sDiv Workshop

Biodiversity meets Physiology - Physiology meets Biodiversity

26. - 27.9.2013

1. Short description of the workshop

In the past biodiversity was restricted to organismic research with special attention to plant or animal taxonomy, phylogeny and ecology, whereas physiology was focussed on molecular processes studied in model organisms. Organismic research was merely descriptive, whereas physiology is mainly oriented to describe molecular mechanisms which underlay changes in plant performance.

This gap became the most obvious by the methodologies: organismic work was concentrated on species description, sampling and subsequent statistical analysis, whereas physiology uses biochemical, biophysical and molecular and transgenic methods to analyse the functions of genes involved in physiological regulation. The recent approach to use traits to describe biodiversity on a functional level means that physiology becomes an integrative part for biodiversity understanding.

It is the aim of this workshop to bring together molecular physiologists and functional ecologists to explore the present day knowledge for its potential to bridge organismic and molecular sciences.

2. Contact person:

Prof. Dr. Christian Wilhelm, Institute of Biology, Department of Plant Physiology, University of Leipzig

3. List of Participants

Name	Institut	Stadt
Jennifer Albrand	Universität Leipzig, iDiv	Leipzig
Anette Becker	Bundesanstalt für Gewässerkunde	Koblenz
Wolfgang Bilger	Christian-Albrechts-Universität Kiel	Kiel
Christina Bock	Universität Essen	Essen
Jens Boenigk	Universität Duisburg-Essen	Essen
Claudia Büchel	Goethe Universität Frankfurt	Frankfurt
François Buscot	Helmholtz Zentrum für Umweltforschung	Halle
Susanne Dunker	Universität Leipzig	Leipzig
Angela Falciatore	UPMC	Paris
Andrea Fanesi	Universität Leipzig	Leipzig
Kerstin Flieger	Universität Leipzig	Leipzig
Matthias Gilbert	Universität Leipzig	Leipzig
Edvard Glücksman	Universität Duisburg-Essen	Essen
Katja Herrera Glomm	Algenol Biofuels Germany	Berlin
Torsten Jakob	Universität Leipzig	Leipzig
Manfred Jensen	Universität Duisburg-Essen	Essen
Marcel Kansy	Universität Leipzig	Leipzig
Ralf-Bernd Klösgen	Martin-Luther Universität Halle-Wittenberg	Halle
Peter Kroth	Universität Konstanz	Konstanz
Bernard Lepetit	Universität Konstanz	Konstanz
Maike Lorenz	Georg-August Universität Göttingen	Göttingen
Jutta Ludwig-Müller	Technische Universität Dresden	Dresden
Stephen Maberly	Centre for Ecology& Hydrology	Lancaster
Marcus Mann	Universität Leipzig	Leipzig
Gabriela Pereyra	Max Planck Institute for Biogeochemistry	Jena
Georg Pohnert	Friedrich Schiller Universität Jena	Jena
Matthias Redlich	Universität Leipzig	Leipzig
Carolina Rio Bartulos	Universität Konstanz	Konstanz
Katja Rostowski	Universität Leipzig	Leipzig
Wolfgang Rühle	Universität Mainz	Mainz
Rowan Sage	University of Toronto	Toronto
Benjamin Schellenberger Costa	Universität Leipzig	Leipzig
Elly Spijkerman	Universität Potsdam	Potsdam
Bastian Steudel	Georg August Universität Göttingen	Göttingen
Wanwen Su	Universität Leipzig	Leipzig
Heiko Wagner	Universität Leipzig	Leipzig
Sabina Wodniok	Universität Duisburg-Essen	Essen
Ute Wollenzien	Algenol Biofuels Germany	Berlin
Chunhong Yang	Institute of Botany, Chinese Academy of Sciences	Beijing
Gerhard Zotz	Universität Oldenburg	Oldenburg
Peter Gresshoff	University of Queensland	Queensland

