Connecting young scientists: the international programme GAME establishes a unique global research network in marine benthic ecology

GAME is an international training and research programme for young marine scientists and stands for "Global Approach by Modular Experiments". In the framework of thematically oriented research projects on ecological issues, identical experiments are carried out simultaneously at different locations around the world. This approach is new in ecological science and is as innovative as it is efficient: Only globally comparable findings can provide insights that transcend biogeographical regions and ecosystem boundaries. This innovative new concept was developed by Prof. Martin Wahl (IFM-GEOMAR) and is sponsored by the Mercator Foundation.

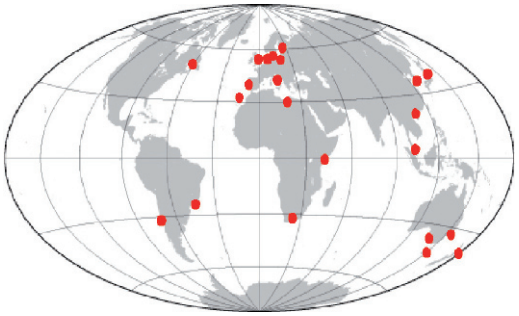

Fig. 1: The GAME global network in 2007. The number of 22 partner institutes on five continents allows the replication of experiments across biogeographical regions and climate zones.

GAME projects are concerned with the structure and functioning of marine benthic communities, their biological diversity, their significance and their potential or actual endangerment. In this context the participants also study the consequences of global change for the marine ecosystems which are among the most important on our planet: coastal waters. These are used by man in many different ways and are subject to continuous change.

GAME was initiated in 2002 and currently co-operates with a total of 22 marine science institutes on five continents. Its unique worldwide network of scientists and institutions, which unites a broad range of competences and research facilities, spans the globe from Australia to Finland, from Chile to Japan. GAME therefore links up scientific expertise and resources across the boundaries of nations and continents.

GAME – accomplished projects

Changes in coastal habitats: Does lack of light reduce the defensive capacity of macroalgae? - 2006-2008

Human activities often lead to an increase in the concentration of microalgae, induced by eutrophication, and suspended particles in coastal waters. This reduces the amount of light penetrating the water column leading to low-light stress for the benthic macroalgae. The latter are important habitat engineers in many coastal systems, e.g. the large brown seaweeds in temperate waters, and provide manifold ecosystem services.

Macroalgae contain active chemical substances which they can use to deter herbivores, such as snails, marine woodlice and fish. It is a widely accepted notion that these defence systems are energy dependent. This GAME project investigated whether seaweeds that are suffering from low-light stress are less capable of protecting themselves against herbivory than less stressed individuals. If impaired algae fall victim to their predators more easily, the structure of coastal habitats could alter dramatically when light regimes change. We studied more

Fig. 2: Installation of an experimental set-up in Kuala Terengganu, Malaysia.

than 20 seaweeds species worldwide and found that most of them show a high capacity to adapt to short-term low-light conditions. Only in 3 cases we observed an influence of low-light stress on algal palatability for mesograzers.

Invasions in the ocean: How stable are fouling communities in the face of environmental change? - 2005 to 2007

Assemblages of organisms living attached to ship hulls are highly mobile and can therefore easily enter new habitats. The speed and distance of their movements are constantly increasing as shipping activity expands. The survival of individual species during transport depends primarily on the stability of the community. In this project we studied the connection between the diversity of fouling communities and their stability towards environmental change. Sheets of plastic were exposed to natural colonization by fouling organisms for four months and were then moved to new locations with different environmental conditions. In all cases, the actual introduction of species into new habitats was avoided by the experimental set-up. In our study younger fouling communities were generally less diverse than older ones and offered more available space for local species to colonise after transplantation. In contrast, the older fouling communities had greater diversity and less available space and native species did not succeed against the introduced community and allowed non-indigenous species to survive. Thus if the dispersal of alien species in the oceans is to be avoided, preventive measures must be taken, e.g. frequent removal of sessile organisms from ship hulls.

