Contrasts in benthic community structure off the North Yorkshire coast

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ABSTRACT

Two macro-infaunal communities have been monitored for 2.5 years. Sandsend (depth 11 m) community dynamics are characterised by annual cycles of recruitment and mortality, but the declines unexpectedly do not correlate with periods of storms and may be controlled by density dependent effects. A survey strategy must contain frequent sampling to monitor the large, rapid changes. Maw Wyke (depth 45 m) fauna is diverse, but is structured overall by the polychaete Melinna cristata which occurs in dense aggregations. The density of infauna is positively correlated with the number of Melinna. Analysis of Melinna population structures suggests that the aggregations have long term stability, but spatial fluctuations pose difficulties for an ecosystem survey.


RÉSUMÉ

Contrastes dans la structure d'une communauté benthique de la côte nord du Yorkshire

Deux communautés de la macrofaune endogée ont été étudiées pendant deux ans et demi. Les variations de la communauté de Sandsend (11 m de profondeur) sont caractérisées par des cycles où le recrutement annuel est l'un des principaux traits. Les baisses de densité ne sont pas corrélées, comme on pouvait s'y attendre, avec les périodes de tempête, et paraissent contrôlées par des effets dépendant de la densité. Une stratégie d'étude doit comporter de fréquents prélèvements de façon à prendre en compte les changements bruts et rapides. La faune de Maw Wyke (45 m) est diversifiée, mais elle est dominée par une polychète : Melinna cristata, qui est présente en agrégats denses. La densité de la faune endogée présente une corrélation positive avec le nombre de Melinna. L'analyse de la structure de la population de Melinna suggère que les agrégats présentent une stabilité à long terme, mais l'existence de fluctuations spatiales rend difficile l'étude de l'écosystème.


INTRODUCTION

This study describes the results of intensively monitoring two soft sediment habitats at opposite ends of the spectrum of physical regulation. The aims were to compare the magnitude of seasonal cycles and the degree of biological organisation in the communities. Major differences in the type of stability manifested and the consequences for surveying and monitoring the contrasting ecosystems are discussed. By concentrating frequent sampling on a single station in each habitat, the present study attempts to extend current insight into community regulation, with emphasis on population structure and dynamics of the dominant species.
METHODS

The study sites, Sandsend Bay (grid ref. NZ873138) and Maw Wyke (NZ965105), were visited from September 1979 to May 1982 at 4-6 week intervals (weather permitting). All samples were obtained using a Hunter grab with a sampling area of 0.1 m². Eight grab hauls were obtained from each site on each visit. The vessel was anchored and samples were spaced along a “transect” by paying out 2 m of anchor warp between each haul. Six samples were retained for macrofaunal analysis, while numbers 1 and 8 were sub-sampled, via the grab’s removable cover, for meiofaunal studies (50 mm diam. core) and sediment analysis (96 mm diam. core).

The sieve mesh size was varied between sites for the following reasons. A 0.5 mm mesh retained 40-50% more animals from Sandsend samples than a 1.0 mm mesh while not significantly increasing the bulk of sediment to be sorted. However, the 0.5 mm mesh increased retention by less than 10% from Maw Wyke samples but doubled the sorting time. Data presented are based on analysis of 4 samples per site per date, and species abundances are quoted in numbers per 0.1 m². Sediment samples were analysed according to the procedures of Folk (1968).

RESULTS

Sandsend Bay is an inshore site (depth 11 m), below the influence of normal wave action but strongly affected by storms. The sediment was well-sorted, clean fine sand with no significant change in any parameter recorded during the course of the study. The polychaete Spiophanes bombyx was the numerically dominant species in an assemblage of polychaetes, amphipods, cumaceans and bivalves. The 11 top ranked taxa, with the maximum abundance obtained, are given in Table 1. The species composition was stable for the duration of the study with no alteration in the dominants listed in Table 1. Numbers of species per 0.1 m² ranged from 11 to 27 (Fig. 1 B).

Numbers of individuals fluctuated between 150 and 15 000 animals per 0.1 m² (Fig. 1 A, C), being at a minimum each year in May with major peaks each August. In 1980 and 1981, the August peak characterised all 11 dominant species and was closely related to the heavy recruitments occurring at this time of year.

