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Holocene ostracod and foraminiferal assemblages of the Romanian Black Sea shelf

Andrei Briceag, Gabriel Ion*

National Institute of Marine Geology and Geo-ecology – GeoEcoMar, Seismo-Acoustics and GIS, 23-25 Dimitrie Onciul Street, RO-024053 Bucharest, Romania

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ABSTRACT

Qualitative and quantitative study of the ostracod and foraminiferal assemblages were performed on two cores, around 0.30 m depth bsf in thickness, collected from the Romanian Black Sea shelf. The lithology of the studied cores is characterised by grey and black muds, topped by a centimetre thick fluffy mud layer. One of the cores, MN 103_09, is placed on the Romanian inner shelf, at water depth of 17.80 m. The sediments of this core contain very few and small bivalve fragments and no gastropods. In this core, the ostracod and foraminiferal assemblages are influenced by a quite high-energy environment, due to the Sulina arm of the Danube Delta. This feature is mirrored in the poor preservation and low abundance of the species, as well as the mixed Caspian and Mediterranean character of the ostracod assemblages. The other studied core, MN 103_04, is situated on the Romanian outer shelf, at a water depth of 78 m. Its deposits commonly contain gastropods and bivalves, as well as microfauna displaying a low diversity and a very high abundance; the character of the ostracod assemblages is a Mediterranean one. Overall, the identified microfaunas of the two investigated cores reflect the environmental conditions of modern and/or latest Holocene sea-floor assemblages and their relationships to salinity, sediment input and water depth. Even the depositional time of the 30 cm cored interval in the two studied cores is quite different, i.e., possibly several hundreds of years, up to 1000 years, on the inner shelf and several thousands (from 3000 BP to the Present), in the outer shelf, the results are indicative for modern Black Sea conditions. A stable marine environment with a salinity around 17–18‰, comparable with the present one, could be assumed for the whole cored interval of the Romanian shelf. Besides, the age structure, i.e., the ratio between adults and juvenile taxa of ostracod population in the outer shelf indicates a moderate to high energy autochthonous thanatocoenosis, with some post-mortem disturbance by currents. By contrast, the ratio between adults and juvenile ostracod taxa in the inner shelf mirrored a taphocoenosis with post-mortem disturbance, sorting and transport. This assemblage, dominated mainly by disarticulated valves of juveniles, does not represent the environment in which the ostracods lived.

1. Introduction

The ostracod taxa are in general benthic organisms, their abundance and diversity being controlled by environmental factors such as the type of substrate, hydrodynamic conditions, salinity and temperature (Aiello et al., 2006). This group of organisms is very useful in deciphering environmental and climatic changes in the Earth history, and especially in the Quaternary (Horne et al., 2012), their fluctuation pattern being a good proxy of the water and surface sediments chemistry, as well as nutrients and sea-level fluctuation. This feature is very useful in interpreting environmental changes in various settings, such as fresh-water, brackish and marine ones.

Many ostracod species inhabiting the NW part of the Black Sea shelf are well adapted to fluctuating environmental conditions caused by the freshwater influx from the Danube, Dniester and Dnieper Rivers (Aksu et al., 2002; Opreanu, 2008). Nowadays, the diversity of typical marine ostracods is very poor in the Black Sea in contrast with the Mediterranean.

The present-day Black Sea ostracod community contains a mixture of brackish Caspian taxa, such as *Candona* sp., *Candona fabaeformis*, *Cyprideis* sp., *Amnicythere* spp., *Euxinocythere* spp., *Tyrrhenocythere donetziensis* and *Loxocaspia* (= *Loxoconcha*) *lepida*, Black Sea endemic marine species, such as *Pontocythere bacescoi*, as well as Mediterranean immigrants, i.e., *Leptocythere multipunctata*.

* Corresponding author.
E-mail addresses: andrei.briceag@geoecomar.ro (A. Briceag), gion@geoecomar.ro (G. Ion).

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Cytheroma variabilis, *Callistocythere diffusa*, *Xestoleberis cornelii* and *Palmoconcha granulata* (Schornikov, 1965, 2011; Olteanu, 1978, 2004; Stancheva, 1989; Kiliç, 2001; Tunoğlu, 2002; Opreanu, 2005, 2006; Ivanova et al., 2012; M. Stoica, pers. comm.).

Since the Late Holocene, the foraminifers from the NW part of the Black Sea basin show a low diversity and a very high abundance. The foraminiferal assemblages of the NW Black Sea region (i.e., Ukrainian and Romanian shelf) are exclusively benthonic (Yanko, 1990; Yanko-Hombach, 2007), being largely dominated by the representatives of the *Ammonia* genus (Yanko, 1990; Briceag et al., 2012).

Due to high salinity fluctuation of the NW part of the Black Sea, linked to the significant fluvial water input of the Danube, Dniester and Dnieper rivers (synthesis of data in Yanko-Hombach et al., 2007), a high morphological variability of *Ammonia* taxa was recorded in the Black Sea. Hence, at least 10 species of *Ammonia* could be found in Upper Holocene sediments of the Black Sea (Yanko, 1990), and each displays a specific ecological preference that varies from an oligohaline environment (1–5%) to a polyhaline one (18–26%).

Only a few Holocene microfaunal works on the Romanian Black Sea shelf region have been published (Caraion, 1958, 1967; Olteanu, 1978). Most of the older works lack any illustrations of the taxa. Recent papers focused on Late Holocene ostracod assemblages of the NW Black Sea have been published by Olteanu (2003) and Opreanu (2006). Boomer et al. (2010) published data on the taxonomy of the ostracod taxa identified in the NW Black Sea, within a large interval, i.e., Pleistocene to Recent, including the latest Holocene. Qualitative and quantitative investigations of Late Holocene foraminiferal and ostracod assemblages from the Romanian Black Sea shelf (southern part) have been published by Briceag et al. (2012).

