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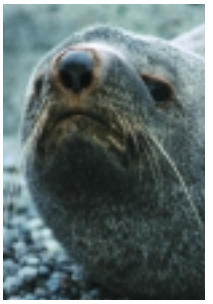
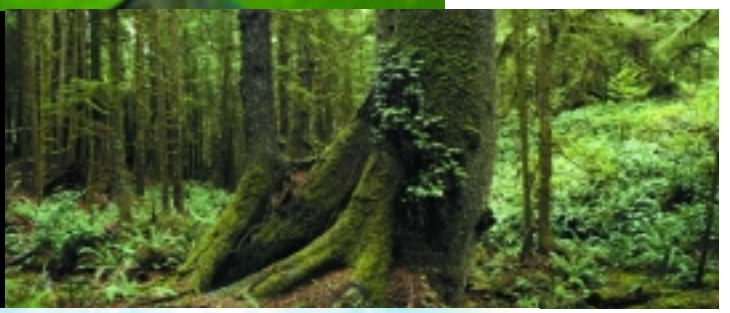


ASSESSMENT AND MANAGEMENT OF ALIEN SPECIES THAT THREATEN ECOSYSTEMS, HABITATS AND SPECIES



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ESTUARIES AS A HABITAT: ON THE STATUS OF INTRODUCED MACROINVERTEBRATES ON THE GERMAN NORTH AND BALTIC SEA COAST

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Introduction

All over the world, marine and estuarine systems are subject to human-mediated invasion of non-indigenous species at an increasing rate which results in a greater uniformity of biocoenoses on a global scale. It is recognized that a number of introduced species have become numerically dominant in invaded communities and have caused damage to environmental and commercial interests.

A basic requirement for a proper processing of measures, which should lead to a minimization of man-induced spreading of species, is a comprehensive analysis of the phenomenon"bioinvasion". The scope of this contribution is to evaluate the significance of different human-mediated vectors and the reasons for successful establishment with the example of introduced macrozoobenthic species in German coastal waters of the North and Baltic Sea.

GERMAN NORTH SEA COAST

In total, 26 recently established macrozoobenthic species were identified as introduced on the German North Sea coast. The main area of origin is the Atlantic coast of North America (9 species). In general, non-indigenous species only became established if they were introduced from similar latitudes. The main vector was the transport by fouling on ship hulls (example: barnacle Elminius modestus). Also the transport in ballast water tanks (example: American jack knife clam Ensis americanus) as well as deliberate commercial introductions (example: Pacific oyster Crassostrea gigas) and associated unintentional forms by these imports (example: slimper limpet Crepidula fornicata) were important vectors (Fig. 1). The intentional release play a subordinate role. On account of the limnic barriers the coastal faunal replacement through canals is insignificant. Up to now only three Pontocaspian species (example: amphipod Corophium curvispinum) as well as one Mediterranean species (isopod Proasellus coxalis) arrived the brackish areas of the North Sea estuaries.

The share of the introduced species compared to the respective total macrozoobenthic species numbers amounts to 1% in the open German Bight of the North Sea, 3% in the Wadden Sea, 10% in the brackish water zone of the estuaries of the rivers Elbe, Ems and Weser and 7% in the brackish canals and ditches. However, no relevant ecological or economic effects of the non-indigenous macroinvertebrates could be shown for the German North Sea coast as yet. They become integrated and lead to an increase in the number of species.

GERMAN BALTIC SEA COAST

Recently 15 macrozoobenthic species have been identified as introduced on the German Baltic Sea coast (Fig. 1). It seems that only the polychaete Marenzelleria viridis was directly introduced by ocean shipping. All other species either come from the Pontocaspian and are transported through canals with inland waterway crafts or were at first introduced into the North Sea and transported from here through the Kiel Canal or by natural drift in water currents to the Baltic. At present two North Sea species (example: amphipod Corophium multisetosum) are considered as introduced on the German Baltic Sea coast, because they arrived in this area through the Kiel Canal.

The share of the introduced species compared to the total macrozoobenthic species numbers amounts to 3%. Relevant ecological and economic damages by introduced macroinvertebrates are not known on the German Baltic Sea coast as yet. Also mass forms as e.g. the polychaete Marenzelleria viridis did not apparently replace any native species. The relatively distinct bioturbation of M. viridis could have effects on the biogeochemical cycle, although without consequences for the entire Baltic Sea.

ESTUARIES: THE HABITAT FOR INTRODUCED MACROINVERTEBRATES

It is striking that most of the introduced macroinvertebrates have established permanent populations in the German North Sea estuaries (19 species in total). Several reasons are probably responsible for this:

1. Salt-tolerant limnic species, which were transported through canals with inland crafts, reached the coast first in the estuaries (currently four species, see Fig. 1).
2. The estuaries are characterised by intense intercontinental shipping and have a higher potential infection rate also with the background, that ballast water often has estuarine character.
3. About half of the introduced macroinvertebrates in the estuaries are genuine brackish water species, which have a high tolerance for changing environmental conditions and by this have a better chance of being transported alive than euhaline species.
4. Of considerable importance is the natural autochthonous species minimum in the brackish water zone of estuaries, i.e. many vacant ecological niches are present. Because of this it is easier for an introduced species to establish itself there.

Conclusions

Even if no relevant ecological and economic effects by introduced species could be found as yet in the German coastal waters, on international level the need for action concerning the minimization of organism introduction by the transportation vector ocean shipping has been recognized for some years. Among others, different sterilisation methods for ballast water were checked for their effectiveness, e.g. irradiation with ultraviolet, ultrasound and microwaves. However, no method could be found yet, which is technically feasible on a large scale, safe, cost effective and compatible to the environment. An ecological mild method would be the exchange of ballast water on the high seas as required by the MEPC of the IMO London. But investigations have shown that as a result of this method the introduction of organisms can only be minimized in a limited manner.

However, it is very likely that the discussion about the vector ballast water misjudges much more important threats. A recent summary by Nehring (2001) about the introduction vectors of non-indigenous species in the entire North Sea revealed that phytoplankton and phytobenthos species are mainly introduced in association with aquaculture products (especially oysters). The majority of introduced faunal species have reached the North Sea (as well as the German North Sea coast, see above) by transportation on ship hulls. These findings show that the development of ecologically acceptable methods for the prevention of fouling on imported aquaculture products as well as on ship hulls is much more important. In this context, due to the proposed IMO ban of the harmful but effective biocide tributyltin in ship antifoulants, the pathway of invasive species introductions via ship fouling can attain a new dimension worldwide.

References

Nehring, S. 2001.
After the TBT era: Alternative anti-fouling paints and their ecological risks, Senckenbergiana maritima (in press).

Fig. 1: Introduced macrozoobenthic species on the German North and Baltic Sea coast. Known or probable introduction vectors (* ballast water, ** hull, *** hull or active migration), number of introduced species and their amount on total species number (in percent), important canals and their opening date. For further explanations, see text.