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Research article

Establishment of *Oithona brevicornis* Giesbrecht, 1892 (Copepoda: Cyclopoida) in the Black Sea

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Abstract

Long-term, regular studies of coastal plankton communities were resumed in 2002, based on bi-weekly plankton casts at three stations located within and adjacent to Sevastopol Bay, Crimea, northern Black Sea. In October 2005 two adult females of *Oithona brevicornis* were initially discovered in a sample taken during a routine plankton survey. Within one month after this discovery *O. brevicornis* began to appear in the samples regularly. In November 2005 the total abundance of *O. brevicornis* exceeded 1000 ind./m^3 in the central part of the Bay. From April 2006, *O. brevicornis* disappeared completely from net catches and was absent until July 2006 when this species reappeared. The peak abundance of this species – 42667 ind./m^3 – was recorded at the central station within the Bay at the end of October 2006. The possible route of invasion and the seasonal dynamics of this new copepod species in the Black Sea coastal region are discussed.

Key words: invasion, *Oithona brevicornis*, Black Sea, zooplankton

Introduction

Sevastopol Bay in southwestern Crimea, Ukraine is about 7000 m long and 850 m wide, with an average depth of 12 m. It receives freshwater input from the Chernaya River. *Oithona brevicornis* Giesbrecht, 1892 (Figure 1) is widespread in the tropical and temperate Pacific, Indian and Atlantic oceans (Shuvalov, 1980; Razouls et al., 2005 - 2007), where it can be abundant in shallow coastal waters.

This euryhaline marine copepod is common in estuarine and brackish waters and may occur in low salinity (10-13‰) waters (Deevey, 1948). *O. brevicornis* had not previously been reported from the Black Sea and Sea of Azov. So, special attention was paid to the study of the ecology of *O. brevicornis* in a new habitat for this species.

Materials and Methods

Samples of zooplankton were collected during 2005-2006 from two stations located in Sevastopol Bay and one station located outside (Figure 2).

Samples were typically collected by vertical hauls through the whole water column (from bottom to the sea surface) using a Juday plankton net (mouth area 0.1 m^2 and mesh size 150 µm). Samples were taken in the morning usually bi-weekly and were fixed with 4% formaldehyde solution and subsampled. Zooplankton counts

were made under a MBS-9 stereomicroscope in Bogorov counting chamber. Copepods of all developmental stages (I-VI copepodite stages) were identified to species using the taxonomic keys of Shuvalov (1980). Abundance was calculated per cubic meter. Appendages were dissected under a stereomicroscope and mounted in microscope slides for detailed examination.

Results

Only two of 44 species of the genus *Oithona* Bair, 1843, presently known in the World Ocean (Razouls et al. 2005–2007), were native in the Black Sea: *Oithona nana* Giesbrecht, 1892 and *O. similis* Claus, 1866. Detailed descriptions of the species belonging to *Oithona* were given by Shuvalov (1980) and by Nishida (1985). Species-level identification is rendered more difficult by the small size of these copepods. Fortunately, the two native Black sea species of *Oithona* and invader *O. brevicornis* differ markedly in the shape of the head and rostrum (Figure 3).

A brief comparison of the head and rostrum of these three *Oithona* species is given below:

- *O. nana*: head narrow, truncate anteriorly in dorsal view; rostrum blunt and not visible dorsally.
- *O. brevicornis*: head rounded anteriorly in dorsal view; frontal margin produced ventrally into sharply pointed, slightly curved rostrum, readily visible in lateral view.
- *O. similis*: head anteriorly abruptly blunt or slightly rounded; rostrum ventrally directed, sharply pointed and not visible dorsally.

In Sevastopol Bay the body lengths of these three species varied as follows:

- *O. nana*: female 0.5 – 0.53 mm; male 0.48 – 0.51 mm.
- *O. brevicornis*: female 0.53 – 0.6 mm; male 0.47 – 0.53 mm.
- *O. similis*: female 0.71 – 0.8 mm; male 0.7 – 0.73 mm.

Oithona similis is a cosmopolitan species widespread in the World Ocean. According to Shuvalov (1980), in the tropical zones these copepods occur mostly in areas influenced by coldwater currents. In the Black Sea *O. similis* represents the coldwater copepod complex (Greze 1971).

