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What is the structuring role of biotic interactions in explaining distribution and zonation patterns on West European sandy beaches?

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INTRODUCTION

Biological communities on sandy beaches are generally considered physically controlled. Physical processes such as the movement of waves and tides, habitat characteristics en the swash climate are considered to be the strongest ecological factors structuring the communities on sandy beaches. Until recently, biotic interactions are regarded to be of minimal importance, although biotic interactions are known to play important roles in other intertidal habitats as rocky shores and intertidal flats. Some recent studies however, suggest that biotic interactions might play a role in structuring communities on sandy beaches as well, especially on a small scale and on dissipative beaches. As West European beaches are generally quiet dissipative, it was expected to find indications of biotic interactions on these beaches.

The main objective of this research was to examine the role of abiotic and biotic factors in clarifying the distribution and zonation patterns of sandy beach macrobenthos in Western Europe.

MATERIAL & METHODS

Data were collected of several West European beaches in Belgium, The Netherlands, Germany, France and Spain. Both macrobenthos data and environmental data were available for these beaches.

The seven most important macrobenthos species were selected based on their prominent abundance on the West European sandy beaches. These selected species were the amphipods *Bathyporeia pilosa* and *B. sarsi*, the isopods *Eurydice pulchra* and *E. affinis* and the polychaetes *Scolelepis squamata*, *Nepthys cirrosa* and *Eteone longa*. These species show a distinct zonation pattern on the beach, every species is occurring in its own specific zone. As information on the trophic position of these species is known, it was hypothesized that biotic interactions as competition and predation could play an important role in clarifying the distribution and zonation patterns.

Recently, modeling techniques have been used for analyzing analogous ecological questions. In this study, a regression model was developed for each of the selected species, including possible abiotic and biotic factors influencing their distribution. The most appropriate models with significant abiotic and biotic factors were then selected by the AIC method (Akaike's Information Criterion; Akaike 1974). The variance explained by the total model was divided in a part explained by the abiotic factors and a part explained by the biotic factors.

RESULTS & DISCUSSION

Results suggest that the two abiotic variables, generally considered as most important structuring factors on sandy beaches (mean sediment and emersion time), do not exclusively explain the variance in species distribution. Other variables such as food supply may play an important role on the beach and species-specific explanations might also be significant. Some species like *Bathyporeia sarsi* and *Eteone longa* inhabit a broad zone on the beach. The response of these species to abiotic variables is not that specific, so these variables were not selected in the regression models or their contribution was low. On the other hand, biotic

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interactions are suggested to explain up to one third of the variance in species distribution explained by the model. For more than half of the species models, other species were indicated as significant biotic variables, suggesting biotic interactions to be important. Both predator-prey interactions and competition were indicated for specific species associations. As on rocky shores, it could be stated that the lower distribution limits of several species were determined by the presence and interactions with other present macrobenthos. Furthermore, the presence of epibenthos and hyperbenthos on the beach during high tide might also influence the zonation pattern of the macrobenthos.

The modelling approach does however not give sound proof for the presence of interactions. Only experiments can elucidate true interactions and the specific processes behind these interactions but this study gives strong indications for biotic interactions on sandy beaches.

It is in our knowledge the first study that explicitly addresses the consequences of incorporating both abiotic variables and biotic interactions in modelling distribution and zonation patterns of sandy beach macrobenthos. It showed that the ecology of organisms inhabiting these apparently simple intertidal landscapes might be more complex than generally assumed.

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