Until now, most of the investigations have been concentrated on biotic fluctuation identified in the Holocene deposits of the Black Sea from deeper parts of the basin. This study is focused on qualitative and quantitative analyses of microfaunas from Holocene deposits sedimented in shallow settings of the Black Sea (Romanian inner and outer shelf).

The main aim of this work is to investigate the latest Holocene sea-floor assemblages, including the recent microfaunas from water/sediment interface, along with their relationship to salinity and energy gradients related to the Danube mouth. Another aim is to reveal the character of the microfaunas, and to point out the Caspian and/or Mediterranean influences in the ostracod assemblages of the Romanian Black Sea shelf.

2. Regional setting

The Black Sea is a semi-enclosed marginal basin which connects with the Mediterranean Sea through the Bosphorus Strait, Marmara Sea and Dardanelles Strait. Beside the connection with the Mediterranean Sea, in the Late Pliocene–Pleistocene times the Black Sea experienced a period of connection with the Caspian Sea through the Manych Corridor due to the melt waters from the Scandinavian ice sheets (Fedorov, 1977; Badyukova, 2001; Chepalyga et al., 2004; Bahr et al., 2006; Kislov and Toropov, 2007).

The Black Sea is also the largest marine anoxic basin in the world. The anoxia is given by the vertical stratification of the Black Sea waters, the surface layer is well oxygenated and has a salinity of approximately 18‰, while the deep water layer, below 150–200 m, is anoxic and contains a high hydrogen sulfide concentration with a salinity of around 22.5‰ (Özsoy et al., 1995; Bahr et al., 2006; Murray et al., 2007). Through the Bosphorus Strait there are two strong directional currents that give this vertical stratification: one deep water current that brings high salinity Mediterranean waters into the Black Sea and another surface outflow current, which expels low salinity waters to Marmara Sea (Özsoy et al., 1995).

The Black Sea continental shelf extends significantly in the northwestern part of the basin, covering almost 30% of the total Black Sea area and 90% of this geomorphologic province (Panin and Jipa, 2002). In this area, there is an important fluvial water and sediment discharge into the Black Sea from the Danube, Dniester, Dnieper and Southern Bug rivers (Tolmazin, 1985; Margvelashvily et al., 1999; Hiscott et al., 2007; among many others).

The Danube River is the main water and sediment supplier of the Romanian Black Sea region. The average Danube sediment discharge into the Black Sea basin is estimated by Panin and Jipa (2002) between 25 and 35 million t/y, of which 4–6 millions t/y are sandy material. For the NW part of the Black Sea, the other three rivers Dniester, Dnieper and Southern Bug are low suppliers of sediment discharge, most of the sediments being deposited in isolated lagoons, separated by sand barriers from the open basin (Panin and Jipa, 2002).

The littoral area of the Romanian Black Sea is divided into two units: the Danube Delta coastal zone and the Southern Unit, which extends between Cape Midia and Romanian-Bulgarian border (Panin and Jipa, 2002). The Danube Delta coastal zone is characterised by a longshore sediment drift along the delta, with intense erosion of the delta littoral area located south of the Sulina mouth (Panin and Jipa, 2002). The Southern Unit is directly influenced by the Midia harbour jetties, which traps the sandy sediments of the longshore drift, causing sediment starvation of the entire southern coastal zone (Panin and Jipa, 2002).

On the N Romanian Black Sea shelf several major depositional areas, such as the Delta Front and the Danube Prodelta, as well as the continental shelf and the shelf break, located between 100 and 200 m water depths, were delimited (Panin et al., 1983; Panin and Strechie, 2006). The Delta Front extends to water depths between 15 and 45 m, while the Danube Prodelta could be found to depths of 50–60 m (Panin, 2003). Within the Danube littoral zones, superficial sediments are mainly fine to very fine well-sorted sands, sourced from the Danube and redistributed onshore by waves and currents (Stănică et al., 2007).

Concerning the Holocene sedimentation of the Black Sea, Ross and Degens (1974) identified in the deep parts of the basin three lithological units: the oldest unit, Unit 3, the lacustrine lutite, deposited during the freshwater or oligohaline stage; Unit 2, the sapropel mud, corresponding to a brackish, anoxic phase, and the youngest unit, Unit 1, the microlaminated coccolith ooze, a pelagic sediment deposited under recent marine conditions, associated with the full invasion of the coccolithophoridae species *Emiliania huxleyi*. These units can be found only in the deeper parts of the Black Sea, at water depths below 200 m (Giunta et al., 2007; Melinte-Dobrinescu and Briceag, 2011; Oaie and Melinte-Dobrinescu, 2012).

In the shallow setting of the NW Black Sea the lithological units of deeper parts of the basin could not be recognised. In this shallower setting (i.e., the Romanian Black Sea shelf), Giunta et al. (2007) and Oaie and Melinte-Dobrinescu (2012) identified the Shallow Unit, which corresponds to Unit 1 and Unit 2 deposited in the basinal setting.

3. Material and methods

For this study, two undisturbed cores collected by using a multicorer were analysed: (1) MN 103_04 at 78 m water depth, S of the Sfântu Gheorghe (Saint George) branch of the Danube Delta, at 44° 33′ 00.378″ N; 30° 27′ 01.104″ E; and (2) MN 103_09 at 17.80 m water depth, located in front of the Sulina branch of the Danube Delta, at 45° 07′ 22.446″ N; 29° 47′ 33.792″ E (Fig. 1). The two cores