KIEL PLANT CENTER

KPC Summer School 2021

Monday 30 August – Wednesday 1 September 2021

Highlight Talks

Monday 30 August

09:20 – 10:20	**Establishment of nitrogen fixing symbiosis and its impact on microbiota assembly at the root-soil interface of Lotus japonicus**	**Simona Radutoiu,** Department of Molecular Biology and Genetics, Aarhus University, Denmark

Join Zoom Meeting
https://zoom.us/j/99678220948?pwd=VzIyem5nbExnRGtraXMya0Y4SHlaUT09
Meeting ID: 996 7822 0948
Passcode: 859890

Protein-carbohydrate recognitions are central molecular events in host-microbe interactions. Legumes use LysM proteins to recognize carbohydrates produced by pathogens or symbionts. This suggests that an ancient recognition process has been used by legumes for evolution of elaborated mechanisms for perception of various carbohydrates. In Lotus japonicus two LysM receptor kinases, NFR1 and NFR5, initiate root nodule formation and rhizobial infection after perception of Nod-factors secreted by M. loti. Lotus encodes for additional LysM receptors. We used reverse genetics coupled with gene expression and in planta functional studies of LysM receptors, and have identified novel components, as well as protein motifs involved in Nod factor recognition and signaling contributing to the symbiotic interaction between Lotus and its nitrogen-fixing symbiont. To understand how root nodule symbiosis influences the ability of Lotus to associate with other soil bacteria, we performed a comparative analysis of microbiota associated with soil-grown wild-type and symbiotic mutants. Community profiling of 16S rRNA gene amplicons identified a previously unsuspected role of the nodulation pathway in the establishment of distinctive bacterial assemblages in root and rhizosphere. These findings imply a role of the legume host in selecting a

broad taxonomic range of root-*associated bacteria that, in addition to nitrogen-fixing rhizobia, may have an impact on plant growth and ecological performance.*

14:00 – 15:00	**Microbial interactions and co-evolution in the plant phyllosphere**	Eva Stukenbrock, Botanical Institute, Kiel University

Join Zoom Meeting
https://zoom.us/j/97338316788?pwd=U3VaRHovMU9JY3Y5T09XN3ozMktDdz09
Meeting ID: 973 3831 6788
Passcode: 253133

Plants are associated with a variety of microorganisms, some being highly specialized to plant-associated lifestyles. We have isolated 65 distinct Operational Taxonomic Units from apoplastic fluids of two wheat cultivars non-infected and infected with the fungal pathogen Zymoseptoria tritici. One wheat cultivar is susceptible to Z. tritici, the other resistant. Infection of the pathogen changes the composition and abundance of endophytes. To investigate the direct and indirect impact of pathogen infection on bacterial endophytes we set up in vitro confrontation and growth assays. We find evidence of antagonistic interactions where some bacteria inhibit the growth of Z. tritici while others are inhibited by the fungus. We also identify endophytes exhibiting an increased tolerance to immune related plant compounds. Our findings identify key wheat endophytes and demonstrate functional adaptations of bacterial endophytes.

Tuesday 31 August

09:15 – 10:15	**The biomasses and activities of soil microorganisms - from microscale to ecosystem functioning**	**Pål Axel Olsson,** Department of Biology, Biodiversity Division, Lund University, Sweden

Join Zoom Meeting
https://zoom.us/j/93744025465?pwd=N1J1V0plc3VhM2JlaEZWNmdRWWZpQT09
Meeting ID: 937 4402 5465
Passcode: 004701

Although we can explore soil microorganisms in detail using DNA profiling, functional genes etc., there is still an increasing interest in methods exploring gross activities and biomass of major functional groups in soil. Such methods can increase the understanding of C fluxes and soil C sequestration since different groups clearly respond differently to environmental change. They can thereby provide a link between functional genes and modelling of responses of soil functions and vegetation to environmental change. I will give examples of the use of signature molecules for soil organisms as well as plant functional trait analysis.

Wednesday 1 September

09:15 – 10:15	**From plants to soil, how soil organic matter is formed at biogeochemical interfaces**	**Carsten Müller,** Department of Geosciences and Natural Resource Management, Section for Geography, University of Copenhagen, Denmark

Join Zoom Meeting
https://zoom.us/j/95575935545?pwd=ajZIZWU4elh2TGxpOGNOUlJoQ1pRZz09
Meeting ID: 955 7593 5545
Passcode: 037059

Soils represent the largest terrestrial carbon reservoir, thus by far exceeding the amount of carbon stored in plant biomass. However, the dominating primary source of soil organic carbon are plant derived organic compounds. The amount and composition of plant residues entering the soil differ between above and belowground sources. Especially root derived organic matter, root exudates and cell fragments from living roots, and decaying roots comprise an important soil carbon source forming spatially distinct hot spots of microbial activity. At such hot spots interactions between microbiota, organic matter and mineral particles are thought to control the long-term fate of soil carbon. The rhizosphere thus represents a soil volume hosting the complex interplay of biological, chemical and physical soil processes determining the fate of soil organic matter.

