PROJECTS FOR THE 2014 UWA-ZJU RESEARCH TRAINING PROGRAM

1. A/Prof. Matthias Leopold & Dr Falko Mathes

A/Prof Matthias Leopold (matthias.leopold@uwa.edu.au) or Dr Falko Mathes (falko.mathes@uwa.edu.au) to discuss aspects of this project.

Paleosols – Life in ancient, buried soils

Paleosols are distinctly visible layers within sediment profiles that were once at the surface and underwent soil development processes prior to burial. Therefore, paleosols likely contain higher organic carbon and nutrient concentrations than the surrounding sediments which did not undergo soil formation. These higher levels of organic carbon will allow survival of the trapped microbial communities over geological timescales depending also on water availability.

We hypothesise that the paleosols contain higher organic carbon and nitrogen concentrations compared with the surrounding sediments and this allowed trapped microorganisms to survive resulting in a more diverse community and higher biomass compared with the surrounding sediment layers. We also hypothesise that the microbial communities within the paleosols differ from those in the topsoil.

To test these hypotheses, we will investigate the bacterial abundance (quantitative PCR) and community composition (next-generation sequencing) of two, several thousand year old paleosols and compare them with the surrounding sediment layers and the topsoil at Hamelin Bay (Western Australia). We will link this microbiological information with pedological (particle size, mineralogy, pedogenic oxides etc.) and chemical (pH, % C & N, etc.) soil data.

The ideal candidate has background knowledge and practical experience in either pedology or soil microbiology but more importantly should be interested in combining these two disciplines in this project. Strong knowledge of statistics and of statistical software (e.g. R project) will be required to analyse the data set.

Contact A/Prof Matthias Leopold (matthias.leopold@uwa.edu.au) or Dr Falko Mathes (falko.mathes@uwa.edu.au) to discuss aspects of this project.

Location of Hamelin Bay in
Western Australia
Section at Hamelin Bay
with clearly visible

2. Professors Graeme Martin, Dominique Blache, Phil Vercoe

Supervisor – A/Prof Dominique Blache

A genetic marker for temperament in sheep:

1) Investigation into the association of polymorphisms of three candidate genes (CYP17, 5-HTTLPR, DRD4 exon III) with temperament in Merino sheep;
2) Validation of the use of at least one of the polymorphisms as a genetic marker for temperamentselection.

Supervisor –Professor Phil Vercoe
The 'pan-genome': the aim is to understand the interaction between genes influencing efficiency within the host, within the microbiome, and between the host and microbiome (or, more generally, the gastrointestinal tract). For animal breeding, we can consider ruminants as having two genomes, the animal's and the microbial, operating to determine the amount and quality of products and the efficiency with which they are produced. Consequently, the variation on which we base selection decisions involves G x E interactions of the animal, G x E interactions of the microbiome, as well as the interaction between the host and microbial community.

Supervisor – Professor Phil Vercoe
'Magic plants' for animal feed: we have found new fodder plants that i) add to the biodiversity of the flora on farms, ii) are deep-rooted so increase soil stability, reduce erosion and lower the water table (to reduce salinity), iii) provide shade and shelter, iv) improve livestock health because they are anthelmintic; vi) are anti-methanogenic and thus reduce emissions of greenhouse gas. How do these plants do all these things? We use molecular biology to study the way they are digested in the rumen.

Supervisor – Professor Phil Vercoe
The genetics and biology of parasite resistance: sheep in Australia are affected by two major parasitic issues: breech flystrike (cutaneous myiasis) and gastrointestinal nematodes. Current control methods are costly and not 'clean, green and ethical'. One method is to increase the host resistance to the parasites. We know this works, but the process of improving resistance in the national flock is slow. We need more precise biology and we are therefore asking "how does the resistance work". This involves study of the immune system of sheep and also the host-parasite interactions (semiochemistry)

3. Professor Kadambot Siddique

Efficient root system for abiotic stress tolerance in crops

Plant survival and fitness are dependent on root system architecture (RSA). In Australia, root systems of major agricultural crops are poorly adapted to soils that mostly have poor water holding capacity and nutrient deficiencies. Decreasing water availability due to drying and variable climate in the Australia's grain-belt exacerbates these soil-related stresses. Development of future crop genotypes with efficient root system for enhanced abiotic stress tolerance is essential for improved crop adaptation. Root traits that overcome abiotic constraints are critical to maintaining structural and functional properties, and are considered first order targets in breeding programmes for rainfed environments. Root traits, such as deep root systems, increased root density in subsoil, increased root hair length and density and / or xylem diameters, may contribute to enhanced water and nutrient uptake. Narrow-leafed lupin genotypes with increased capacity to take up water from deep soil horizons were linked to increased yield potential; similar relationship exists in wheat, soybean and upland rice. Modification of RSA could contribute to improvements of desirable agronomic traits such as yield, drought tolerance, and resistance to nutrient deficiencies. Wide-scale use of rootrelated genetic information in breeding programs relies on accurate phenotyping of relatively large mapping populations. Such large-scale phenotyping of root-related traits remain the most important issue in translating recent physiological and genetic advances in understanding the role of root systems in improved adaptation to abiotic stress and enhanced productivity of agricultural crops.

The candidate will be involved in measuring root systems of crop plants using some innovative techniques during the project period.

4. Professor Michael Considine

Characterising and visualising development and disorder in grapevine buds

The dormant buds of fruit such as grapevine house the embryonic shoot that bears the fruit in spring and summer. In many ways, it resembles a seed, but is far more complex, with multiple meristems, including the premature flowers. To date, we don't know which processes initiate the process of 'bud burst' following winter, and the order of the processes that follow in optimal conditions or in stressed and disordered conditions.

Project 1: Your project will advance this knowledge by using visualisation techniques including microscopy and 3D modelling during the stages of bud burst. You will work in a small team of postgraduate and postdoctoral researchers, following progress that our group has made on this knowledge already. You will require basic skills in dissection, preparation and microscopy of biological tissues. Some knowledge of histochemistry and 3D computer modelling approaches would be an advantage.

Project 2: Your project will explore the same system (dormant buds) but will focus on acute methods to measure reduction-oxidation (redox) metabolites in buds. You will require basic skills and knowledge of biochemical techniques, particularly enzyme activity and metabolite analyses. *Additional projects*: Several other project opportunities exist on this topic, particularly for students with basic skills and knowledge of gene expression assays (qRT-PCR).