands/Belgium or/and Germany, but only detailed molecular analyses could provide more reliable information on the source population of *M. nitida*. Unfortunately, there is no regular, nationwide monitoring program for introduced species, either in Polish ports or Polish coastal waters. Implementation of such a program could have led to earlier detection

Table 1

Taxonomic characters to distinguish *M. nitida* from *M. palmata* (Bousfield 1973; Chapman 1988; Jarrett & Bousfield 1996)

Taxonomic character	*M. nitida* Smith, 1873	*M. palmata* Montagu, 1804
antenna 1	accessory flagellum with 2-3 segments	accessory flagellum with 2-4 segments
dorsal teeth on pleon and urosome segments	absent; a group of dorsolateral spines on either side of urosome 2	single tooth on urosome segment 1, two smaller dorsolateral teeth on urosome segment 2
male gnathopod 2		propodus very broad across the distal margin (almost triangular)

of the new species (Lehtiniemi et al. 2015). Therefore, it is highly likely that *M. nitidia* was introduced to Polish waters already before 2014.

The use of different sampling techniques during biological surveys increases the efficiency of finding the introduced species. Therefore, different traps have been developed to attract specific organisms (e.g. Hewitt & McDonald 2013). One of them was a self-made non-baited trap filled with empty oyster shells developed by Fowler et al. (2013). *Melita nitida* was caught in such a trap, previously used in the Polish coastal waters to catch Harris mud crab *Rhithropanopeus harrisii*. Although oysters do not occur in the Polish waters, they were used to provide shelter for small mobile fauna. Previous studies demonstrated that *M. nitida* is commonly associated with oysters in both its native and non-native region (Watling & Maurer 1972; Faasse & van Moorsel 2003; Heiman et al. 2008; Gouillieux et al. 2016). It seems that the species prefers hard substrates, both natural and artificial, which offer crevices, such as reefs of the Pacific oyster *Crassostrea gigas*, boulders, rock fills or asphalt fragments in loose gravel (Chapman 1988; Faasse & van Moorsel 2003; Reichert & Beermann 2011). In the invaded regions of the Pacific Ocean, the species lives between macrophytes, such as *Enteromorpha* spp. or colonial invertebrates, like hydroids or ectoprocts (Chapman 1988). In ports, wharfs and other underwater constructions provide a hard substrate suitable for the development of fouling organisms (both flora and fauna), which in turn provide habitat for many mobile species. In the Port of Gdynia, *M. nitida* may find a shelter in colonies of *Mytilus edulis trossulus* or *Amphibalanus improvisus* or between macrophytes, such as *Cladophora glomerata*, *Ulva* spp. or *Pylaiella littoralis* (Normant-Saremba, unpublished data).

Melita nitida usually co-occurs with other amphipods (Chapman 1988; Faasse & van Moorsel 2003; Reichert & Beermann 2011). In the port of Gdynia, five species belonging to the families Gammaridae ($n = 3$) and Corophiidae ($n = 2$) were identified together

Table 2

Basic ecological characteristic of *M. nitida* Smith, 1873

Factor/Biological process	Species characteristic
Temperature	- distribution shows tolerance of low and high temperatures; individuals found in water up to 32°C (Faasse & van Moorsel 2003)
Salinity	- mesohaline regions of estuaries, in salinities 3-20 PSU, occasionally to 30 PSU (Bousfield 1973)
Substrate	- muddy bottom areas, the species can burrow into soft sediment (Bousfield 1973; Borowsky et al. 1997); - at the base of clumps of hydroids and ectoprocts (Bousfield 1973); - in crevices created by oyster reefs (Watling & Maurer1972; Faasse & van Moorsel 2003; Heiman et al. 2008); - in pen shells *Atrina rigida* (Munguia et al. 2007); - on hard substrates, both natural and artificial, like boulders, rock fills, asphalt fragments in loose gravel (Chapman 1988; Faasse & van Moorsel 2003; Reichert & Beermann 2011)
Nutrition	- consumes epiphytes, seagrass debris and detritus; macrophagy and microphagy were both observed, with the latter occurring most often (Zimmerman et al. 1979); - consumes soft sediment (Borowsky et al. 1997)
Reproduction	- annual life cycle with several broods, ovigerous females occur in May-September, their size is 5.00-8.71 mm, the number of juveniles per female is 5-51 (Bousfield 1973; Borowsky 1980)

