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The effect of increased rainfall on the sandy beach ecosystem: results from a pan-European experiment

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Sandy beaches represent a dynamic interface between the marine, terrestrial and groundwater systems which may be rapidly influenced by rainfall events. The meiofauna of beach sediments are responsive to changes in salinity, drying and periods of emergence and may be ideal organisms for modelling the direct effects of climate change. Recent research suggests that patterns of rainfall over Europe will change in quantity, frequency and intensity.

Here we present the results from the largest fully standardised and replicated field experiment ever undertaken in meiofaunal ecology carried out in the framework of the European NoE MarBEF MANUELA subproject. Sandy beaches from four European locations (Poland - Baltic Sea, Belgium - North Sea, Portugal - NE Atlantic Ocean and Crete - Mediterranean Sea) representing different kinds of beaches in different climatic areas were subjected to artificially increased rainfall during a period of 2 weeks in order to investigate the response of meiofaunal nematodes in terms of densities, diversity and community composition to predicted climate change. Artificial rainfall was applied in such a way that it mimicked increased intensity and frequency. Changes in the benthic environment were assessed by analysing the vertical distribution of the concentration of chloride ions, as a proxy for interstitial salinity.

Multivariate patterns in nematode community composition were investigated using Permanova. Homogeneity of multivariate dispersion was checked by the PERMDISP procedure. Univariate indices (densities and diversity) were analysed using repeated measures ANOVA after testing for assumptions.

Our results show that climate change indeed affects the sandy beach ecosystem of Europe. The application of artificial rain caused changes in the sedimentary environment, as salinity profiles (upper 15cm) changed drastically. After 4 days of artificial heavy rainfall, salinity levels were generally depressed. Only at the Baltic Sea station, concentrations of chloride ions were below detection limit in both treatment and control samples. However, the effect of increased rainfall on the biological communities depends on the geographical location. Nematodes from less dynamical beaches (e.g. the microtidal Mediterranean beach) were more drastically affected in terms of nematode density, diversity and community composition compared to nematodes inhabiting more dynamical beaches (macrotidal beaches from NE Atlantic or North Sea coasts). Nematode densities decreased significantly after 4 days of artificial rain in the North Sea (Fig. 1) and Mediterranean beaches. At the very dynamic Atlantic beach, nematode community composition was marginally affected ($p=0.05$) while the rain application did not affect nematode densities. Nematode communities inhabiting the low salinity Baltic coast appear to be more resistant. Therefore, we hypothesise that the decrease in nematode abundances and shifts in community composition that were observed were caused by changes in the interstitial salinity levels causing osmotic stress for the nematodes. The absence of large seasonal differences in e.g. temperature and rainfall in the Mediterranean locations probably

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increase the vulnerability of the sandy beach ecosystem to increased rainfall as the receiving communities are less adapted to such fluctuations. In addition, our results suggest that many sandy beach ecosystems are indeed vulnerable to consequences of climate change.

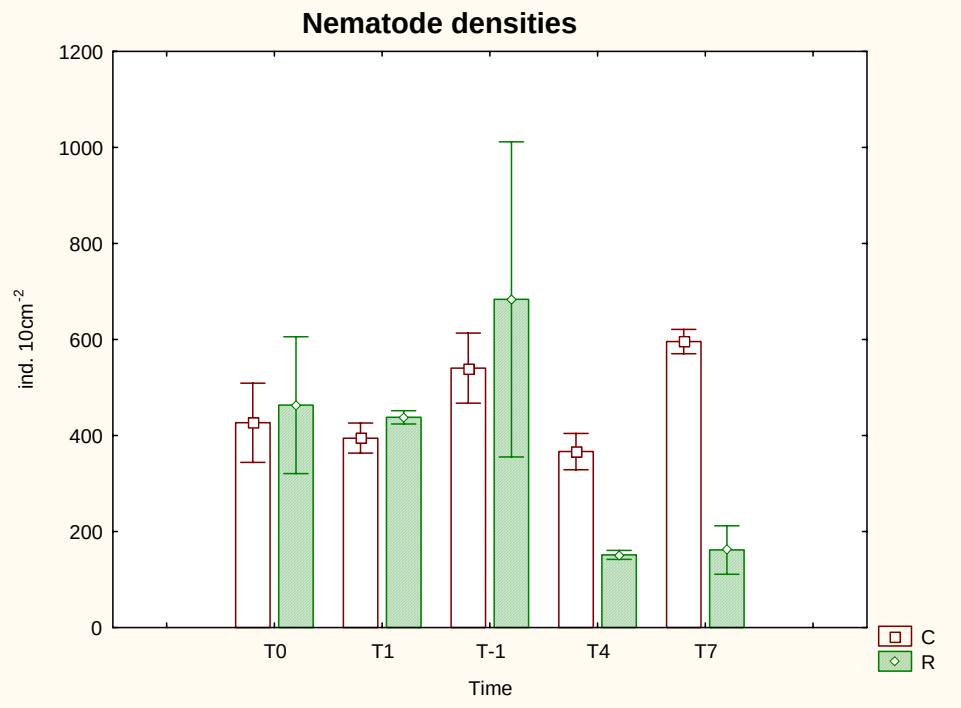

Figure 1: Evolution of nematode densities in treatment plots (R) and control plots (C) at the beach of De Panne (Belgium)