

Estuaries as a habitat:

On the status of introduced macroinvertebrates on the German North and Baltic Sea coast

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Mollusca - *Crassostrea gigas*

Origins: north-west Pacific
 Vector: aquaculture product
 First sighting: 1991

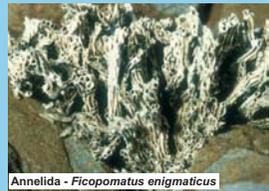
The Pacific oyster was introduced in 1986 to Germany to replenish the stock of the indigenous European oyster *Ostrea edulis*, which was strongly diminished in the past by overexploitation. From extreme spatfalls of cultured Pacific oysters wild populations developed in the Wadden Sea.



Mollusca - *Ensis americana*

Origins: north-west Atlantic
 Vector: ballast water
 First sighting: 1979

Within few years the American jack-knife clam has spread rapidly in southern North Sea areas. Although dense populations were reported recently there are no indications that this mussel does interfere with species in the original European benthic communities.



Annelida - *Ficopomatus enigmaticus*

Origins: Indian Ocean (?)
 Vector: ship hull
 First sighting: 1975

The tubed worm has been recorded from a number of brackish water sites, mostly confined to southern coasts. In northern Europe its occurrence is favoured by the discharge of heated effluent water from power plants. The worm builds massive calcareous tube-like aggregates, which can affect the form and structural stability of e.g. harbour structures.

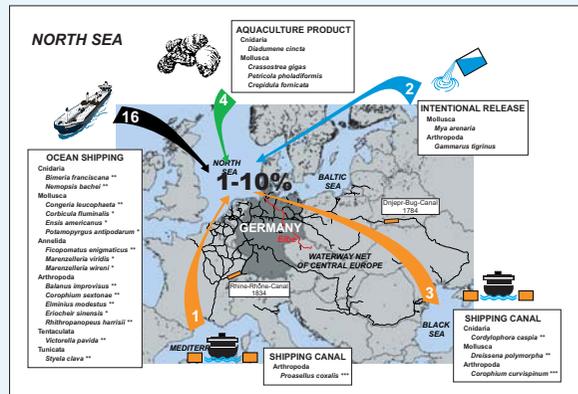


Arthropoda - *Eriocheir sinensis*

Origins: south-east Asia
 Vector: ballast water
 First sighting: 1912

Because of favourable conditions, little competition and an abundant food supply the Chinese mitten crab became abundant mainly in German waters within few years. Following the late 1940s their abundance decreased because of increased water pollution. Since several years increasing populations in Europe are reported and first crabs are re-imported to Asia for human consumption.

INTRODUCED MACROINVERTEBRATES ON THE GERMAN NORTH SEA COAST



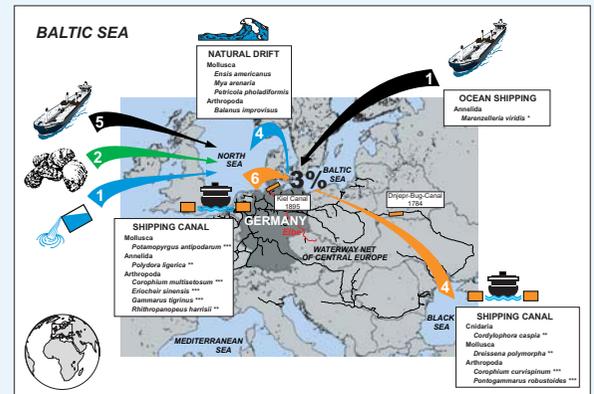
Known or probable introduction vectors, number of introduced species and their amount on total species number (in percent), important canals and their opening date; * ballast water, ** hull, *** hull or active migration.

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.

Macroinvertebrates	North Sea	Baltic Sea
number of introduced species	26	15
main area of origin	NW Atlantic	NW Atlantic Pontocaspian
main introduction vector	ocean shipping	shipping canal
amount on total species number	open waters: 1% Wadden Sea: 3% Estuaries: 10%	3%
relevant ecological or economic effects	no	no

ON THE GERMAN BALTIC SEA COAST

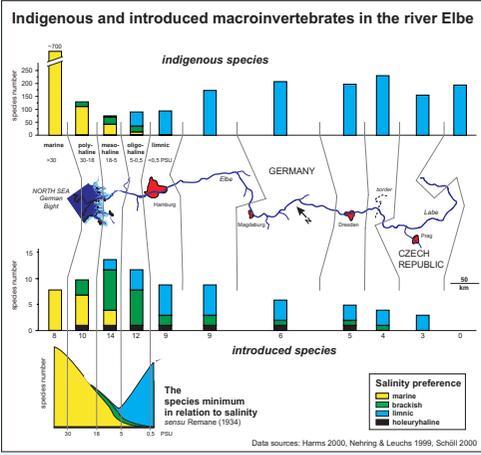


Known or probable introduction vectors, number of introduced species and their amount on total species number (in percent), important canals and their opening date; * ballast water, ** hull, *** hull or active migration.

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).
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.

Ballast water vs. ship hull

However, it is very likely that the discussion about the vector ballast water misjudges much more important threats. 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 ship hulls (as well as on imported aquaculture products) is much more important.

IMO ban of tributyltin

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.