Christian Wirth	Universität Leipzig	Leipzig
Reimund Goss	Universität Leipzig	Leipzig
Jofre Carnicer	University of Groningen	Groningen
Marcel Kansy	Universität Leipzig	Leipzig
Christian Wilhelm	Universität Leipzig	Leipzig
Joseph von Fischer	Colorado State University & MPI Biogeochemistry	Fort Collins , Jena
Christian Zörb	Universität Leipzig	Leipzig

Yellow mark: invited speaker funded by sDiV, Blue mark: students from University of Leipzig, Grey mark: invited but declined, however offered to contribute a paper to the special issue, **No mark**: external participants

4. Workshop Agenda

Thursday 26th September 2013

9.00-9.15 C. Wirth: Welcome to the Participants "Philosophy of iDiv"
9.15-9.30 C. Wilhelm: Why this topic in iDiv?
9.30-10.15 C. Büchel: Evolution and Function of light harvesting proteins
10.15-11.00 R. Goss: Biodiversity and Light protection

Coffee Break

11.30-12.15 A. Falciatore: Biodiversity and Evolution of Photoreceptors
12.15-13.00 Round table:

Lunch Break

14.45-15.30 P. Kroth: Evolution and Function of Carbon Assimilation
15.30-16.15 Round table
Coffee Break
16.15-17.00 C. Yang: Photosynthetic mechanisms in extreme environments
17.00-17.45 P. Gresshoff: Natural genetic and developmental resources to aid global food and fuel crisis
17.45- 18.30 Round table

20.00 – open end Dinner

Friday 27th of September

9.00-9.45 F. Buscot: Biodiversity of Mykorrhiza
9.45-10.30 S. Maberly: Explaning biodiversity dynamics in Lakes
Coffee Break
11.00-11.45 Round table

11.45-12.30 G. Pohnert: Allelochemicals regulating Biodiversity
Lunch Break
R. Sage: System flaws create opportunities for diversification

14.15-15.00 Round Table

Coffee Break

15.45-16.00 J. Müller-Ludwig: Bacteria and Fungi controlling plant growth: balance between benefit and pathogen

16.30-17.15 Summary of the Workshop

5. Feedback of participants

The feedback of the participants was monitored during the round table discussions. Each round table discussion was summarised by a rapporteur.

The rapporteurs summarised the feedback as follows.

1. The big challenge to bridge biodiversity and physiology is the scaling of the methods. Ecologists work on a community level whereas physiologists analyse species. There are two strategies to fill the gap.
   a) top down model: Starting on a community approach and to interpret the results on the level of species (so-called "trait approach")

   b) bottom up model: expand the knowledge of key species and scaling key species physiology to the community level. The latter approach is not often used because most physiologists avoid other species than Arabidopsis or crop plants because of limited molecular tools.

Idea for the future: what could be key species (functional groups?) for ecological research which could be elaborated to become molecular tools?

2. Problem of data collection and scaling
   Modern high throughput methods also allow physiological screening in communities. However, it is not clear which physiological processes are crucial for the abundance of the species. One idea to identify key processes is to scale different processes from plant to canopy. E.g.
   a. One plant→ Carbon Flux→Canopy
   b. Which plant does which part of carbon fixation?
3. Hypothesis driven key species
   Physiologists analyse limiting processes and characterize ecological shift responses. Ecologists observe in canopy with similar environmental pattern if the shift responses are in agreement with observed biodiversity.
4. Key process "Primary productivity"
   a) Comparison of modelling and observation in micro/mesocosm experiments. Here ecologists design the experiment to test ecological hypothesis and invite physiologists to measure on the species level physiological acclimation/adaptation.
   Conclusion: The gap between biodiversity and physiology can be bridged only if both views meet at the same experimental system.
   b) Improving input parameters for modelling
   It is not clear which assumptions are really proved. Most models work on leaf area, however, one process/physiological activity (example leaf area) is not enough to describe system (example carbon distribution, or heat dissipation). Can models be improved by more complexity? The better the resolution, the worse the results? What models do not take into account:
   - modified carbon allocation/altered carbon fluxes
   - climatic distribution of invasive species
   - minimum temperature
   - life history

