Predicting the response of aquatic invertebrates to chemical stress using species traits and stressor mode of action

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Biography

- Research institute Alterra
- Wageningen University

- Ecological risk assessment of chemicals
  - development of effect models
  - validation of risk assessment procedures
  - risk assessment in the tropics
- 1999 PhD
  - Ecological and statistical evaluation of effects of pesticides in freshwater model ecosystems.

Ecological Risk Assessment of chemicals

- Often based on results of single species studies

- If performed with many species variation in sensitivity can be estimated

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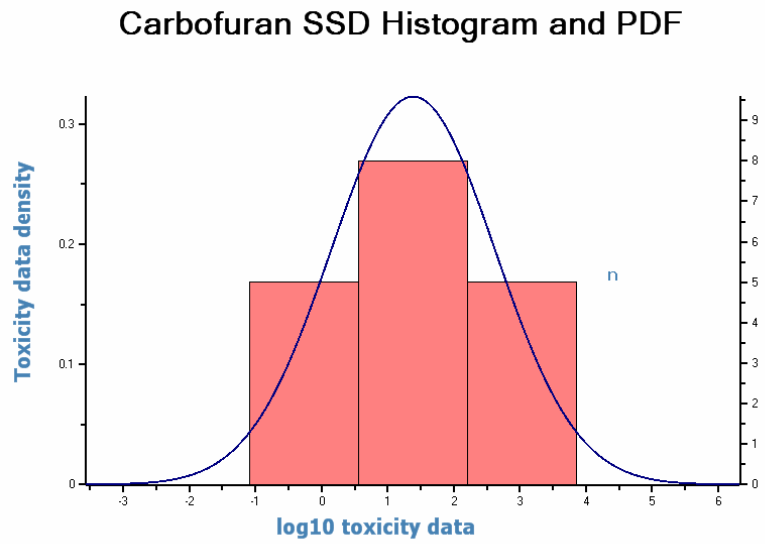
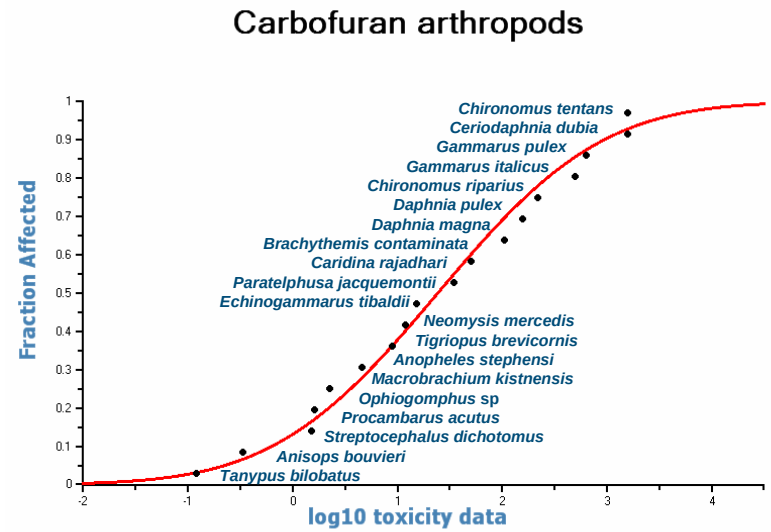
Species Sensitivity Distribution concept

- Species sensitivity distribution increasingly used to characterise variability in sensitivity
  - Often threshold value from distribution is taken as “safe concentration”





