# PHYTOGEN

A
NEWSLETTER
FOR
AUSTRALIAN
PLANT SCIENTISTS

Volume 12 Number 3
December 2010

# PHYTOGEN

Volume 12: Number 3

## *In This Issue*



Thanks to all the contributors for being prepared to give their time to provide informative articles for this issue of Phytogen

# AUSTRALIAN SOCIETY OF PLANT SCIENTISTS

## *News from the Presidents*

### Messages from the Outgoing and Incoming Presidents

## *Outgoing President's Report*

The two years of my Presidency have seen some major changes.

We have an executive assistant - Jen Price. She will essentially be our membership secretary, and also help the treasurer, secretary and president with various recurring jobs. She will help with the organisation of ComBios, and liase with Sally Jay. Jen will also assist editors and authors for Plants in Action, having had extensive experience with this in her former job at CSIRO Plant Industry.

The update of ***Plants in Action2*** is ready to go. I am very pleased to announce three new sponsors for our project: University of Western Australia, University of Western Sydney (Hawkesbury Institute for the Environment), and Australian Centre for Plant Functional Genomics. They have each provided $5,000. This generous support will enable IT and editorial assistance for the new edition, with the expected completion date of September 2011. We are also very grateful to our founding sponsors, ACIAR (Australian Centre for International Agricultural Research) and the University of Queensland.

***Plants in Action2*** will be a fully edited and peer-reviewed wiki, with a discussion and comments page for each chapter. The overall structure of the first edition will remain, with some additional chapters, but ***Plants in Action2*** will only be published on-line as open access book.

http://plantsinaction.science.uq.edu.au/

The society has joined the Global Plant Council, a coalition of plant science societies from North America, Asia, Africa and Europe. The inaugural meeting took place at the ASPB meeting in Montreal this year. Barry Pogson represented our society. Mel Oliver from the USDA-ARS and based at the University of Missouri, was elected as the founding Executive Directory. The purpose of the Global Plant Council is to provide a platform for bringing plant scientists together to work synergistically toward solving the pressing problems facing humankind, and speak with a strong voice from a plant science perspective to inform the global debate on those problems.

ASPS continues to support FASTS, the Federation of Australian Scientific and Technological Societies, which works to raise the profile of science in the community and in parliament. It organises Science meets Parliament (the next meeting is June 2011) and publishes significant reports and policy statements (http://www.fasts.org).

Lastly, thanks to our outgoing Treasurer, Tony Ashton, for setting up the new website and the online payment of annual subscriptions. I welcome the new council especially Ros Gleadow (President), Helen Irving (Treasurer), and thank the outgoing members for their work for the society.

*Rana Munns,*
*Outgoing President ASPS*

## *A Message from the Incoming President*

This is an exciting time for plant scientists[1]. The resurgence of interest is being driven by the realisation that we need creative solutions to feed 8+ billion people on less land, in the face of almost certain climate change, and without causing massive environmental degradation. It is easy to forget that we faced a similar challenge back in the 1960s, one that was met through the 'green revolution'. Since then, investment in research in agriculture and plant sciences has waned and may be a contributing factor to the current plateau in crop productivity rates[2].

The first of the UN Millennium Development Goals is to eradicate extreme poverty and hunger. Significant progress has been made, and the challenge is to keep pace with increasing demand. On top of this is the need for improved nutrition to address 'hidden hunger' from nutrient deficiencies. Plant breeding and genetic technologies have already delivered crops such as golden rice, and efforts to fortify other staples with iron and zinc are progressing.

The new National Institute of Food and Agriculture in the USA (NIFA), likened to the successful National Institute of Health (NIH), is a promising development[1]. In Europe the mood is also changing, driven in part by umbrella organisations such as the European Plant Sciences Organisation (EPSO). The EPSO, ASPS and the American Society of Plant Biology are all founding members of the Global Plant Council. One aim of the GPC is to increase the visibility of plant sciences internationally, and to promote the crucial role plant science must play in the current global environment. Our representative is Barry Pogson.

Next year the International Botanical Congress will be in Melbourne. This major conference, held every 7 years, is a forum for a broad range of plant sciences, from taxonomy to genomics. There is a movement amongst younger Australians to work on 'things that matter'. It is important that they are aware that a career in plant biology is one way they can do that. High profile meetings such as the IBC create opportunities for plant research to be reported in the media and raise the profile of plant biology in Australia.

*Ros Gleadow*
*Incoming President ASPS*
*December 2010*

[1] McCormick SJ, Tjian R, 2010.A new focus on plant sciences Science, 330:1021-2.
[2] Rosegrant MW, Cline SA 2003 Global Food Security: Challenges and Policies Science, 302: 1917-9.

