Rapid Communication

First record of the Japanese cumacean *Nippoleucon hinumensis* (Gamô, 1967) (Crustacea: Cumacea: Leuconidae) from Europe

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Abstract

The cumacean *Nippoleucon hinumensis* was recorded for the first time in Europe during a national monitoring survey of macrozoobenthos in the German Baltic Sea in April 2019. In total, five female individuals were found in the Strelasund near Stralsund, Germany. *Nippoleucon hinumensis* is native to the northwest Pacific and a successful invader of the American west coast since the 1970s. Since ovigerous females were detected among the collected individuals, *N. hinumensis* might have already reproduced successfully in the Baltic Sea.

Key words: non-indigenous species, alien species, Baltic Sea, brackish water, inner coastal waters

Introduction

The Baltic Sea exhibits a naturally low species diversity due to its brackish water conditions and young geological age. Its unique mixture of marine, brackish, and freshwater species is constantly exposed to the increasing introduction of non-native species. The number of alien species in the Baltic has grown rapidly in the past hundred years, closely associated with the increase of global shipping traffic (Leppäkoski et al. 2002; Gollasch 2006; Berezina et al. 2011).

In the southern and southwestern Baltic Sea, at least two introduction pathways intersect: on one side is the nearby Szczecin Lagoon, where species from the Pontic-Caspian region have been introduced through anthropogenic waterways. On the other side, the introductions occur from the adjacent North Sea and Northeast Atlantic through the Danish Straits, and even more importantly through the Kiel Canal (Panov et al. 2009). Additionally, other anthropogenic pressures such as man-made construction activities and pollution worsen environmental conditions for indigenous species, leading to a greater chance for non-natives to establish and maintain populations (e.g. Piola and Johnston 2008).

Crustaceans are one of the most successful groups of aquatic invaders, affecting native species and ecosystems in many ways (Hänfling et al. 2011). Currently, approximately 25 species of non-native crustaceans (none of them cumaceans) are known from the southern and southwestern Baltic Sea (Jażdżewski and Grabowski 2011; Lackschewitz et al. 2015; Zettler et al. 2018; Neobiota-Plattform 2019). Two recent examples are the Asian crab *Hemigrapsus takanoi* Asakura and Watanabe, 2005 (Geburzi et al. 2015) and the amphipod *Grandidierella japonica* Stephensen, 1938 (IfAÖ 2016; Zettler and Zettler 2017). The latter spread and established populations along the coast of Mecklenburg-Western Pomerania within the past four years (IfAÖ 2019; IfAÖ *unpublished data*).

During national monitoring surveys along the inner coast of the German Baltic Sea (Mecklenburg-Western Pomerania), the non-native cumacean *Nippoleucon hinumensis* (Gamô, 1967) was found. This species is native to Japan and Korea, where it inhabits coastal bays and estuaries (Lee and Lee 2003). It has been introduced to the Pacific coast of North America in the 1970s and is known to have great potential for invading brackish coastal regions (Fofonoff et al. 2018).

In this study, we report the first find of *N. hinumensis* in Europe and its identification characteristics in order to facilitate determination of this species in the future. Moreover, we review possible introduction pathways, as well as the species invasion potential.

Materials and methods

Study area and sampling

Macrozoobenthos of soft-bottom habitats was investigated at 15 locations in coastal waters of Mecklenburg-Western Pomerania (Baltic Sea, Germany) from Wismar Bay in the west to Szczecin Lagoon in the east (Figure 1). Seven locations were investigated with a van Veen grab. At eight locations, specimen collection was conducted by a scientifically qualified diver using a metal sampling frame measuring 33 cm × 33 cm with an attached net bag (mesh size: 0.5 mm). Sediment within the frame was carefully collected to a depth of 10 cm, and transferred into the net bag. Afterwards, the samples were preserved in 4% formalin. At every location, the main habitat of the local water bodies was investigated. For this purpose, ten representative samples were taken along a transect. The length of these transects differed, depending on local conditions such as depth range, exposition and colonisation, according to the instructions for the MarBIT evaluation procedure. For salinity determination, the practical salinity scale was used.

Identification of examined material

In the laboratory, all benthic organisms were sorted under a dissection microscope. Specimens of *N. hinumensis* were identified using a stereomicroscope (Olympus SZX10) and a light microscope (Olympus BX51).

