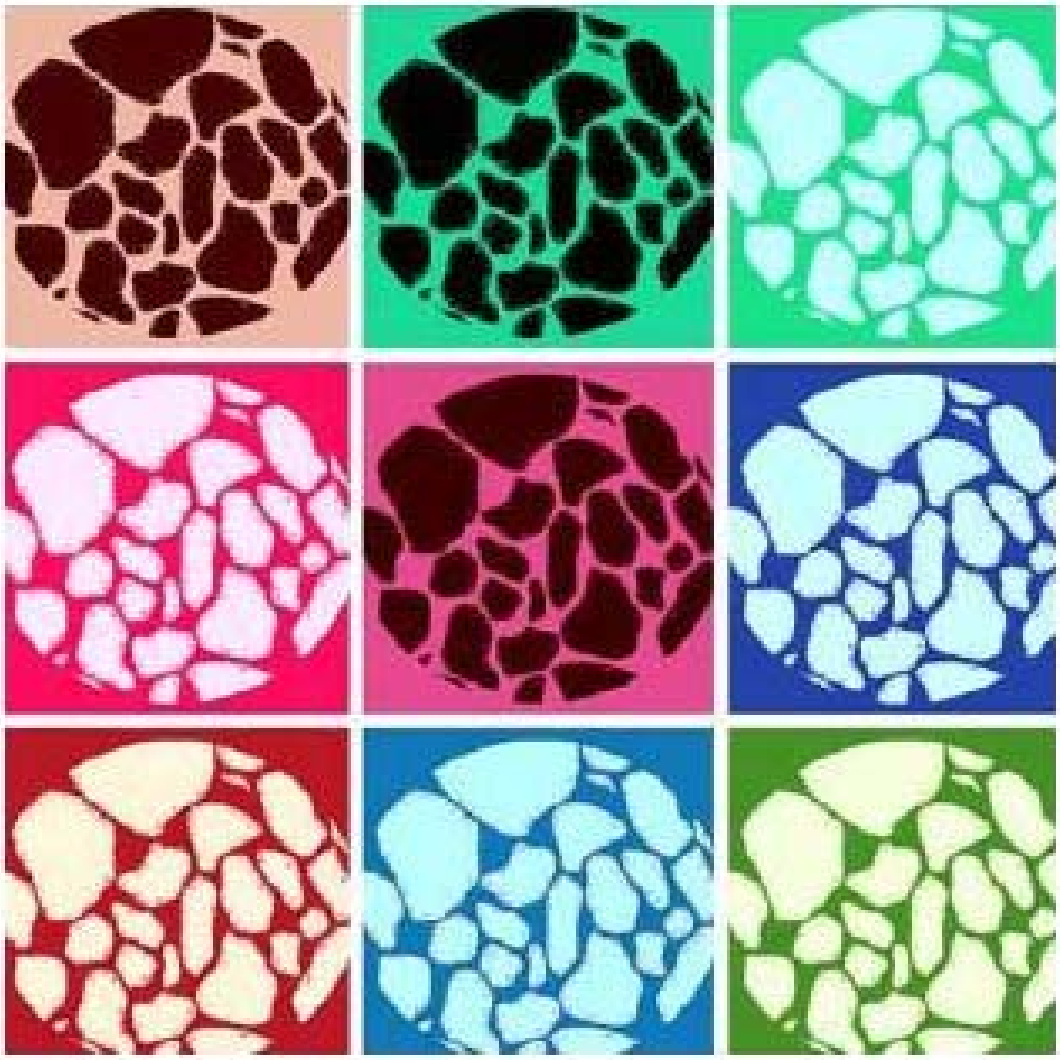

The Functions and Relevance of Soil Biodiversity

2-6pm, Friday, March 4th 2011,
Kane Building G19,