On two occasions, namely 20 February 1979 and 21 March 1980 (marked on Fig. 1 A, B), samples were obtained after several days of northerly gales (mean wind speeds over 30 knots), providing an opportunity to directly assess the effect of physical disturbance on the fauna. Figure 1 C, D shows abundance of all the dominant species before and after the periods of disturbance in both years. All species except Cumacea in both years showed no statistically significant change in density resulting from the storms. Total numbers (Fig. 1) were actually higher (not significant) in post storm samples in both years, indicating that storms do not cause measurable mortality or disruption to the community.

Maw Wyke

This offshore site (depth 45 m) was selected as a more physically stable habitat (Grasse, Sanders, 1973) to contrast with Sandsend. The sediment was polymodal and very poorly sorted (Folk, 1968). Species diversity was much higher than Sandsend, with polychaetes the dominant group (54 species), followed by amphipods (3 species), echinoderms (6 species) and bivalves (16 spe-
cies). Most species were “rare” (< 10/0.1 m²) with “suits” of about 20-40 species present in each 0.1 m² sample. The most common species with maximum abundance obtained are given in Table 2.

Both numerically and in biomass terms, the ampharetid polychaete Melinna cristata was the unique dominant species, attaining its maximum abundance in dense aggregations of up to 4000/0.1 m². The amphipod Ampelisca spinipes was frequently associated with Melinna at densities of up to 1000/0.1 m². Some Melinna aggregations appeared to be in discrete “patches” a few meters across amongst an otherwise sparse fauna, but in most cases patches were much less distinct and the density of Melinna was found to be continuously variable. The community showed high seasonal stability, with no significant annual cycles in numbers of individuals, number of species, Shannon diversity (H) or evenness (J).

The top ranked species all showed high spatial variability, making seasonal cycles difficult to detect, but appeared to be generally stable with no suggestion of the major fluctuations typical of Sandsend. Absence of large scale recruitments suggesting mainly conservative reproductive strategies at Maw Wyke, was confirmed by analysis of meiofauna cores. Melinna excepted, these samples revealed only very small numbers of juveniles throughout the year, with no dense settlements.

The presence of biological structuring in the community was assessed by examining the effect of Melinna aggregations on the distribution of other species in the habitat. Figure 2A is a scatter diagram of numbers of Melinna per sample plotted against total numbers of all other species. The density of the associated community is shown to be highly positively correlated with the density of Melinna. The product moment correlation coefficient of 0.49 using log data is significant at a probability level of 0.001%.

Size frequency analysis of Melinna to determine population structure was used to give an indication of the long term stability of the aggregations. Patches dominated by single cohorts are likely to have low stability with a duration approximately equal to the lifespan of Melinna (Woodin, 1976); those with animals of all sizes suggest much longer continuity. Figure 2B shows population structure obtained from measurements of head width of 200 animals selected randomly from dense aggregations and spaced approximately 2 months apart. The results accord with the life cycle described by Hutchings (1973) with a winter spawning influencing macrofauna samples in March. Despite some variation between years (cf. numbers of small animals in 1979 and 1980 especially) and also between patches (cf. April and September with March, June and August 1980) these random samples from different patches at different times of years show remarkably similar population structures. June and August 1980 excepted, there is relative uniformity in the proportion of new recruits and all samples contain most size categories. The majority of patches are dominated by larger animals, suggesting high persistence and stability.

