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Grounding Icebergs in the Antarctic: A "Curse" or a "Blessing" for the Sea-Floor Inhabiting Fauna

Kurzfassung

Untersuchungen der Fauna am Meeresboden der Antarktis haben gezeigt, dass der Einfluss strandender Eisberge zu den fünf nachhaltigsten Störungen gehört, die größere Ökosysteme auf der Erde überhaupt erfahren. Offensichtlich entscheidet eine Kombination aus dem speziellen Störungsregime solcher natürlichen Katastrophen und Umweltstabilität darüber, ob eine hohe oder niedrige Biodiversität erwartet werden kann. Die Vielfalt von Wiederbesiedlungsstadien zuvor zerstörter Flächen und als Folge dessen ein hohes Maß an Faunenwechsel (species turnover) zeigt, dass die faunistische Entwicklung nur kaum vorhersagbar ist.

Abstract

Investigations on the sea-floor inhabiting fauna in the Antarctic showed that the impact of grounding icebergs is among the five most significant disturbances that large ecosystems on earth experience. Obviously the specific disturbance regime of such natural catastrophes combined with environmental stability determines whether a high biodiversity can be expected or not. The variety of recolonization stages and its contribution to a high species turnover gives evidence that the faunal succession is hardly predictable.

Résumé

L'identification de la faune au fond de la mer nous a montré que l'influence d'icebergs jetés à la côte compte parmi les dérangements les plus importants que les grands écosystèmes de la terre subissent. Évidemment une combinaison entre les causes perturbatrices de telles catastrophes naturelles et la stabilité de l'environnement décide du degré de la diversité biologique. Les diverses phases de peuplement entraînent un haut degré de changement de faune, donc le développement de la faune n'est guère prévisible.

Keywords

Benthos, Complexity, Diversity, Disturbance

1. Contrasting Paradigms, Stability versus Disturbance

Increasing knowledge on the structure and processes in marine ecosystems such as coral reefs, the deep-sea and the polar regions stimulated scientists in the 70ies to develop various hypotheses on the relationship between biodiversity, ecosystem function and evolution. The sea-floor inhabiting fauna, called benthos, was recognised to be relatively rich in species around the Antarctic continent. This was explained, similarly to the deep-sea fauna, by the long-term stability of environmental variables. The corresponding time-stability hypothesis (GRASSLE & SANDERS 1973) assumes that if animals do not have to cope with significant environmental changes interspecific competition can lead to the occupation of distinct ecological niches by many species. On the other hand disturbance is known to play an important role for a high biodiversity maintained at ecological time scales e.g. in tropical shallow systems (HUSTON 1979) but also in the deep-sea (DAYTON & HESSLER 1972).

2. Natural Catastrophes and Resulting Diversity Patterns Visualised by Modern Technology

Recent investigations using a Remotely Operated Vehicle (ROV) at the Alfred Wegener Institute provided for the first time continuous video-records of the Antarctic sea-floor. At present, this is the only method to obtain spatially high resolution results on the larger fauna colonising the deeper shelves. The observations show clearly that grounding icebergs shape the Antarctic benthos considerably; similar findings are from the Arctic off Northeast Greenland. Up till now a quantitative as well as a qualitative approach in the analysis of this phenomenon have been followed. A global comparison showed, that the impact of iceberg disturbance in the Antarctic, expressed as a function of the total area destroyed per time and the speed of recolonization, is among the five most significant disturbances that large ecosystems on earth experience (GUTT & STARMANS 2001). The co-occurrence of different stages of recolonization leads to an increase in biodiversity at an intermediate spatial scale of a few hundred metres (WHITE & PICKETT 1985, Reise 1991, GUTT et al. 1998). These results refer to the megafauna, being visible by imaging methods, to which in the Antarctic mainly sessile filter feeders such as bryozoans, ascidians and sponges belong and thus, the microhabitat is considerably affected by a biogenic three-dimensional structure. As a consequence also the mobile fish fauna is affected by iceberg scouring since demersal fish is well known to have a very selective habitat preference. A similar relationship can also be expected for mobile invertebrates such as amphipods and shrimps.

3. Conclusions: Iceberg Scouring Contributes to High Complexity of the Antarctic Ecosystem

The variety of early stages of recolonization and a resulting contribution to a high species turnover (beta-diversity) gives evidence that the faunal succession is not predictable as it can be suggested for some more simply structured systems. This could be explained by various pioneer organisms having a similar chance to form the initial fauna, a process in which the sequence of species is just a matter of chance (see CONNELL 1978). Alternatively a very first recolonizer could determine the further succession (see RHOADS & YOUNG 1970) because it allows only a limited number of species belonging to a specific life mode to co-occur.

These results also show that obviously the specific regime of physical disturbance including longer phases of stability in many but not all environmental variables in combination with natural catastrophes determines whether a high or a low biodiversity can be expected. Since interglacial ice surges are already known for the Antarctic since 25–30 Mio. years (HAMBREY et al. 1991), an effect of iceberg scouring on the origin or

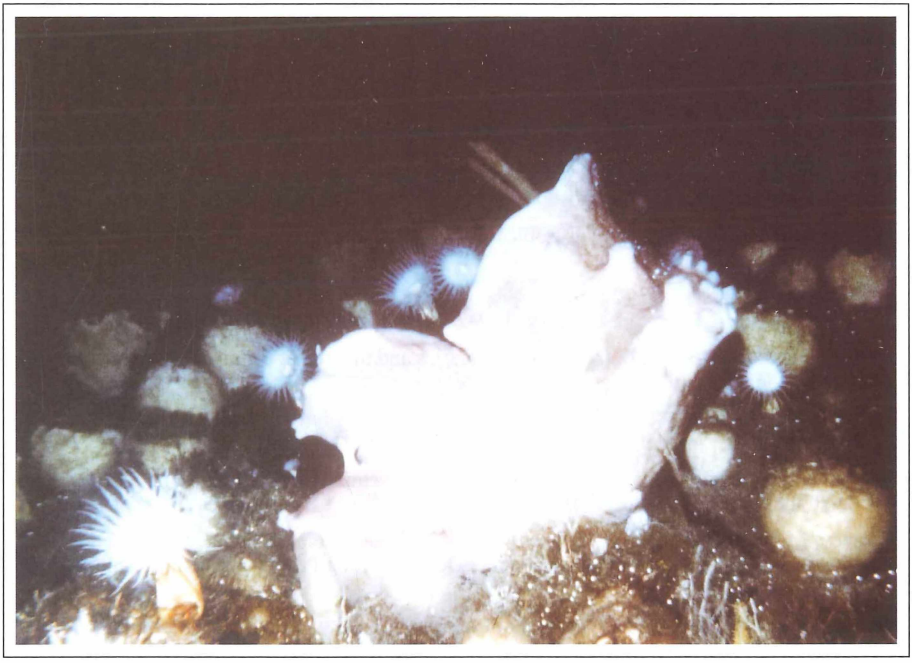


Fig. 1/2: Due to iceberg scouring the benthic habitat on the Antarctic shelf can vary whithin a few metres distance from a rich community locally dominated by extremely slowly growing sponges (Fig. 1) to totally devastated areas (Fig. 2). Both photos are from the southeastern Weddell Sea, Kapp Norvegia area; water depth 135 and 190m, respectively.



extinction of species cannot be excluded. The same phenomenon is discussed for the periodical extension and retreat of the inland ice cap during glacials and interglacials, known as the climate-diversity pump (CLARKE & CRAME 1992).

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