# ASPS COUNCIL MEMBERS – 2010

## Executive

| | | |
|---|---|---|
| President | Rana Munns | CSIRO Plant Industry |
| President Elect | Ros Gleadow | Monash University |
| Honorary Secretary | John Evans | Australian National University |
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| Plant Microbe Interactions | Peter S Solomon | Australian National University |
| Plant Development | Prem Bhalla | University of Melbourne |
| Plant Science Education | Amanda Able | University of Adelaide |
| Whole Plants | David Tissue | University of Western Sydney |
| Environment & Ecophysiology : | | |
| Global Change | Margaret Barbour | University of Sydney |
| Student Representative | Erica Wright | La Trobe University |

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| *Functional Plant Biology:* | | |
| Editor in Chief | Rana Munns | CSIRO Plant Industry |
| Representative on Organizing Committee: | | |
| ComBio 2011 | Joe Holtum | James Cook University |
| | Graham Bonnett | CSIRO Plant Industry |

## ASPS Sustaining Members

| | |
|---|---|
| Beckman Coulter | www.beckmancoulter.com |
| Functional Plant Biology, CSIRO | www.publish.csiro.au |
| GeneSearch | www.genesearch.com.au |
| Promega Corporation | www.promega.com.au |
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| Sapphire Bioscience | www.sapphirebioscience.com |
| Australian Plant Phenomics Facility | www.plantphenomics.org.au |

## Phytogen Editor

| | | |
|---|---|---|
| tina.offler@newcastle.edu.au | Tina Offler | University of Newcastle |

# *A message from the editor*

Dear Fellow ASPS Members,

In this issue, the last for 2010, you will discover more of the history of the society, this time through an article written by David Day on Joe Wiskich (FAAS) one of Australia's most eminent plant biochemists, a former President of ASPP and a Life Member of ASPS. Sadly this year has seen the death of two of our members Tom Neales and Mike Dalling and you will find tributes to them in this issue. Under "*Highlights from OzBio 2010"* are contributions from John Evans who delivered the Robertson Lecture, Chris Cazzonelli the recipient of the Goldacre Award, Megan Shelden who received the Best Paper Award and Tim Cavagnaro the winner of the Teaching Award. There have been a plethora of other excellent conferences in 2010. Steve Tyerman has prepared a comprehensive report on IWPMB2010 (International Workshop on Plant Membrane Biology) that is included in this issue - I am hoping that we will have reports from the other conferences in the 2011 issues. Finally, please note that aplicantions for the Plant nutrition Trust Awards are due in February 2011.

Next year's three issues are in the planning (at least in my mind) with a resurgence of *State of Affairs*. My aim is that we hear from those states that haven't reported on their research activities for a few years – yes Tasmania, Victoria and Queensland be warned of an impending request! I will also attempt to stir our youngest members into action to report their exciting PhD research. To balance the new frontiers of research with our history I intend to continue to seek articles for the *Historical Perspectives* section. The older members of our society provide extraordinary achievements coupled with much wisdom that it would be a shame to lose. Of course the International Botanical Conference, Melbourne 2011 on which many of you are working very hard will undoubtedly be reported in the third issue for 2011. These are just my ideas so far. Any suggestions, and of course contributions, are very welcome. Phytogen is your newsletter.

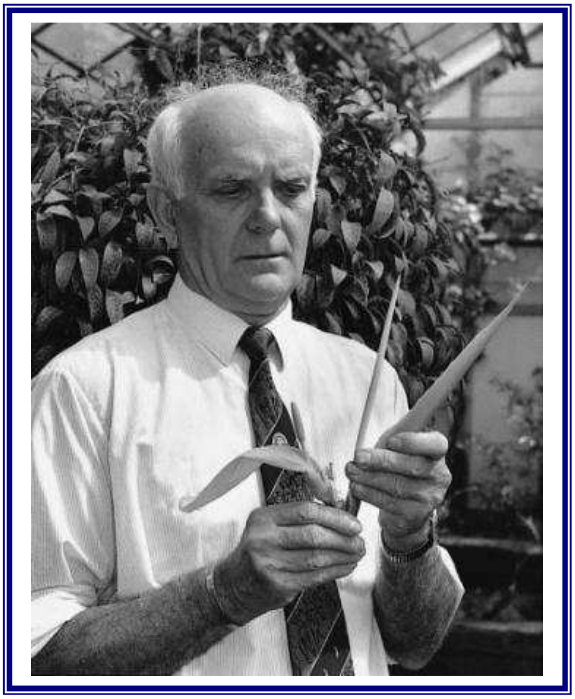
As always, thanks to all those who have contributed to this issue. I hope you will all enjoy reading it.

My best wishes for the festive season and 2011

*Tina Offler*

# *OUR SOCIETY*
# *AN HISTORICAL PERSPECTIVE*

## Joseph (Joe) T. Wiskich 1935 –
### ASPP President 1996 – 97
### Life Membership ASPS 2008 -



Joe Wiskich (FAAS) is one of Australia's most eminent plant biochemists who has contributed greatly to the Society over many years and who has mentored two generations of plant biologists.

Joe was born in Tully, Queensland, in 1935. He was educated largely at the University of Sydney (BSc (Hons) 1956, PhD 1960), where he was supervised by Bob Robertson, in the same department as fellow biochemist and close friend, Hal Hatch. Joe subsequently took up postdoctoral fellowships at the Johnson Research Foundation, the University of Pennsylvania, working with Walter Bonner Jnr., and in the Department of Sub-Tropical Horticulture, University of California, Los Angeles, working with Jacob Biale and George Laties. At the end of these fellowships, he was enticed back to Australia to the Botany Department, University of Adelaide by his mentor Bob Robertson, taking up a lectureship in 1964. Joe remained at Adelaide for the remainder of his career, eventually as Professor and serving as Head of Department. He was also pre-eminent in the administration of the university, serving on the University Council. Joe formally retired from Adelaide at the beginning of 2000, but continued his research as a Professorial Fellow at Flinders University's School of Biological Sciences.

