Summary

Since the 1990s the marine isopod *Idotea metallica* is a regular summer immigrant in the North Sea. The species inhabits exclusively objects floating at the sea surface. Far range transport of these objects by surface currents results in an efficient dispersal of the animals. The occurrence of *I. metallica* in the German Bight correlates temporally with a period of extraordinarily mild winter seasons. Even though *I. metallica* is not able to hibernate in the North Sea, the annual reproductive period of the animals is extended by the observed temperature anomaly enabling the species to become conspicuous in that region. Permanent populations of *I. metallica* exist only in the Mediterranean and off the east coast of North America. Considering the prevailing surface currents in the North Atlantic (Gulf Stream) it appears likely that the animals found in western European waters derive from the North American population. However, abundances of *I. metallica* off North America are quite low making a regular re-colonization of European waters exclusively from this region unlikely.

This work reveals mechanisms responsible for the repeated re-colonization of NW-European waters by *I. metallica*. Furthermore, the outcome and the underlying mechanisms of a probable competitive interaction of *I. metallica* with the indigenous species *Idotea baltica* are described. These investigations might help to assess the consequences of the occurrence of this exotic species in the North Sea ecosystem.

Drifting objects collected in the Mediterranean harboured small populations of *I. metallica* consisting of up to 55 animals. As the populations contained all developmental stages, successful reproduction of *I. metallica* on drifting objects results in independent local population dynamics. The resultant network of small local populations exhibits all structures of a marine metapopulation. The average current velocities of the Gulf Stream allow for a drift from America to Europe within several months. As it appears unlikely that single animals are able to survive such a long period a metapopulation of small, self-sustaining populations on floating objects must be assumed for the North Atlantic, too.

Even though mild winter temperatures are the pre-condition for the efficient spread of *I. metallica* into the North Sea an increase in summer temperatures (e.g. in the course of global warming) inhibit the population growth of the species. Experimentally determined population growth rates which are considered as a measure of fitness

decreased significantly at temperatures above 16°C. Consequently, the species tolerates only a small temperature range as it occurs, for example, along the thermally stable Gulf Stream. So, the metapopulation probably expands along the Gulf Stream providing a permanent input of small populations into the North Sea where these can proliferate successfully during the summer. In contrast, *I. baltica* was not affected by high summer temperatures. The species proved to tolerate high temperature variations as they are typical of shallow, continentally influenced shelf seas such as the North Sea.

Floating macroalgae provide not only a substrate to settle on but also a valuable source of food for inhabiting herbivorous organisms. Consuming the algae the animals reduce the persistence of the small habitats. On abiotic substrates, however, associated animals can feed only on other inhabitants or on the zooplankton from the surrounding waters which is often only temporally available because of its patchy distribution in the oceans. Therefore, abiotic substrates provide sub-optimal food supply for inhabiting animals but an efficient dispersal mechanism because of their resistance to natural decay. *Idotea metallica* proved to be well adapted to these feeding conditions. Population growth rates were highest with mixed food but only slightly affected by the absence of plant food resulting in reduced female fertility and a delayed juvenile development. So, the species exhibits a strong tendency towards carnivory enabling the animals to largely abstain from plant food. Consequently, plant substrates offered in experiments were destroyed only slowly by *I. metallica*. Without animal food, however, the animals did not mature. This demonstrates that for *I. metallica* animal food is obligatory.

For *Idotea baltica*, too, population growth rates were highest under mixed food conditions consisting of both plant and animal food, but in contrast to *I. metallica*, this species was strongly affected by the absence of plant food. Inclining rather to herbivory the species destroyed algal substrates much faster than *I. metallica*. In *I. baltica* a lack of either food component also affected female fertility and juvenile development. Thus, *I. baltica* appears to be poorly adapted to life on abiotic substrates where it experiences sub-optimal feeding conditions.

Idotea baltica was also less tolerant to quantitative food limitation than *I. metallica*. Young *I. baltica* survived only a relatively short starvation period. With unlimited food supply total lipid content was lower for adult *I. baltica* than for adult *I. metallica*. Lipid content remained constant after various periods of starvation indicating that the species metabolises different internal storage products such as proteins or carbohydrates. *Idotea metallica*, however, reduced the total lipid content during an initial starvation period in favour of other compounds. This may be interpreted as an adaptation to frequently occurring starvation periods.

According to the species' qualitative and quantitative food requirements *I. metallica* appears to be better adapted to the epipelagic life-style than *I. baltica*.

Under spatially limited conditions of 5-litre-microcosms both species were able to maintain persistent populations in single-species cultures at least for 24 weeks. However, in *I. baltica* strongly oscillating population densities increased the stochastic risk of population extinction and thus the population's sensitivity towards unpredictable environmental fluctuations.

In mixed-species cultures *I. metallica* was always driven to extinction by *I. baltica*. But for increased summer temperatures (20°C) and in the absence of plant food the competition model of Lotka & Volterra revealed density combinations that allow for co-existence of the species or even for competitive exclusion of *I. baltica* by *I. metallica*. Since food was always available in excess competition was not primarily for resources but occurred as direct interference. Juveniles of both species are fed by both conspecific and heterospecific adults. Predation rate was highest by subadult females. As the juveniles of neither species exhibit a particular defence mechanism both are preyed with the same rate. Adult animals, however, are able to distinguish between conspecific and heterospecific juveniles and prey more intensively on heterospecifics so that the outcome of the interaction is determined by the relative abundances of the species. As *I. baltica* normally exhibits a higher population growth rate and a higher capacity the species is likely to become competitively superior if confronted with *I. metallica*. Consequently, *I. metallica* will most likely remain of minor importance in coastal waters of the German Bight because *I. baltica* is the numerically dominant isopod species in the North Sea floatsam.

Far offshore, however, where the portion of abiotic objects increases *I. metallica* is more likely to prevail because of the species' tolerance to qualitative and quantitative food limitation. Consequently, the distribution of *I. metallica* will probably remain restricted largely to abiotic objects in a considerable distance to the coast as it was observed in the Mediterranean where macroalgae are rare in the neuston.