University College Cork

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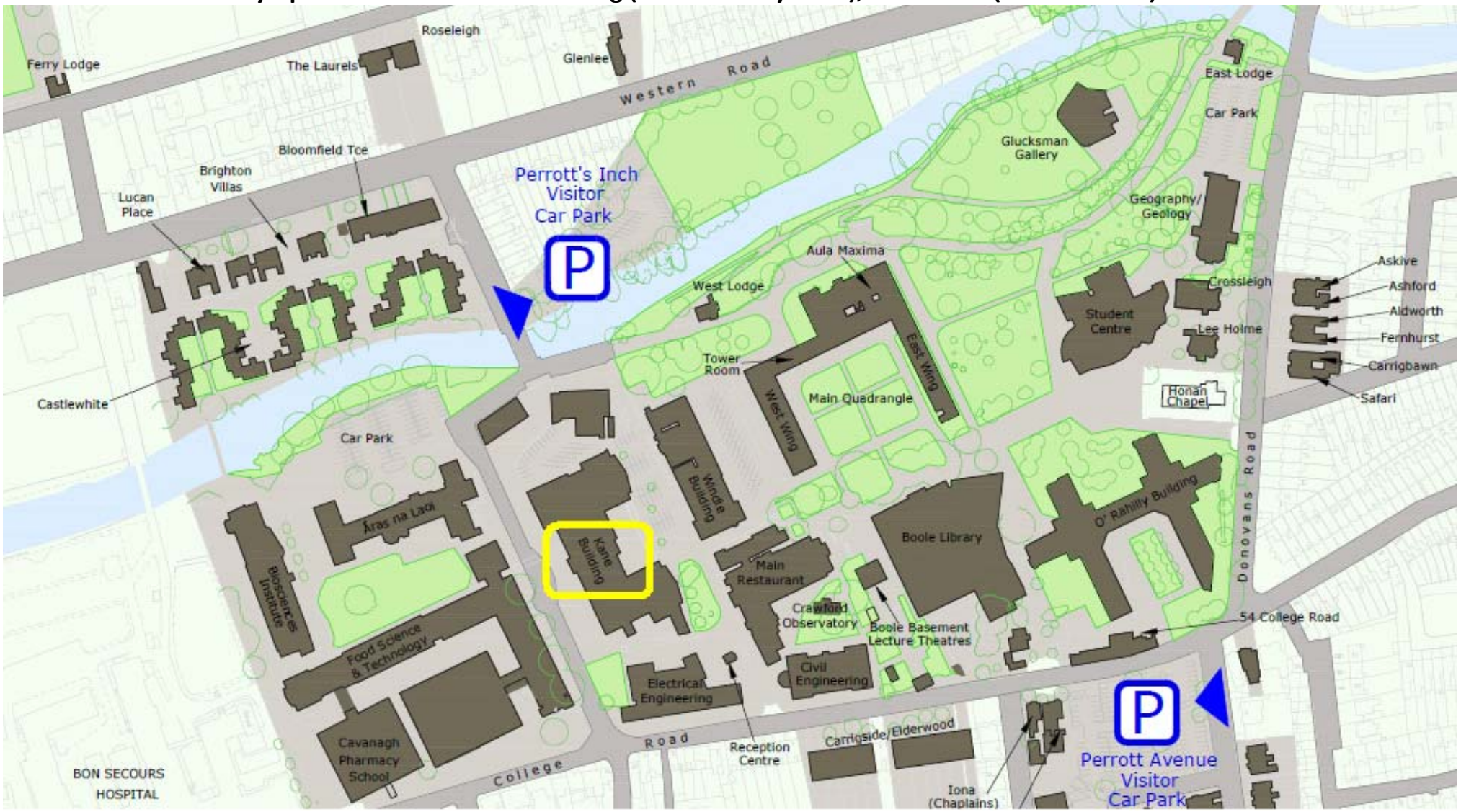
Preface

