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Mesozooplankton in the open Black Sea: Regional and seasonal characteristics

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ABSTRACT

Coordinated cruises conducted in the Black Sea offshore waters in spring and autumn 2008, within the framework of European project SESAME, allowed the obtainment of a quasi-synoptic picture of the mesozooplankton standing stock and community composition. A clear spatial difference in total abundance was observed in spring with higher values over the slope than over the deep basin, due to the development of the fast boundary current. In autumn, standing stock was lower than in spring; weakening of the boundary current and extensive eddy formation caused small-scale variability in mesozooplankton distribution and intensification of the exchange between the different parts of the sea. In both seasons, copepods comprised the bulk (62–95%) of mesozooplankton biomass. Community composition variability was tested for the first time using data obtained from the entire basin; the application of neural network analysis (Self-organizing Maps) revealed a rather homogenous picture of community composition. The development of cladocerans in autumn resulted in the differentiation of the slope areas from the deep basin. Mass development of the heterotrophic dinoflagellate *Noctiluca scintillans* was observed in the western and north-western areas in autumn. No change in standing stock values and community composition seem to have occurred since 2000 in the north-eastern region.

1. Introduction

The Black Sea is a deep basin (maximum depth 2200 m) with narrow shelves (except the north-western shelf), characterized by permanent anoxia below the sharp halocline. The depth of the oxic/anoxic boundary varies at temporal and spatial scales within the 100–200 m depth interval, depending on the water dynamics (Murray et al., 1991; Tugrul et al., 1992; Vinogradov and Nalbandov, 1990). Water circulation is dominated by a boundary current, whose instability stimulates cross-shelf water exchange and lateral mixing (Ozsoy and Unluata, 1997; Sur et al., 1994). The Black Sea is a nearly enclosed basin; water exchange with the Mediterranean Sea is restricted through the Turkish Straits System. The north-western and western regions are more eutrophic than the eastern one, due to the Danube runoff (Humborg et al., 1997; Yunev et al., 2005), while the south-western region is influenced by the Mediterranean waters penetrating through the Bosphorus (Kovalev et al., 1998a). The limited exchange with the World Ocean and the small thickness of the oxygenated layer, make the Black Sea ecosystem very sensitive to the influence of external forcing. In the Black Sea, the pattern of the spatial distribution of mesozooplankton is highly dependent on water dynamics (Arashkevich et al., 2002b; Ozsoy and Unluata, 1997; Sur et al., 1994; Zatsepin et al., 2003).

During the last decades, the pelagic community of the Black Sea revealed dramatic changes due to several biotic and abiotic pressures. Eutrophication (Humborg et al., 1997; Yunev et al., 2005), overfishing (Daskalov, 2002), climate variability (Oguz et al., 2006), and the development of the non-indigenous ctenophores *Mnemiopsis leidyi* and *Beroe ovata* (Kideys et al., 2005) were the main pressures and their effects on the ecosystem have been discussed extensively from different perspectives. In the early 90s, the abrupt decrease in mesozooplankton biomass reflected the deep changes occurring at the different levels of the pelagic food web; this was associated with top-down and bottom-up controls, enhanced by a cooling climate (Kideys, 2002; Kovalev et al., 1998b; Oguz, 2005).

A limited number of studies have been performed at basin scale in the last decades (Gruzov et al., 1994; Shushkina et al., 1987; Vinogradov et al., 1991). The survey carried out in August–September 1989 offered the best coverage of the basin and revealed biomass differences along the west–northeast axis (Vinogradov et al., 1991). In contrast, the data

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obtained in different seasons during the1992–93 period from the northern half of the sea did not confirm any longitudinal difference in mesozooplankton abundance (Gruzov et al., 1994). However, some species revealed high sub-mesoscale spatial variability. Both Vinogradov et al. (1991) and Gruzov et al. (1994) emphasized the changes in zooplankton composition after the introduction of *M. leidyi*. The recent sub-basin scale studies in the western area (Moncheva et al., 2010; Stefanova et al., 2005) and in the north-eastern area (Arashkevich et al., 2008; Vinogradov et al., 2005) revealed a recovery of zooplankton communities as compared with the early 90s. In spite of the interannual variations in the propagation of species populations, a gradual increase of mesozooplankton biomass seems to be occurring in the western and north-eastern offshore areas.

Coordinated cruises were conducted in the Southern European Seas, in spring and autumn 2008, within the framework of European project SESAME. Mesozooplankton was studied in the Mediterranean Sea (Mazzocchi et al., in this issue) and in the Black Sea, in order to obtain a quasi-synoptic picture of the mesozooplankton standing stock and community composition in the offshore waters of both seas. The purpose of this study is to produce an overall picture of the mesozooplankton spatial distribution in the Black Sea, in terms of total abundance and biomass, community composition and structure. The study is based on samples collected at 39 stations positioned in the offshore waters; similarity among stations, as regards community composition was tested by multivariate analysis, an approach used for the first time in a study covering the entire Black Sea offshore waters. The results will also define the present state of the Black Sea mesozooplankton community in comparison with previous years.

