Spread and invasiveness of the recently introduced Chinese mystery snail (*Bellamya chinensis*) in riverine ecosystems in the Netherlands

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Introduction

• 2008 Chinese mystery snail (*Bellamya chinensis*)
  - Origin: Eastern Asia (e.g., China, Taiwan, Japan)
  - Introduced: United States (32 states); Canada (Quebec)

• Dispersal vectors
  - Recreational boats
  - Waterfowl
  - Aquatic mammals
  - Aquarium and ornamental trade
Introduction

• Human mediated dispersal → likelihood new introductions Netherlands/Europe

• Risk assessments
  - Policy tool to identify species impacts and invasiveness
  - Takes the four main stages of invasion into account:
    • 1) Entry; 2) Establishment; 3) Spread; 4) Impacts

• Aim:
  Acquire relevant information on the four stages of *B. chinensis* invasion, subsequently perform a risk assessment using the acquired information
Material and methods

Risk analysis of the Chinese mystery snail (*Bellamy chinensis*) in the Netherlands

- Literature review
  - Web of Science
  - Google Scholar
  - Google

Risk assessment protocols
(*ISEIA and Harmonia+*)

- Introduction
- Establishment
- Spread
- Impacts
  - environmental
  - human

Risk inventory
(current knowledge)

- Field surveys
  - dispersal rate
  - substrate
  - abiotic conditions
  - density
  - population structure

Probability of introduction, establishment, dispersal and impacts

Expert meeting

Risk classification

Conclusion and recommendations
Results – field survey

- Overview of distribution in the Netherlands (11 sites)

- Largest known population (Eijsder Beemden)
  - Natural dispersal rate: ~ 500 metres / 5 years
  - Substrate – mud, boulders
  - Abiotic conditions – similar to other reported conditions
  - Density – low compared to other densities

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Values</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>6.5 - 8.4</td>
<td>Jokinen 1982</td>
</tr>
<tr>
<td>Conductivity (µs/cm)</td>
<td>63.0 - 400</td>
<td>Jokinen 1982</td>
</tr>
<tr>
<td></td>
<td></td>
<td>This study</td>
</tr>
<tr>
<td>Calcium concentration (ppm)</td>
<td>5.0 - 97</td>
<td>Jokinen 1982</td>
</tr>
<tr>
<td>Magnesium concentration (ppm)</td>
<td>13 - 31</td>
<td>Jokinen 1982</td>
</tr>
<tr>
<td>Sodium concentration (ppm)</td>
<td>2.0 - 49</td>
<td>Jokinen 1982</td>
</tr>
<tr>
<td>Oxygen concentration (ppm)</td>
<td>7.0 - 11</td>
<td>Jokinen 1982</td>
</tr>
<tr>
<td>Water temperature (°C)</td>
<td>0.0 - 30</td>
<td>Karatayev et al. 2009</td>
</tr>
<tr>
<td></td>
<td></td>
<td>This study</td>
</tr>
<tr>
<td>Salinity (ppt)</td>
<td>0.1 - 0.2</td>
<td>This study</td>
</tr>
<tr>
<td>Flow rate (m/s)</td>
<td>0.03 - 0.08</td>
<td>This study</td>
</tr>
</tbody>
</table>

Location | Estimated density (snails/m²) | Estimated population size / surface | Reference
---|-------------------------------|-------------------------------------|----------|
Long Island, New York, USA | 0.01 - 0.07 | 150 - 970 snails / 1.46 ha | McCann 2014 |
Kidd Springs, Dallas, Tarrant County, USA | 100 | n.a. | Karatayev et al. 2009 |
Otter Lake, Wisconsin, USA | 38 | n.a. | Solomon et al. 2010 |
s-Gravezande, The Netherlands | < 0.5 | n.a. | Soes et al. 2012 |
Eijsder Beemden, The Netherlands | 0.3 | 6000 / 2.00 ha | This study |
Results – literature study

• Species description
  - Height up to 70 mm, lifespan up to five years
  - Facultative filter feeder, detritivore, browses on microalgae
  - Mostly sandy to muddy substrates
  - Internal fertilization, parthenogenesis?
  - High fecundity (27.2 – 65 young per year)

• Ecological effects
  - Trematode infection ↓ in North America
  - Crayfish attack protection ↑ compared to native species
  - Native snail species abundance ↓
  - Filtration rate ↑; alteration of microbial community
  - N:P ratio may increase (low excretion of P)
  - Food source for (native)crayfish, rats and other mammals
Results – literature study

• Socio-economic effects
  - Cultured for the food market
  - May clog water intake pipes
  - Fishing nets can become clogged
  - Dead or decaying shells → nuisance

