THE BENTHIC FOOD PATH

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The exchanges in the coastal zone through its boundaries with the open ocean on the one hand and with the terrestrial systems on the other, are of overwhelming importance to understand its structure and function.

Organisms living in the coastal zone have a suite of adaptation mechanisms. These adaptations are integrated into the structure and function of ecological communities that have evolved in the changing and variable coastal environment. Why species exist and in what ways they are adapted to living in the coastal zone are questions that require both a historical (evolutionary) and a functional (ecological) explanation.

Of particular interest in this respect is the study of the link between structure of ecological communities - for example in terms of species composition, functional groups and size spectra, but also in terms of the genetic characteristics of the constituting species - and their functioning. Even the - relatively - low diversity communities in the coastal zone contain many species. However, several species may perform similar functions in the system and there is a certain redundancy in function which may permit reductions in diversity before system collapse occurs. On the other hand, certain species can influence the structure of the entire system by their activity.

In the Marine Biology Section of the University of Gent, the benthic food path is investigated since more than 20 years and recently through means of the national Impulsprogramme Sea , named *Structure and Function of the benthos in estuarine and coastal ecosystems in relationship to present and future anthropogenic influences* and several other European initiatives from the MAST or ENVIRONMENT programmes.

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The composition of the benthos (in terms of densities, biomass and diversity) and the function of the benthos (which are the processes as well on a specific as on a community level) are greatly determined by the nature and the amount of organic material which sedimentates on the bottom out of the water column. There is also a significant flux back to the water column out of the sediment, mainly through the microbial loop. This last path can be stimulated by the activity of the animals living in the sediments.

In the frame of the Impulsprogramme Sea, four topics are investigated in more detail :

1. Spatial and temporal variability of the meiobenthos; 2. Function of the meiobenthos with emphasis on their trophic role and the relationship with the biogeochemistry; 3. spatial and temporal variability of the hyperbenthos and 4. the trophic role of mysids (dominant hyperbenthic component) in estuarine ecosystems.

The benthic-pelagic coupling is especially clear when investigating the hyperbenthic compartment. The hyperbenthos lives in the lowest meter of the watercolumn, is in the order of 1 - 40 mm length and consists mainly of mysids, amphipods, and larvae of epibenthos (e.g. fish, shrimp & crab larvae).

In the frame of the Impulsprogramme Sea, a first quantitative study of the North Sea hyperbenthos has been performed. 41 stations have been sampled in september 1993 on the Belgian Continental Shelf. Analysis of the species composition of the hyperbenthic communities (with 135 functional species) from which the mysids are most dominant in number with 10 species, the crabs with 20 species, amphipods with 33 species and Caridea with 14 species.

Six geographic communities have a characteristic species assemblage on the basis of species composition, diversity, density and biomass. The strongest variation is present in a gradient perpendicular to the coast with the highest densities and biomass onshore and the highest diversoty offshore. A detailed analysis of this dataset, together with the interpretation of the data of the monthly sampling of a number of coastal stations is still under investigation.

The brackish part of the Westerschelde contains the highest number of hyperbenthic organisms in comparison with the marine environment.

In the brackish zone of estuaries the suspended matter flocculates into larger particles, and increases turbidity. This phenomenon typically occurs at salinities around 1 to 5 psu and the area is defined as the Maximum Turbidity Zone (MTZ). The axial position of the MTZ depends on freshwater drainage and varies seasonally depending on the river flow. In the Westerschelde estuary, 250000 ton of detritus and organic matter are imported to the brackish zone per year, 46% of which flocculate and precipitate in the MTZ. The impact of the hyperbenthos on suspended particles in the MTZ can be twofold : the hyperbenthos may be described as a higher trophic level feeding on particles present in the MTZ.

On the other hand, the hyperbenthic fauna can be source of particles (e.g. through the production of feacal pellets or fragmentation of larger particles). Only the feeding aspect of the most abundant hyperbenthic species, the mysid *Neomysis integer*, has been investigated so far.

