

sDiv workshop summary
"sEcoToxDiv"
15. – 18.12.2014

Background and aims of the workshop:

The question how biodiversity (B) and ecosystem functioning (EF) connect has fascinated ecologists for decades. The incorporation of environmental variables simultaneously and non-randomly affecting B and EF, and the contribution of vertical interactions in food-webs, list among the key challenges for future B-EF research. The use of aquatic multi-trophic experiments ("cosms") to study community- and ecosystem-level effects of chemicals is a central approach in ecotoxicology, with a strong bias towards pesticides. Although available ecotoxicological cosm data demonstrate that pesticides are excellent agents to study non-random community restructuring and indirect knock-on effects mediated by vertical interactions, these data have remained unexplored in the context of B-EF science. The objective of sEcoToxDiv was therefore to evaluate how B-EF relations in multitrophic systems exposed to pesticides would look different than those emerging in the undisturbed systems most B-EF research is based on. The second and main objective was to design cosm experiments that would use chemicals as environmentally significant selection factors to add a new dimension to the field of B-EF science. Our workshop is timely as it seeks to promote two major evolutions that are on-going in B-EF science and ecotoxicology, respectively: the incorporation of environmental variables, and the up-scaling to higher levels of biological organisation.

Focal areas of discussion, main results/conclusions + open questions

Day 1 (December 15, 2014)

We started by revising the objectives of the workshop, as specified in the workshop proposal, and by discussing the participant's expectations for the workshop. Next, we discussed briefly the history of Biodiversity (B)-Ecosystem functioning (EF) science to evaluate how the dimension we want to add to this field would fit with its historical context and could broaden it. During the rest of the morning and early afternoon we discussed:

- The experimental design of ecotoxicological cosm studies and on-going B-EF studies.
- The effects pesticides typically elicit in aquatic freshwater food-webs.

- How existing ecotoxicological data can (and cannot) be used in the framework of B-EF science.

In the late afternoon, we split up in two working groups (WGs) to discuss what new B-EF questions would emerge when considering ecosystems exposed to chemical pollutants, and how the answers to classical B-EF questions would be different between undisturbed systems and 'polluted' systems. Based on the discussions in these WGs, we decided to merge both discussion points into the more tangible question of how chemical pollutants could be used in B-EF science. This would then be the focus of the paper.

Day 2 (December 16, 2014)

A structure of a paper on the use of chemicals in B-EF science was drafted during a plenary session. We decided to focus the paper even more by concentrating on the use of chemicals as agents for indirect B manipulations in B-EF science. Afterwards, we split up in groups to discuss the different aspects: refining how indirect B manipulations are located in the historical context of B-EF science; summarizing the proof showing that chemicals can actually manipulate B (and EF) of specific taxa/trophic levels; how chemical dose can be used to control the magnitude and type of B (and EF) effect; what the implications could be of 'ecotoxicological' B-EF studies for conservation of natural systems.

Day 3 (December 17, 2014)

We discussed how the concepts specified on day 2 could be concretized in a more quantitative way. We decided to illustrate key effects of pesticides in food-webs using existing ecotoxicological cosm data. We also applied structural equation modelling (SEM) to such data to tease out the different ways in which chemicals can affect B and EF. Finally, we developed an extension of a simple community model to illustrate how chemicals could be used as agents of indirect B and EF manipulations in B-EF science, explicitly acknowledging the fact that such simulations merely serve structuring our thoughts and not making any claims on their predictive value.

Performing actual data analyses or modelling was initially not planned for this workshop. However, the participants felt such an effort was an absolute necessity to give substance to our ideas and opinions.

Day 4 (December 18, 2014)

We reiterated the paper's structure, discussing how the different figures drafted during the past days fitted. Finally, we decided to organize a follow-up workshop that would be dedicated to performing a formal meta-analysis of existing ecotoxicological cosm data. Various subgroups initiated

discussions on other follow-up activities such as preparing joint project proposals and expanding the community modelling in a separate paper.

Summary of presentations

The number of presentations was limited to 5 in order to maximize the time available for discussion, preliminary data analyses and modelling. All presentations were held on the first day, with the exception of that by J. Rohr (plenary iDiv talk on day 3).

- A short history of B-EF science (F. De Laender)
A brief historical context was provided in order to revise some current B-EF concepts and terminology and to streamline workshop discussions.
- Micro- and mesocosm design in aquatic ecotoxicology (I. Roessink)
- Ecological effects of pesticides in aquatic food-webs (L. Maltby)
Details of available ecotoxicological cosm studies and typical "effect chains", including vertical propagation, were explained. These two talks were the basis for later re-analyses of available data and SEM.
- Exploring the usefulness of existing ecotoxicological data to test B-EF relationships (V. Radchuk)
This talk illustrated how chemical effects on the stability of B and EF can be split into effects on mean B and EF and on the temporal variance of B and EF.
- The ecotron experiment and its experimental design (N. Eisenhauer)
Giving an overview of on-going efforts in experimental B-EF work, with application to terrestrial systems.
- Moving towards a predictive framework for the effects of agrochemicals on biodiversity and ecosystem functions (J. Rohr)
Showing how food-web ecology combined with toxicological knowledge can be used to gauge B-EF impacts of agrochemicals.

Outputs and workplan

A rough draft of an 'ideas and perspectives' paper was finished on Wednesday evening. This draft is on google docs. All sections of the paper have leading authors that are responsible for timely finalisation (deadline 1/3/2015). The main applicant (Frederik De Laender) is the leading author and responsible for timely finalisation and submission of the manuscript (deadline 1/4/2015). Action points include:

- Finalising SEM analyses.
We have two teams working on this topic at the moment, exchanging software and data.
- Finalising community modelling.
The model was coded in python during the workshop, and will be re-coded in a different software platform to test for robustness and

bugs. Simulations need to be finalised, as only a subset was ran during the workshop.

- Include perspectives on new experimental designs.
During the workshop, we spent less time on this issue because of the numerical analyses and the drafting of the corresponding schemes and figures. At the moment, this is taken up by a subgroup of cosm specialists.
- Expand the section on implications for nature conservation.
- Write the conclusion section.

General working atmosphere and feedback on sDiv-support

We've been spoiled for 4 days. Very professional and competent staff, excellent facilities and catering.

Participant list

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