Highly regarded by his peers, Joe received many honours, including election to the Australian Academy of Sciences and the 1997 Verco Medal by the Royal Society of SA for his outstanding achievements in plant physiology over a period of 35 years. Joe is the author of more than 150 refereed journal articles and numerous reviews, conference proceedings and presentations. He received continuous grant support for his research throughout his career and held a prestigious Special Investigator award of the Australian Research Council from 1993-95. Joe was a prominent and popular member of the Australian Society of Plant Physiologists and was its president in 1996-97.

Joe is regarded by his students and his colleagues as a truly outstanding plant biochemist with a fierce intellect and little tolerance for fools and pretenders. Joe was amongst the first advocates of the chemiosmotic hypothesis of energy transduction, being heavily influenced by Bob Robertson and Peter Mitchell from an early age, at a time when most in the field refused to believe it. He also pioneered the isolation and study of organelles, especially mitochondria and chloroplasts, from plants. His early paper

with Bonner on mitochondria from sweet potato in 1964, became one of the first citation classics celebrated by ISI and he went on to make many more seminal contributions to energy metabolism and ion transport in plants. In the field of photosynthesis, Joe and colleagues were amongst the first to demonstrate control of electron transport by ATP synthesis and also made seminal contributions to the transport of metabolites across the chloroplast envelope. In the later stages of his career, Joe devoted much of his research to a study of the mitochondrial electron transport chain, especially the role and regulation of the alternative oxidase and other components of the non-phosphorylating bypasses that we now know to be vital for the plant's ability to cope with oxidative stress. Joe was co-author on seminal papers that elucidated the regulation of the alternative oxidase by respiratory metabolites and the redox state of the mitochondria, discoveries that changed the way plant respiration is understood and measured.

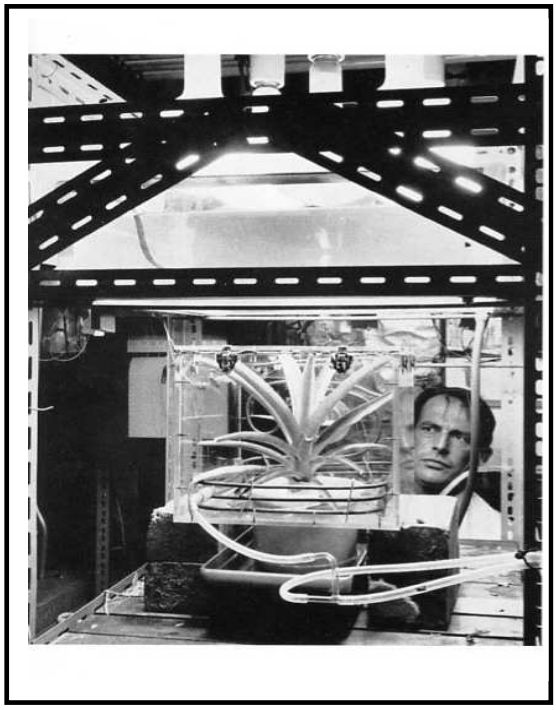
Joe leaves a huge legacy, having contributed many important ideas to the field and influencing a large cohort of current plant physiologists and biochemists, who have taken his rigour and critical thinking into their own research.

*David Day*
*Flinders University*

# *Tributes to Tom Neales and Mike Dalling*

## A Tribute to Dr. Thomas Finnis Neales

(5th March 1929 – 15th August 2010)



Tom was one of 64 plant physiologists who gathered in a sparsely furnished moderate-sized hall in Adelaide during the August 1958 Australian & New Zealand Association for the Advancement of Science (ANZAAS) Meeting. Papers were presented on topics ranging over electron microscopy, plant physiology and biochemistry. The participants voted enthusiastically to found a new society that would provide more time for papers on plant function than was possible within the frame of ANZAAS and a greater stimulus to the growth of the discipline. Tom keenly supported the Australian Society of Plant Physiologists (ASPP) as its membership grew tenfold, as interstate highways widened to freeways, as chalk and 35mm slides were displaced by powerpoint presentations in luxurious auditoria and as the ASPP broadened into the Australian Society of Plant Scientists. From early days the Society 'punched beyond its weight' as members gained the ear of the Federal Government. Sir Rutherford Robertson ('Bob') and Professor Michael Pitman were key figures in the establishment of the Australian Research Grants Commission (ARGC later the ARC) and the Cooperative Research Centres (CRC) respectively that are so important in promoting scientific research in Australia Tom was continuously active in the ASPP/ASPS. He described his research projects regularly at the Society's meetings. He served as an Honorary Secretary of the Society, delivered the 1993 J.G. Wood Lecture and in 1994 wrote a valuable resumé "Early history of the Society" that was republished in the June 2009 Phytogen.

In about 1955, John S. Turner Professor of Botany at the University of Melbourne was confronted by an irate Denis J. Carr (later Professor at RSBS) - "That's the last lecture I'm ever going to give those bloody agriculture students". A lectureship was advertised. Tom, an Assistant Lecturer in Agricultural Botany at Wye College of the University of London, was selected and in 1956 Tom and his wife Elisabeth arrived in Melbourne where they were welcomed warmly by Dr & Mrs Carr. Whether or not Tom first faced the Melbourne Agriculture students with equanimity is not clear. Future decades of lectures and laboratory classes proved his skill in managing the vocal down-to-earth agriculture students.

