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Sediment-related distribution patterns of nematodes and macrofauna: Two sides of the benthic coin?

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ABSTRACT

We investigated the sediment-related distribution of both nematodes and macrofauna on the Belgian part of the North Sea (Southern Bight of the North Sea) in order to evaluate whether both faunal groups reflect similar patterns in community composition and diversity. Fine-grained sediments (median grain size <200 μm) were inhabited by nematode communities characterised by a low diversity and dominated by non-selective deposit-feeding nematodes. Nematode communities from coarser sediments were significantly different in terms of community composition and diversity. Moreover, all nematode feeding types were present in coarser sediments. These differences were explained by the contrasting biogeochemical processes prevailing in both sediment types, rather than granulometry and food availability *per se*. Macrofaunal distribution patterns were different from those of the nematode communities and seem to be related to water column processes (SPM loading, food availability, hydrodynamic stress) that promote the establishment of diverse communities in the coarser sediments but not in the finest sediments. This suggests that data on nematodes and macrofauna reveal different, complementary aspects of the factors structuring the benthic ecosystem that can be of importance in assessing the ecological status of the seafloor.

1. Introduction

As a consequence of the ever growing anthropogenic impact on the marine ecosystem, there is increasing demand for scientific data underpinning a sustainable management of the marine environment. The European Marine Strategy Framework Directive (2008/56/EC) creates a framework within which European member states should take the necessary measures to achieve or maintain a good environmental status in the marine environment by the year 2020. Seafloor integrity (i.e. the combination of spatial connectedness and having natural ecosystem processes functioning in characteristic ways, Rice et al., 2010) should be at a level that ensures the structure and functions of the ecosystem to be safeguarded and benthic ecosystems should not be adversely affected. One of the qualitative descriptors of good environmental status is a description of the biological communities associated with the predominant seabed habitats. So far, ecological status (e.g. in the framework of the implementation of the European Water Framework Directive) was based on a large variety of biotic indices based on data on macrofauna (Gremare et al., 2009) which is justified by the fact that macrofauna is ecologically important and obviously present, resulting in a wide availability of data on the spatial distribution of the macrofauna (e.g. Arvanitidis et al., 2009). For the same reasons, it is realistic to assume that biological indicators for the description of seafloor integrity will be based on data on macrofauna as well. Although the smaller sized nematodes are known to be good indicators of the health of the benthic environment also (Heip et al., 1985; Kennedy and Jacoby, 1999), they are not considered when assessing the ecological status of the benthic environment, probably since extensive datasets covering the needs for the Water and Marine Strategy Framework Directive purposes are lacking. However, it is to be expected that the community characteristics of both size groups reflect different aspects of the benthic environment as the small size of the nematodes induces an interstitial life style opposite to the burrowing of surface dwelling behaviour of the larger macrofauna (Schwinghamer, 1981). The distribution of macrofauna was linked to the combination of a variety of environmental variables such as grain size, organic and microbial content, food supply, trophic interactions (Snelgrove and Butman, 1994) and interactions between the organisms and the sediment (Gray, 1974). On the other hand, information on the factors influencing the spatial distribution of nematodes is still

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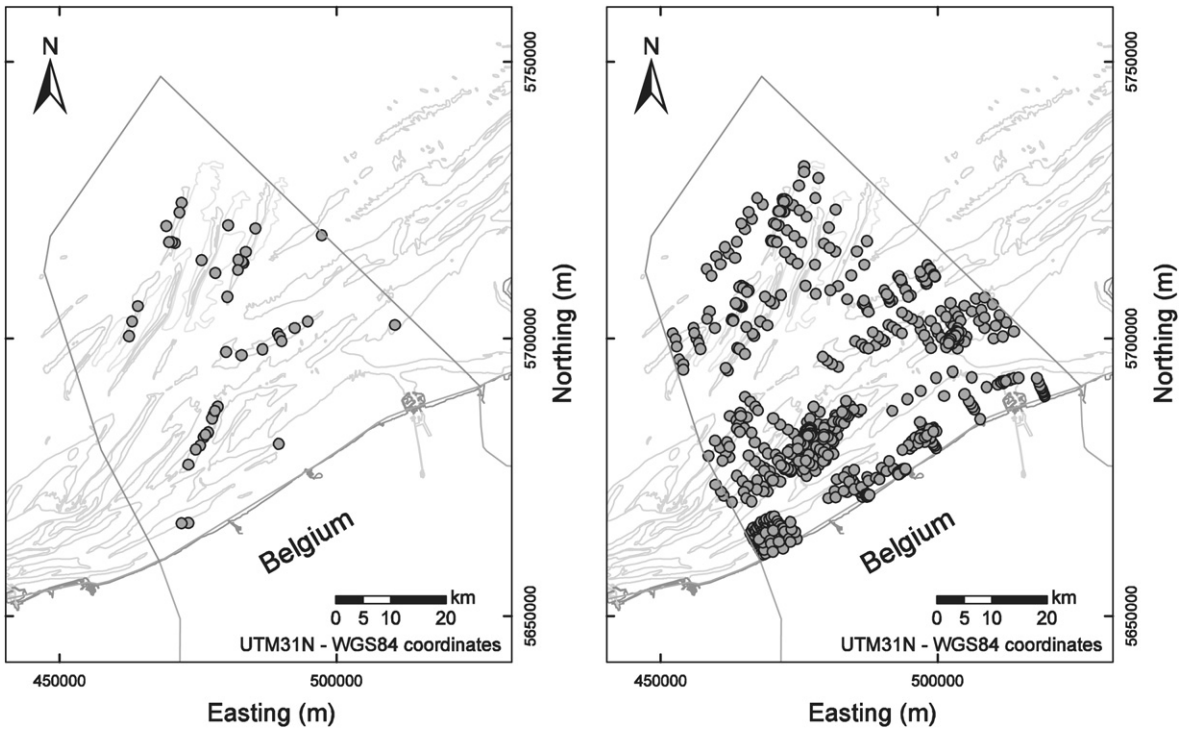