2. Materials and methods

2.1. Data collection

SESAME cruises were performed in spring (April) 2008 and in autumn (September–October) 2008. Zooplankton samples were collected at 36 stations in spring and at 31 stations in autumn. Stations were positioned over the continental slope with bottom depths from 100 to 1900 m, and over the deep basin with bottom depth >2000 m. (Fig. 1, Table 1). Vertical hauls of nets were performed within the entire oxic zone (extending from the surface down to the depth of sigma theta = 16.2)

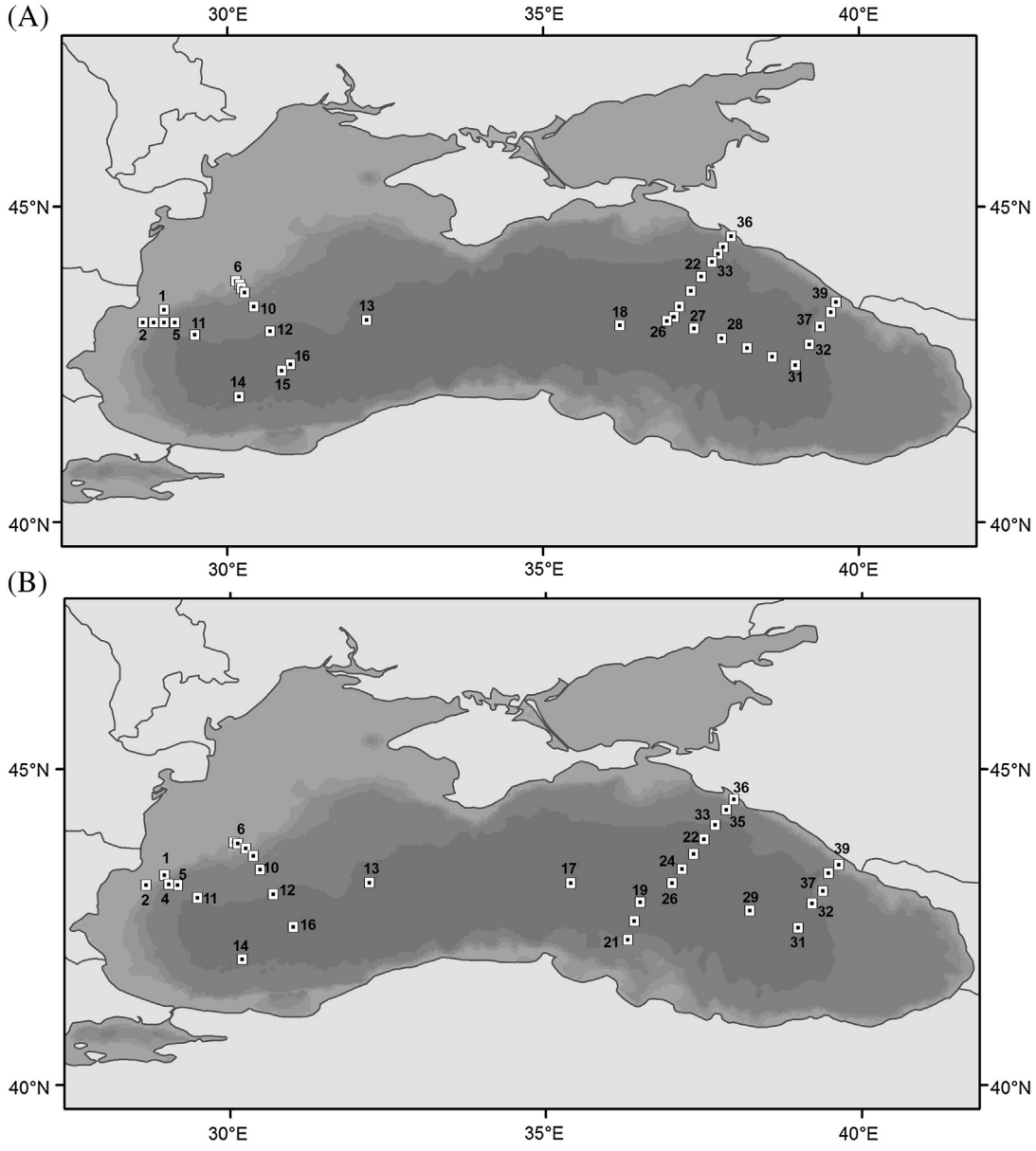

Fig. 1. Map of zooplankton stations sampled in spring (A) and autumn (B) 2008.

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