Krichagin (1873) was the first to find *O. nana* in the Black Sea and he described it as *O. minuta* Krichagin, 1873. Later, Giesbrecht (1892), unacquainted with Krichagin's paper,

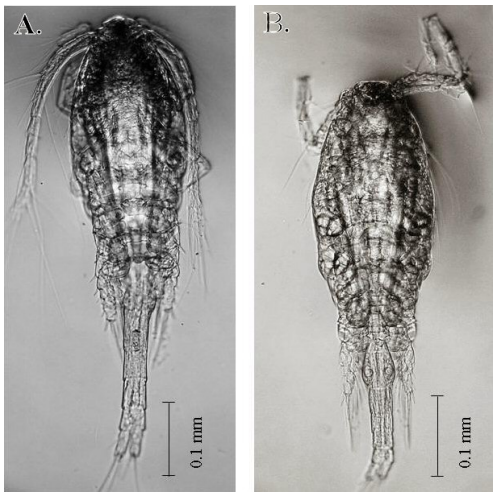

Figure 1. *O. brevicornis* Giesbrecht 1892: A. female, dorsal view; B. male, dorsal view (from sample taken in the central part of Sevastopol Bay in October 2006)

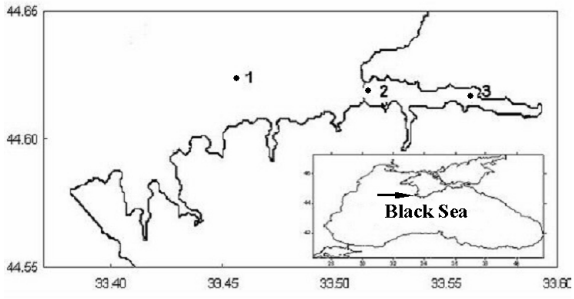

Figure 2. Study area. Sevastopol Bay and Black Sea. The Bay is surrounded by the center of Sevastopol city. Black circles: Sampling stations 1 to 3. Arrow: Area of Sevastopol in the Black Sea

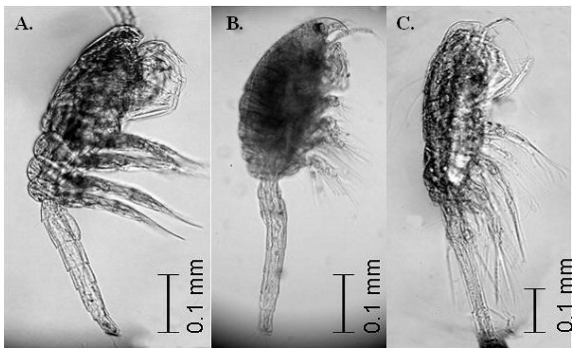

Figure 3. Left lateral views of *Oithona* species of the Black Sea showing form of rostrum: **A**. *O. nana*, female (from mouth of Sevastopol Bay, September 1976); **B**. *O. brevicornis*, female (from center of Sevastopol Bay, October 2006); **C**. *O. similis*, female (from mouth of Sevastopol Bay, December 2006)

described the same copepod as *O. nana*. These two species are synonyms (Karavaev 1895), but *O. minuta* T. Scott, 1894 is a separate species. *O. nana* is a eurythermic species that is widespread in the World Ocean (Nishida 1985, Razouls et al. 2005-2007). Until the late 20th century it was among the most abundant copepods in the neritic zone of the Black Sea (Greze 1971). Since the 1990s, *O. nana* has not been found there (Gubanova et al. 2002).

O. brevicornis was first found in the Black Sea in December, 2001 (Zagorodnyaya 2002, Altukhov and Gubanova 2006) but this discovery appeared to represent an isolated record. New specimens were found in Sevastopol Bay only four years later: two adult females of *O. brevicornis* were found at stations 2 and 3 (one at each station) in October 2005. Two months later, at the end of December 2005 more than 2000 ind/m^3 of *O. brevicornis* in the central and coastal areas of the Bay were found (Figure 4).