• Public health effects
  - Intermediate host for echinostoma parasites (native range)
  - Infection through consumption
  - Echinostamiasis: diarrhoea, abdominal pain and anorexia
  - No reported infections from North America
  - Though, consumption takes place
## Results – risk assessment

**ISEIA**

<table>
<thead>
<tr>
<th>Category</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dispersion potential or invasiveness</td>
<td>2</td>
</tr>
<tr>
<td>Colonisation of high conservation value habitats</td>
<td>3</td>
</tr>
<tr>
<td>Adverse impacts on native species</td>
<td>3</td>
</tr>
<tr>
<td>1) Predation/Herbivory</td>
<td>2</td>
</tr>
<tr>
<td>2) Interference and exploitation competition</td>
<td>3</td>
</tr>
<tr>
<td>3) Transmission of diseases to native species</td>
<td>2</td>
</tr>
<tr>
<td>4) Genetic effects</td>
<td>DD</td>
</tr>
<tr>
<td>Alteration of ecosystem functions</td>
<td>2</td>
</tr>
<tr>
<td>1) Modification of nutrient cycling or resource pools</td>
<td>2</td>
</tr>
<tr>
<td>2) Physical modifications of the habitat</td>
<td>2</td>
</tr>
<tr>
<td>3) Modifications of natural succession</td>
<td>2</td>
</tr>
<tr>
<td>4) Disruptions of food webs</td>
<td>2</td>
</tr>
</tbody>
</table>

**Sum of assessments:** 10

**Invasion stage:** Isolated populations

**Classification:** B1 (watch list)

- Risk classification individually → meeting to form consensus
- Score: high (3), medium (2), low (1), data deficient (0)
## Results – risk assessment

- **Harmonia+**

<table>
<thead>
<tr>
<th></th>
<th>Risk classification</th>
<th>Risk score</th>
<th>Certainty</th>
<th>Certainty score $^3$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Introduction$^1$</strong></td>
<td>High</td>
<td>1.00</td>
<td>High</td>
<td>0.67</td>
</tr>
<tr>
<td><strong>Establishment$^1$</strong></td>
<td>High</td>
<td>1.00</td>
<td>High</td>
<td>1.00</td>
</tr>
<tr>
<td><strong>Spread$^1$</strong></td>
<td>Medium</td>
<td>0.50</td>
<td>Medium</td>
<td>0.50</td>
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<tr>
<td><strong>Environment$^1$</strong></td>
<td>Medium</td>
<td>0.50</td>
<td>Medium</td>
<td>0.50</td>
</tr>
<tr>
<td><strong>Plant impact$^1$</strong></td>
<td>Low</td>
<td>0.00</td>
<td>High</td>
<td>1.00</td>
</tr>
<tr>
<td><strong>Animal impact$^1$</strong></td>
<td>Low</td>
<td>0.00</td>
<td>Low</td>
<td>0.33</td>
</tr>
<tr>
<td><strong>Human impact$^1$</strong></td>
<td>Low</td>
<td>0.25</td>
<td>Low</td>
<td>0.33</td>
</tr>
<tr>
<td><strong>Other$^1$</strong></td>
<td>Low</td>
<td>0.00</td>
<td>High</td>
<td>1.00</td>
</tr>
<tr>
<td><strong>Invasion score$^2$</strong></td>
<td>High</td>
<td>0.79</td>
<td></td>
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<tr>
<td><strong>Impact score</strong></td>
<td>Medium</td>
<td>0.50</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Risk score</strong></td>
<td>Medium</td>
<td>0.40</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1: maximum score for each category; 2: introduction x establishment x spread; 3: average for each category

- Risk classification together
- Score: risk score and certainty score (scale from 0 – 1)
Discussion

• Preliminary ISEIA risk score of 10:
  - Moderate impact
  - Isolated populations

• Harmonia+ risk score is medium

• New York invasiveness assessment
  - *B. chinensis*: 83 / 100 points → invasiveness rank: very high

• Early invasion stage
  - Re-evaluation when more data available
Conclusion

• *B. chinensis* has a medium risk

• Management is needed
  - Pathway management: aquarium trade + food market
  - Public health: outreach preparation, consumption and risks
  - Elimination and control measures
    – Copper sulphate (applied, no full eradication)
    – Drawdowns (not successful, tolerant to desiccation)
    – Manual removal (Missouri, decreased abundance)

• Future research
  - Environmental impacts (dispersal potential, ecosystem alteration)
  - Human health and animal impacts
  - Management options
Thanks for your attention – Questions?

For more information or cooperation:

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