15th International Congress of the Geological Society of Greece
Athens, 22-24 May, 2019 | Harokopio University of Athens, Greece
Bulletin of the Geological Society of Greece, Sp. Pub. **7** Ext. Abs. GSG2019-289

Summer coccolithophore community in the Western Black Sea

A. Ravani[1] M.D. Dimiza[1], M.V. Triantaphyllou[1], E. Malinverno[2], B.-T. Karatsolis[3], A. Lagaria[4], S. Psarra[4]

(1) Department of Geology and Geoenvironment, National and Kapodistrian University of Athens, Panepistimiopolis, 15784 Athens, Greece, mdimiza@geol.uoa.gr
(2) University of Milan – Bicocca, Department of Earth and Environmental Sciences, Piazza della Scienca 4, Milano, Italy
(3) Uppsala University, Geocentrum, Villav 16, Sweden
(4) Hellenic Centre for Marine Research, Institute of Oceanography, 190 13 Anavyssos, Attiki, Greece

Background

Coccolithophores have a widespread distribution in the photic zone, ranging from polar to tropical waters, but overall show preference to warm, low productivity regions (e.g., Winter et al., 1994; Karatsolis et al., 2017). Most coccolithophore taxa are more diverse and abundant in low and middle latitude warm, and stratified oligotrophic waters. However, certain species, such as *Emiliania huxleyi*, reveal an opportunistic and r-selected behavior (e.g., Tyrrell and Merico, 2004) thriving in high productivity areas and often form intense blooms over large areas of the ocean (e.g., Westbroek et al., 1993).

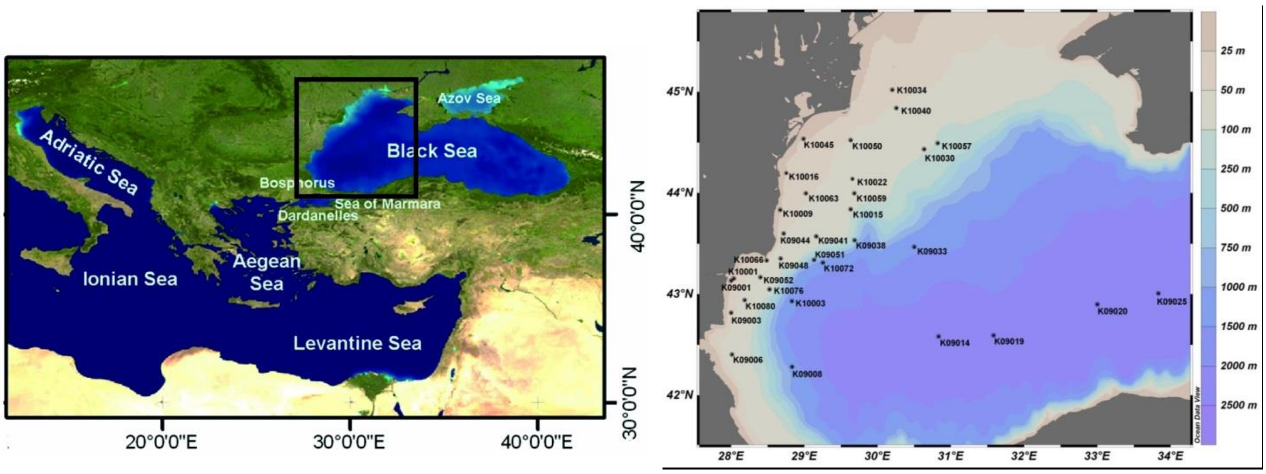
The Black Sea is the largest semi-enclosed marginal sea and receives drainage from almost one-third of continental Europe. Intensive coccolithophore blooms (*Emiliania huxleyi*, primarily) are typical events for the Black Sea. According to satellite observations, on a temporal scale the most extended bloom occurs in May-June, although differences in intensity and area of coverage have been recorded (e.g., Cokacar et al., 2004; Kopelevitch et al., 2014; Triantaphyllou et al., 2014; Mikaelyan et al., 2015). These blooms can be detected by ocean color sensors as a result of light being scattering by the coccolith plates that are detached from cells. The optical signature of coccolithophore blooms on satellite true color images is a very bright patch of water with a milky turquoise color. The Black Sea is an ideal site in which to study the effect of biogeochemical properties on coccolithophore blooms.

Objectives

The main aim of this study was to determine the spatial and vertical distribution patterns of living coccolithophores from the oxic surface zone in the western part of the Black Sea in June 2016.

Materials and methods

The present study focuses on the analysis of 95 seawater samples from 33 stations from the inner (<50 m depth), outer (50–200 m depth) self and the open sea (>200 m depth), in the western part of the Black Sea, that was undertaken in June 2016 (2–24/06). For each sampling station, a surface sample was taken from 1 m depth and 1-4 more depths within the surface layer (5 m – 50 m), adjusted to bottom topography and bathymetry. Water samples were taken with a 5 L Niskin bottles positioned in a rosette over the CTD system of the ship.



Figur3 1. Map of the study area and location of the stations sampled for coccolithophore analysis at the western part of the Black Sea.

Several physico-chemical parameters including temperature, salinity profiles were measured at most of the stations using a SBE-19 CTD-Rosette System. The amount of chlorophyll-a (Chl *a*) that corresponded to the 0.2-2.0 μm and >2.0 μm size classes was measured fluorometrically (Holm-Hansen et al., 1965).

