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The epilithic macrofauna and macroalgae of the hard substrates along the Belgian coast

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Introduction

Intertidal rocky shores around the world are noted for their high density and diversity of marine organisms, these include algae, invertebrates, fish and birds amongst others. These shores form complex ecosystems where species richness is the result of biotic (e.g. predation, competition, grazing, etc.) and abiotic (tides, wave-action, topography, etc.) factors. The majority of organisms living on rocky shores are restricted to this shore-type where they live in unique communities. As a result these shores differ from the surrounding sandy shores.

In contrast to the north French and east English coasts, Belgium has no natural hard substrates along the coast. Coastal zone management has resulted in a number of artificial structures being built on this coastline e.g. harbours, dykes and groins. These structures provide the hard substrate needed for the attachment, growth and development of rocky shore organisms. These organisms, *sensu lato*, may be considered to be exotic species as they are only present as a result of man-made constructions. These hard structures thus contribute to an increase in the Belgian marine biodiversity. The epilithic organisms on these hard substrates also fulfil an ecological function, being a food source for birds such as the turnstone *Arenaria interpres* and the purple sandpiper *Calidris maritime*.

Physical characterization of hard substrates

The physical characterization of hard substrates of the Belgian coast resulted in the description of four types of structures: harbour walls, dykes, groins and piers. Further division was made on the basis of: degree of wave exposure, angle of slope (45° or 90°), orientation of structure to coast (parallel or perpendicular to coast), the length and height of substrate, material of substrate (e.g. concrete, sedimentary rock, asphalt, wood), and the presence or absence of rock-block piles. A selection was made from the above defined substrate types along the Belgian coast, which resulted in 17 sample sites.

Method

Each sample comprised a 0.25 m^2 square quadrat. The relative abundance of the various organisms was estimated and a sub-sample removed for further determination in the laboratory.

The term ''epilithic macrofauna'' is used to describe all invertebrates greater than 1 mm that occur on the hard substrate. The macrofauna fulfils an important function in marine ecosystems, this includes the processing of dead organic matter, grazing, predation, and filter-feeding. They also form an important source of food for higher trophic levels (e.g. fish, birds, crabs).

Macroalgae refers to all macroscopic seaweeds that belong to the divisions Chlorophyta, Phaeophyta and Rhodophyta. All macroscopic filament-forming or colonial diatoms and blue-green algae were also taken into account.

Results

Species richness and density

A total of 91 epilithic macrofaunal species and 78 macroalgal species were determined for the artificial hard substrates. The species richness being lower than that of the rocky shores of northern France and England, or of the hard substrate coast of the Netherlands, it nevertheless contributes greatly to the biodiversity of the Belgian coast. The importance becomes clear when comparing these structures biodiversity to the adjacent sandy shores (91 macrofaunal species as opposed to 47).

The observed epilithic macrofauna were all species with a wide distribution range within north-west Europe (HAYWARD & RYLAND 1990). The most abundant taxa are the Polychaeta, Mollusca, and Crustacea. This trend is true for the Belgian coast as a whole as well as for each of the sites individually.

Barnacles (Crustacea: Cirripedia) are the most dominant macrofaunal group, with respect to species richness and percentage cover, for all sites within the sessile organisms. Further, it was noted that within the sessile organisms mussels showed a preference for wave exposed shores (e.g. groins), while oysters were more prevalent in sheltered harbour sites (FISH & FISH 1996).

The exotic New Zealand species, *Elminius modestus,* is the most abundant species within the barnacles. This species was first noted in an English harbour in 1945. It was probably introduced via ship transport during the second world war. The displacement of the indigenous species, *Semibalanus balanoides,* by this species is a general phenomenon along the coasts of western Europe (LITTLE & KITCHING 1996, HARMS 1999). The success of this exotic is attributed to its long breeding season, high productivity, eurythermal and -haline physiology of the larval and adult phases (HARMS 1999).

The groins are the most species rich, with respect to mobile organisms, as compared to the other three substrate structures (harbour walls, piers, dykes). This may be due to the greater numbers of microhabitats (intertidal pools, rock blocks, etc.) present on groins. Although the same dominant species are found within all the sampled sites e.g. *Corophium* spp. (Crustacea) and *Polydora* spp. (Polychaete).

There has been an increase in ''polydora silt'' along the Belgian coast over the past few years (pers. comm. F. KERCKHOF). This may be attributed to the increased siltation along the Belgian coast, where the polychaetes use this material to build their casings (DARO 1970, SARTMANN-SCHRÖDER 1996). These worms are often found in close association with mussels, which provide a ''silt-reserve'' in the form of faeces (DARO 1970). As a result thick polydora-mats tend to occur predominantly on shores where mussels (*Mytilus edulis*) are present.

The green seaweeds (Chlorophyta) form the largest component within the algae (71 % cover), the Ulvaceae (*Blidingia* spp., *Enteromorpha* spp. and *Ulva* spp.) being the largest family in this division. The brown seaweeds comprise 19 % of the total surface area of the sampled area. They were however predominantly found in the more sheltered habitats. The red algae, which often form a dominant component of temperate rocky shores, had low representation with respect to percentage cover and species richness. This may be attributed to the highly disturbed habitat which prevents the formation of climax communities. Greatest diversity within the algae was usually found in the more sheltered sites.

Zonation patterns

The vertical distribution of the fauna and flora on artificial hard structures within the intertidal is similar to that of rocky shores, being strongly dependant on the physical conditions. Many intertidal organisms, due to their species-specific habitat preferences, give rise to a clear zonation pattern.

The most important environmental factor is the length of exposure to air during low tide. The height above the low-water mark is a surrogate measure of this phenomenon. A decreasing species richness was observed with increasing height above the low-water mark. There is a decreasing number of species that are able to survive the increasing physical stresses as one moves up the shore.

A second factor that was taken into account was material-type of the substrate. In general there is a slight preference for concrete by macroalgae. This is probably due to its grainy texture that is advantageous for attachment. The fauna seemed to have a preference for wood, which may have to do with the latter's water-holding capacity.

The degree of wave exposure is also an important factor determining species composition on rocky shores. When the sample sites are arranged in order of exposure a trend was observed where macroalgae had a preference for slightly sheltered sites (e.g. inner harbour walls), while the macrofauna were most species rich and abundant in more wave exposed sites.

As a result of the effect of wave exposure a zonation scheme was drawn-up for an exposed shore (groins) and a sheltered shore (inner harbour walls). In general the exposed shores tend to be dominated by mussels (*M. edulis*) and the green seaweeds (*Ulva* spp. and *Enteromorpha* spp.), while the more sheltered sites have a dominance of oysters and brown seaweeds (*Fucus* spp.).

Prototype of an ecologically useful hard substrate

An analysis of the data has resulted in an ecologically valuable groin prototype. The main aim is to increase biodiversity on these structures. This can be achieved by increasing the number of microhabits. A relatively high groin that would allow for a sheltered and exposed side to a limited extent may accomplish this. It should also be long and varied in shape and topography. Concrete with wooden elements are the preferred material types.

These are the preliminary results of a much broader study. Other aspects that are still to be studied are temporal variation and ecological interaction between organisms. It is however clear that the hard substrates along the Belgium coast contribute towards Belgian biodiversity.

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