

A New Transoceanic Invasion? First Records of *Neomysis americana* (Crustacea: Mysidae) in the East Atlantic

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Abstract: First records in the East Atlantic are reported for the North-West Atlantic endemic mysid *Neomysis americana* (S. I. Smith, 1873), previously known as an invader of South-West Atlantic coasts. Two specimens were caught in 2010 in coastal waters of The Netherlands. The new records provide the first evidence for a west to east transfer of a mysid species across the Atlantic, whereas previously published transfers were observed only in the opposite direction. Major diagnostic characters are reconsidered and the validity of the European species of *Neomysis* and *Acanthomysis* is discussed. A pictorial key to these species is given to facilitate future assessments of potential range expansions of *N. americana*.

Keywords: *Acanthomysis*, East Atlantic neozoans, Key to species, *Neomysis*, The Netherlands, Transoceanic expansion, West Atlantic endemics.

INTRODUCTION

There is currently great concern about the rapid invasion of the Ponto-Caspian mysid *Hemimysis anomala* G.O. Sars into the aquatic biota of North America, due to possible detrimental effects as a predator of zooplankton, especially of daphniids [1]. This species lives in fresh- to brackish waters and may have crossed the Atlantic in ballast water of transoceanic ships. A likely scenario involves the busy transoceanic harbors on the coast of the Netherlands, where it was first recorded in 1997 [2]. Less commonly known is the case of the marine euryhaline, North-East Atlantic endemic *Praunus flexuosus* (O.F. Müller): it first appeared in about 1960 on the east coast of North America [3], possibly also mediated by ballast water [4]. The present contribution provides the first indication of a successful transfer of a mysid species in the opposite direction. Nonetheless, evidence of a potential long-term establishment in European waters is still lacking. A profound knowledge of the local endemics is essential for reliable classification of any newly recorded species as non-indigenous. Therefore, the major diagnostic characters and the taxonomic validity of the European relatives are reconsidered with respect to the new immigrant. A pictorial key to these species is given to facilitate future assessments of potential adventive species and their range expansions.

MATERIAL AND METHODS

As part of the ecological monitoring of a beach-nourishment project on the Wadden Sea island of Ameland on the north coast of The Netherlands, benthic samples were taken on the North Sea coasts of two islands, Ameland and to the east Schiermonnikoog. The sea side of Schiermonnikoog is characterized by an exposed, barred dissipative beach [5] with two subtidal bar-troughs. The sediment is fine, well-sorted sand with a median grain size between 230 and 240 μm . The beach is considered pristine, i.e. with no nourishment (sand supply from elsewhere) history. Samples were taken with van Veen grabs – normally not well suited to capture hyperbenthic organisms such as mysids.

Salinity (S) is expressed as a dimensionless equivalent of electric conductivity. Body length was measured from the tip of the rostrum to the terminal margin of the telson without spines. Dissected parts were mounted in a bleaching medium (Swan medium [6]) on slides. Examined materials belong to the introduced species *Neomysis americana* (Dutch specimens and comparable specimens from various locations in North America) and the native species *Neomysis integer* and *Acanthomysis longicornis*, with which it is most likely to be confounded in Europe. The materials were deposited at the NCB Naturalis (Netherlands Centre for Biodiversity; reg. nos. RNMH.CRUS.E.3779 to RNMH.CRUS.E.3783) and the Natural History Museum of Vienna (22995, 25447-25450):

Neomysis americana (S.I. Smith, 1873) [7]: 1 female incubating 11 postnauplioid larvae, North Sea, north coast of The Netherlands, Schiermonnikoog, N53 30.575, E06

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16.184, marine, van Veen grab, 0.7 m, 24 Sept. 2010, 01:46 h. – 1 immature male, coast at Schiermonnikoog as above, N53 30.642, E06 17.292, marine, van Veen grab, 1.0 m, 24 Sept. 2010, 02:11h. – 10 spec., east coast of North America, North Carolina, Oregon Inlet, night plankton tows, 9-10 Jan. 1957, leg. A.B. Williams, det. T.E. Bowman. – 24 spec., from Gulf of Mexico, culture stock of Environmental Research Laboratory, Narragansett, Rhode Island, USA, 1985, leg. et det. Suzanne M. Lussier.