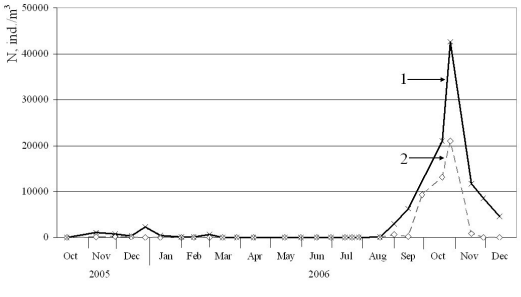

Figure 4. Seasonal variation in *O. brevicornis* abundance at two stations in Sevastopol Bay: 1 – central part of Bay; 2 – mouth of Bay

In January and February 2006 the abundance of *O. brevicornis* in the samples decreased considerably. From May to mid-July 2006 this species was entirely absent and appeared again in the late summer as solitary specimens. Intensive development of *O. brevicornis* population started again in late August and lasted until the end of October 2006, when its abundance had reached 42667 ind/m^3 in the central part of the Bay. In November – December 2006 *O. brevicornis* numbers decreased. From mid-September until the end of 2006 the contribution of *O. brevicornis'* to total copepod numbers was calculated as at least 70%, sometimes up to 96-97% (Figure 5).

Throughout the period of study the abundance of *O. brevicornis* gradually increased in the central locations compared to the mouth of the Bay. At the station outside the Bay (in more than 40 m water depth), the abundance of *O. brevicornis* was considerably less than inside the Bay, over the entire period of study.

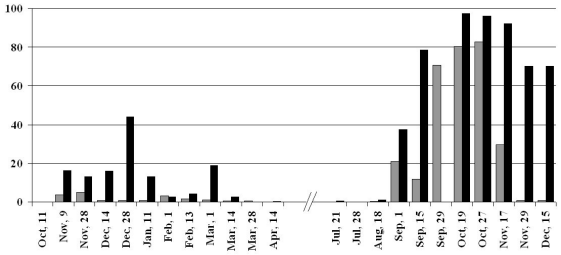

Figure 5. Seasonal changes of contribution (%) of *O. brevicornis* to total copepod abundance at two stations in Sevastopol Bay: grey bars: station 2; black bars: station 3 (no data for 29 September 2006)

During this study, the *O. brevicornis* population included all ontogenetic stages and adult females, some of which had egg sacs in November – December 2005 and in August – December 2006.

Discussion

As other recent pelagic invaders – the copepod *Acartia tonsa* Dana, 1849, ctenophores *Mnemiopsis leidyi* A. Agassiz, 1865 and *Beroe ovata* Bruguiere, 1789 (Pereladov 1983, Belmonte et al. 1994, Konsulov and Kamburska 1998, Gubanova 2000) - *O. brevicornis* was most probably brought into Sevastopol Bay in the ballast water of a ship. Accessibility or low resilience of the native zooplankton community to *O. brevicornis* invasion was possibly preconditioned by earlier invasions of the predatory ctenophores *M. leidyi* and *B. ovata*. The unexpected, but highly destructive invasion of *M. leidyi* into the Black Sea in the early 1980s extremely increased grazing pressure on plankton in the late 1980s – early 1990s, especially during summer and autumn (Gubanova et al. 2002). As a result, some indigenous species, including *O. nana* with its peak abundance during autumn, disappeared completely from the community. The abundance of other species dropped drastically at the same time. In the late 1990s, due to the accidental invasion of the comb-jelly predator *B. ovata*, consuming *M. leidyi*, its mass development time decreased considerably and reduced the grazing pressure on

the plankton during summer and autumn (Gubanova 2003). Therefore, we infer that the establishment success of *O. brevicornis* is due to the loss of *O. nana*, an ecologically closely similar and closely related species that vanished from plankton, and to the reduced predation impact of *M. leidyi* upon copepods that reproduce in autumn.

Based on the 20-year (1976-1996) study completed in the Sevastopol Bay, it was hypothesized (Gubanova et al. 2002) that the unstable state of zooplankton community during 1989-1990s might force further changes in the copepod population structure and species composition. Our investigation confirms this prediction.

Conclusions

The establishment of the copepod *O. brevicornis* in the Black Sea is reported. Most probably, this copepod, formerly unknown in the Black Sea, was transported to this region in the ballast waters of a ship. In the Black Sea *O. brevicornis* occupies coastal areas. The peak abundance of *O. brevicornis* in Sevastopol Bay was registered in October 2006. Most likely, *O. brevicornis* will be the dominant copepod species in the Sevastopol Bay in autumn. In the middle of the Bay this species dominated in copepod community from mid-September to mid-December 2006, whereas at the mouth of the bay – only from mid-September to late October 2006.

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