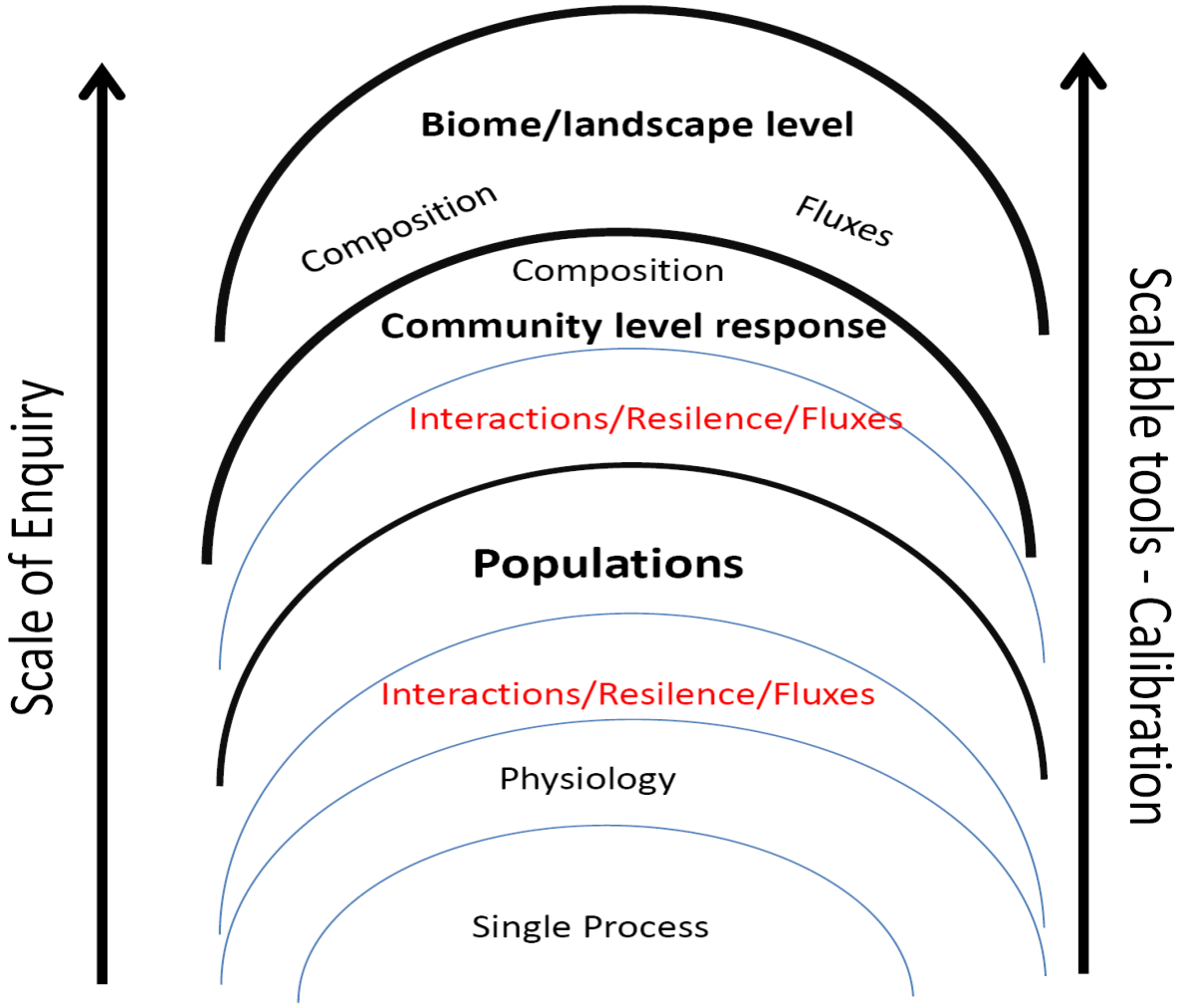
5. How can we identify key processes?
   Physiological state of the art shows that:
   a) NPQ (Heat dissipation) was/is a process under strong phylogenetic pressure indicating relevance for biodiversity formation. NPQ can be measured on large scale from single cell to the community level ("scalable tools", see scheme).
   b) NPQ is strictly related to light harvesting proteins and their organization. This can be measured on the level of single cells up to the community level using RNA-metagenomics.
   c) CO2 fixation is a key stone; however, its regulation is not yet understood and reflects different phylogenies (CCM, different