Tom made a conscious effort to adjust to the ethos of his new country. In this he was aided enormously by a highly supportive spouse. Together Tom and Elisabeth made Melbourne not a temporary exile, but a new initiative for their future. Tom settled easily into the School of Botany where almost all of his colleagues were English or Australians who had taken higher degrees in Cambridge University. Nor was he the only Plant Physiologist: John Turner, Denis Carr and Kingsley Rowan (CSIRO) were daily present for lively discussions of plant function in its broadest botanical context. The English institution of morning and afternoon tea ranged over all topics and helped the acceptance

of new staff. The friendships that Tom soon made with the academics in botany, agriculture, and forestry and with Martin Canny in ICI provided further academic stimulus in related fields.

After distinguished achievement in the classroom and in sport at his boarding school in England, Tom had enrolled in science subjects at Oxford University. A period of war service in the Royal Navy intervened before he completed his Master of Arts at Oxford. For the summer of 1950 Tom ventured to the Arctic Island Jan Mayen as Assistant Botanist on the Oxford University Exploration Society Expedition there. His career in Education began in 1951 in King's School Canterbury where he took Biology classes, before becoming Assistant Lecturer in Agricultural Botany at Wye College of the University of London from which he gained his Ph.D. in Plant Physiology in 1956 for his thesis on "The magnesium nutrition of certain herbage plants."

Tom and his graduate research students continued investigating the mineral nutrition of plants in Melbourne, turning his attention to the micronutrient boron. He disproved the suggestion that boron was necessary for the transport of sucrose. Whereas earlier researchers could not show any requirement for boron for growth of excised roots, Tom was able with improved technique and careful experimentation to demonstrate this requirement clearly in cultured roots and that the plant response to boron was not related to an effect on calcium metabolism. Tom used a diatom *Cylindrotheca fusiformis*, which required boron for growth, to examine its metabolic effects. His data were consistent with a role in the complexing of cis-polyols, and/or with a Lewis-acid action of boric acid. His numerous papers on mineral nutrition included three contributions in Nature.

When Tom joined the University of Melbourne, it was the only University in Victoria. In the century since its founding, the student population rose to seven thousand students. Funds provided by the University for research in the School of Botany were very limited. Research in plant physiology was still operating in an age of 'make-it-yourself' apparatus with glass tubes, glass manometers and rubber tubing. Data accrued slowly; manipulative skill and patience were needed. The introduction of electrically-driven mechanical calculators sped data analysis. The pride of the University was its single computer, whose banks of radio-valves occupied the whole of a large room. The age of desk-top personal computers lay decades ahead.

The advent of the Infra Red Gas Analyser (IRGA) revolutionised research on the fluxes of carbon dioxide to quantify and to record continuously changes in photosynthesis and respiration. An IRGA purchased from a Wheat Research Grant was installed, launching Tom and his research team into new exciting research possibilities. Water vapour and $CO_2$ became the 'breath of life' for most of Tom's research from that point on. Crassulacean acid metabolism (CAM) was a particular interest. Barry Osmond recalled "Tom pioneered CAM research in Australia with a Nature article in 1968, and subsequent studies of *Agave*, pineapple and prickly pear". Tom wrote "Watching the charts show increases in $CO_2$ uptake and in transpiration rate, after the lights went out, was one of those rare Eureka moments". In studies also published in Nature, he demonstrated that variations in $CO_2$ concentration controlled the opening and closing of stomata of CAM plants in darkness and that short days and cool nights accelerated CAM.

Investigations by Tom and Linton Incoll found no evidence in the short term of what Tom termed 'the constipation hypothesis' - that accumulation of assimilate in a leaf, beyond the needs of leaf growth and the scope of phloem transport, would reduce the rate of photosynthesis. A review of the subject (T.F. Neales & L.D. Incoll 1968 Botanical Reviews 34, 107) was widely read and named a 'Citation Classic' for Agriculture, Biology and Environmental Sciences by Current Contents (469 citations!). Tom attributed the success of the review to its relevance to plant productivity and to "a good first sentence"! Tom's research interests ranged widely from effects of elevated $CO_2$, mesophyll resistance, stem reserves, defoliation, senescence, salinity, abscisic acid's role in plant responses to drought and the coupling of root respiration with photosynthetic rates.

Tom's contribution to scientific research was recognized by the conferral of the Degree of Doctor of Science in 1979 by the University of Melbourne.

Tom took several of his study leaves in laboratories in Britain with particular relevance to his interests. This had the added advantage of allowing renewed contacts with his and Elisabeth's families. Royal Society and Nuffield Foundation Bursaries supported his research with Professor H.E. Street at the University of Swansea (1962/3). Shorter periods were spent with Professor J.P. Cooper at the Welsh Plant Breeding Station (1970), with Professor J. Burnett at Oxford University (1976), Dr. L.D. Incoll at the University of Leeds (1982), and Professor T.A. Mansfield at the University of Lancaster (1987). A Carnegie Travelling Scholarship funded visits to institutes in Canada and the USA, particularly to Professor H. Mooney at Stanford University (1969). More exotic assignments included 2 months teaching at the Agricultural University of Malaysia and 4 months in the Phillipines at the University of Los Banos and at the International Rice Research Institute.
At John Passioura's request, Tom hosted the Melbourne section of a visit to Australia of a delegation, interested in Plant Sciences and Agriculture, of the Chinese Academy of Science in 1969. A visit that Tom organized to the Yeringberg winery was made memorable by Tom swinging a billy over his head to make genuine "billy tea". Tom participated in a subsequent "return visit" of an Australian delegation to the Chinese Academy of Science.