Variability in the occurrence of natural disturbances and their consequences - 2004 to 2006

In many ecosystems, disturbances play a significant role in determining the structure of biotic communities. Their role in ecological processes has often been studied, although the emphasis has been on the intensity of disruptive events. However, the occurrence of natural disturbances is often extremely variable in space and time. Global change will increase this variability in the future for many disturbances connected with climate. For this reason we studied the influence of the temporal variability of disruptions on the diversity of marine benthic communities. To this end disturbance events were artificially created in hardbottom communities, and were distributed either evenly or in clusters over a specified period of time.

Fig. 3: Last preparations for an outdoor experiment in Arraial do Cabo, Brazil.

Against expectations, variability in the occurrence of disturbances had an effect on the diversity of communities in only one location, while in two more locations effects on the presence of individual species were observed. The general absence of effects seems to indicate that the temporal variability in disturbance regimes, at least over short periods of time, does not have major relevance for the communities studied.

The interactive influence of disturbance and the availability of nutrients on biotic communities in shallow coastal waters - 2003 to 2005

Disturbances and the availability of nutrients are important factors in

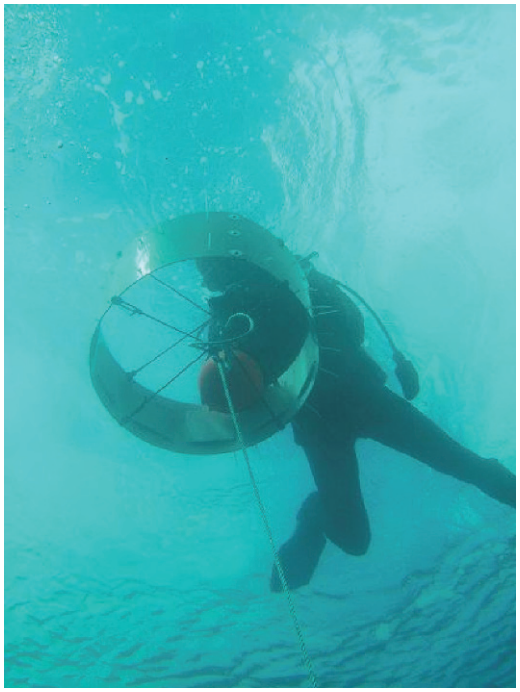

Fig. 4: Sampling near the Leigh Marine Laboratory, New Zealand.

Fig. 5: All data are collected: termination of an experiment in the Bay of Gdansk, Poland.

structuring communities and in coastal habitats both are changing under human influence. Disturbances make resources available and reduce the dominance of strong, competitive species. In this way they help to maintain diversity in biological systems. In contrast, an increased availability of nutrients favours strong, competitive species and counteracts the effects of disturbance. Thus the effects of perturbations should change as the availability of nutrients increases. We tested this hypothesis in nine locations and did not find the predicted interaction between productivity and disturbance in any of the study locations. However, in three of the nine locations we observed a maximum diversity of species at medium frequencies of disturbances what supports one of the central concepts in the theory of biodiversity.

The response of macroalgae to grazing stress: How widespread are inducible defences against herbivores? - 2002 to 2004

It is generally assumed that algal defence systems against herbivory require energy and therefore put a strain on the plants' scarce resources. An adaptable defence strategy based on need would therefore be advantageous. In theory such defences would be triggered by the threat of being eaten and could be shut down in the absence of predators. In this GAME project the taxonomical and geographical distribution of adaptable defences were studied and the findings clearly show that this ability is unexpectedly widespread among macroalgae. Furthermore, it was demonstrated that algae can communicate with each other: by using transmitters they can warn conspecifics over short distances when a grazer is feeding on them. On reception of this information other algal individuals then activate their own defences before they come into contact with the predators.

So far GAME results have been published in 19 peer-reviewed articles.

Mark Lenz