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Species composition of Black Sea marine planktonic copepods

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ABSTRACT

This paper reviews the changes in the marine planktonic copepods of the Black Sea species' list from the beginning of taxonomic research to the present day. The study was based on the SESAME biological database, unpublished data, literature and data obtained during the course of the SESAME project. Comparisons were made with the Guidebook for Marine Fauna of the Black Sea and the Sea of Azov, which revealed changes both in the taxonomic status of some species and in the structure of the copepod community. The taxonomic status of two species (*Acartia clausi* small form and *Centropages kroyeri pontica*) and the nomenclature of two species (*Oihona minuta* and *Calanus helgolandicus*) have been changed. Three native species (*Acartia margalefi*, *Oithona nana*, and *Paracartia latisetosa*) have disappeared. Two non-indigenous copepods (*Acartia tonsa* and *Oithona davisae*) became established in the Black Sea ecosystem in the 1970s and 2000s, respectively. The success of their establishment was determined by biological features of the species and vulnerability of the native copepod community to invasions. It is highly probable that both species were introduced to the Black Sea by vessel ballast water. The hypothesis of "mediterranization" of the Black Sea fauna does not appear to hold true for zooplankton. Numerous claims of alien copepod species in the Black Sea remain largely unverified due to insufficient information. Data on newly discovered species of the *Acartia* genus are not authenticated. An updated list of marine planktonic copepods of the Black Sea is hereby presented.

1. Introduction

The detailed taxonomic analysis of species composition is crucial for any ecological study, including community dynamics and variability, the influence of external factors, extinctions and invasions, as well as for biogeography and comparison with similar communities throughout the world.

Studies of the Black Sea zooplankton started in the mid-nineteenth century. The first researchers focused their efforts on the species composition of zooplankton, specifically pelagic copepods. A number of publications resulting from these studies were produced at the end of the nineteenth and beginning of the twentieth centuries by renowned scientists of the age (e.g. Chichkoff, 1912; Dolgopolskaya, 1940; Galadzhiev, 1948; Karavaev, 1894; Klyucharev, 1952; Krichagin, 1873; Potemkina, 1940; Ulomskiy, 1940). By the late 1950s investigations into the species composition of Black Sea fauna were considered to be complete. The results were summarized in the "Guidebook for Marine Fauna of the Black Sea and the Sea of Azov" (Dolgopolskaya et al., 1969), which listed all copepod species of the Black Sea and the Sea of Azov known at that time. Further detailed studies of Copepoda taxonomy resulted in species name modifications and clarification of the taxonomic status of some native species (Belmonte and Mazzocchi, 1997; Hulsemann, 1991; Sazhina and Kovalev, 1971).

During the 1960s, about fifteen Mediterranean species were recorded in the Black Sea, mostly near the Bosphorus (Kovalev et al., 1976; Pavlova, 1965). These findings were one of the outcomes of intensive investigation of the water exchange between the Sea of Marmara and the Black Sea through the Bosphorus. The Mediterranean species which were occasionally found in the Bosphorus were included in several lists of the Black Sea copepod species (Shmeleva et al., 2009).

During the second half of the twentieth century, research revealed serious changes in the copepod community caused by intensive human activities in the Black Sea (Belmonte et al., 1994; Gubanova et al., 2002). The occasional introduction of alien species into the Black Sea can be deemed as the most serious anthropogenic impact. The invasion of the predatory ctenophore *Mnemiopsis leidyi* in the Black Sea is consequently considered one of the most catastrophic invasions known to date (Boxshall, 2007; Oğuz and Öztürk, 2011). It has led to dramatic changes in plankton biodiversity, both in general as well as

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in the copepod community (Altukhov and Gubanova, 2006; Kamburska et al., 2003).

Recent reports on new findings of alien copepod species have appeared rather frequently (Selifonova et al., 2008; Shmeleva et al., 2008, 2009). Finally, eight species of *Acartia* new for science were found in the Black Sea: *A. eremeevi*, *A. hasanii*, *A. ioannae*, *A. janetae* *A. lamasii*, *A. mollicula*, *A. vivesei* and *A. zaitsevi* (Pavlova and Shmeleva, 2010).

For the above reasons the list of copepod species presented in the "Guidebook for Marine Fauna of the Black Sea and the Sea of Azov" (Dolgopolskaya et al., 1969) does not correspond to the present day species composition of copepods.

In this paper we (i) discuss changes in the species composition of copepods from the 1970s to the present; (ii) review the list of native copepod species; and (iii) finally present the updated list of the Black Sea marine planktonic copepods.

2. Materials and methods

The present study is based on historical data, data obtained during the SESAME scientific cruises and current literature.

The historical data include detailed taxonomic analysis of zooplankton samples carried out by scientists from Bulgaria, Romania, Russia, Turkey and the Ukraine within the framework of national monitoring and research programs and a number of international research projects (such as the NATO Hydroblack program, GEF projects, the NATO TU-Black Sea project and TUBITAK). The historical data were mainly obtained from the SESAME biological database (http://isramar.ocean.org.il/sesamemeta/).