Tom commented that, "Balancing intellectual curiosity with the necessity to obtain research grants was always a problem". His success with grant applications supported his research team well. Tom trained many research students in the general area of crop physiology: he supervised at least 19 Honours/Masters of Science and 12 Doctors of Philosophy. Three projects were jointly supervised by colleagues in Botany or Agriculture. After receiving their Doctorates, Paul Kriedemann and Linton Incoll were two who remained particularly active in research in Crop Physiology. Paul Kriedemann headed the CSIRO Unit on irrigation related research and has been very energetic in administrative aspects of the ASPP/ASPS. Linton Incoll continued publishing joint papers with Tom for many years after Linton moved to the University of Leeds.

Tom was both a lateral thinker and a sceptic - characteristics that were reflected in his imaginative design and careful execution of experiments. The tight critical thinking, that characterised his scientific work, was in marked contrast to his easy personal approach to his friends and colleagues. I have no doubt that he was an astute observer of people but he was not judgemental of them: instead he was tolerant, friendly and always willing to help where he could. No doubt his easy friendly nature helped him manage the student classes and to build lasting friendships with colleagues and with his contacts outside the University. Tom seems to have been especially skilful in balancing the multiple pressures of an academic career with the needs of his family. The purchase of a holiday house on the Mornington Peninsula propelled the family into shared vacations with the fun of sand and sea, of fishing, swimming and tennis. Relaxed socializing with their beach neighbours established enduring friendships.

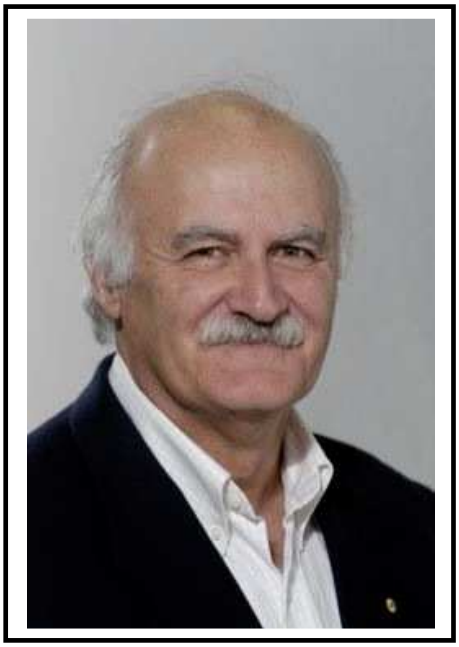
Retirement brought Tom the opportunity for a full and active life beyond academia. He joined the Probus Club of Melbourne North and was a highly esteemed Volunteer Guide at the Royal Botanic Gardens at Melbourne. Tennis continued unabated, giving him an envious level of physical fitness for most of his retirement. Unfortunately, following a heart attack during a visit to England in 2008, Tom's health declined until renal failure brought a life well-lived to its end. He left his loving family (Elisabeth, their children Kate, Sue, Tim and Jenny and eight grandchildren) and his friends with many happy memories of their times together.

Tom once expressed disappointment that so many people, even avid gardeners, have little knowledge of how plants grow and function. Perhaps this is a challenge that our Society might well address!

*Donald Gaff*
*Peter Attiwill*

# A Tribute to Michael Dalling

Michael Dalling died on 5 September 2010. He was a person of boundless enthusiasm, warmth and generosity in his personal life and an astute and strategic thinker about biology and agriculture. For those who knew him well, his death was so shocking that they remember where they were when told the news.



He is known to many from his former career as a plant physiologist working on nitrogen metabolism, and from a later career as a molecular biologist in pioneering the blue carnation and blue rose. Much of his career is recounted in an obituary on 5 October in The Age that deals with his most recent career in business and philanthrophy: www.theage.com.au/national/obituaries/scientist-pioneered-the-blue-rose-20101004-164bo.html. This tribute relates mostly to his work in biology and agriculture.

Michael completed his first degree in agricultural science at the University of Melbourne in 1966 and stayed to complete a Masters in wheat agronomy with Jack Wilson, and at the same time was a member of the lightweight four that won the intervarsity rowing competition. He found that his interest in plant biology were at a more fundamental level and he and Sharon sailed to the US in 1968 for a PhD at the University of Illinois, working on a project with Bob Hageman on nitrate reductase in wheat. On his returned to Melbourne in the early 1970s he avoided Conscription but was obliged to work for the Department of Agriculture, preferring a veterinary laboratory over a return to crop agronomy. The University of Melbourne soon found a lecturing position and he quickly set up a strong group of postgraduate students and visitors, mostly working on nitrogen metabolism and re-translocation in wheat. Meanwhile he was warden of the University Farm at Mount Derrimut and was active in state politics.

