The department aims to obtain a mechanistic understanding of the structure and dynamical behaviour of marine macrobenthos populations, ranging from the shelf margin to the intertidal. The department focuses both on the role of bottom-up (food input and competition for food and other resources) and top-down (predation) processes in structuring benthic communities. Research methods include (1) field observations, along with long-term (and wide range) surveys; (2) manipulative field experiments, e.g. using new lander technology; (3) laboratory experiments, e.g. using the experimental large-scale tidal facilities; and (4) modelling.

Within the department three different types of benthic communities are studied intensively: the tidal flats in the Wadden Sea and some tropical systems, notably in north-west Australia and West Africa; the soft-sediments of the North Sea and continental shelf margin; and the coral reefs in the Caribbean and Indonesia. On the species-poor tidal flats of the Wadden Sea, easily accessed from the institute, only four species (three bivalves and one polychaete) account for 80% of the total biomass of the intertidal infauna. Detailed studies focus on these four most abundant species, and their predators. The studies on tropical flats emphasize insightful latitudinal contrasts in ecological processes. Recent developments in the employment of landers that can be installed at the seafloor for longer periods, enables advanced manipulative experiments. Hence, 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. In contrast to Wadden Sea and North Sea, coral reefs carry the most species rich marine communities and strong competition for space appears to be a major characteristic of these systems.

In addition to detailed individual-oriented studies, long-term population and community studies are being performed in all three types of systems. In the Wadden Sea twice-annual surveys 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. They provide an important mean for generating and validating hypotheses on the structuring processes in marine ecosystems. Mollusc shells and coral skeletons accommodate an archive for studying environmental and climatic changes over much longer periods.

Most of our studies are embedded in national or European programmes. Although emphasis is put on benthic communities, studies on seabirds and marine mammals are also performed, yet mainly externally (national government, EU) funded.

Research Themes

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

1. The structuring role of top-predators in marine ecosystems
2. Competition, life-history strategies and dynamic energy budgets
3. Recruitment and dispersal in relation to spatial and genetic structure of benthic invertebrate populations

2.1 The structuring role of top-predators in marine ecosystems

One of our main hypotheses is that predation and other “top-down” processes 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 such 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 red knot Calidris canutus as the most important model organism.

2.2 Competition, life-history strategies and dynamic energy budgets

Intra- and interspecific competition for food and other resources may also play a major role in determining community processes. Our particular interest is directed towards the performance of benthic organisms in terms of e.g. growth rate, age and size at maturity, and fecundity, in response to food availability and other environmental conditions. The consequences of choosing a specific energetic strategy for competitive interactions and fitness are studied. One hypothesis that deserves further testing is that larger organisms with better energy storage capacities are more adapted to fluctuating food supplies, whereas smaller organisms are more able to cope with constant low food supply. Another point of interest is the phenotypic flexibility, that is the reversible within-individual variation, in both benthic invertebrates as well as in their avian predators. In filter-feeding bivalves there is adaptive variation in sizes of gills and palps and in shorebirds the various parts of the digestive system are flexible to optimize per-

formance. Finally, the spatial competition in corals, i.e. what energetic strategy determines competitive ability, has our special attention.

2.3 Recruitment and dispersal in relation to spatial and genetic structure of benthic invertebrate populations

At the population level, it has been observed that particularly the period around the settlement of the recruits may be of utmost importance in marine benthic population regulation. Henceforth the department increasingly focuses on recruitment processes (e.g. intra- and interspecific adult-juvenile competition by means of settlement inhibition by adults, or the competition for food affecting the age and size at metamorphosis). Recruitment studies are performed in intertidal systems, shallow coastal seas and in coral reef communities. Settlement racks in the latter community are providing records of coral recruitment already since 1979. Thus far it has been impossible to perform manipulative experiments on the shelf sea floor, but our recently developed autonomous "permanent" bottom landers are a promising new tool.