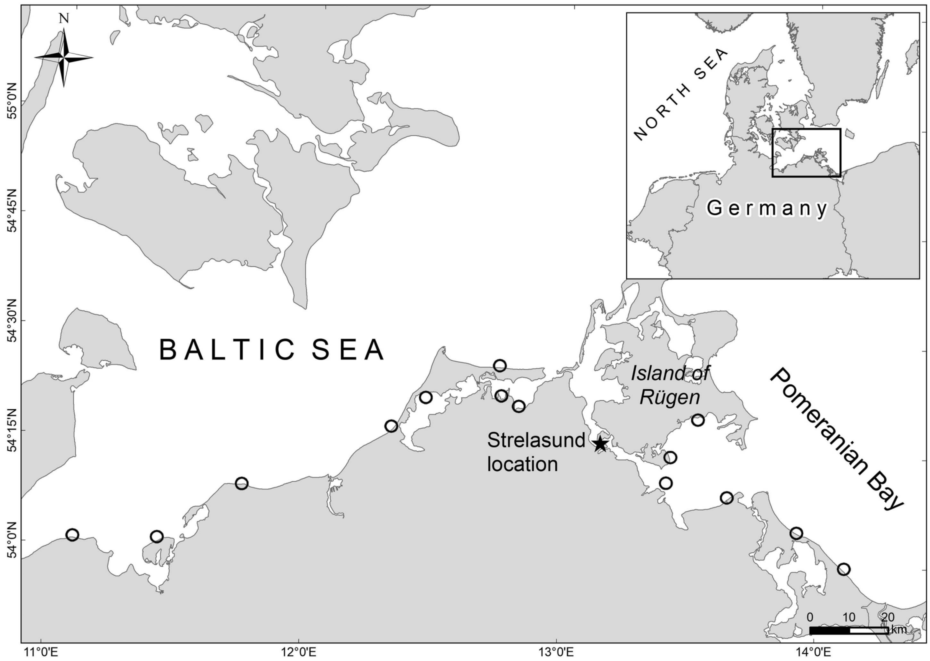

Figure 1. Location of the find of Nippoleucon hinumensis in the Strelasund, Baltic Sea in April 2019. Small map displays the general geographical location of the investigated area in the southwestern Baltic Sea. Large detail map shows the sampling locations along the coast of Mecklenburg-Western Pomerania. Black star: Sampling location of *N. hinumensis*. Circles: Sampling locations without records of *N. hinumensis*. Scale bar: 20 km. For details see Supplementary material Table S1.

For species identification, the characters given in Sars (1899), Jones (1957a), Jones (1957b), Jones (1957c), Gamô (1967), Jones (1976), Watling (1991), Lee and Lee (2003), Lee and Lee (2006), and Hiebert (2015) were used. All individuals of *N. hinumensis* were stored in 70% ethanol in the species collection of the Institute for Applied Ecosystem Research in Neu Broderstorf (catalogue number: SBRO-C 37156).

Photos were taken with an Olympus microscope camera (UC 30) and morphological measurements were conducted using the Olympus CellSens Dimension program, version 1.4.1. Body length was measured from the anterior tip of carapace to the last abdominal segment. All figures and maps were arranged and labelled using the software Gimp 2.10.8 and ArcGIS version 10.6.1.

Results

On 26 April 2019, at the Strelasund location near Stralsund, Germany, a total of five female individuals of *Nippoleucon hinumensis* were found. Three of the individuals were brooding. Male individuals have not been found.

The Strelasund is a sound which separates the island of Rügen from the mainland. Water depth of the ten sample sites at Strelasund location varied between 4.7 m and 5.5 m. Water temperature was 13–14 °C, and salinity approximately 8. The substrate was characterized by muddy sediment with detritus. *Nippoleucon hinumensis* was found in four out of ten sample sites, which are located along a transect of about 200 meters.