In the mid 1980s he won a Fulbright Scholarship and spent time in Davis California when the prospects of plant biotechnology were becoming obvious. He met the group which later formed Calgene and who decided to pursue Bt resistance and glyphosate tolerance in crops. Michael decided to develop a blue rose. His thinking was that blue was the most popular colour, the rose the most popular flower, the pathway of anthocyanin biosynthesis was reasonably well known and the ornamental industry was of a manageable size. On his return to Melbourne, Michael resigned from the University and set up Calgene Pacific that later became Florigen. For almost a decade his colleagues in the company did excellent science in cloning the genes in the pathway while Michael kept the company afloat. The first output was not a blue rose but a blue carnation, which remains the first commercial product of Australian plant biotechnology and which has worldwide sales. Meanwhile the blue rose remains a goal for the current owners of the IP. The success of Michael and his colleagues was not just the science but in protecting their own IP and in securing, in advance, all the licenses to operate. By selecting a non-food crop and getting it to market so quickly they avoided most of the controversy and regulations that ensnared later GM plant products.

Michael left Florigen and worked first for the Victorian Government and then as research and development manager for Nufarm where his job was to set up a wheat breeding consortium as well as manage Nufarm's worldwide R&D activities. At that time Nufarm purchased Florigen so Michael

again found himself leading the bid for the blue rose. He 'retired' from Nufarm in 2002 but the retirement was totally unsuccessful when he joined and ran more boards and committees than in his

previous jobs. Since 'retirement' his main interest was in commercialising scientific discoveries, mostly in the biomedical field. In fact, in the week before he died he was visiting universities in China and was excited at the prospects for commercialising genetically modified ornamentals that were being developed there. Michael died of a heart attack while addressing the Starlight Foundation, a children's charity. Michael will be greatly missed by family, colleagues and students. Those who fondly remember Michael should consider a donation to the Starlight Foundation.

*John Angus*

# *Highlights from OzBio 2010 - Melbourne, Australia*

Altogether OzBio (an expanded ComBio) was an excellent meeting. Marilyn Anderson and Tony Bacic organized a super program for the plant sciences, with high quality speakers covering a broad range of topics. Another highlight was the opening talk by Peter Doherty on the immune system's recognition of virus-infected cells, and life after winning the Nobel Prize.

*Rana Munns*

## RN Robertson Lecture -- John Evans

### Membrane physiology in leaves: Earth's lungs

John R Evans
Plant Science Division, Research School of Biology, The Australian National University, Canberra, ACT 0200, Australia

Two aspects relating membranes in leaves to photosynthesis were considered: the protein complexes contained in the chloroplast thylakoid membranes and the permeability of the plasma membrane and chloroplast envelope to carbon dioxide. Thylakoid membranes within chloroplasts are fundamental to photosynthesis as they contain the protein complexes associated with light capture, electron transport and ATP synthesis. Maximum rates of photosynthetic oxygen evolution are linearly related to the ATP synthase and cytochrome f contents. Leaves acquire carbon dioxide from the atmosphere for fixation by photosynthesis in exchange for water and oxygen. Certain characteristics of leaves resemble those of lungs as the morphology of both organs reflects solutions to the problem of exchanging gases. The flux in leaves is the same as that in the lungs of mammals when expressed per unit area at the gas/liquid interface. To enable greater fluxes for a given tissue volume, the surface area of mesophyll cells and alveoli are greatly ramified. However, the concentration gradients driving carbon dioxide exchange differ greatly between leaves and lungs. Consequently, the permeability of plant membranes to carbon dioxide must be orders of magnitude greater than the permeability of membranes in lungs. The prospect of being able to manipulate $CO_2$ permeability has been encouraged by the discovery that aquaporins can alter membrane permeability to carbon dioxide in red blood cells and leaf mesophyll cells. Two opportunities to enhance photosynthesis are raised.

Sir Rutherford Robertson retired as director of the Research School of Biological Sciences when I was an undergraduate at ANU and I had the pleasure of attending a lecture series he gave which included dramatic practical demonstrations. He subsequently published a book entitled: 'The lively membranes' (Fig. 1) in which he states 'I want to give the reader a picture of how lively these remarkable structures are at the molecular level'. In keeping with his passionate interest in this topic, I structured this lecture around two aspects of membrane physiology associated with photosynthesis that I have researched.

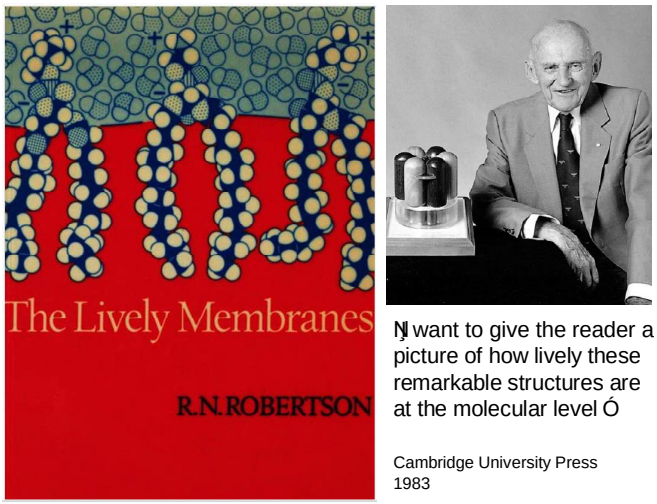



**Figure 1.** Cover of RN Robertson's book published in 1983 and a portrait of Sir Rutherford Robertson in 1995 alongside a model of ATP synthase