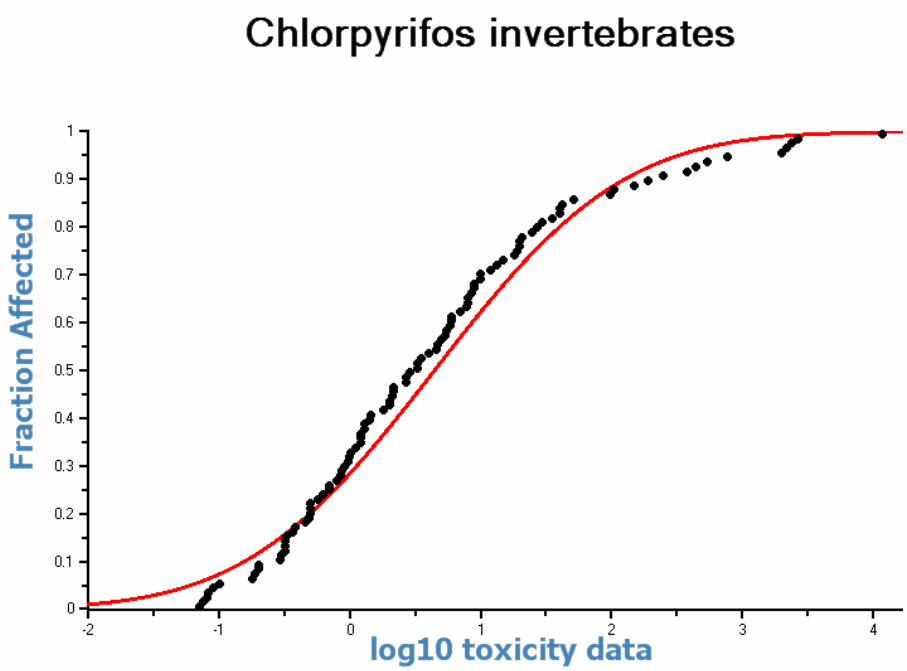
SSD criticism

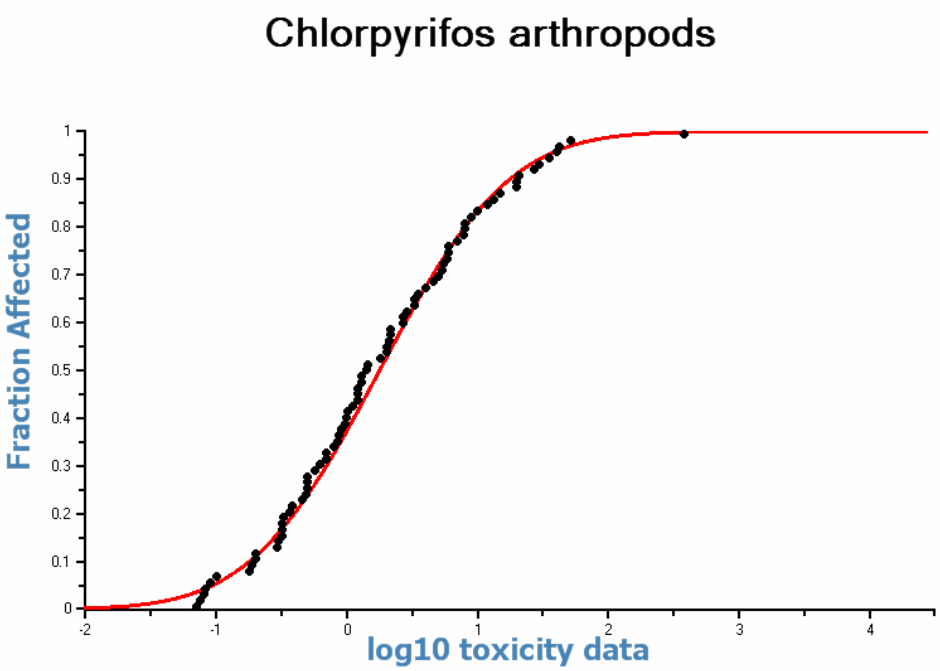
- Criticism on SSD relevant to this presentation
  - The sample of the species is a random selection
  - Interactions among species do not influence the sensitivity distribution
  - All species are equally important for the ecosystem
  - The real distribution of the sensitivity of the community is well modelled by the selected statistical distribution.
  - Etc.