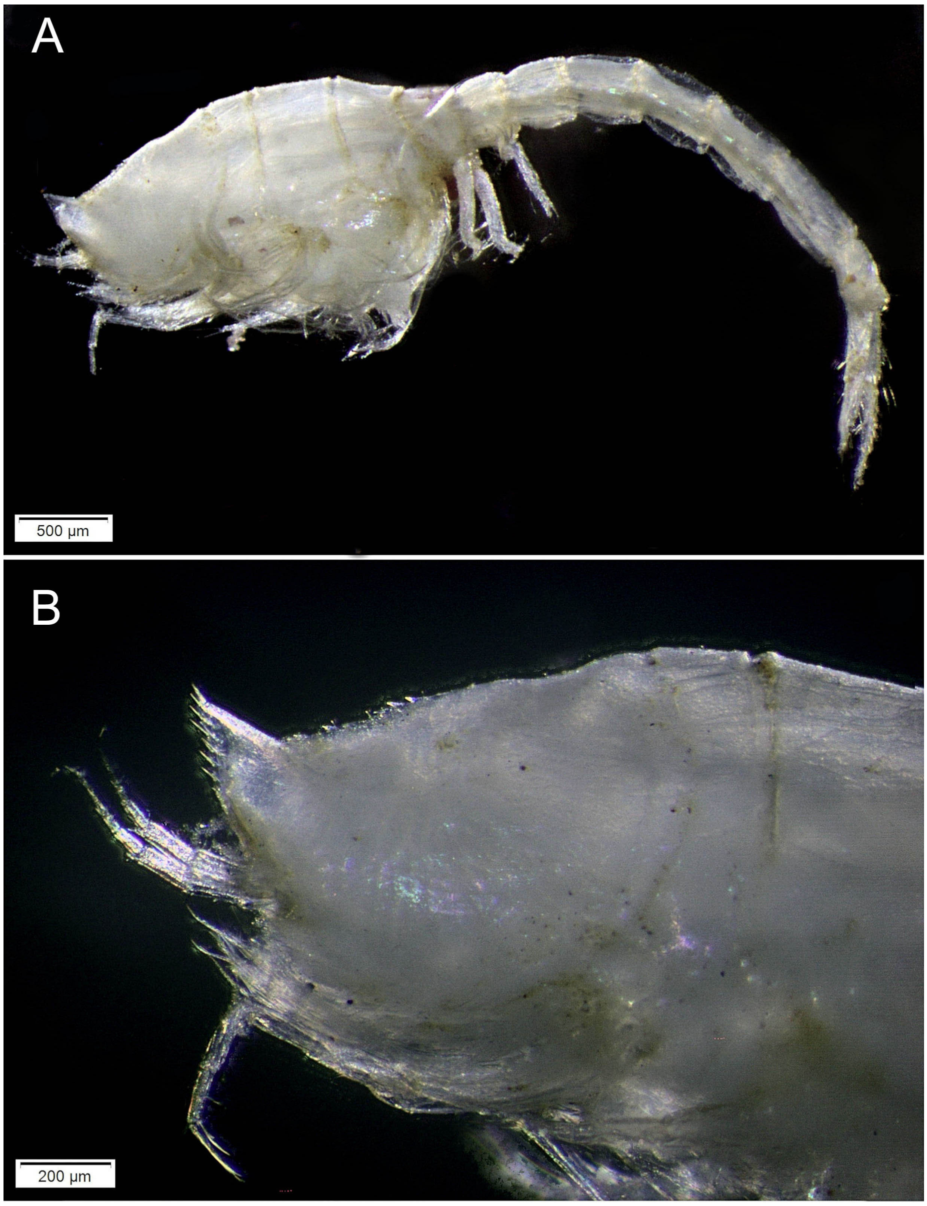

Figure 2. *Nippoleucon hinumensis*, female collected in the Strelasund, Baltic Sea in April 2019: A) habitus lateral view, scale bar 500 µm; B) carapace region lateral view, scale bar 200 µm. Photographs by J. Leitinger.

Description of the species

Based on adult female, 5.27 mm body length (Figure 2A).

Carapace smooth, without lateral ridges or carinae (Figure 2B). Dorso-median crest on the anterior part of the carapace, irregularly serrated with approximately eight teeth on the anterior end, reaching half of carapace. Behind the crest a small depression near the posterior end of carapace. Carapace length approximately one-fifth of total body length, shape nearly triangular in dorsal view. Ocular lobe without visible pigment. Pseudorostrum abruptly upturned at an angle of approximately 120 degrees. Efferent orifice directed to the anterior. Wide antennal notch with a tooth at the anterolateral corner. Lower margin of the carapace slightly serrate.