Jan Anderson proposed the concept of lateral heterogeneity in thylakoid membranes (Andersson and Anderson, 1980) while I was doing my PhD. Instead of the static picture where components of the Z scheme were linearly arranged, photosystem I and II were in separate regions of the thylakoid membrane, linked by the mobile electron carriers plastoquinone and plastocyanin (Fig. 2). The relative stoichiometry between the major protein complexes was also shown to be variable (Leong and Anderson, 1983). Following a postdoctoral fellowship at the Plant Breeding Institute in Cambridge, UK, I returned to Canberra on a CSIRO post-doctoral fellowship to work in Jan Anderson's laboratory. There I investigated how growth irradiance affected thylakoid composition and function, along with Fred Chow (Fig. 3). Many components in the thylakoids changed their relative abundance in response to growth irradiance when expressed on a chlorophyll basis (Chow and Anderson, 1987b, a; Chow and Hope, 1987; Evans, 1987; Evans and Terashima, 1987; Evans and Terashima, 1988; Terashima and Evans, 1988). However, photosynthetic capacity was directly

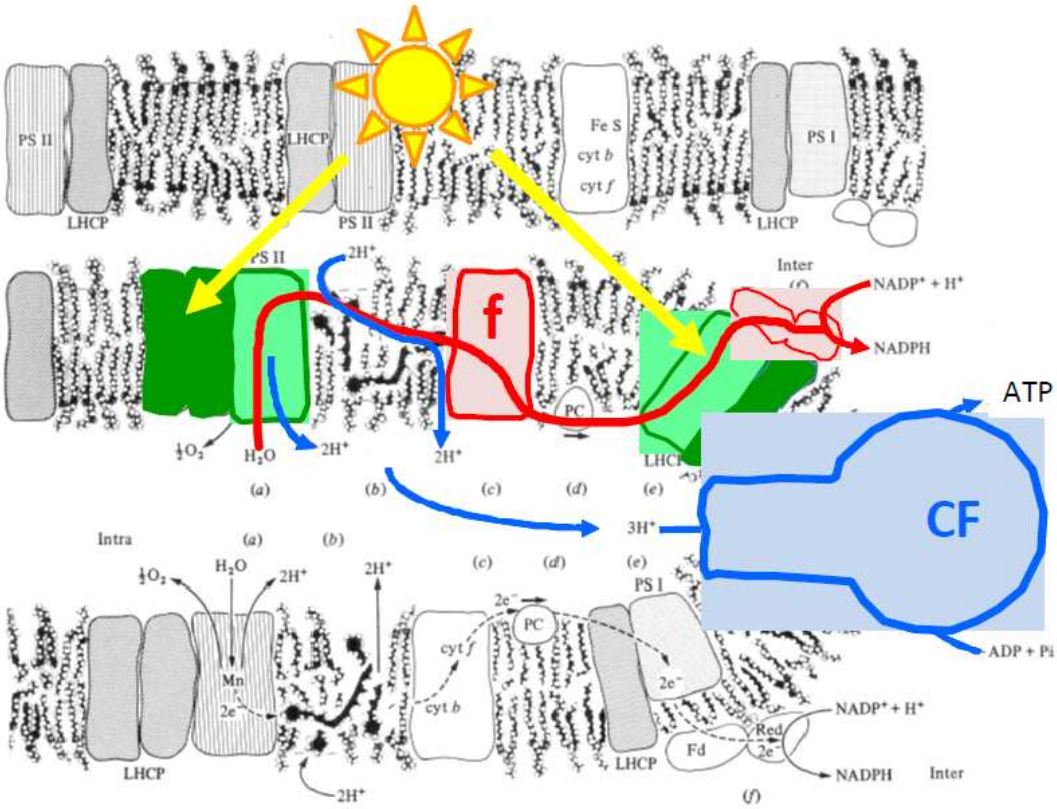



**Figure 2.** Diagram of the thylakoid membranes modified from the book (Fig. 5.11, Robertson, 1983) highlighting the path of electron flow from water to NADP (red) and proton flow used to synthesise ATP (blue) via the coupling factor (CF, ATP synthase).

proportional to cytochrome $b_6f$ and ATP synthase content, rather than photosystem reaction centre content. Subsequently, specific reduction in the content of the cytochrome $b_6f$ complex in tobacco was shown to result in a direct proportional reduction in photosynthesis (Price et al., 1995).