### Table 2

<table>
<thead>
<tr>
<th>Species</th>
<th>Max no./0.1 m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Melinna cristata</td>
<td>3900</td>
</tr>
<tr>
<td>Ampelisca spinipes</td>
<td>836</td>
</tr>
<tr>
<td>Ampharetidae acutifrons</td>
<td>124</td>
</tr>
<tr>
<td>Limnoria lutea</td>
<td>81</td>
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<tr>
<td>Amage adpressa</td>
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<tr>
<td>Chone filicaudata</td>
<td>53</td>
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<tr>
<td>Ophyes albida</td>
<td>45</td>
</tr>
<tr>
<td>Myriophyle heeri</td>
<td>38</td>
</tr>
<tr>
<td>Heteromastus filiformis</td>
<td>28</td>
</tr>
<tr>
<td>Pholidia minuta</td>
<td>28</td>
</tr>
<tr>
<td>Scalibregma inflatum</td>
<td>24</td>
</tr>
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<td>Glyceria tectaleta</td>
<td>23</td>
</tr>
<tr>
<td>Paraonis pyra</td>
<td>19</td>
</tr>
<tr>
<td>Owenia fusiformis</td>
<td>14</td>
</tr>
</tbody>
</table>
is followed by a winter decline. In a habitat subjected to disruption by winter storms, the hypothesis of disturbance induced mortality seems very plausible. However, attempts to directly correlate faunal loss with severe storms were unsuccessful. McCall (1977) also demonstrated that storms cause sediment resuspension, but was similarly unable to relate faunal changes to particular periods of storms, either directly or indirectly through increased predation or starvation. Several studies have found only small faunal changes in intertidal sediments after the passage of hurricanes (Saloman, Naughton, 1977, and references therein).

Buchanan et al. (1978) found similar cycles of summer recruitment followed by winter mortality at stations off the Northumberland coast. Here winter mortality was highly positively correlated with absolute numbers of individuals at the start of the winter, while summer recruitment was negatively correlated with the previous March density. Similar density dependent effects appear to be influencing the Sandsend community, since 1979-1980 winter mortality was very low following the recruitment failure in August 1979 (see Fig. 1 A). Also, density in May 1981 following the heavy recruitment in 1980 was only slightly higher than the May density the previous year. Thus in all 3 years, the community stabilized at a minimum density of 150-300 animals in the period May-June, despite the fluctuation in recruitment levels between years. The 1979 failure may also be explained by the same density dependent effects, since February and March densities of that year were much higher than in the following 2 years. Buchanan found March to be the critical period for correlation with summer recruitment.

Stability in the Maw Wyke community is conferred by the ability of Melinna to perpetuate its own dense aggregations, thereby providing an environment for a large number of other species. The associated community consists of a high diversity (H 2.5) of stable species with conservative features. The increased abundance of other species may be explained by an increased food supply for deposit feeders resulting from the sediment trapping effect of large numbers of tube caps (Woodin, 1976). The consequent increase in density and species diversity will create a food resource for higher trophic groups. It is also likely that the sediment binding effect of the mat of tough dense tubes will provide a refuge from the digging activities of mobile predators such as fish and crustacea. Woodin (1978) showed experimentally that the infauna abundance was positively correlated with density of the onuphid polychaete Diopatra with tubes providing spatial refuges from predation.

The population structure of Melinna indicates a small brood size and a conservative life history strategy, characteristics typical of stable deep sea habitats and biologically regulated communities (Grassle, Sanders, 1973). Hutchings (1973) reported a lifespan of up to 5 years and a time to first spawning of 2 years for Melinna. The large heavy eggs adhere to adult tubes after fertilization and the non-planktonic lecithotrophic larval stage lasts about 3 days only (Nyholm, 1951). These features are non-opportunistic, and will all tend to confer seasonal and long term stability on Melinna populations.

The differences in community organisation in these two systems have important consequences for an approach to their longer term study. A monitoring strategy at Sandsend would need to contain several sampling dates per year in order to measure the baseline density each May-June and the annual recruitment in August. If sampling could only be on one date annually as suggested by Gray (1981), the period would need to be May-June. The advantage at Sandsend is the low spatial variation, necessitating only one sampling station. Conversely, at Maw Wyke spatial variation is high and temporal variation low. The community could be monitored by annual sampling at almost any time of year, but it is doubtful whether even a large number of replicates would sufficiently overcome aggregation to demonstrate density fluctuations. Any natural or anthropogenic perturbation would need to be measured in terms of changes in community or population structure.

Acknowledgements

I am indebted to Dr. J. R. Lewis for supervising this work and critically reading the manuscript. My thanks also go to Drs. J. Graham, M. A. Kendall and S. A. Woodin for useful discussions and to Messrs. A. E. Simpson, C. Wright and R. Worral for technical assistance. The research was financed by Messrs. Cremer and Warner, consulting engineers and scientists, to whom I am extremely grateful.

REFERENCES


