Interaction between stress induced by competition and an insecticide on the response of aquatic invertebrates

Paul J. van den Brink, Sylvan Klein, Andreu Rico

Introduction

- ERA based on extrapolations from single-species tests to the whole ecosystem
- Ecological interactions are not taken into account
- Effects on sensitive populations could be underestimated

Objective

- To study how and to what extent ecological interactions influence the effects of chemicals on aquatic invertebrate populations

Two experiments:
- **Gammarus pulex** (Amphipoda) vs **Asellus aquaticus** (Isopoda)
- **Daphnia pulex** (Cladocera) vs **Brachionus calyciflorus** (Rotifers) vs **Chaoborus sp. larvae** (Insecta)
- **Chlorpyrifos** (OP insecticide)

**Gammarus pulex** experiment

- To study how and to what extent ecological interactions influence the effects of chemicals on aquatic invertebrate populations

**Gammarus pulex** experiment

- Chlorpyrifos: Control, 0.15, 0.20, 0.25 µg/L
- Representing the LC0, LC10, LC30 and LC50 (Rubach et al. 2011)
- Pesticide application:
  - Survival: day 0, 2, 4, 7, 11, 14 after the first application

**Gammarus pulex** experiment

<table>
<thead>
<tr>
<th>Intraspecific</th>
<th>Interaspecific</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>5 G. pulex</td>
</tr>
<tr>
<td>Low</td>
<td>10 G. pulex</td>
</tr>
<tr>
<td>Medium</td>
<td>15 G. pulex</td>
</tr>
<tr>
<td>High</td>
<td>20 G. pulex + 10 A. aquatic</td>
</tr>
</tbody>
</table>

**Gammarus pulex** experiment

- Statistical analyses
  - Effects of pesticide, competition treatment and their interaction
  - Generalized Linear Models (GLMs) with GenStat

\[ \text{Abundance} = \alpha + \text{CPF} + \text{Pesticide} + \text{Inter} \]

- Binomial distribution with a logit link
- **G. pulex** experiment: EC50s
**Gammarus pulex experiment**

- **Intraspecific competition**
  - Sign. effect (day 4 and 7)
  - Density & Survival
  - EC50-7d: Control 0.07 - Low 0.09 - Medium 0.12 µg/L

**Daphnia pulex experiment**

- Glass jars with 1L WC-medium
- Water bath (T=20°C; 12h photoperiod)
- Food source: *Scenedesmus obliquus* (0.5g/C per jar)
- Competition and predation (*n*=3):
  
<table>
<thead>
<tr>
<th>Intraspecific</th>
<th>Interspecific</th>
<th>Predation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>10 D. pulex</td>
<td>10 D. pulex</td>
</tr>
<tr>
<td>Low</td>
<td>20 D. pulex</td>
<td>10 D. pulex + 333 B. calyciflorus</td>
</tr>
<tr>
<td>Medium</td>
<td>40 D. pulex</td>
<td>10 D. pulex + 666 B. calyciflorus</td>
</tr>
<tr>
<td>High</td>
<td>10 D. pulex</td>
<td>1 D. pulex + 1 Chaoborus sp.</td>
</tr>
</tbody>
</table>

- **Statistical analyses**
  - Effects of pesticide, competition/predation treatment and their interaction
  - Generalized Liner Models (GLMs) with GenStat
  
  Abundance = α + CPF + Competition/Predation + Inter.
  - *D. pulex*: Poisson distribution with a log link

- **Intraspecific competition**
  - CPF effects only after 2nd application
  - No sign. effects of competition
  - Sign. decrease juveniles and sub-adults highest exposure
**Daphnia pulex experiment**

- Interspecific competition
  - Pesticide Concentration
  - Control: 0.10 µg/L, 0.40 µg/L, 0.75 µg/L

- Low exposure, competition favours survival
- No sign. effects of competition
- Sign. decrease sub-adults at highest exposure (day 14)

**Conclusions**

- **Gammarus pulex experiment**
  - Antagonism between pesticide exposure and competition
  - Intraspecific: social behaviour/cannibalism?
  - Interspecific: predation

- **Daphnia pulex experiment**
  - Competition effects more evident on population structure than on species abundance
  - Predation results in higher effects than competition (Poster WE055)
  - Effects of predation are lower at high exposure concentrations

**Thanks for your attention**

ChimERA: an integrated modelling tool for ecological risk assessment – towards more ecologically realistic assessment of chemicals in the environment

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