The fertility/health of our soil is a key factor for life on the planet with most (~99%) of the world's food being produced in a terrestrial environment. A quarter of the earth's biodiversity is found in soils. Biodiversity is the variation of biological activity which exists and is a valuable resource which is under threat from factors including an expanding population, intensive agriculture, pollution, and climate change. The impact of these factors on soil biodiversity is becoming an increasing concern. As part of the International Year of Biodiversity (United Nations) in 2010 the biodiversity of soil was highlighted for the first time. Last year also saw the launch of the European Atlas of Soil Biodiversity by the EU
http://eusoils.jrc.ec.europa.eu/library/maps/biodiversity_atlas/.
The European Commission has also proposed a Soil Framework Directive to address soil degradation across the European Union, and to repair the damage that has already been done. This symposium will highlight the importance of conserving and protecting the biological diversity while also looking at ways at improving our scientific knowledge of soil interactions and its potential in terms of medicine, food security.

This symposium is part of the VALORAM project which is funded under the European Community's Seventh Framework Programme FP7/2007-2013 (Grant No: 227522, 01/02/2009-31/01/2014). The overall objective of VALORAM is to promote the sustainable development of potato-based systems in the inter-Andean valleys and Altiplano areas to focus on cropping systems that will make use of natural microbial resources as inputs to improve production of high quality potato crops. For more details check out the project website: http://valoram.ucc.ie/

Symposium Venue: Kane Building (indicated in yellow), Room G19 (Ground Floor)



For more information on getting to UCC or parking please go to the following website: http://www.ucc.ie/en/visitors/

Symposium Programme

2.00 – 2.15 **Welcome address**
Barbara Doyle Prestwich, University College Cork

2.15 – 3.00 **Keynote address: Drivers of soil-borne microbial diversity and functionality**
George Kowalchuk**,** Institute of Ecological Sciences, Amsterdam, The Netherlands

3.00 – 3.20 **The functions and potential of Plant-Growth Promoting Rhizobacteria in crop production**
Boguisa Janczura, University College Cork, Ireland

3.20 – 3.40 **Mining soil biodiversity in order to enhance plant productivity and utility**
Shahin S. Ali, University College Dublin, Ireland

3.40 – 4.00 **Impact of land management on soil microbial diversity and phosphate solubilisation activity**
Patrick Browne, University College Cork, Ireland

4.00 – 4.30 Coffee break

4.30 – 5.00 **Arbuscular mycorrhizal fungi as key actors in agro-ecosystems**
Stéphane Declerck, Université Catholique de Louvain, Belgium

5.00 – 5.20 **The effect of past land use on the biodiversity of woodland soils**
Aileen Cudmore, University College Cork, Ireland

5.20 – 6.00 Discussion

Keynote Speaker Profile:

Prof. George Kowalchuk is an American scientist who did his primary degree in Duke University, North Carolina and his PhD in Yale University, Connecticut. He is currently a senior scientist within the Department of Terrestrial Microbial Ecology at the Netherlands Institute of Ecology and holds the professor's chair in Plant-Microbe Interactions at the Institute of Ecological Science of the Free University of Amsterdam. He is the Netherlands Ambassador for the International Society for Microbial Ecology. He is editor of Applied & Environmental Microbiology and the Journal of Microbiological Methods and editor in chief Molecular Microbial Ecology Manual. His main research foci include drivers of microbial diversity and function in the rhizosphere, environmental genomics of ecologically relevant microorganisms, and determining the roles of plant-microbe interactions in nutrient acquisition and cycling. George has many publications including some of the most recent listed below:

- Kielak Anna M; van Veen Johannes A; Kowalchuk George A. , (2010). **Comparative analysis of acidobacterial genomic fragments from terrestrial and aquatic metagenomic libraries, with emphasis on acidobacteria subdivision 6.** *Appl Environ Microbiol.* 76(20):6769-77.
- Drigo Barbara; Pijl Agata S; Duyts Henk; Kielak Anna M; Gamper Hannes A; Houtekamer Marco J; Boschker Henricus T S; Bodelier Paul L E; Whiteley Andrew S; van Veen Johannes A; Kowalchuk George A,. (2010). **Shifting carbon flow from roots into associated microbial communities in response to elevated atmospheric CO2.** PNAS June 2010. http://www.pnas.org/content/early/2010/05/21/0912421107.full.pdf+html
- Verbruggen Erik; Röling Wilfred F M; Gamper Hannes A; Kowalchuk George A; Verhoef Herman A; van der Heijden Marcel G A, (2010). **Positive effects of organic farming on below-ground mutualists: large-scale comparison of mycorrhizal fungal communities in agricultural soils.** *New Phytologist* 186(4): 968-979.