The quality and quantity of the diet of *Neomysis* were assessed through measurement of the stomach fullness and microscopical analysis of the stomach content. *Neomysis integer* was found to be an omnivore which mainly utilizes mesozooplankton and detritus carbon pools. Phytoplankton and benthic organisms, though present in the stomach, were negligible. Macrophytal detritus and amorphous material, unidentifiable under the light microscope, were very abundant food items. The amorphous detritus was found to originate from the suspended sediment flocs which are characteristic for the Maximum Turbidity Zone. These mainly consist of clay minerals (silicon, aluminium, magnesium, potassium & iron), as shown by EDAX-analysis. The energetic value of the flocs for *Neomysis* remains unclear. The absolute composition of the diet (expressed in numbers per individual *Neomysis*) of adults in the Elbe, Westerschelde & Gironde is shown and divided into a zooplankton component, plant material and detritus.

The second component of the benthos which is investigated in detail are the smaller interstitial meiobenthic animals. They are always characterized by communities consisting of millions of individuals per square meter, they have a very high diversity, consisting of about one hundred different species per square meter of sediment. Nematodes are the dominant group.

A question, especially of interest in the framework of the Impulsprogramme Sea, is whether there is any link with the pelagic production and if effects of eutrophication are detected within those communities. To that purpose, sediment is sampled in three stations along the Belgian coast by means of a box-corer.

Several cores are investigated for biological as well as for biogeochemical analysis of the interstitial water. Therefore, the cores are divided in slices of 1 cm sediment and per slice the following characteristics were determined : density, species diversity and biomass of the nematode community and for the environmental factors : concentration of nitrate, nitrite, ammonia, phosphate, silicate, the redoxpotential, grain size, % organic C, bacterial density and several pigment concentrations. The redoxprofiles of the three stations for three different periods indicate that station 702 (off Zeebrugge) mainly consisting of fine sand, the RPD layer is at 10 cm sediment depth in March, about 3 cm sedimentdepth in June and at the upper surface in August 1993. In station 790 (off Oostende) , consisting of fine and coarse sand, the redox profile is positive throughout the whole period. For station 115 (off

Nieuwpoort), the silty station, a similar decrease in oxygen is noted from March to August similar as in station 702 and the redox is generally lower than in the other stations. The nitrogen profile of station 702 indicates a similar profile as the redox profile with a high amount of ammonia in August. The distribution of the dominant nematode species in station 702 shows that two nematode species *Sabatieria punctata* and *Daptonema tenuispiculum* showed their highest abundance in August. *Daptonema* is a surface dweller while *Sabatieria* occurs deeper down in the sediment. The third most dominant species, *Richtersia inaequalis*, is only present when the sediment is well oxygenated. The nitrogen profiles of station 790 show an oxygenated sediment throught the year. Nevertheless, two dominant nematode species, *Ixonema sordidum*, a diatomfeeder, and *Viscosia* langrunensis, an omnivorous, predator, show a clear vertic al profile which could not be explained by the oxidation state of the sediment.

The distribution of chlorophyll a and bacteria in station 790 indicate that the maximum of *Ixonema* in August coincides with an increase in chlorophyl a in the sediments; the maximum of *Viscosia* in March coincides with high bacterial densities in March as well.

As a conclusion we may state that depending on the sediment grain size, oxidation is more or less important in the distribution of the different species.*Sabatieria* and *Daptonema* can be considered as real indicators of eutrophication (reduced sediments), while the distribution of other species like *Viscosia* and *Ixonema* in sandy sediments are clearly effected by the amount of food within the interstitial water of the sediment.

Summarizing it can be said that important functions of benthic processes in the coastal zone are the following and still need more investigations : we know that the zooplankton in the coastal zone is often largely composed of larvae of benthic invertebrates and therefore fundamentally different from oceanic zooplankton. The impact of benthic reproduction on pelagic productivity however is not known. The relationships between characteristics of benthic communities and biogeochemical processes require further study in terms of quality and quantity of organic material deposited by pelagic processes, interactions between animals and bacteria and the structure of the benthic food web. Conversely, the structure of the benthos may have a significant influence on the fluxes of nutrients from the sediment to the water column, on demersal fish production and on the stability of sediments. The coupling between the benthic food chain and the pelagic one is especially important in the coastal zone. Some benthologists even say that in the North Sea, it is only the benthos that matters.

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