

# Four arguments why so many alien species settle into estuaries

## Introduction

Among the aliens established in German waters euryoecious and potent competitors predominate. It is remarkable that most of the introduced macroinvertebrates have established permanent populations in the estuaries of the German North Sea coast (19 species in total), a phenomenon also recorded from other estuarine areas.

On account of studies on estuaries in the Netherlands, Wolff (1999) formulated three hypotheses to explain this phenomenon. On basis of a comprehensive analysis of data with special reference to the macrozoobenthos of the German river Elbe, these hypotheses were checked, modified and complemented with a further argument.

## First Salt-tolerant limnic alien species

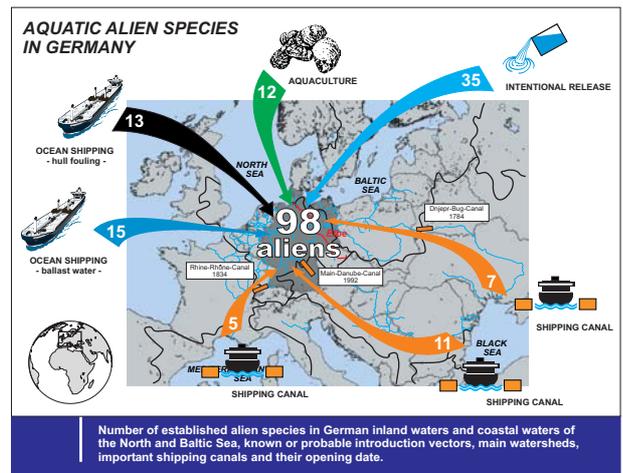
reached the coast first in the estuaries and found fitting salinity conditions somewhere along the estuarine gradient.

About 98 established alien species are known in German coastal and inland waters, whereby in the latter at least 62 species are recorded (Nehring in press). The invasion of German inland waters is facilitated primarily by the canals built during the last centuries, which eliminated the natural range barriers between distinct basins. Larval and postlarval drifting, transport on ships' hulls as well as active migration enabled alien species to extend their distribution rapidly. In the brackish part of the Elbe estuary 4 macrozoobenthic "limnic" alien species have established currently, since they can adapt to low salinities.

## Second Most major ports are located

in brackish regions or especially in estuaries (sensu Wolff). The same goes to German North Sea coast estuaries which are characterised by intense intercontinental shipping. Therefore they have a higher potential infection rate than other coastal zones, combined with the fact that ballast water often has estuarine character.

It has been demonstrated that up to 4,000 pelagic and benthic species are being transported between continents by ships every day. Recent calculations of Gollasch (1996) on the individual entry through ballast water discharges from overseas areas into the ports on the German North Sea coast revealed that 2.7 million individuals are being released every day.



## Third Genuine brackish water species

are characterized by a high tolerance for changing environmental conditions and therefore have a better chance of being transported alive than euhaline species (sensu Wolff).

About half of the alien macroinvertebrate species in German estuaries belong to this ecotype. There was evidence that anthropogenic stress (corrections, deepening) had a negative effect on the occurrence of native genuine brackish water species, of which many are listed in Red-Lists now. However, due to the intrusion of a number of "new" species, these losses have partly been 'compensated'.

## Fourth The natural species minimum

in brackish waters (sensu Remane 1934) with its unsaturated ecological niches is of considerable importance for the establishment of alien species (sensu Wolff).

As described by Remane for the Baltic Sea, the greatest 'indigenous species poorness' occurs in the Elbe estuary where salinities are 5-18 psu (mesohaline zone). In contrast, this area is characterized by the highest number of alien macrozoobenthos species found in German waters (14 species). Both downstream in fully marine waters, and upstream, their number is significantly lower. The simple conclusion is, that the 'poorer' a community is, the more alien species can potentially establish (Nehring 2001).

## Conclusion

It seems that low native species richness in aquatic communities is not an inconsiderable factor for invasions, but the frequency and intensity (or size) of inoculation are critical components in colonization success. In conclusion, it can be stated that the combination of brackish water with its unsaturated ecological niches and intense intercontinental ship traffic has the highest potential infection rate for coastal areas, especially in Germany.

### Further reading

- Gollasch, S. (1996): Untersuchungen des Artenintrans durch den internationalen Schiffsverkehr unter besonderer Berücksichtigung nichtheimischer Arten. - Verlag Dr. Kovach, Hamburg: 312 pp
- Nehring, S. (2001): Estuaries as a habitat: On the status of introduced macroinvertebrates on the German North and Baltic Sea coast. - CBD Technical Series no. 1: 55-57
- Nehring, S. (in press): International shipping - A risk for aquatic biodiversity in Germany. - Naebiotica.
- Remane, A. (1934): Die Brackwasserfauna. - Verh. dt. zool. Gesell. 36: 34-74
- Wolff, W.J. (1999): Exotic invaders of the meso-oligohaline zone of estuaries in the Netherlands: why are there so many? - Helgoländer Meeresunters. 52: 393-400