- **Species identity matters!!!**

SSD species identity

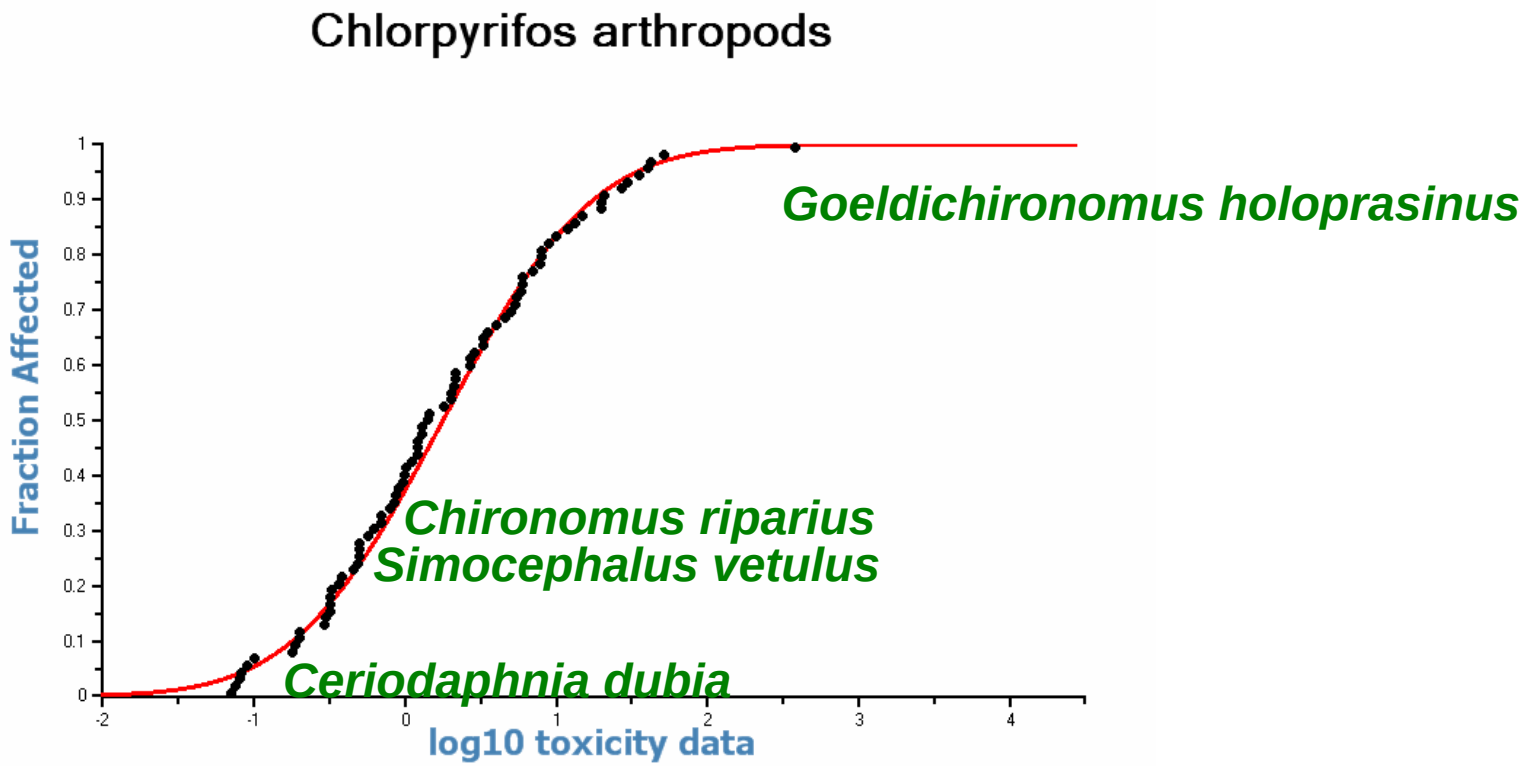
- For instance: taxonomy



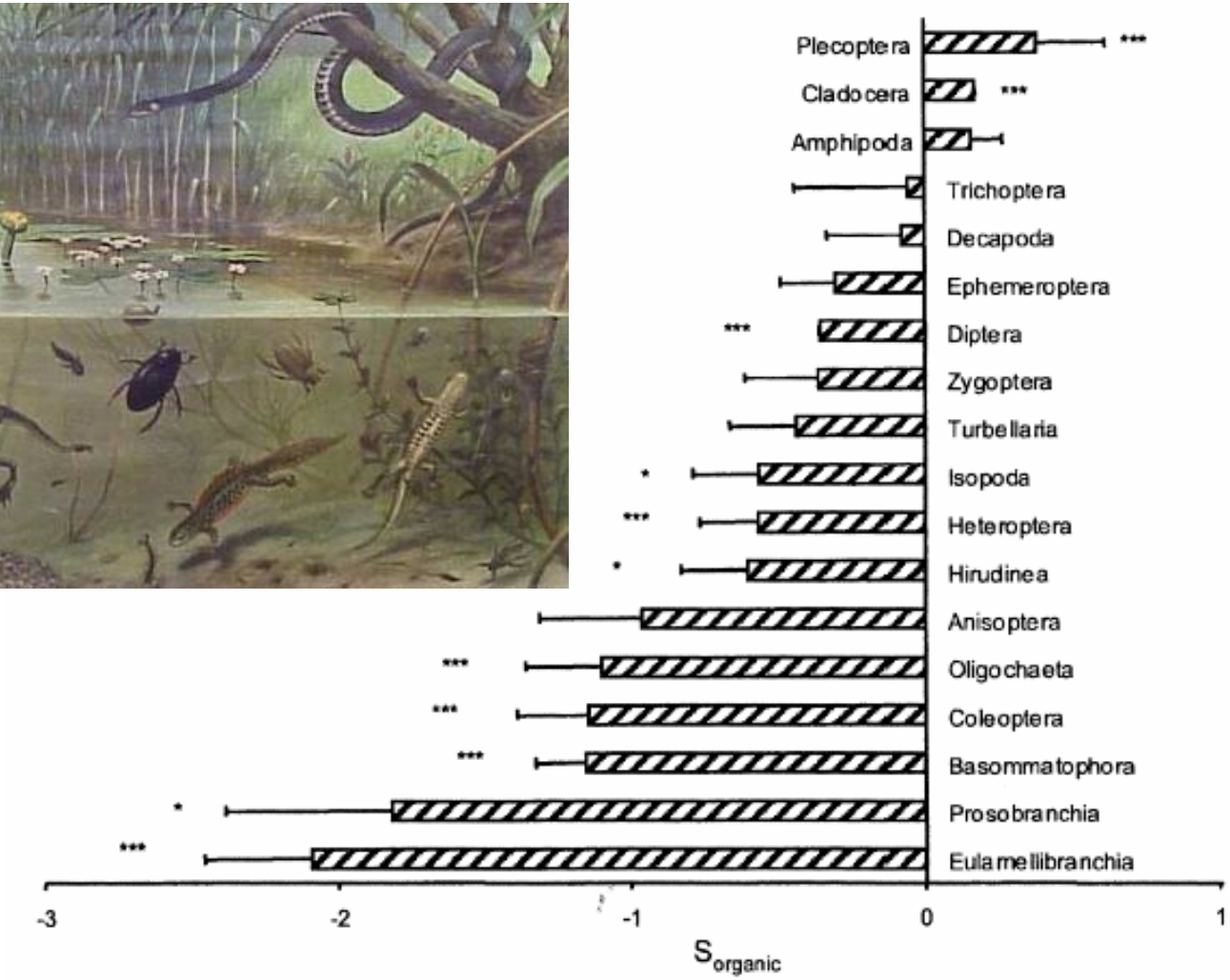


SSD why do species differ in sensitivity?

- For risk assessment estimating variability enough but: why do species differ in sensitivity?



Analysis by von der Ohe and Liess (2004)



