DISCOVERY OF 3 NEW INVASIVE COPEPOD SPECIES IN DANISH WATERS 2021-2023

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Abstract

Since 2021 three new copepod species were found in the Danish Waters during the **NOVANA surveillance programme** by the Danish Ministry of the Environment. Copepods comprise the major part of the marine zooplankton biomass in Danish Waters.

The calanoid copepod ***Pseudodiaptomus marinus*** Sato, 1913, was first discovered in *The Limfjord* in 2021 and in the *northern North Sea* in 2022 (Utteri et al., 2023).

The calanoid copepod ***Tortanus (Boreotortanus) discaudatus*** Thompson I.C. & Scott A. (In Herdman, Thompson & Scott, 1897), was first discovered in *The Limfjord* 2022 (P. Seebach, unpublished).

The cyclopoid copepod ***Oithona davisae*** Ferrari F.D. & Orsi, 1984. Now present in all Danish Waters and *well established in The North Sea, Kattegat and The Sound (Øresund)* connecting the Kattegat strait (northwest) with the Baltic Sea (south) in 2023 (K. Engell-Sørensen, unpublished).

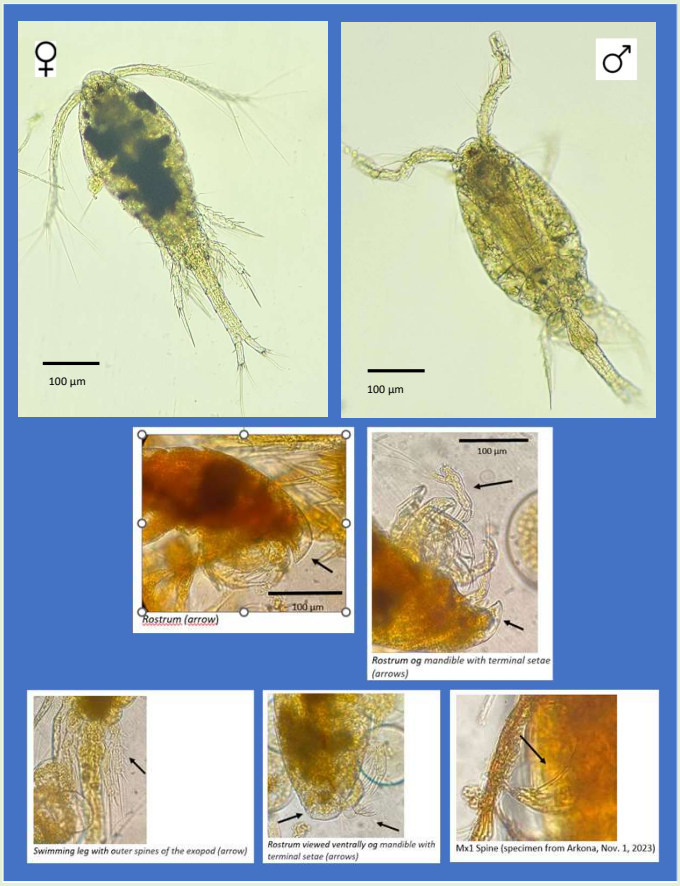

Fig 3. ***Oithona davisae.*** Upper left: female; upper right: male; lower figures: various female details important for species determination.

