THERMAL POLLUTION IMPACT ON BENTHIC FORAMENIFERAL ASSEMBLAGES AS ANALOG TO GLOBAL WARMING, SE MEDITERRANEAN SHORE (ISRAEL)

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Abstract

This study examines the effects of heated water originating from the "Orot Rabin" power plant on benthic foraminifera known to be sensitive bioindicators of environmental change. We performed 10 sampling campaigns during a period of one year, at 4 stations located along a temperature gradient of approximately 10 °C. The SST along the transect vary between 25/18 °C in winter, and 36/31 °C in summer. A significant negative correlation was found between SST and benthic foraminiferal abundance, species diversity and species richness. If this research is taken as a model, it may be concluded that global warming has a primary negative effect on foraminifera assemblage characteristics and thereby most likely on other marine organisms as well.

Keywords: Foraminifera, Thermal Pollution, Eastern Mediterranean, Biodiversity

Over the past several decades public and scientific awareness to global warming has increased significantly. As a result, many studies have examined the potential deleterious effect of global warming on the natural environments, though few have explored its effect on marine living organisms in the southeast Mediterranean Sea. As of today, an accepted forecast for the next two decades is that ocean temperatures will rise at a rate of 0.2 °C per decade [1]. The current rate of warming in the Mediterranean Sea is in accordance with the rate of global warming and stands at 0.028 °C/year [2].

This study was set to examine the effects of increased SST on benthic foraminifera known to be sensitive bioindicators of environmental change. The thermal patch originating from a power plant on the coast of Israel was chosen as a sampling area for this research, since it presents a unique small-scale analog for the expected future rise in sea surface temperatures. Ten monthly sampling campaigns, were performed in 4 stations located along a temperature gradient of approximately 10 °C, from the discharge site of the heated seawater to a few kilometers south. Benthic foraminifera were collected from a shoreface complex of macroalgae and sediment trapped within. The SST varied between winter, 25/18 °C and summer, 36/31 °C along the transect (Fig. 1). During the summer, the addition of the temperature anomaly to the already extreme summer temperatures becomes a threat.

The natural seasonal pattern in this near-shore environment, depicted best by station 4 located beyond the thermal patch, shows that foraminifera reach maximal abundance in winter and spring, ~2 months prior to a deeper (~40 m) inner shelf habitat, probably due to faster warming of the shallow waters. A significant negative correlation was found between SST and benthic foraminiferal assemblage characteristics. The abundance and species diversity show negative correlation with the SST anomaly throughout most of the sampling period, though the species diversity was not as significant as the abundance. The total foraminiferal abundance was significantly lower at the thermally polluted stations, especially during the summer, but also throughout the entire year, indicating that the thermal pollution has a detrimental effect on benthic foraminifera, irrelevant to the natural cyclic changes in SST. The foraminiferal abundances decrease as the SST rises (Fig. 1), reaching minimal abundances when the SST rises above 30 °C, indicating that this temperature maybe a critical threshold above which foraminifera growth and reproduction are severely retarded.

Species richness reached extremely low values at the thermally polluted stations during the summer, with a minimum of 3 species compared to a maximum of 24 in the natural, unaffected station. This indicates that some species have adapted to the elevated temperatures better than others. The foraminiferal assemblage at the sampling area is composed mostly of epiphytic species. A total of 42 species belonging to 24 genera were identified with six species dominating the assemblage throughout most of the sampling period. These species appeared to have different seasonal patterns, out of the six dominant species *Rosalina globularis*, *Tretomphalus bulloides* and *Textularia agglutinans* show a clear preference to the winter months, while species belonging to the genus *Lachlanella* reach maximum abundances in spring and *Pararotalia spinigera* in summer. The temperature tolerance varied considerably among the different species with some being more tolerant to the raised SST than others. The miliolids, *Lachlanella* sp. 1 and sp. 2 seem to have high tolerance to the elevated SST and even survived the most extreme summer temperatures at the thermally polluted stations.

In this research we show that even a rise, as small as 2 °C, in SST can have serious ramifications on the benthic communities living in the near shore environment. If foraminifera are affected to such an extent it is not unlikely that other more developed marine creatures will be negatively affected as well, either directly by the rise in SST or via the decrease in organisms lower down the marine food chain, such as foraminifera. If this research is taken as a model, it may be concluded that global warming has a primary negative effect on foraminifera assemblage characteristics and thereby most likely on other marine organisms as well.

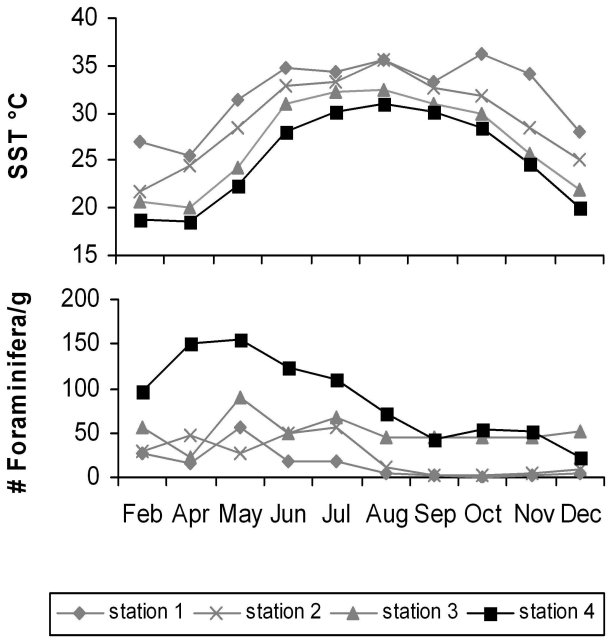

Fig. 1. The SST and the average foraminiferal abundance at the 4 stations throughout the sampling period

References

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