The coccolithophore composition and community structure was evaluated through Optical Microscopy. The samples were examined in a Leica DMLSP polarizing light microscope and the coccospheres per liter were calculated following the methodology of Jordan and Winter (2000).

Results and Discussion

At the northern areas of the inner shelf the sea surface temperature ranged from 16 to 22 °C. In the outer shelf region the temperature increased reaching the values of ~21°–24 °C, whereas in the open sea the values fluctuate from 21 to 22 °C. The sea surface salinity was relatively low, both in the shelf and open sea areas. Generally, the salinity values ranged from the minima of < 17.5, near the northern shelf area reflecting the influx of fresh water from the Danube River to the maxima of 17.5–18.9 in the open sea.

The spatial distribution (1 m depth) of Chl *a* was revealed from the seventeen samples collected mainly from the south-western part of the studied areas. Total Chlorophyll-*a* concentrations in surface waters ranged from 0.147 $\mu g\ l^{-1}$ to 5.764 $\mu g\ l^{-1}$. The values of Chl *a* were increased near the self-region with maxima in the northern stations, with decreasing trend towards the open sea stations.

Living coccolithophores showed excessively high densities ranging from $2.44x10^4$ to $7.63x10^6$ coccospheres l^{-1}. *Emiliania huxleyi* lightly calcified morphotypes ($1.24x10^4$–$7.38x10^6$ coccospheres l^{-1}) dominated in the surface assemblage and constituted the 98% of the coccolithophore community. Differences in spatial distribution between inner self and open-sea environments were observed that are primarily associated with freshwater inputs and nutrients influx from the Danube River. A significant positive correlation between *E. huxleyi* density and Chl *a* concentrations (Pearson $r=0.255$, $p<0.05$) indicate a direct relationship between coccolithophores and chlorophyll-*a*.

In general, *Emiliania huxleyi* was usually higher in the surface layer (up to around 35 m), and tended to decrease in density below ~35 m water depth, while *Algirosphaera robusta* occurred in high densities in the deeper parts (up to $7.94x10^6$ coccospheres l^{-1}), indicating low light availability below the thermocline.

The present study suggests that some Syracosphaeraceae and Rabdosphaeraceae taxa such as *Syracosphaera dilatata*, *Syracosphaera molischii*, *Acanthoica acanthifera*, *Acanthoica quattrospina* and few holococcolithophores (*Syracosphaera arethusae* HOL and *Helladosphaera cornifera*) that have also been identified in the studied Black Sea water samples prove to thrive well in low salinities and relative eutrophic conditions.

Acknowledgments

The material studied for coccolithophore analysis was provided during the BIO-OPT-2016 EUROFLEETS cruise, onboard the R/V Akademik.

References

Cokacar, T., Oguz, T., Kubilay, N. 2004. Satellite-detected early summer coccolithophore blooms and their interannual variability in the Black Sea. Deep-Sea Research Part I, 54: 1017–1031.

Holm-Hansen, O., Lorenzen, C.J., Holmes, R.W., Strickland, J.D.H., 1965. Fluorometric Determination of Chlorophyll. ICES J Mar Sci. 30(1), 3–15.

Jordan, R.W., Winter, A., 2000. Assemblages of coccolithophorids and other living microplankton off the coast of Puerto Rico during January-May 1995. Mar. Micropaleontol. 39, 113–130.

Karatsolis, B.-Th., Triantaphyllou, M.V., Dimiza, M. D., Malinverno, E., Lagaria, A., Mara, P., Archontikis, O., Psarra, S., 2017. Coccolithophore assemblage response to Black Sea Water inflow into the North Aegean Sea (NE Mediterranean). Continental Shelf Research 149, 138–150.

Kopelevich, O.V., Burenkov, V.I., Sheberstov, S.V., Vazyulya, S.V., Kravchishina, M., Pautova, L.A., Silkin, V.A., Artemiev, V., Grigoriev, A. 2014. Satellite monitoring of coccolithophore blooms in the Black Sea from ocean color data. Remote Sensing of the Environment, 146: 113–123.

Mikaelyan, A.S, Pautova, L.A., Chasovnikov, V.K., Mosharov, S.A., Silkin, V.A. 2015. Alternation of diatoms and coccolithophores in the northeastern Black Sea: a response to nutrient changes. Hydrobiologia, 755: 89–105.

Triantaphyllou, M.V., Malinverno, E., Dimiza, M.D., Gogou, A., Athanasiou, A., Skampa, E., Tselenti, D., Thanassoura, E., Birli, A., Stavrakaki, I., Stavrakakis, S., Corselli, C., Lykousis, V. 2014. Coccolithophore biogeographic trends and export production in the Eastern Mediterranean and Black Seas. Journal of Nannoplankton Research, 34: 97–98.

Tyrrell, T., Merico, A., 2004. Coccolithophores—From Molecular Processes to Global Impact, Ed. by H. R. Thierstein & J. R. Youngs (Springer, 2004), pp. 75–97.

Westbroek, P., Brown, C. W., Bleijswijkbrownlee, J. Van C., Brummer, G. J., Conte, M., Egge, J., Fernandez, E., Jordan R., Knappertsbusch, M., Stefels, J., Verdhuis, M., Van Der Wal, P., Young, J., 1993. A model system approach to biological climate forcing: the example of Emiliania huxleyi. Global and Planetary Change, 8, 27-46.

Winter, A., Jordan, R. W. & Roth P., 1994. Biogeography of living Coccolithophores in oceanic waters. In: A. Winter & W.G. Siesser (eds), Coccolithophores, p. 13-27, Cambridge University Press.