Data gathered during the SESAME cruises (spring and autumn of 2008) were issued from the detailed taxonomic analysis of 211 samples collected in the Bulgarian, Romanian and Russian regions of the Black Sea.

In total, data obtained from over 3500 samples acquired at 942 geographical locations and which cover the entire Black Sea for the period from1954 to 2009 are used in this study (Fig. 1).

Samples were collected by vertical hauls using plankton nets of different types (mesh sizes 100–180 μm). A Nansen net (mesh size 300 μm) was used by the Institute of Marine Sciences (Turkey). All nets allowed the capture of adult individuals of all copepod species in the Black Sea. Samples were fixed with a 4% formaldehyde solution and zooplankton counts were made under stereomicroscopes. The copepods were identified up to species level.

Only the marine pelagic Black Sea copepod species are considered in the study. Freshwater species recorded in the river estuaries and coastal lagoons have not been taken into account.

3. Results and discussion

3.1. Inventory of the Black Sea copepods list. Native species

Despite the fact that the Black Sea fauna is mainly of Mediterranean origin, it is much less diverse. It has been found that the overall species biodiversity of the Black Sea is 3.5–4 fold less than in the Mediterranean (Mordukhay-Boltovskoy, 1972; Zaika, 2000), which can be explained by specific features of the Black Sea basin. This is because the low salinity (17–18 versus 37–39 in the Mediterranean Sea), low winter water temperature and hydrogen sulfide below 200 m depth form ecological barriers for the penetration of zooplanktonic Mediterranean species. In the mid-twentieth century, 13 species and 1 form of copepods were included in the Guidebook for Marine Fauna of the Black Sea and the Sea of Azov (Dolgopolskaya et al., 1969) (Table 1).

The names and status of some species in the taxonomic classification system have been revised. It is important to note these changes to avoid confusion in taxonomy and to routinely monitor ongoing changes within the copepod community.

3.1.1. Species whose names have been changed

Centropages kroyeri was first described as being from the Mediterranean Sea (Giesbrecht, 1892). Karavaev (1895) found differences in the morphology of the fifth pair of legs in specimens from the Black Sea and designated these to be the variety *C. kroyeri* var. *pontica* (Sazhina and Kovalev, 1971). He supposed that these differences were distinctive for the Black Sea community of *C. kroyeri*. Gurney (1927) found specimens similar to *C. kroyeri* var. *pontica* in the Suez Canal and deduced that this was not the Black Sea variety but a separate species. Later Kovalev (1967), based on materials collected from different seas of the Mediterranean basin (including the Black Sea), proved *C. ponticus* Karavaev, 1895 to be a species separate from *C. kroyeri*.

Oithona minuta was firstly found in the Black Sea by Krichagin (1873). Giesbrecht (1892), having no knowledge of Krichagin's paper, described the same species from the Mediterranean Sea as *O. nana*. The latter name was used in copepod publications throughout the world. Nevertheless, this species continues to be cited as *O. minuta* in several publications on the Black Sea zooplankton (Koval, 1984). Sazhina and Kovalev (1971) noted that such nomenclature inconsistency has led to some confusion in taxonomic publications. Moreover, in

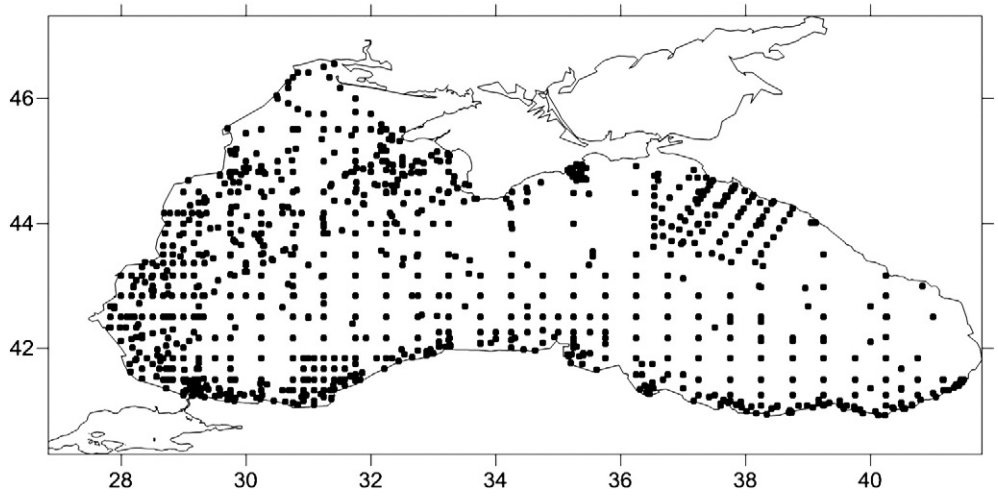

Fig. 1. Map of mesozooplankton stations sampled in the Black Sea during 1954–2009.