Fig. 1. Sampling locations on the Belgian Part of the North Sea. Left panel: nematode sampling locations; right panel macrofauna sampling locations.

limited and based on a relatively low number of papers reporting on results gathered from sampling a narrow range of sediment types or a limited amount of stations. Nematode distribution has been mainly linked to granulometric variables (Vanreusel, 1990; Vincx et al., 1990; Vanaverbeke et al., 2002) in combination with trace metals (Schratzberger et al., 2006). However, detailed research on the vertical distribution of nematodes highlighted the importance of sediment biogeochemistry, food availability and sediment oxygenation (Steyaert et al., 1999; Vanaverbeke et al., 2004a,b; Franco et al., 2008a) but these findings were never coupled with the spatial distribution of nematode communities. In this paper, we analyse two datasets on the nematode communities and macrofauna of the Belgian Part of the North Sea (Southern Bight of the North Sea), covering a wide variety of sediment types. We aim to understand the factors governing the spatial distribution of nematodes by integrating the spatial patterns with the recently developed ideas on the influence of biogeochemical processes on nematode communities. Characterisation (Van Hoey et al., 2004) and mapping (Degraer et al., 2008) of macrobenthic communities at the BPNS was done before and will not be repeated here. We used the data from Degraer et al. (2008) to compare patterns in community composition and diversity of nematodes with similar patterns in the macrofauna from the same area. This integrated analysis of different benthic groups with differing life history strategies and abilities to cope with local environmental stress will result in a more holistic view of the benthic ecosystem needed for the implementation of ecosystem-based approaches to marine management.

2. Material and methods

Analysis of similarities in spatial distribution and diversity of different size groups within the benthos is ideally performed using data on both macrofauna and meiofauna that are simultaneously collected at identical stations. To our knowledge, these kind of analyses were only performed twice, based on data collected in a relatively small number of stations (Schratzberger et al., 2006: 19 stations along the UK coast in the southwestern North Sea; Schratzberger et al., 2008b: 18 stations in the Celtic Deep and NW Irish Sea) covering a narrow range of sediment types. In order to increase the knowledge on similarities in distribution of differently sized benthic groups in a wider ecological setting, we used independently collected databases representing a wide variety of sediment types within a rather limited area (3600 km^2). All data were collected by a single research team using the same techniques at all sampling stations and moments, excluding possible methodological bias in the data.

2.1. Study site

The Belgian Part of the North Sea (BPNS) is located in the Southern Bight of the North Sea (Fig. 1) and has a surface of 3600 km^2. Despite being small, the BPNS is characterised by a highly variable and complex topography due to the presence of four series of sandbanks (Maes et al., 2005) and by highly variable sediments (Verfaillie et al., 2006). Both meiofauna and macrofauna were sampled extensively at the BPNS (Fig. 1), resulting in a good representation of all habitats among the available data.

2.2. Nematode data

Nematode data were obtained from the MANUELA database, which contains 83 component datasets on meiobenthos from almost 1300 stations, representing about 140 000 distribution records (Vandepitte et al., 2009). This database was queried for datasets containing both nematode species information and data on median grain size gathered on the BPNS. All data were collected and treated in the same way. Sediment sampling was done using replicate drops of a Reineck boxcorer, which was subsampled with 10 cm^2 perspex cores. Macrobenthos was removed by sieving the