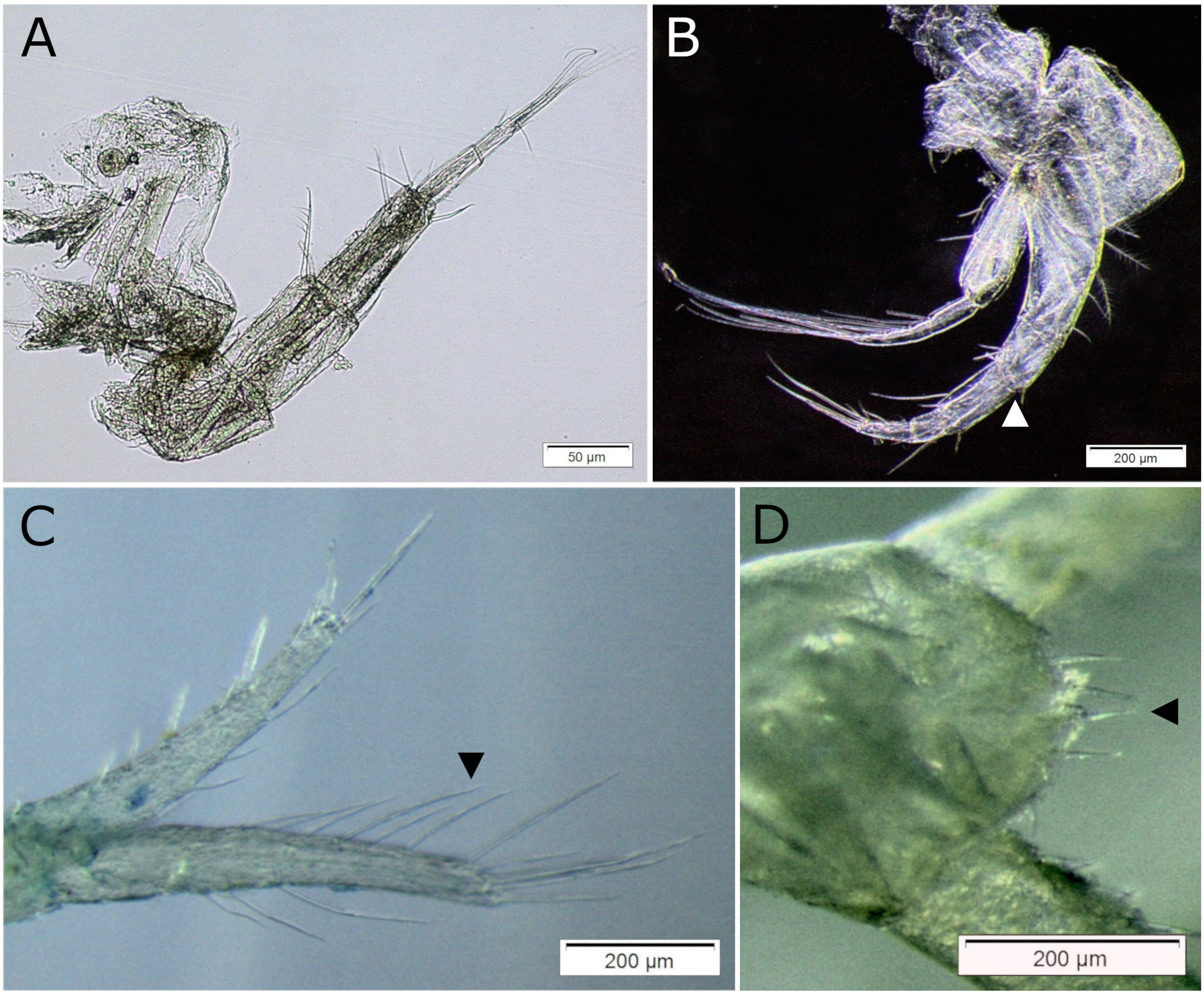

Figure 3. *Nippoleucon hinumensis*, female collected in the Strelasund, Baltic Sea in April 2019: A) antenna 1 detail, scale bar 50 µm; B) pereopod 2 detail with short ischium visible (arrow), scale bar 200 µm; C) left uropod detail with simple setae on inner margin of uropodal exopod visible (arrow), scale bar 200 µm; D) last abdominal segment detail with four terminal setae visible (arrow), scale bar 200 µm. Photographs by J. Leitinger.

Length of free thorax segments approximately one-third of total length, second segment largest. Length of pleon approximately half the total body length. No free telson.

First antennae not geniculate (Figure 3A). Three segments of the peduncle nearly subequal in length. Third maxilliped and first three pereopods with exopods. Pereopods four and five without exopods. Second pereopod ischium much shorter than wide (Figure 3B).

Uropodal endopod biarticulate (Figure 3C). Uropodal exopod approximately 1.2 times as long as uropodal endopod. Six simple setae on inner margin and five simple setae at distal part of uropodal exopod (Figure 3C, arrow). Four short terminal setae on last pleon segment (Figure 3D).

Remarks

In general, taxonomic determination in cumaceans can be difficult due to sexual dimorphism, since both male and female individuals are needed for a most reliable identification. For instance, in commonly applied identification keys, the genus *Nippoleucon* can be distinguished from the closely resembling genus *Leucon* (Gamô 1967; Watling 1991) by male characters only. Since all individuals in the present study are females, additional characters were included (see below). Regarding these characters, the Strelasund specimens can be identified as *Nippoleucon hinumensis*.