Neomysis integer (Leach, 1814) [8]: 98 spec., southern Baltic, Fehmarn-Belt, Puttgarden, N54 30.30, E11 13.32, sandy shore, S = 14, 0.3 m, hand net, 23 Aug. 1985, leg. Ariani & Wittmann. – 3 spec., west coast of Scotland, Argyll, Firth of Lorn, Dunstaffnage Bay, N56 27.00, W05 25.98, S = 28-33, 0.1-0.2 m, algae, mud, hand net, 13 Sept. 1983, leg. K.J. Wittmann. – 68 spec., coast of the North Sea, Den Helder, Noordhollands kanaal, N52 57.828, E04 46.002, S = 2-3, 1-2 m, macrophytes, hand net, 22 June 1989, leg. K.J. Wittmann. – 114 spec., Gulf of Biscay, Bassin d'Arcachon, chenal de La Hume, N44 35.526 W01 7.422, S = 1.2, 2 Aug. 1983, leg. et det. J.C. Sorbe. – 2 adults, Mediterranean coast of France, delta of the Rhône River, Canal d'Arles à Fos at its crossing with the Liaison Rhône-Fos, N43 27.9867, E04 50.0042, S = 12.3, 0.5-1.5 m, concretions of *Mytilus*, mud, hand net, 14 June 2007, leg. K.J. Wittmann.

Acanthomysis longicornis (H. Milne Edwards, 1837) [9]: 8 spec., Mediterranean, Adriatic Sea, Gulf of Trieste, Bay of Strunjan, N45 33.00, E13 34.98, S = 31-33, 22 m, mud with *Cucumaria*, diver-operated hand net, 14 Feb. 1975, leg. K.J. Wittmann. – 11 spec., Mediterranean, Tyrrhenian Sea, Gulf of Salerno, Lido Lago, N40 33.00, E14 52.98, S = 37, 7-10 m, 1700 m off sandy beach, sand, *Cymodocea*, boat-operated bottom net, 16 July 1995, leg. K.J. Wittmann.

RESULTS

Two specimens of *Neomysis americana* were unexpectedly sampled with van Veen grabs in very shallow marine coastal waters of The Netherlands along the North Sea coast of Schiermonnikoog (see material listed above). The collected specimens of *N. americana* were accompanied by numerous specimens of the amphipods *Bathyporeia pelagica* (Bate) and *B. elegans* Watkin, one specimen of the amphipod *Pontocrates altamarinus* (Bate & Westwood), one specimen of the mysid *Schistomysis kervillei* (G.O. Sars), two specimens of the isopod *Eurydice pulchra* Leach, and one specimen of the decapod shrimp *Crangon crangon* (Linnaeus) [10].

Morphology of *N. americana* from The Netherlands (Fig. 1b,e,h): The adult female with body length 9.6 mm, and if extrapolating from the immature male (5.0 mm) to a mature individual, showed intermediate body size between the large winter animals from North Carolina (1 F ad. 10.7 mm, 3 F subad. 9.1-11.6 mm, 6 M subad. 7.3-10.2 mm) and the small specimens from the Gulf of Mexico in laboratory culture (12 F ad. 7.0-8.3 mm, 3 F subad. 6.3-6.5 mm, 9 M ad. 5.7-7.8 mm), these latter likely corresponding to summer animals. Among the main diagnostic characters examined in the adult female (data for the immature male in parentheses), the terminal segment was 16-17% (15-17%) of the entire length of the lanceolate antennal scale; this scale was 2.5-2.8 (2.3-

2.4) times the length of the trunk of the antennal flagellum. Endopods of uropods with comb-like series of 16-17 (13) spines on ventral face near statocyst, these spines continuously increasing in length caudally. Triangular telson with 29-34 (21-23) spines distributed over entire length of each lateral margin; spines on terminal half of telson arranged in groups of large spines with 1-5 (1-3) small spines in between. As for body size, the data for antennal scale, uropods, and telson are between and/or close to the average values found in North Carolina and the Gulf of Mexico materials.

Morphology of the three species studied (adults of both sexes; Fig. 1): antennal scale length divided by length of the trunk of the antennal flagellum was 2.8-3.2 in *N. integer*, 2.3-2.8 in *N. americana*, and 1.3-1.5 in *Acanthomysis longicornis*. Endopods of uropods with 18-40 spines below statocyst in *N. integer*, 8-25 in *N. americana*, and 2-3 in *A. longicornis*. Only in *N. integer* were these spines inserted (always) on a longitudinal ridge below the statocyst. Only *A. longicornis* with scales scattered over large parts of the body surface and certain appendages, giving the body a hispid appearance. Both *Neomysis* species with triangular telson, armed with series of spines along entire lateral margins, unlike the more linguiform telson with a spine-free zone along most of the basal third in *A. longicornis*. Number of spines on each lateral margin of the telson was 16-24 in *N. integer*, 20-43 in *N. americana*, and 31-40 in *A. longicornis*, not counting the large apical spines. Terminal half of the telson of *N. americana* and *A. longicornis* with groups of large spines with small spines in between, unlike the almost continuous series of spines along the lateral margins in *N. integer*. Dense series of thin hairs were detected on the inner margins of both rami of the uropods and on both lateral margins of the telson in dissected parts of *N. integer*. These hairs were up to half the length of the lateral spines of the telson, but were so thin that 200-400x magnification was needed for definite identification (not visible with the low magnification in Fig. 1g,h). Some hairs were also present in *N. americana*, but were not easy to see in the small space between the spines on the lateral margins of the telson. No such hairs were seen in the dissected uropods and telson of *A. longicornis*.