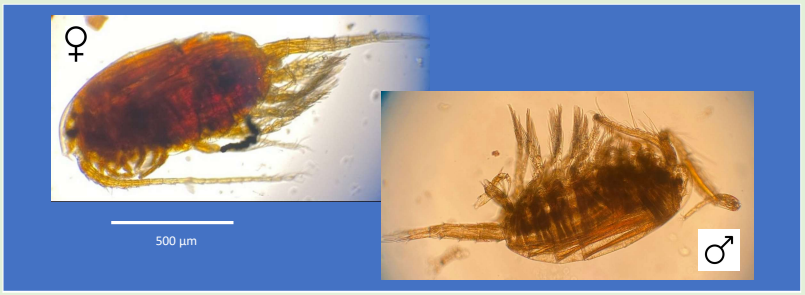

Fig 1. ***Pseudodiaptomus marinus***. Left: female; right: male

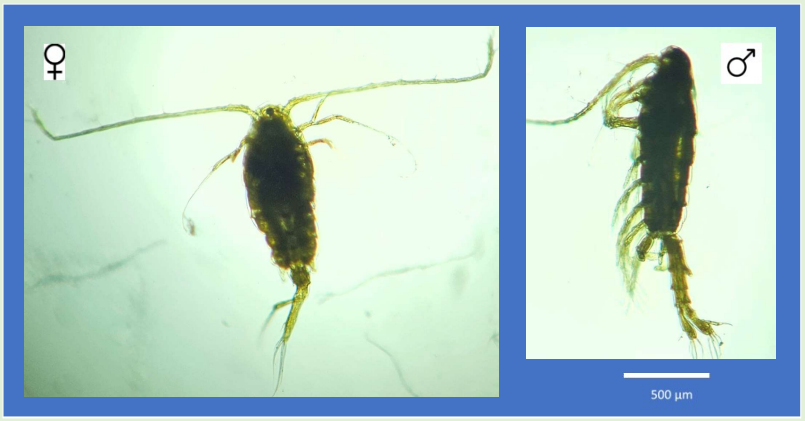

Fig. 2. ***Tortanus (Boreotortanus) discaudatus*** Left: female; right: male

Occurrence in Danish waters and possible pathways of introduction

Pseudodiaptomus marinus

P. marinus is native to the Northwest Pacific but was found in 2013 the Southern part of the **North Sea**, probably introduced by ballast water (Jha et al., 2013). It was also found in the Belgian part of the North Sea (Deschutter et al, 2018) and in 2018 it was found in the southeastern part of the North Sea (Wootton et al. 2018).

In September 2021 *P. marinus* was found as an established part of a multispecies culture in a constructed lagoon used for production of flatfish fry in the western part of the **Limfjord.** The temperature was 18 °C and the salinity was 29 PSU at the time of the sampling. *P. marinus* was probably introduced to the lagoons by inlet of water of North Sea origin. The lagoon water was kept for next year's production, but *P. marinus* apparently did not survive during winter, and was not found in 2022 or 2023.

As part of the NOVANA surveillance programme. *P. marinus* was found in the Limfjord in 2022 in low numbers. In November 2022, two specimens of *P. marinus* (a female and a copepodite) were also found near the offshore waters of Hirtshals City, at 18 m depth, so far the northern-most registration (Utteri et al, 2023). The sampling location was characterized by a permanently thermally mixed water column with high salinity (31-32.5 CPU), fully oxygenated and with temperatures of approximately 12°C. In 2023 it was found on 6 occasions on the west coast of Denmark. Spreading further north in The North Sea, and perhaps also to the Limfjord, was probably facilitated by the North Sea currents as predicted by Jha et al. (2013).

Tortanus (Boreotortanus) discaudatus

This copepod was first discovered in *The Limfjord* in 2022. In 2023, it was also found in *The Sound and the North Sea* in low numbers. *T. discaudatus* is typically found in coastal waters off North America. The family produces dormant eggs, therefore the eggs might have drifted by current or the copepods could have arrived via ship ballast water.

Oithona davisae

O. davisae inhabits eutrophic coastal waters and is indigenous to Japan and China Seas. It is an invasive species along the west coast of the US and is established in the Mediterranean and the Black Sea (Doğan and Işinibilir, 2016). *O. davisae* was discovered in the northern part of the Wadden Sea in 2010, and had by 2023 spread to most Danish Waters and is well established in some locations.

O. davisae has been shown to outcompete our native copepod *O. nana* in two locations in the Black sea (Isinibilir et al, 2016), probably due to several factors, for example that *O. davisae* is euryhaline and tolerates wider salinity ranges than *O. nana*, that egg production rates are higher in *O. davisae* and that the generation time is shorter. In the Black Sea, *O. nana* was eliminated by the ctenophore *Mnemiopsis leidyi*, in Denmark known as the "killer medusa" at the beginning of the 1990's, and did not return after the trophic balance recovery from year 2000 and onwards.

It may be speculated whether *O. davisae* will also outcompete *O. nana* or other species in some Danish waters.

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