SPATIO-TEMPORAL VARIABILITY OF BIOEROSION IN THE EASTERN MEDITERRANEAN SEA

C. Färber [1]*, M. Wisshak [1], J. Titschack [2], C. H. L. Schönberg [3] and A. Freiwald [1]
[1] Senckenberg am Meer, Abteilung Meeresforschung, Wilhelmshaven, Germany - claudia.faerber@senckenberg.de
[2] MARUM - Center for Marine Environmental Sciences, University of Bremen, Bremen, Germany
[3] Oceans Institute, The University of Western Australia, Crawley, Australia

Abstract
In order to investigate the spatio-temporal distribution and impact of carbonate bioeroding biota in the Eastern Mediterranean Sea, three settlement experiments were carried out from ½ to 14 years along a bathymetric transect from bathyal depths across the supratidal zone. The assessment of bioerosion rates and patterns was based on gravimetrical measurements, scanning electron microscopy, and micro-computed tomography. The results show that bioerosion in the Eastern Mediterranean Sea distinctly varies in context of time, light, water temperature, and nutrient supply.

Keywords: Algae, Mediterranean Sea, Porifera, Cyanobacteria, Erosion

Bioerosion is a key process during the recycling of carbonate substrate and the formation of calcareous sediments in the ocean [1]. Settlement experiments are an important tool for monitoring the impact of bioerosion under different environmental conditions. In the last years, a series of short-term experiments was carried out, providing a detailed picture on microbioerosion in different biogeographical settings, but long-term experiments on the succession of macrobioeroders were previously limited to the tropical realm [2]. In the Mediterranean Sea, bioerosion affects sensitive ecosystems such as limestone coasts, deposits of coralline algae, and cold-water coral reefs as well as molluscs in aquaculture, submerged man-made materials, and artefacts [3]. Ongoing eutrophication, pollution, warming, and ocean acidification are considered to magnify the intensity of bioerosion [3]. Taxonomical studies on bioeroding cyanobacteria and chlorophytes have been carried out in the Mediterranean Sea since the late 19th century, but experimental studies remain scarce and were mainly concentrated on the Marseilles region in the Western Mediterranean Sea [4-5].

Aim of this study was to collect first experimental data on bioerosion in the Eastern Mediterranean Sea. This was based on two short-term (½-2 years) and one long-term experiment (1-14 years), resulting in a bathymetric transect from bathyal depths across the supratidal zone. Scanning electron microscopy and micro-computed tomography yielded 44 bioerosion traces that were mainly produced by endolithic cyanobacteria, chlorophytes, fungi, and sponges. During the short-term experiments mostly microbioerosion traces were observed, but only initial macroborings and grazing traces.

The results indicated a distinct zonation of microbial endoliths according to the availability of light in the water column, which seasonally varied in context with water temperature and nutrient supply. The highest bioerosion activity of microbioeroders was recorded in 15 m up-facing substrates in the shallow euphotic zone (mean 83 g m^{-2} yr^{-1}), largely driven by phototrophic cyanobacteria, while towards the chlorophyte-dominated deep euphotic to dysphotic zone and the organotroph-dominated aphotic zone the intensity of bioerosion and diversity of bioerosion traces strongly decreased (mean 1.39 g m^{-2} yr^{-1} in 250 m). During the long-term experiment first distinct macroborings were developed after 2 years with initially very low macrobioerosion rates (1.5-85 g m^{-2} yr^{-1}), followed by an intermediate stage in year 6 to 7 when boring sponges matured and bioerosion rates increased (308-648 g m^{-2} yr^{-1}). After 14 years, 30 % of the block volumes were occupied by boring sponges, yielding maximum bioerosion rates of 900 g m^{-2} yr^{-1}, but a high spatial variability prohibited clear conclusions about the onset of macrobioerosion equilibrium conditions.

These findings highlight the impact of bioerosion in the Mediterranean Sea and underline the necessity of long-time exposure and high replication at various factor levels in order to better understand and quantify macrobioerosion in the marine realm.

References
1 - Neumann, A.C., 1966. Observations on coastal erosion in Bermuda and measurements of the boring rate of the sponge, *Cliona lampa*. Limnol. Oceanogr., 11: 92-108.
2 - Wisshak, M., 2006. High-latitude bioerosion: The Kosterfjord experiment. Springer, Berlin.
3 - Schönberg, C.H.L. and Wisshak, M., 2014. Marine bioerosion. In: Goffredo, S. and Dubinsky, Z. (eds.), The Mediterranean Sea. Springer, Netherlands, pp 49-68.
4 - Le Campion-Alsumard T., 1979. Les cyanophycées endolithes marines. Systématique, ultrastructure, écologie et biodestruction. Oceanol. Acta, 2: 143-156.
5 - Sartoretto S., 1998. Bioérosion des concrétions coralligènes de Méditerranée par les organismes perforants: essai de quantification des processus. C. R. Acad. Sci., Ser. IIa, 327: 839-844.