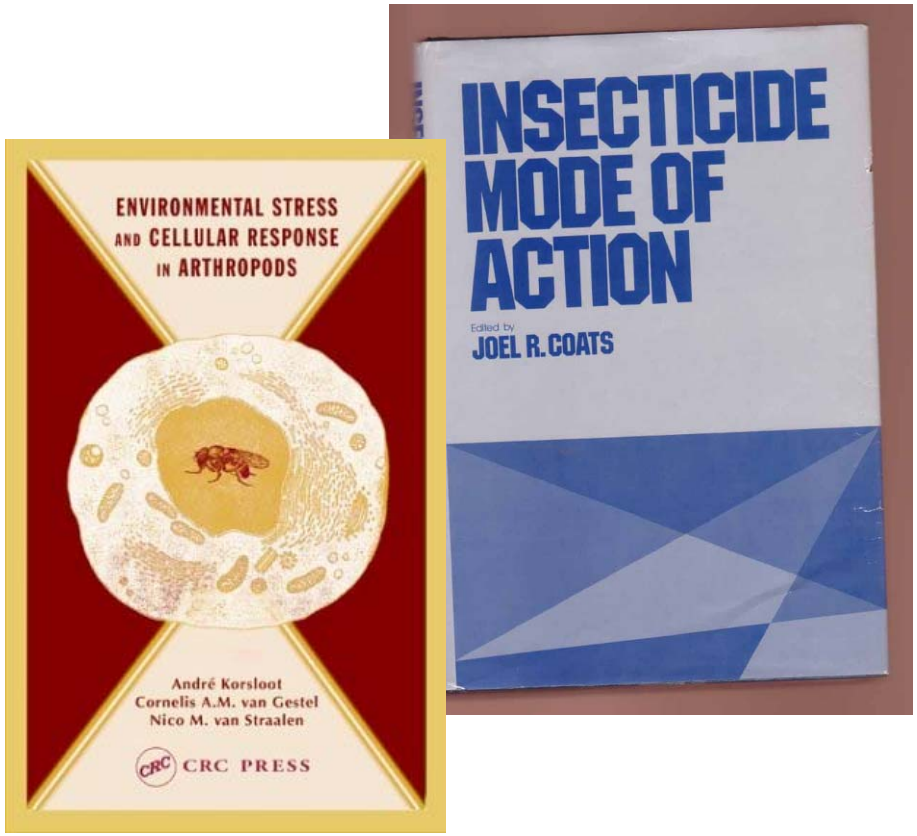
SSD why do species differ in sensitivity?

- Assumption: sensitivity is not a random process
- Might be related to morphological, biological and ecological species traits

- QSAR approach
  - Sensitivity species A = F(characteristics chemicals)
  - Many chemicals, 1 species
- Inverse QSAR (QTSR ?) approach
  - Sensitivity many species = F(traits species)
  - Chemicals with similar MOA, many species

SSD why do species differ in sensitivity?

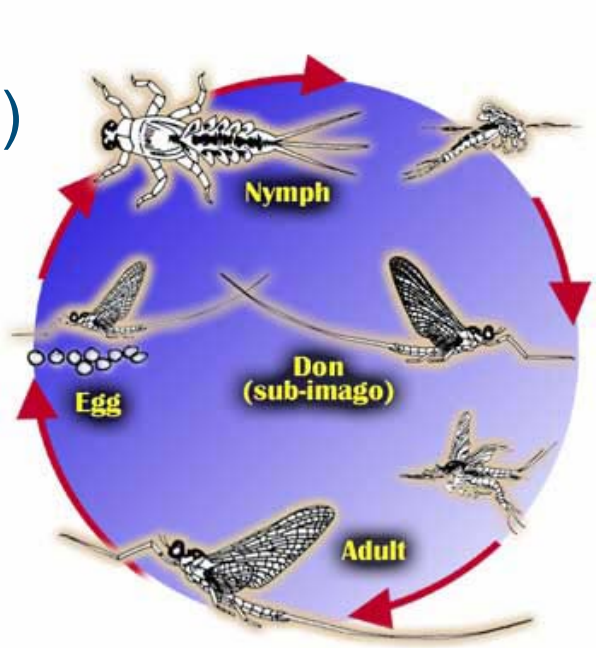
- Morphological species traits
  - Enzyme systems / neurotransmitters → mode of action
  - Fat content
  - Mode of respiration, etc.
- Biological species traits
  - Life cycle duration
  - Resistance form
  - Food, feeding etc.
- Ecological species traits
  - Distribution
  - Substrate, etc.



Analysis by Baird and Van den Brink (subm)

- Constructed a closed data set from the EPA AQUIRE data set

- Looked at different traits:
  - Taxonomic group (insect, crustacean)
  - Size (dry mass, length)
  - Life cycle duration
  - Mode of respiration
  - Feeding type
  - Etc.