with *M. nitida*. Only two of them, *Gammarus salinus* Spooner, 1947 and *Leptocheirus pilosus* Zaddach, 1844, co-occurred earlier with *M. nitida* in Dutch and German waters, respectively (Faasse & van Moorsel 2003; Reichert & Beermann 2011). The native species, *Melita palmata* (Montagu, 1804) has not been found in the traps despite the fact that, according to Faasse & van Moorsel (2003), the species frequently co-occurs with *M. nitida* in Dutch waters. Both species might be distinguished based on the taxonomic characters presented in Table 1. It is worth mentioning that the distribution range of native *M. palmata* in the Gulf of Gdańsk significantly decreased over the last decades. By the end of the 1960s, *M. palmata* was common in the phytal zone of the inner part (Klekot 1980), but in the mid-1970s it was recorded at only one site (Legeżyńska & Wiktor 1981). At that time, a change in the bottom environment caused by the ongoing eutrophication has been observed (Kruk-Dowgiałło 1991; Kruk-Dowgiałło & Szaniawska 2008). Consequently, this led to significant changes in macrozoobenthos communities (Wiktor & Pliński 1992; Szaniawska et al. 1999). During a biological survey in 2007, *M. palmata* was not recorded in the inner part of the Gulf of Gdańsk (Janas & Kendzierska 2014). This species was found only at the Polish open sea coast (Gic-Grusza et al. 2009). It seems that *M. palmata* is sensitive to anthropogenic changes in the environment – it was classified as a sensitive taxon in the assessment of the ecological quality status of the Polish waters according to the EU Water Framework (Osowiecki et al. 2012). This may also be a reason why it was not found in the Port of Gdynia. In general, ports being under strong anthropogenic pressure (e.g. vessel traffic, noise, and pollutants) create specific living conditions which may disrupt functioning of some native species, at the same time favoring exotic species which are known to be more tolerant of adverse conditions (Stachowicz et al. 1999; Piola & Johnston 2008; Crooks et al. 2011).

Melita nitida is an eurythermal and euryhaline species (Table 2), more tolerant of lower salinities than native *M. palmata* (Jażdżewski & Konopacka 1995; Faasse & van Moorsel 2003). Moreover, contrary to *M. palmata* which rather prefers sheltered, sandy bottoms where silt is deposited (Żmudziński 1982; Lincoln 1979; Jażdżewski & Konopacka 1995; Gic-Grusza et al. 2009), the North American species occurs frequently also on muddy substrates (Table 2) and it may live deeper (Faasse & van Moorsel 2003). The Polish location is now the most eastern locality for *M. nitida* in Europe and can be a stepping stone to further colonization of the brackish Baltic Sea by this species. Based on the ecological characteristics of *M. nitida* (Table 2), it can be assumed that this amphipod has a high potential for successful invasion of the Baltic Sea and adjacent mesohaline waters, such as lagoons and estuaries. Moreover, it may also replace native *M. palmata*, especially in habitats being under anthropogenic pressure. The introduction of non-native species may lead to changes in local biodiversity as well as to modification of the ecosystem structure and functioning (Ojaveer & Kotta 2015). It is known that *M. nitida* is a herbivorous and detritivorous species that may form the base of fish food chains (Zimmerman et al. 1979; Borowsky et al. 1997). The available literature does not provide evidence for negative impacts of this amphipod, but of course this may vary depending on the invaded regions. For this reason and in the context of the EU Marine Strategy Framework Directive (Ojaveer et al. 2014), further research on this species is required to monitor its spatial distribution and trends in abundance as well as to evaluate the impacts on the colonized ecosystem.

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