Species discrimination of *N. hinumensis* from the other described *Nippoleucon* Watling, 1991 species *N. enoshimensis* (Gamô, 1967) and *N. projectus* (Lee & Lee, 2006) is based on the following female characters (for comparison see Lee & Lee 2006; table 1):

(1) exopod of uropod approximately 1.2 times longer than endopod (longer or shorter in other species);
(2) six simple setae on inner margin of uropodal exopod (in other species number differs);
(3) serrated crest present (absent in other species or only three teeth);
(4) four short setae of last pleon segment (other species two short or four long setae);
(5) body length can reach 5.27 mm (other species smaller).

The taxon Leuconidae is characterized by the absence of an independent telson, pereopods 1–3 with well-developed but 4 and 5 without exopods, inner ramus of uropod two-segmented and absence of visible eyes (Jones 1976; Shalla 2011). There are six leuconid species listed for the Baltic Sea in HELCOM (2012): *Eudorella emarginata* (Krøyer, 1846), *Eudorella truncatula* (Bate, 1856), *Eudorellopsis deformis* (Krøyer, 1846), *Leucon fulvus* Sars, 1865, *Leucon nasica* (Krøyer, 1841) and *Leucon acutirostris* Sars, 1865. None of these six mentioned species occur in inner coastal waters of the southwestern Baltic Sea near Rügen (Köhn and Gosselck 1989; HELCOM 2012), so confusion with indigenous species is not likely to occur.

The genera *Eudorella* Norman, 1867 and *Eudorellopsis* Sars, 1882 can easily be differentiated from the genus *Nippoleucon* in the following respects: efferent orifice distinctly dorsal and pseudorostrum curved backward and directed dorsally (Watling 1991).

Considering all available information, the characters to distinguish *Nippoleucon hinumensis* females from females of European species of the genus *Leucon* Krøyer, 1846 are (compare Sars 1899; Shalla and Bishop 2004):

(1) uropodal exopod inner margin with simple setae (European *Leucon* species have plumose setae);
(2) uropodal exopod approximately 1.2 times as long as uropodal endopod (European *Leucon* species have a longer or shorter exopod);
(3) dorsal serrated crest irregularly toothed and confined to anterior half of carapace (longer or regularly toothed in European *Leucon* species);
(4) presence of four setae on last pleon segment (none in European *Leucon* species);
(5) form of carapace stouter, less elongate than in European *Leucon* species.

Discussion

Generally, Leuconidae are known to be marine species with a preference towards deeper water and are found on the open coastal shelf and slope (Cadien 2006; Shalla 2011). In contrast, *N. hinumensis* occurs in bays and estuaries, as it tolerates a wide range of salinities and temperatures (Lee et al. 2003; Akiyama and Yamamoto 2004). The species can be found in oligohaline waters with a salinity down to 0.7, unlike most of its closer related taxa (Lee et al. 2003). This indicates that low salinity conditions may not be a limiting factor for a further spread into the Baltic Sea, the world's largest brackish water body.

Nippoleucon hinumensis usually lives buried in soft bottom sediment and is known to be a member of disturbed harbour communities (Cadien 2006). During mating season, *N. hinumensis* forms abundant swarms in the water column (Fofonoff et al. 2018). The small body size and planktic mating behaviour indicate that *N. hinumensis* could have been introduced by ballast water. This is further reinforced by the fact that other cumacean species have been found in ballast water tanks before (Gollasch et al. 2002; Humphrey 2008). On the other hand, this may also be an exception since species lists in other ballast water investigations did not contain cumaceans (e.g. Gollasch et al. 2000; Olenin et al. 2000), that are typically benthic organisms. Moreover, the species has been observed in sediment accumulating on artificial hard substrate such as fouling plates (Fairey et al. 2002) and vessels (Fofonoff et al. 2018). Thus, fouling on ship's hulls cannot be excluded as alternative option of transport.

Successful reproduction of *N. hinumensis* in the Baltic Sea is likely. The finding of three ovigerous females and the absence of males on 26 April is noteworthy. In its natural distribution area, late April is the time for *N. hinumensis* females to incubate their second brood. Moreover, this is the time when males have almost disappeared, most probably due to synchronized mating (Akiyama and Yamamoto 2004; Hiebert 2015). It is unclear if the mating cycle is similar in the non-native range of the species.

