The department of MEE aims to assess the relative role of bottom-up (food input) and top-down (predation) processes in structuring benthic communities, ranging from the shelf margin to the intertidal. The general approach that is followed and which is also one of the great challenges in modern ecology, is to try to understand the structure and dynamical behaviour of populations and communities on the basis of characteristics of individual organisms. Research methods include field observations, including long-term (and wide range) surveys; manipulative field experiments, e.g. using new lander technology; laboratory experiments, e.g. using the experimental large-scale tidal facilities; and modelling.

Basically, within the department three different systems are studied: the benthic communities of the tidal flats in the western Wadden Sea; the benthic community of the North Sea and continental shelf margin; and the tropical reef communities in the Caribbean and Indonesia.

The first system has the advantage that these communities are relatively species-poor and, in terms of biomass, dominated by only a few species. This means that the problem of complexity, which is a major obstacle in linking community behaviour to individual characteristics, may be less severe. At Balgzand, only four species (three bivalves and one polychaete worm) account for 80% of the total biomass of the infauna. Detailed individual-based studies focus on these four most abundant species: the soft-shelled clam *Mya arenaria*, the cockle *Cerastoderma edule* (filter-feeders), the balthic tellin *Macoma balthica* (a filter/deposit feeder), and the lugworm *Arenicola marina* (a deposit-feeder). Furthermore, four of the most dominant predators are studied in detail: the crustacean predators brown shrimp *Crangon crangon* and shore crab *Carcinus maenas*, the plaice *Pleuronectes platessa*, a flatfish, and the red knot *Calidris canutus*, an avian predator.

In addition to the detailed individual-based studies, long-term studies are being performed in all three study systems. In the Wadden Sea these series already started in the late 1960s. These long-term studies focus on the population dynamics of the benthic fauna and their predators, the food conditions for the benthic fauna, and on environmental conditions, such as water temperature and salinity. They provide an important mean for generating and validating hypotheses on the structuring processes in marine ecosystems.

Recent developments in the employment of landers that can be installed at the seafloor for longer periods, enables advanced manipulative experiments at the seafloor that were hitherto beyond reach. For example, in situ mesocosms can be installed, in which the amount of food input can be manipulated. This implies that the experimental approach, so far only possible on the tidal flats, can now also be followed in our second area of interest, the shallow parts of the North Sea.

RESEARCH THEMES

The work within the department can be divided in three themes that are closely connected:

(A) The structuring role of top-predators in marine ecosystems

(B) Recruitment and dispersal in relation to spatial and genetic structure of benthic invertebrate populations

(C) Dynamic energy budgets, life-history strategies and implications for competitive relationships

(A) The structuring role of top-predators in marine ecosystems

One of our main working hypotheses is that predation and other "top-down" processes may have cascading effects through the benthic foodweb. This may work directly, that is predators exhibit a serious impact on the mortality patterns of their prey and on the dynamics of the prey populations. The effect of predators may also work indirectly through the occurrence of predator-avoidance mechanisms. There is ample evidence of a widespread occurrence of predator-avoidance mechanisms in the marine environment, e.g. toxic algae (physiological response), gelatinous plankton (morphological response), deep-burying bivalves (behavioural response), early-maturing fish (life-history response), etc. This work is mainly performed in intertidal areas (Wadden Sea), with the knot *Calidris canutus* as the most important model organism.

(B) Recruitment and dispersal in relation to spatial and genetic structure of benthic invertebrate populations

Competition for food and other resources, both intra- and interspecific, may also play a major role in determining community processes. Special attention with respect to competitive processes is paid to adult-juvenile interactions in benthic organisms. Particularly the period around the settlement of the recruits may be of utmost importance in population regulation. Henceforth the department increasingly focuses on recruitment processes (e.g. settlement inhi-

bition by adults). Recruitment studies are performed in both intertidal systems, shallow coastal seas and in coral reef communities.

Thus far it has been impossible to perform manipulative experiments on the shelf sea floor, but recently developed autonomous "permanent" bottom landers form a promise, since they provide data series over periods of months. Past experiences gained by the department with construction and implementation of deep sea landers have paved the way for a new type of autonomous lander which is capable of sampling planktonic stages of benthos and simultaneously exposing (genuine or manipulated) substrates, while measuring a suit of environmental variables. The new landers allow study of topics, such as the effect of planktonic larval abundance on settlement success, hitherto unable to tackle in deeper water.

Another important development in marine benthic ecology is the incorporation of molecular genetics in ecological work. The easy accessibility of molecular techniques over the last decade has already allowed ecologists to describe patterns of genetic variation within and among populations. In itself such descriptions may not be very interesting, but when placed in a general ecological setting, these techniques are already very promising. One example concerns the apparently open character of most marine benthic populations. Most marine benthic animals have dispersive propagules and when studying a local population it usually remains unclear how much real immigration occurs when settlement takes place. Both molecular techniques and marking methods may help to unravel these problems of open systems. The techniques are already available at the NIOZ and intensively used by (population) scientist from all groups (benthic invertebrates, corals) within the MEE department.

(C) Dynamic energy budgets, life-history strategies and implications for competitive relationships

At the level of the individual, interest is directed towards the performance of individual benthic organisms (e.g. their growth and fecundity, or more generally their energy budgets) in response to external factors, e.g. food availability and physical factors, and the consequences of choosing a specific (energetic) strategy for competitive interactions. Filter-feeding bivalves are one of the main study objects. Research basically follows an experimental approach, which is greatly facilitated by the possibilities within the newly renovated aquarium building.