13:30 – 14:30	**Studying Key Rhizosphere Traits to Overcome Multiple Resource Limitation in Plant Production**	**Sandra Spielvogel,** Institute for Plant Nutrition and Soil Science, Department Soil Science, Kiel University

Join Zoom Meeting
https://zoom.us/j/97927172309?pwd=N28wQ2VIb0ZLcDhZeXlsY3g3OWZuQT09
Meeting ID: 979 2717 2309
Passcode: 688295

Sustainable food production is challenged not only by exponential population growth e.g. in developing countries, but also by insufficient crop yields due to land degradation, nutrient scarcity and water limitation. Future development requires an increase in crop productivity and yield stability while avoiding depletion of natural resources. Meeting these challenges requires interdisciplinary approaches as yield restrictions are based on multiple, interacting limitations. My presentation targets the rhizosphere, the key hotspot where

plants overcome water and nutrient scarcity that, however, was widely ignored e.g. in prior breeding programs. I will present different techniques to study chemical, physical and biological rhizosphere properties modified by roots to overcome combined water and nutrient scarcity. Rhizosphere adaptation strategies will be identified by cutting-edge multiple isotope labeling approaches (D2O, 15N, 33P, and 13C) combined with molecular marker analysis, which permit the tracing of multi-directional nutrient and water fluxes in the rhizosphere in-situ. The final data shall be implemented in ecophysiological crop models to assess which rhizosphere traits are crucial to overcome future challenges of sustainable crop production under increasing multiple resource limitation facing global change.

The Speakers

Carsten Müller

Associate Professor for Geography
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I am mainly working on the fate of organic matter (C and N cycling) in soils, from the plant input via roots and decaying litter in rhizosphere and detritusphere over microbial transformations to particulate and mineral-associated soil organic matter. I increasingly focus my work on the formation of soil structure as affected by the organic matter allocation in the rhizosphere, the soil volume directly influenced by root activity. A special interest of work relates to soil functioning in pristine polar environments in the Arctic (C storage in Cryosols) and in Antarctica (nutrient and water availability) and soil structure development under different climate in Chile. In my research I combine quantitative approaches (e.g. density fractionation, elemental and isotopic analyses, lab incubations) with state of the art chemical (GC-MS, NMR spectroscopy) and spectromicroscopic (SEM, NanoSIMS) techniques.

Eva Stukenbrock

Professor for Environmental Genomics
Botanical Institute
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I am interested in population genetics and evolution of fungi that are associated with plants. My early research in Copenhagen focused on population genetics of arbuscular mycorrhizal fungi. Since my PhD in Zurich, I have worked with plant pathogenic fungi. Recently, my group has embarked on a new project aiming to characterize plant-associated microbiota, including bacteria, fungi and oomyctes that colonize the pyllosphere of wild and cultivated wheat species. Main questions in my research are 1) how do fungi adapt to their environment and how does the environment affect evolutionary processes, 2) which evolutionary forces fuel adaptive evolution and 3) how do new species emerge.

Pål Axel Olsson

Professor for Biodiversity
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My main research interest is the interactions between the vegetation and the soil microorganisms and how this is regulated by abiotic factors such as nutrient availability. The arbuscular mycorrhizal symbiosis is of fundamental importance for the understanding of ecosystem processes and the study of regulation of nutrient exchange in the symbiosis at various scales (physiology to ecosystems) is therefore a central research issue. Other projects deal with the biodiversity (plants, fungi and insects) in grasslands and how it can be preserved in the most efficient way.

Sandra Spielvogel

Professor and Head of Department for Soil Science
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The research foci of our group cover a range of scales. At the microscale, our objective is to characterize the ecophysiological control of soil microorganisms on biogeochemical cycles with a special focus on the rhizosphere. Quantitative metabolic flux modelling is used for further flux upscaling from the micro- to the ecosystem level. Within the recently granted Soil Multi-Meta-Omics consortium between University of Göttingen and Kiel University such microbial fluxes are linked to regulation processes at various post-genomic levels. The goal is to unravel the rhizosphere soil microbes' adaptation strategies to various stressors and arising implications for element cycles and plant nutrition.

Simona Radutoiu

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My research interests include Host-microbe interactions, plant microbiome, receptor-mediated signalling, plant physiology.