Drivers of soil-borne microbial diversity and functionality

George Kowalchuk

Systems Ecology, Institute of Ecological Sciences, De Boelelaan 1085
1081 HV Amsterdam, Netherlands
***Tel:** +31 (0)26 4791 314, **Emai**l: G.Kowalchuk@nioo.knaw.nl*

Soil-borne microbial communities are the greatest source of biological diversity on the planet. In this lecture, I will explore the drivers of soil-borne microbial diversity and functionality, including the influence of plants. Furthermore, universal, as well as microbe-specific, drivers of diversity will be discussed. With respect to plant influences on microbial diversity, the level of interaction with the plant will be considered as an especially important factor. Also, although several of the universal patterns in species diversity may hold for microbes, microbe-specific issues, such as those pertaining to scale, dispersal and population size, may be more important in explaining the extreme diversity of microorganisms in terrestrial ecosystems. With the development of novel sampling strategies and high-throughput methodologies, it is now possible to address very fundamental questions of microbial diversity, including “What is the extent of microbial diversity?”, "Which microbes are doing what?", “Is everything everywhere?”, and “Is the world losing microbial diversity?”

The functions and potential of Plant-Growth Promoting Rhizobacteria in crop production

Boguisa Janczura, Siva linga sasanka Velivelli, Eileen O' Herlihy* and
Barbara Doyle Prestwich

School of Biological, Earth and Environmental Sciences, University College Cork,
Butler Building, Distillery Fields, North Mall, Cork, Ireland.
***Tel:** + 353 21 4904642**, Email:** eoh@ucc.ie **

Plant-growth promoting rhizobacteria (PGPRs) are naturally occurring soil bacteria capable of root colonization and plant growth stimulation. The mechanisms for plant growth promotion by PGPR include synthesis of IAA (indole-3-acetic acid), breakdown of plant-produced ethylene by the production of 1-aminocyclopropane-1-carboxylate deaminase and increased nitrogen and mineral availability in the soil. Their ability to serve as biocontrol agents against plant pathogens is well established. Root inoculants also have the potential to induce resistance in plants. There are a number of PGPR formulations in commercial use with *Bacillus* and *Pseudomonas* being mainly studied. Pseudomonads are involved in disease suppression by production of a wide range of antibiotics. Very little is known on production, identification and use of bacterial volatiles in biocontrol. Here the interactions between root colonizing bacteria, plant pathogens and plants will be outlined and the importance and potential of rhizobacteria in crop production and in genetic engineering strategies will be presented.

Mining soil biodiversity in order to enhance plant productivity and utility

Mojibur R. Khan, Shahin S. Ali, Eoghan Smyth, Damian Egan, Brian Fagan and Fiona M. Doohan

Molecular Plant-Microbe Interactions Group, School of Biology and Environmental Science, College of Life Sciences, University College Dublin, Belfield, Dublin 4, Ireland.
Tel: *+353 1 716 2343* ***Email:*** *shahin.ali@ucd.ie*

The soil microbial community is a very important component of sustainable agriculture which includes microbes as bio-fertiliser, bio-control agents and microbes that break downs residual plant material. Soil microbial diversity is influenced by environmental factors, crop species and crop husbandry practices. This study assessed the culturable microbial diversity in wheat and barley rhizosphere of five different fields of Ireland using different culture media. The identity of bacterial isolates was determined by morphological observations and 16S rDNA sequence analysis. Bacterial diversity was higher in the barley rhizospheres than the wheat rhizospheres under study; fungal diversity was not related with the crop species. The *Pseudomonas* species diversity showed a significant correlation with available P in soil. Subsequent studies found that many of these organisms act as plant growth promoting rhizobacteria (PGPR) and bio-control agent along with some other important microorganism involved in cellulosic ethanol production.