Even under unfavourable environmental conditions, e.g. during dry and warm periods, *Nippoleucon hinumensis* is known to reach very high abundances in introduced regions (Hiebert 2015; Fofonoff et al. 2018). The production of lipid droplets in the body cavity can serve as an energy resource during periods of low food availability and even enables the animals to endure high water temperatures by diapausing (Akiyama and Yamamoto 2004). The storing of semen after mating allows the production of a second, third or even fourth brood in a year, whereas most cumacean species in temperate shallow waters incubate two broods (Akiyama and Yamamoto 2004; Jones 1976). These special adaptations ensure its survival and may bring *N. hinumensis* considerable long-term advantages over indigenous cumacean species like *Diastylis rathkei* Krøyer, 1841 that only breeds once a year (Jones 1976). Consequently, the species has a certain potential for rapid reproduction and spreading in the southwestern Baltic.

The inner coastal waters of the southern Baltic differ significantly from outer coastal waters with respect to salinity as the most important factor, but also trophic conditions and exposition, which lead to specific inner coastal biocenosis (Meyer et al. 2008). Lagoons, estuaries and coastal inlets are characterized by oligo- and mesohaline conditions, reduced exchange of water and introduction of polluted and eutrophic fresh water (Meyer et al. 2008). In these aspects, the Baltic inner coastal waters are similar to the native area of *N. hinumensis* and the invaded area in North America, which makes an establishment of this species likely.

In its invaded North American distribution area, no negative impacts on indigenous species by *N. hinumensis* have been observed so far (Fofonoff et al. 2018). The ways in which *N. hinumensis* will influence the area in the Southern Baltic that is naturally species-poor and disturbed by anthropogenic impacts need to be clarified. Since no native leuconid species occur in this area (Köhn and Gosselck 1989; HELCOM 2012; Zettler et al. 2018), high densities of *N. hinumensis* may have an effect on the food web as prey item for fish and invertebrates as it is described for North America (Howe et al. 2014).

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References

Akiyama T, Yamamoto M (2004) Life history of *Nippoleucon hinumensis* (Crustacea: Cumacea: Leuconidae) in Seto Inland Sea of Japan. 1. Summer diapause and molt cycle. *Marine Ecology Progress Series* 284: 211–225, https://doi.org/10.3354/meps284211

Berezina NA, Petryashev VV, Razinkovas A, Lesutienė J (2011) Alien malacostracan crustaceans in the eastern Baltic Sea: pathways and consequences. In: Galil BS, Clark PF, Carlton JT (eds), In the wrong place - alien marine crustaceans: distribution, biology, and impacts. Volume 6. Springer Science & Business Media, Dordrecht, Heidelberg, London, New York, pp 301–322, https://doi.org/10.1007/978-94-007-0591-3

Cadien DB (2006) Cumacea of the NEP: equator to Aleutians and intertidal to the abyss Part 1. Introduction and general comments. Southern California Association of Marine Invertebrate Taxonomists SCAMIT. https://www.scamit.org/tools/ (accessed 03 September 2019)

Fairey R, Dunn R, Roberts C, Sigala M, Oliver J (2002) Introduced aquatic species in California Coastal Waters, Final Report. Appendix A. In: Ashe ME (ed) (2002) Report to the Legislature: A Survey of Non-Indigenous Aquatic Species in the Coastal and Estuarine Waters of California. California Department of Fish and Game, Office of Oil Spill Prevention and Response, Sacramento, CA, 116 pp

Fofonoff PW, Ruiz GM, Steves B, Simkanin C, Carlton JT (2018) National Exotic Marine and Estuarine Species Information System. http://invasions.si.edu/nemesis/ (accessed 03 September 2019)

Gamô S (1967) Studies on the cumacea (Crustacea, Malacostraca) of Japan. Part 1. *Publications of the Seto Marine Biological Laboratory* 15: 133–163, https://doi.org/10.5134/175460

Geburzi JC, Graumann G, Köhnk S, Brandis D (2015) First record of the Asian crab *Hemigrapsus takanoi* Asakura & Watanabe, 2005 (Decapoda, Brachyura, Varunidae) in the Baltic Sea. *BioInvasion Records* 4: 103–107, https://doi.org/10.3391/bir.2015.4.2.06

Gollasch S (2006) Overview on introduced aquatic species in European navigational and adjacent waters. *Helgoland Marine Research* 60: 84–89, https://doi.org/10.1007/s10152-006-0022-y

