ENVIRONMENTAL BIOLOGY

Group Leader: Prof. Graham Farquhar

We study fundamental aspects of plant physiological responses and adaptations to environmental stresses and environmental variation, including global change. Our research focuses on the interactions between biochemical, developmental and genetic control of plant growth, stomatal conductance, carbon and nitrogen assimilation and water-use efficiency.

Our work includes a strong theoretical component and spans from the molecular to the whole plant and, in a few instances, the canopy. Using model plant systems, agricultural or native species, we combine physiological, biophysical and functional genomic approaches to decipher: stress signalling mechanisms, root/shoot communication, water uptake and transport mechanisms, nitrogen fixation, and the mechanisms involved in coordinating water, carbon and nitrogen use for growth.

Our aims are to identify genetic targets for improved plant performance and water use efficiency. The emphasis is on drought, drought-induced soil stresses, and atmospheric conditions (CO_2 concentration, humidity, wind-speed and solar radiation).

This challenging area of research holds the key to the development of plants tailored to harsh environments and an optimum use of scarce resources. It may also contribute to a more appropriate management of biological diversity.

Developing phyllode of *Acacia cyclops*, a wattle native to Western Australia. The impact of elevated atmospheric carbon dioxide and limited phosphorus supply on growth and nitrogen fixation of seven species of wattle is being examined.

HIGHLIGHTS

- Identified Quantitative Trait Loci (QTL) for the control of transpiration efficiency in *Arabidopsis thaliana*. Demonstrated that the gene ERECTA is a key contributor to one of those loci, with effects on both leaf transpiration and leaf photosynthesis and their coordination, the first gene of this nature to be identified in plants (*Nature* **436**: 866-870. DOI: 10.1038/nature03835).
- Investigated the role of a rice ammonium transporter (OsAMT1-1) in ammonium uptake and consequent ammonium assimilation in rice. Transgenic lines over-expressing OsAMT1-1 were produced. Transcript levels correlated positively with transgene copy number. Roots of transgenic plants showed increased ammonium uptake and ammonium content. Growth was initially slower, probably due to the inability of ammonium assimilation to match the greater ammonium uptake but then recovered so that transgenic plants caught up or overtook wild-type plants, flowering later and producing much increased vegetative biomass (*Functional Plant Biology*, in press).
- Developed a simple model of the carbon isotope discrimination by the primary carboxylating enzyme Rubisco (*Functional Plant Biology* **32**(4): 277-291, in collaboration with Université Paris Sud).
- Led a field campaign to examine oxygen, hydrogen and carbon isotopic exchange of a forest in collaboration with ANSTO, CSIRO, Universities of Melbourne, Wollongong, Freiburg Germany and INRA, France.
- Carbon sequestration by plants has the potential to offset emissions from fossil fuels. To be sustainable, additional nitrogen input is needed. Since about 90% of annual nitrogen inputs for Australia come from biological nitrogen fixation, we studied the response of legumes to elevated CO_2 and phosphorus. White clover fixed 900 kg N ha^{-1} in the absence of water and temperature stresses under current [CO_2]. Twice ambient [CO_2] increased nitrogen fixation to 1180 kg N ha^{-1} when phosphorus supply was high. However, many Australian soils have low phosphorus availability and nitrogen fixation was unable to respond to increased CO_2 under these conditions.