Impact of land management on soil microbial diversity and phosphate solubilisation activity

Patrick Browne, Olivia Rice, Hao Tan, John P. Morrissey and Fergal O'Gara

Biomerit Research Centre, Dept. of Microbiology, University College Cork, Ireland.
***Tel:** + 353 21 4902934, **E-mail:** p.browne@umail.ucc.ie*

The exploitation of phosphate solubilising rhizosphere colonising microorganisms is an attractive strategy to ameliorate the requirement for phosphate fertiliser in agriculture. A reduction of phosphate fertiliser inputs would benefit both the environment and the sustainability of agriculture while lowering input costs. However current knowledge is limited by a lack of understanding of the influence of land management on the diversity and activity of the phosphate mobilising soil microbial community. A field site with long term monoculture of winter wheat and spring barley in conventionally managed and decision based low input plots was studied. Overall rhizosphere and bulk soil microbial diversity were studied with respect to land management. The inorganic phosphate solubilising microbial community was studied with special emphasis on rhizosphere colonising fluorescent *Pseudomonas* spp. A sub-clade of the *Pseudomonas fluorescens* complex was shown to be linked with superior inorganic phosphate solubilisation activity. The regulation of microbial phosphate solubilisation activity by components of root exudates is also being investigated with a view to rationalising the design of phosphate biofertilisers that will be highly active in the rhizosphere environment.

Arbuscular mycorrhizal fungi as key actors in agro-ecosystems

Stéphane Declerck,

BCCM/MUCL, Mycothèque de l'Universite catholique de Louvain, Place Croix du Sud 3, B-1348 Louvain-la-Neuve, Belgium
***Tel:** +32 10 47 37 42, **Email:** stephan.declerck@uclouvain.be*

Within plant communities, roots are intimately associated to arbuscular mycorrhizal (AM) fungi and interconnected via indefinite networks of extraradical mycelium. These mycelia favour the movement of soil derived nutrients and plant-derived carbon within the network and possibly between plants. Therefore, these networks play key roles in nutrient cycling, composition of plant communities, via intra- and interspecies competition between plants, and functioning of ecosystems.
Here we will discuss the importance of these networks in the context of sustainable agriculture and functioning of agro-ecosystems and review some of the anthropogenic constraints that impact these networks. Three aspects will be approached (1) the role of AM fungi on the resources re-allocation in and between plants, (2) the importance of life history strategies of AM fungi for agro-ecosystems functioning and (3) the role of anastomoses and hyphal healing mechanisms for plant and fungi interconnection and impact of anthropogenic constraints on these factors.

The effect of past land use on the biodiversity of woodland soils

Aileen Cudmore, Peter Jones and Simon Harrison

School of Biological, Earth and Environmental Sciences,University College Cork, Cooperage Building, Distillery Fields, North Mall, Cork, Ireland.
***Tel:** + 353 21 4904677, **Email:** a.cudmore@ucc.ie*

Deciduous woodland soils are rich in biodiversity largely due to the considerable influx of organic matter from leaf-fall after each growing season. However, many woodland soils have undergone significant changes as a result of past human land use. In particular, the soils of woodlands that have developed on former agricultural land can differ considerably from those of undisturbed woodland; these effects can last anything from a few decades to centuries or even millennia. Such disturbances are also likely to affect the diversity and functionality of the soil community. The aim of this study therefore was to compare the soil animal communities in ancient, undisturbed woodland with adjacent stands of secondary woodland. The results indicate that the soil communities differed considerably between the woodlands. The ancient woodland had a less diverse microbial community than the secondary woodland. It also had a lower abundance of earthworms, but this was compensated for by the occurrence of large numbers of enchytraeids. Decomposition rates also differed between the woodlands. The effects of past land use may have shifted the woodland soil system from a slower cycling system (ancient woodland) to a faster cycling system (secondary woodland) with complex changes to invertebrate populations.