Gollasch S, Rosenthal H, Botnen H, Hamer J, Laing I, Leppäkoski E, MacDonald E, Minchin D, Nauke M, Olenin S, Utting S, Voigt M, Wallentinus I (2000) Fluctuations of zooplankton taxa in ballast water during short-term and long-term ocean-going voyages. *International Review of Hydrobiology* 85: 597–608, https://doi.org/10.1002/1522-2632(200011)85:5/6<597::AID-IROH597>3.0.CO;2-4

Gollasch S, MacDonald E, Belson S, Botnen H, Christensen JT, Hamer JP, Houvenaghel G, Jelmert A, Lucas I, Masson D, McCollin T, Olenin S, Persson A, Wallentinus I, Wetsteyn LPMJ, Wittling T (2002) Life in Ballast Tanks. In: Leppäkoski E, Gollasch S, Olenin S (eds), Invasive Aquatic Species of Europe. Distribution, Impacts and Management. Kluwer, Dordrecht/Boston/London, pp 217–231, https://doi.org/10.1007/978-94-015-9956-6

Hänfling B, Edwards F, Gherardi F (2011) Invasive alien Crustacea: dispersal, establishment, impact, and control. *BioControl* 56: 573–595, https://doi.org/10.1007/s10526-011-9380-8

HELCOM (2012) Checklist of Baltic Sea Macro-species. Baltic Sea Environment Proceedings No. 130, Helsinki, Finland, 203 pp

Hiebert TC (2015) *Nippoleucon hinumensis*. In: Hiebert TC, Butler BA, Shanks AL (eds), Oregon Estuarine Invertebrates: Rudys' illustrated guide to common species, 3rd edn. University of Oregon Libraries and Oregon Institute of Marine Biology, Charleston, OR, pp 470–475

Howe ER, Simenstad CA, Toft JD, Cordell JR, Bollens SM (2014) Macroinvertebrate prey availability and fish diet selectivity in relation to environmental variables in natural and restoring north San Francisco Bay tidal marsh channels. *San Francisco Estuary and Watershed Science* 12: 1–46, https://doi.org/10.15447/sfews.2014v12iss1art5

Humphrey DB (2008) Characterizing ballast water as a vector for nonindigenous zooplankton transport. PhD Thesis, University of British Columbia, Vancouver, Canada, 92 pp

IfAÖ (2016) Makrozoobenthos-Monitoring in Mecklenburg-Vorpommern (2015) Beprobung und Bewertung der inneren Küstengewässer in M-V mit dem MarBIT-Verfahren im Rahmen der Wasserrahmenrichtlinie. Ergebnisbericht. Institut für Angewandte Ökosystemforschung GmbH (Neu Broderstorf). Im Auftrag des Landesamtes für Umwelt, Naturschutz und Geologie Mecklenburg-Vorpommern

IfAÖ (2019) Erfassung und Bewertung nicht einheimischer Arten - Neobiota in Küstengewässern Mecklenburg-Vorpommerns. Endbericht 2018 im Auftrag des Landesamtes für Umwelt, Naturschutz und Geologie Mecklenburg-Vorpommern, 50 pp

Jażdżewski K, Grabowski M (2011) Alien crustaceans along the southern and western Baltic Sea. In: Galil BS, Clark PF, Carlton JT (eds), In the wrong place - alien marine crustaceans: distribution, biology, and impacts. Volume 6. Springer Science & Business Media, Dordrecht, Heidelberg, London, New York, pp 323–344, https://doi.org/10.1007/978-94-007-0591-3

Jones NS (1957a) Cumacea. Key to families and references. Fiches d'Identification du Zooplancton 71. Conseil International pour l'Exploration de la Mer, Kopenhagen

Jones NS (1957b) Cumacea. Figures. Fiches d'Identification du Zooplancton 72. Conseil International pour l'Exploration de la Mer, Kopenhagen

Jones NS (1957c) Cumacea. Family: Leuconidae. Fiches d'Identification du Zooplancton 74. Conseil International pour l'Exploration de la Mer, Kopenhagen

Jones NS (1976) British cumaceans. Arthropoda: Crustacea. Keys and notes for the identification of the species. Synopses of the British Fauna No. 7. Linnean Society of London, Academic Press, London, New York, 63 pp

Köhn J, Gosselck F (1989) Bestimmungsschlüssel der Malakostraken der Ostsee. Mitteilungen aus dem Museum für Naturkunde in Berlin. *Zoologisches Museum und Institut für Spezielle Zoologie (Berlin)* 65: 3–114, https://doi.org/10.1002/mmnz.4830650102

Lackschewitz D, Reise K, Buschbaum C, Karez R (2015) Neobiota in deutschen Küstengewässern - Eingeschleppte und kryptogene Tier-und Pfanzenarten an der deutschen Nord- und Ostseeküste. Kiel, LLUR SH, 216 pp