DISCUSSION

Neomysis americana is well known as the most common mysid in brackish waters and as a less common faunal element in marine waters down to 240 m depth along western Atlantic coasts between southern Newfoundland and Florida [11]. In the 1970-80s it surprisingly appeared along the coasts of Uruguay and Argentina [12], where it may have been transferred in ballast water [13]. Accordingly, the new records in The Netherlands appear to be a continuation of long-term anthropogenic expansion processes across oceanic basins. Both new records are based on an inefficient method for sampling mysids, suggesting that many more individuals were present but escaped.

We found no consistent morphological differences between and within field materials from The Netherlands and North Carolina, and culture animals from the Gulf of Mexico. According to Wigley [3] and Hoffmeyer [12], there are no differences, other than those related to sex and body

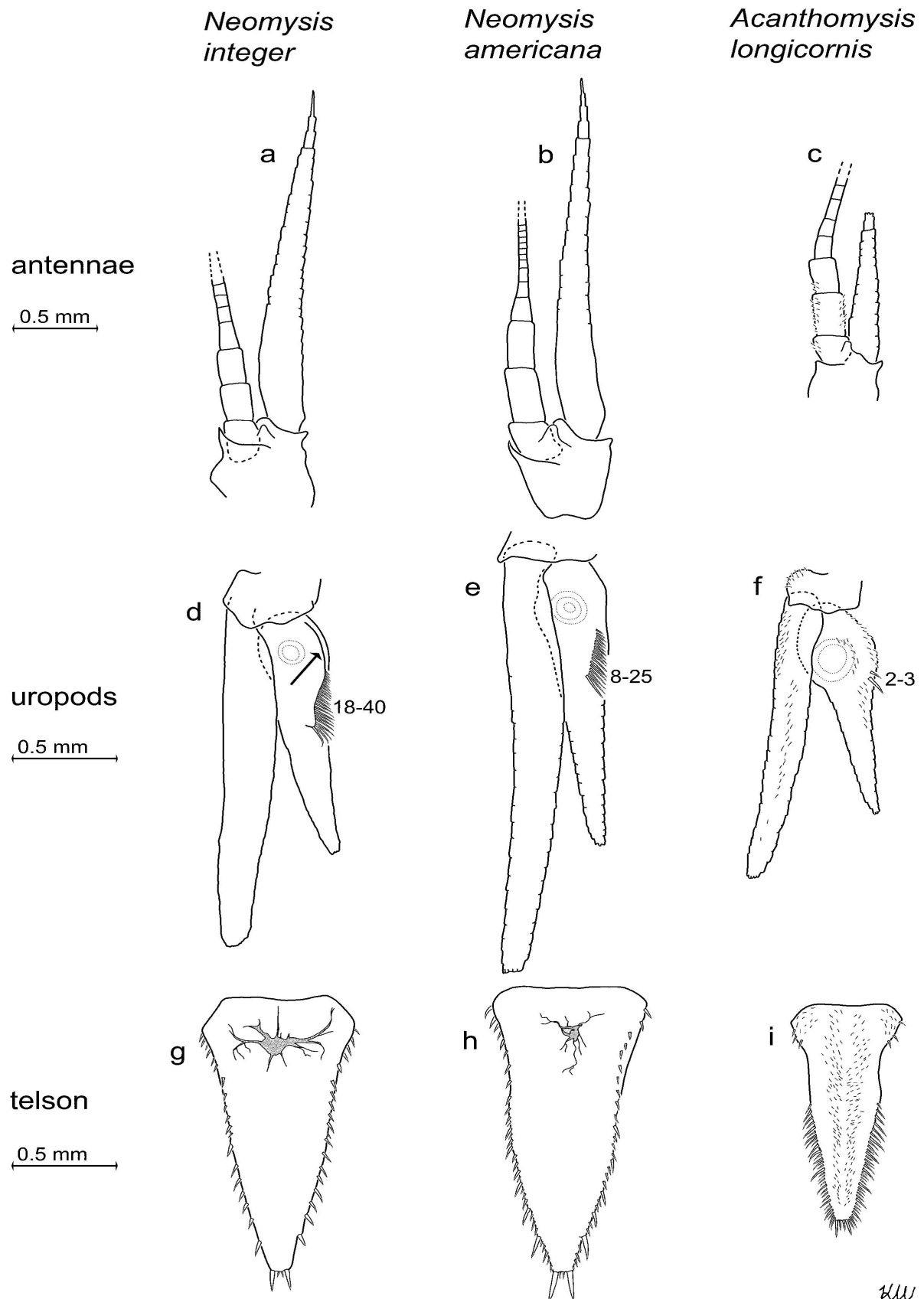


Fig. (1). Pictorial key to *Neomysis integer*, *N. americana*, and *Acanthomysis longicornis* encountered in coastal waters of western Europe. The three species are clearly distinguished by the length relation between the antennal scale and the trunk of the antennal flagellum, by the numbers of spines on the ventral face of the endopods of uropods, by the presence of a longitudinal ridge (**d**, arrow) below the statocyst, and by the size and arrangement of spines on the lateral margins of the telson. (**a-f**), setae omitted.

