Do non-indigenous species replace or coexist with native species? An example from Dutch freshwater invertebrate communities.

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Introduction: the species

Exotic macroinvertebrates in Dutch inland waters

±68 species ~ 3% of all species recorded
Introduction: region of origin

- North America
- East & south Asia
- Ponto-Caspian region
- Other

Number of species recorded

Time period:
- 1976-1980
- 1981-1985
- 1986-1990
- 1991-1995
- 1996-2000
- 2001-2005
- 2006-2010
- 2011-2015
Introduction: transport vectors

**Number of species recorded**

- **Shipping (routes)**
- **Trade passive**
- **Trade active**
- **Unknown**

**Time period**

- **1976-1980**
- **1981-1985**
- **1986-1990**
- **1991-1995**
- **1996-2000**
- **2001-2005**
- **2006-2010**
- **2011-2015**

**Shipping related pathways**

**Trade**

- [Image of shipping and trade pathways]

[Image credits: SEOBRD.COM]
Trends in occurrence and abundance?

Limnodata Neerlandica database

Monitoring data local water authorities
- 34,000 sampling points
- 163,000 biological samples
- >1980

Standardized:
- pond net
- sampled length 5 m
- multiple habitats

60% of the sampling sites contained 1 or more exotic species

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Trends in occurrence and abundance?

Dataset contained 69% of the species, of which 93% occurred yearly.

Trend

- 5x stabilisation
- 15x exponential
- 26x no clear pattern

often rare species

None disappeared
Trends in occurrence and abundance?

32% species dominant [= no. individuals/sample $\geq 255$] within assemblage

Top 5 ubiquists

<table>
<thead>
<tr>
<th>Species</th>
<th>Dominance established in Dutch water types (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Potamopyrgus antipodarum</em></td>
<td>100</td>
</tr>
<tr>
<td>(Gastropoda)</td>
<td></td>
</tr>
<tr>
<td><em>Dreissena polymorpha</em></td>
<td>64</td>
</tr>
<tr>
<td>(Bivalvia)</td>
<td></td>
</tr>
<tr>
<td><em>Gammarus tigrinus</em></td>
<td>64</td>
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<tr>
<td>(Amphipoda)</td>
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<tr>
<td><em>Limnomysis benedeni</em></td>
<td>50</td>
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<tr>
<td>(Mysida)</td>
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</tr>
<tr>
<td><em>Dugesia tigrina</em></td>
<td>36</td>
</tr>
<tr>
<td>(Tricladia)</td>
<td></td>
</tr>
</tbody>
</table>

Verdonschot, Vos & Verdonschot (2013) WOT
Underestimation of exotic species presence?

1. Site selection
   - e.g. 70% of all samples are taken in linear water bodies

2. Identification issues: lag time before discovery

3. Sampling method & type of habitat sampled
Differences in occurrence between water types

1. Are there differences in the richness of exotic species between water types?
2. Can we explain these differences based on environmental characteristics of the water types?

All linear water types in Limnodata with >25 sites sampled: n = 21
Differences in occurrence between water types

Response variable: no. of exotic species recorded in water type (corrected for no. of samples)

Explanatory variables, based on typological differences:
- Stream order / position within network
- Trophic level
- Acidity
- Flow
- Permanency
- Presence of ship traffic
Differences in occurrence between water types

Key parameters: 1. position within network (65% explained var.) and 2. trophic status (22%)

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Native versus exotic species

Is there a relationship between the number of exotic species and:

1. Total species richness
2. Richness of indicator species
Native versus exotic species

Ditch
‘poldersloot’

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Native versus exotic species

Slow flowing lowland stream on sandy soil (middle-lower course)
Native versus exotic species

Difference in response in environmentally ‘benign’ versus ‘harsh’ habitats?

Slow flowing lowland stream on sandy soil (upper course)

![Graph showing comparison between native and exotic species richness and number of indicator species across different Preston classes.](image-url)
Conclusions

1. Exotic macroinvertebrate species will not disappear anymore once established.

Isolation of water bodies is the key to prevention.

Desirable from an ecosystems’ perspective?
Conclusions

2. Co-occurrence instead of outcompeting native species is the rule: novel ecosystems!

Focus on potential positive roles exotic species in ecosystem functioning

- Niche differentiation
- Facilitation
- “Insurance effect”

3. Both native and exotic species are affected by ecosystem degradation
Questions?