Lee C-M, Lee K-S (2003) A new record of genus *Nippoleucon* (Cumacea: Leuconidae) from Korea. *The Korean Journal of Systematic Zoology* 19(2): 257–265

Lee C-M, Lee K-S (2006) *Nippoleucon projectus*, a new species of leuconid cumaceans (Cumacea, Leuconidae) from Korea. *Integrative Biosciences* 10: 93–101, https://doi.org/10.1080/17386357.2006.9647288

Lee H, Thompson B, Lowe S (2003) Estuarine and scalar patterns of invasion in the soft-bottom benthic communities of the San Francisco Estuary. In: Pederson J (ed), Marine Bioinvasions: Patterns, Processes, and Perspectives. Springer, Dordrecht, The Netherlands, pp 85–102, https://doi.org/10.1007/978-94-010-0169-4_8

Leppäkoski E, Gollasch S, Olenin S (eds) (2002) Invasive aquatic species of Europe - Distribution, Impacts, and Management. Kluwer, Dordrecht/Boston/London, 584 pp, https://doi.org/10.1007/978-94-015-9956-6

Meyer TH, Berg T, Fürhaupter K (2008) Ostsee-Makrozoobenthos - Klassifizierungssystem für die Wasserrahmenrichtlinie. Referenz-Artenlisten, Bewertungsmodell und Monitoring. Im Auftrag des Instituts für Aquatische Ökologie Universität Rostock, MariLim, 130 pp

Neobiota-Plattform (2019) Neobiota-Plattform Nord- und Ostsee - Informationen der Blano Fach-AG Neobiota. https://www.neobiota-plattform.de/ (accessed 03 September 2019)

Olenin S, Gollasch S, Jonušas S, Rimkutė I (2000) En-route investigations of plankton in ballast water on a ship's voyage from the Baltic Sea to the open Atlantic coast of Europe. *International Review of Hydrobiology* 85: 577–596, https://doi.org/10.1002/1522-2632(200011)85:5/6<577::AID-IROH577>3.0.CO;2-C

Panov VE, Alexandrov B, Arbačiauskas K, Binimelis R, Copp GH, Grabowski M, Lucy F, Leuven RSEW, Nehring S, Paunovic M, Semenchenko V, Son MO (2009) Assessing the risks of aquatic species invasions via European inland waterways: from concepts to environmental indicators. *Integrated Environmental Assessment and Management* 5: 110–126, https://doi.org/10.1897/IEAM_2008-034.1

Piola RF, Johnston EL (2008) Pollution reduces native diversity and increases invader dominance in marine hard-substrate communities. *Diversity and Distributions* 14: 329–342, https://doi.org/10.1111/j.1472-4642.2007.00430.x

Sars GO (1899) An account of the crustacea of Norway: with short descriptions and figures of all the species. Vol. 3 Cumacea. Alb. Cammermeyers Forlag, Christiania, 115 pp

Shalla SH (2011) Cumacea - Identification guide to British cumaceans. NMBAQC 2010 taxonomic workshop, Dove Marine Laboratory, 46 pp

Shalla SH, Bishop JD (2004) Four new species of the genus *Leucon* (Crustacea: Cumacea) from the Atlantic Frontier Margin. *Journal of the Marine Biological Association of the United Kingdom* 84: 139–153, https://doi.org/10.1017/S0025315404009002h

Watling L (1991) Revision of the cumacean family *Leuconidae*. *Journal of Crustacean Biology* 11: 569–582, https://doi.org/10.2307/1548527

Zettler ML, Zettler A (2017) Marine and freshwater Amphipoda from the Baltic Sea and adjacent territories, 2nd edn. Conchbooks, Hackenheim, 845 pp

Zettler ML, Beermann J, Dannheim J, Ebbe B, Grotjahn M, Günther C-P, Gusky M, Kind B, Kröncke I, Kuhlenkamp R, Orendt C, Rachor E, Schanz A, Schröder A, Schüler L, Witt J (2018) An annotated checklist of macrozoobenthic species in German waters of the North and Baltic Seas. *Helgoland Marine Research* 72: 5, https://doi.org/10.1186/s10152-018-0507-5

Supplementary material

The following supplementary material is available for this article:

Table S1. Details of locations of finds of *Nippoleucon hinumensis*.

This material is available as part of online article from:
http://www.reabic.net/journals/bir/2020/Supplements/BIR_2020_Schuler_etal_Table_S1.xlsx