size, between and within populations on the coasts of Canada, the United States, Uruguay, and Argentina. Therefore, morphological characters do not appear suitable to identify the source area of the European animals, which is expected to be anywhere along the coast of the West Atlantic between 50°N and 40°S, except tropical latitudes.

N. americana (Fig. 1b,e,h) shows great morphological similarity with the native European species *N. integer* (Fig. 1a,d,g). The latter is a common constituent of brackish water faunas and is less common in marine waters down to 30 m depth. It occurs in the south-western Barents Sea and along north-eastern Atlantic coasts southward down to southern Spain [14], in the Baltic, and as a potential neo-zoan locally also in the western Mediterranean [15]. True freshwater populations of *N. integer* do exist but are rare [16]. This species appears to be somewhat more euryhaline and less thalassophilic than *N. americana*.

We acknowledge only one additional, closely related species, endemic to the North-East Atlantic, namely *Acanthomysis longicornis* (Fig. 1c,f,i). There are only 2-3 spines below the statocyst, as already emphasized by Ariani [17] and Holmquist [18]. Additional small spines seen in this spine series by Sars [19] and Tattersall & Tattersall [20] actually belong to the scales widely scattered over the body and appendages ("general spininess" according to Holmquist [18]). This species lives over soft bottoms in 2-100 m depths along the coasts of the North-East Atlantic from the North Sea to the Gulf of Biscay, and more commonly of the Mediterranean Sea. In summary, there is only one native species each of *Neomysis* and *Acanthomysis* in North-East Atlantic waters. In contrast, there are many species of both genera in the Pacific and Indian Oceans [21]. The Pacific species most similar to *N. americana* is *N. orientalis* Ii, 1964 [22]. The latter clearly differs by more (about 27) spines in more marginal position ventrally on the endopods of uropods [22].

We do not acknowledge *Acanthomysis strauchi* (Czerniavsky, 1882) [23], to date very often cited for European waters in the secondary literature [f.i. 21,24,25] including online databases [f.i. 26-28]. We consider it to actually be a junior synonym of the Ponto-Caspian endemic *Paramysis ullskyi* Czerniavsky, 1882. Our exhaustive literature survey showed that this invalid taxon was created in 1957 as a twofold bibliographic error by Gordan [29], who firstly overlooked that *Metamysis strauchi* (Czerniavsky, 1882) was already synonymized with *P. ullskyi* in 1939 by Derzhavin [30]. Secondly, she confounded the genus name *Metamysis* G.O. Sars, 1895 [31], now considered a subgenus [32] of *Paramysis* Czerniavsky, 1882, with the homonym *Metamysis* Nakazawa, 1910 [33], in turn in 1957 still considered a junior synonym of *Acanthomysis* Czerniavsky, 1882, but now an invalid senior synonym of *Oriantomysis* Derzhavin, 1913 [34]. More recently, *A. strauchi* was quoted in the secondary literature [24,25] for the Mediterranean, without indication of primary literature or data sources for this binomen. Consequently, neither *P. ullskyi* nor any *Acanthomysis* species other than *A. longicornis* are acknowledged by us for the Mediterranean.

At present it appears uncertain whether *N. americana* will become a permanent constituent of the European fauna. All keys to species currently utilized in Europe indicate *N.*

integer as the only local representative of its genus. One cannot exclude that *N. americana* has already gained a wider distribution along European coasts but has been overlooked. Future sampling programs should take the potential presence of this species into account and may, to this end, use the pictorial key in Fig. (1) as a supplement to already established keys [f.i. 35-37].

CONFLICT OF INTEREST

The authors confirm that this article content has no conflicts of interest.

ACKNOWLEDGEMENTS

The present work is part of an ongoing coastal nourishment research project, funded by the Dutch Ministry of Infrastructure and Environment. The authors thank Harriette Holzhauer and Jan van Dalven (Deltares) for their scientific support, and Jannes Heusinkveld (The Fieldwork Company) for leading the field campaign. Bert Hoeksema (NCB Naturalis) commented on an early draft of the manuscript.

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Received: July 30, 2012

Revised: August 01, 2012

Accepted: September 15, 2012

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