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BENTHIC HISTORY OF THE WADDEN SEA

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ABSTRACT

Over the last hundred years, conspicuous changes occurred in the benthos of the Wadden Sea. Direct exploitation and disturbances by the fishery, and enhanced eutrophication of the coastal waters seem to be the primary agents of change. Oyster beds were overexploited and vanished together with associated species. Sessile epibenthos declined. More recently, natural mussel beds are affected by exploitation. Red algae retreated from the deeper part of their vertical range, and green algae showed unprecedented mass developments on tidal flats in recent years. Benthic infauna became more numerous, and mussel beds showed an intermittent expansion. An increased supply of nutrients and food may explain these changes. Seagrass declined in the 1930s. A comeback was restricted to the intertidal zone. Now it is declining again. The cause is unknown. There is a need for comprehensive, regional surveys of the entire benthos in order to detect changes in the biota.

INTRODUCTION

A summary of benthic changes in the Wadden Sea over the past 100 years is presented. Reports on the benthos started with Möbius (1893), Dahl (1893) and Warming (1904) at the turn of the century. Evidence is taken from these and later publications to reconstruct historical change. This endeavour may help to judge upon the ongoing changes, and to evaluate present ecological conditions.

SEAGRASS

Populations of *Zostera marina* crashed in the 1930s throughout the northern Atlantic (den Hartog 1987). In the Wadden Sea, subtidal seagrass beds did not recover. On the intertidal flats, *Z. marina* came back, where *Z. noltii* was not or only very little affected. However, in recent years, these intertidal seagrass beds seem to decline from south to north in the Wadden Sea. According to an aerial survey in 1991 (Reise, in prep.), there is almost no seagrass left in the Dutch Wadden Sea, few beds occur in the German Wadden Sea, except in the most northern part and in the Danish Wadden Sea, where both seagrasses are still thriving. A slimemold-like protist (*Labyrinthula P*), a disease agent affecting *Z. marina* in the 1930s, is back again, but does not yet attain epidemic proportions (Vergeer & den Hartog 1991). The cause of the present seagrass decline is still a riddle.

MACROALGAE

Red algae, once abundant on the former oyster beds of the North Frisian Wadden Sea, are rare today on subtidal bottoms but are still common in the lower intertidal (Reise et al. 1989). This pattern suggests that less light penetrates the muddy waters of the present Wadden Sea. Green algae, on the other hand, regularly showed mass developments during the last decade, while being of marginal occurrence in the earlier Wadden Sea (Reise 1983, Reise et al. 1989). Aerial surveys conducted in 1989 to 1991 revealed extensive algal mats covering sandy tidal flats along the sheltered side of the islands (Reise, in prep.). Underneath these green algal mats, mainly composed of *Enteromorpha spp.*, anoxic conditions develop which kill the endobenthic fauna. It also causes nutrients to be released from the sediment which further enhance algal growth.

Benthic Epifauna

Natural beds of oysters (Ostrea edulis) have been overexploited in the Wadden Sea since the middle of the 19th century (Möbius 1977). In 1925 economic use came to an end, and the last living oysters were caught in 1940 (Hagmeier & Kändler 1927, Hagmeier 1941). Several associated species vanished together with the oyster beds (Reise 1982, 1990a). Comparative dredging in the subtidal channels revealed that sessile and slow moving epifauna were more common in the period 1924 to 1940 than in the 1980s, while mobile species showed little change (Reise et al. 1989, Reise 1990b). Bottom trawling of the fishery is a likely cause. Mussel beds (*Mytilus edulis*) increased (Riesen & Reise 1982, Reise & Schubert 1987, Michaelis 1987). This may have resulted from culturing practices, and/or the mussels were augmented by an increase in planktonic food. During the 1980s, exploitation of the wild beds intensified, and the the former trend reversed (Obert & Michaelis 1991).

Benthic infauna

Benthic infauna increased in abundance. This is revealed by revisiting subtidal and intertidal stations, sampled before in the 1920s and 1930s (Riesen & Reise 1982, Reise & Schubert 1987, Reise 1990b) and by regular sampling over the past 20 years (Beukema & Cadee 1986, Beukema 1989). Polychaetes became more abundant, and infaunal bivalves gained in biomass. Presumably, the endobenthic fauna takes advantage from an increased food supply.

Conclusions

Over the past hundred years gains as well as losses occurred in the benthos of the Wadden Sea. There seem to be two major agents. One is the direct exploitation and disturbance of the benthos by the fishery. Oyster beds and associated species vanished, epibenthos declined, and more recently natural mussel beds are on the retreat. The other major cause of change seems to be enhanced eutrophication. This is suggested by mass developments of green algae, an increase in the infauna, and an intermittent expansion of natural mussel beds. Even the contraction of the vertical range of red algae, if caused by decreased light penetration, may be ultimately related to eutrophication. The recent decline of seagrass still presents a riddle. The inherent spatial and temporal variability in the benthos of the Wadden Sea makes it difficult to recognize long-term changes by repeated sampling at some selected stations. The historical changes summarized in this article are often better identified by occasional, large-scale surveys. Comprehensive studies on the entire benthos of particular regions of the Wadden Sea in the first half of the century, i.e. by Hagmeier & Kändler 1927, Thamdrup 1935, Wohlenberg 1937 and Linke 1939, are nowadays of great value to judge upon the present ecological conditions. Encouragement should be given to modern equivalents of such studies, requiring versatile naturalists.

Literature

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