compartmentalization in C3/C4 plants and algae (diatoms). At present it cannot be measured in all scales
d) resource allocation efficiency is crucial, however, there is no methodology available for all scales
e) info-chemical controlled interactions. Here is more knowledge necessary. Model systems in mesocosms seem to be more adequate than large scale studies.
e) Biological control by pathogens and symbionts. At present there are no methods available which can be used from single cell to communities.

6. Possible cooperation between ecologists and physiologists:

Ecologist	Physiologist
Metagenome Multivariate statistics	Interpretation
Extract relevant processes Small scale experiments with master genes to test hypotheses	

Which types of ecological question can best be support/informed by physiological investigation ?



7. List of papers published in the special issue in the Journal of Plant Physiology Vol 172 (1), 2015Feedback of participants

(1) Büchel, C. Evolution and Function of light harvesting proteins. J Plant Physiol 2015, 172/1
(2) Buscot, F. Implication of evolution and diversity in arbuscular and ectomycorrhizal symbioses. J Plant Physiol 2015, 172/1
(3) Carnicer J, Sardans, S, Stefanescu C, Ubach A, Bartons M, Asensio L, Peñuelas J. Global biodiversity, stoichiometry and ecosystem function responses to human-induced C-N-P imbalances. J Plant Physiol 2015; 172/1
(4) Dong L, Tu W, Liu K, Sun R, Liu C, Wang K, Yang C. The PsbS proteins plays important roles in photosystem II supercomplex remodellung under elevated light conditions. J Plant Physiol 2015: 172/1
(5) Fortunato AE, Annunziata R, Jaubert M, BoulyJ-P, Falciatore A. Dealing with light: The widespread and multitasking Cryptochrome/Photolyase family in photosynthetic organisms. J Plant Physiol 2015, 172/1
(6) Gresshoff PM, Hayashi S, Biswas B, Mirzaei S, Indrasumunar A, Reid D Samuel S, Tollenae A, van Hameren C, Hastwell A, Scott , Ferguson BJ. The value of biodiversity in legume symbiotic nitrogen fixation and nodulation for biofuel and food production. J Plant Physiol 2015; 172/1
(7) Goss R, Lepetit B. Biodiversity of NPQ . J Plant Physiol 2015, 172/1
(8) Kroth P. The Biodiversity of Carbon Assimilation. J Plant Physiol 2015; 172/1
(9) Ludwig-Müller, J. Bacteria and fungi controlling plant growth by manipulating auxin: balance between development and defense. J Plant Physiol 2015; 172/1
(10) Maberly SC, Berthelot SA, Stott AW, Gontero . Adaptation by macrophytes to inorganic carbon down a river with naturally variable concentrations of CO2. J Plant Physiol 2015; 172/1
(11) Mausz M, Pohnert G. Phenotypic diversity of diploid and haploid *Emiliania huxleyi* cells and of cells in different growth phases revealed by comparative metabolomics. J Plant Physiol 2015; 172/1
(12) Quaas T, Berteotti S, Ballottari M, Flieger K, Bassi R, Wilhelm C, Goss, R. Non-photochemical quenching and xanthophyll cycle activities in six green algal species suggest mechanistic differences in the process of excess energy dissipation. J Plant Physiol 2015; 172/1
(13) Sage RF, Stata M. Photosynthetic Diversity meets Biodiversity: The C4 plant Example. J Plant Physiol 2015, 172/1

Cover of Special Issue