Analysis by Baird and Van den Brink

- Concluded:
  - 4 species traits explained 71% of the variability in sensitivity to toxicants
  - Skin respiration, insect/crustacean, life-cycle duration, gill respiration
  - Within a group of 12 species exposed to 15 chemicals

  - Should be done by mode of action
  - Insects underrepresented
  - This approach could revolutionise the SSD concept

Assessment of response

- Response of species to stress not only determined by sensitivity but also by:
  - Likeliness of exposure
  - Recovery

- Fortunately more work has been done already on these subjects

Aim of the project

Building a mechanistic and/or emperical model to predict the response of aquatic invertebrates to chemical stress using species traits and stressor mode of action

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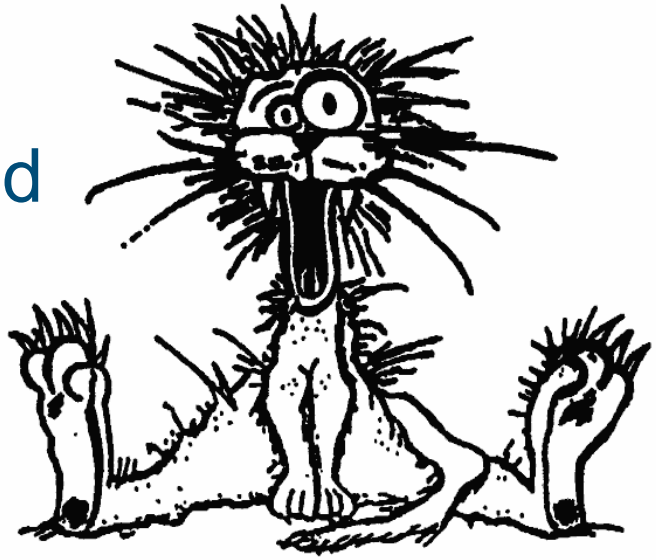
Aim of the project

- This is done by using
  - sensitivity,
  - likeliness of exposure and
  - recovery potential
- as determinants of response and
- using
  - morphological,
  - biological and
  - ecological species traits
- as predictors



"STRESS"

Benefits to CEFIC and community

- Improving the scientific foundation of ERA
  - Insight in sensitive species for different MoA
  - Reduced sensitivity uncertainty
  - Can be used to better assess SSD
  - Ecologising ERA → stress ecology
- Reduced animal testing
- Other compounds in the assessment besides pesticides
- Enables preliminary RA when data is scarce
- REACH, Uniform Principles; WFD; Biocide directive;

Available expertise and infrastructure

- Three laboratories (Alterra, Wageningen University and Syngenta)
- Experts on stress ecology, toxicology, fate assessment, bioconcentration, efficacy, ecology, etc.
- International network (e.g. data of Van der Ohe and Liess will be available)
- Species trait data base by Alterra (including POND-FX and French data bases)

Timeline of the project

- PhD project (4 years)
- Year 1 and 2:
  - Review paper on the response determinants and species traits (a.o. using Van der Ohe and Liess data and trait data base)
  - Experiments (at least 5 chemicals including non pesticides, 10 species)
    - Effects and lethality → relation with all traits
    - Lethal Body Burden → morphology → internal conc.?
    - Behavioural → behaviour, activity, respiration
  - Data analysed by multivariate statistics

Timeline of the project

- Year 3 and 4:
  - Modelling of recovery and likelihood of exposure
  - Mechanistic and/or empirical modelling of sensitivity
  - Integration of these models in overall framework to assess response of species to chemical stress
  - Validation of rejection of model using results of mesocosm experiments
  - Completion of thesis

Budget breakdown

- PhD will be partly financed by Syngenta and Alterra
- LRI award will be used for
  - PhD student (€ 50.000)
  - Research assistant for performing experiments (7 months: € 50.000)
  - In total 1.8 man year
- In kind contribution of Alterra
  - € 27.200: PhD student
  - Internal daily rate for research assistant
  - € 27.020: 2¼ months Van den Brink at internal rate

Thanks!

To CEFIC

To selection panel

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