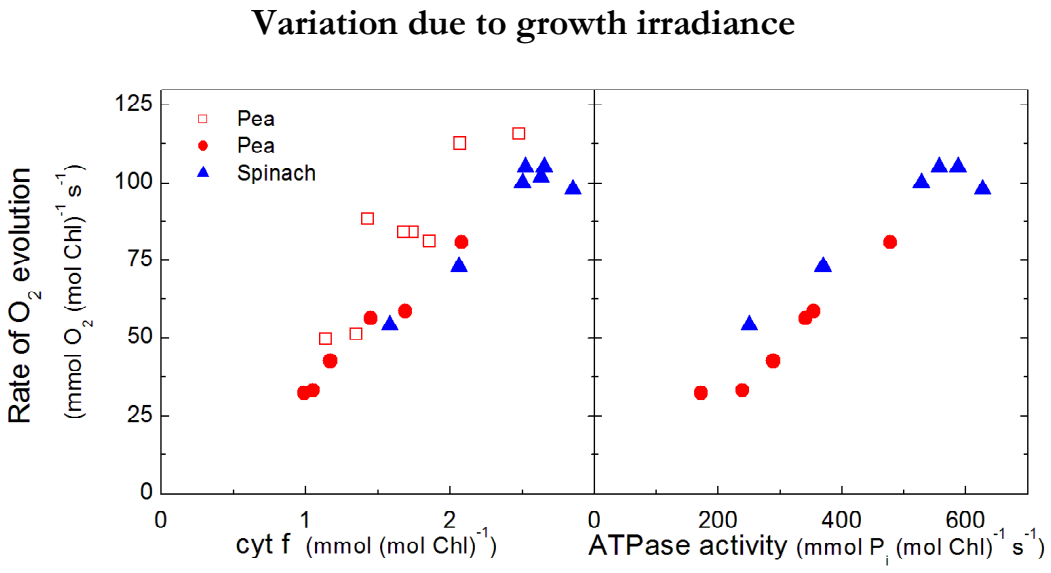




**Figure 3.** Work in Jan Anderson's lab. Photosynthetic capacity of leaves grown under different irradiances was directly proportional to both cytochrome f and ATP synthase content.

There are growing efforts to enhance photosynthesis in order to increase crop yields and biomass production (Long et al., 2006; von Caemmerer and Evans, 2010). It is clear from the strong dependency between photosynthetic capacity and both cytochrome f and ATP synthase content, that any increase in photosynthetic capacity is likely to require an increase in these two complexes. This goal has not yet been achieved but is worthy of pursuit.

Carbon dioxide in the Earth's atmosphere is monitored at many stations (http://www.cmdl.noaa.gov/ccgg/iadv/, Fig 4A). The $CO_2$ concentration is rising, caused by human use of fossil fuels and deforestation. However, there is also an annual cycle in concentration particularly

evident at higher northern latitudes. This annual cycle is like breathing, with uptake of $CO_2$ during spring/summer photosynthesis, following an exhalation of $CO_2$ over winter due to respiration and decomposition. $CO_2$ is taken up from the atmosphere during photosynthesis, but in order to conserve water, plants restrict the diffusion pathway. Once inside the leaf, $CO_2$ dissolves into the aqueous phase inside cell walls and must pass through the plasma membrane, cytosol and chloroplast envelope to reach the enzyme Rubisco where it is fixed into triose sugars. By contrast, in animals, $CO_2$ produced during respiration diffuses back to the atmosphere. The gas exchange performed by leaves and lungs are analogous but in opposite directions. Leaves take up $CO_2$ and give off oxygen during photosynthesis whereas lungs take up oxygen and give off $CO_2$ as a consequence of respiration. The flux of $CO_2$ out of mammalian lungs is similar to that for photosynthesis by leaves when expressed per unit surface area at the gas/liquid interface (Evans and Loreto, 2000).

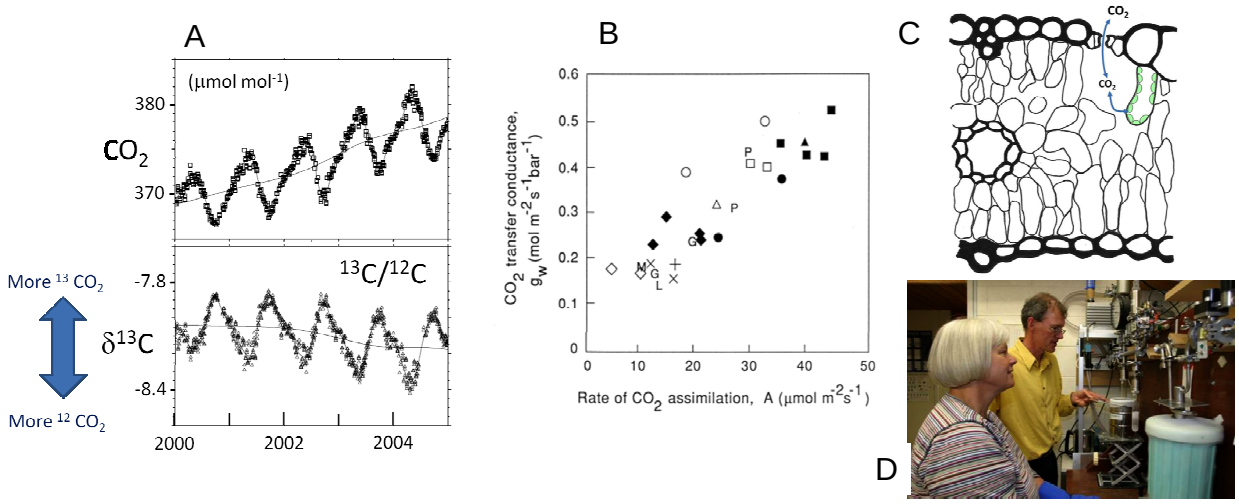



**Figure 4.** Carbon dioxide concentrations in the atmosphere have been increasing since the industrial revolution. An annual cycle is evident in the northern hemisphere (A) being drawn down by photosynthesis, then increasing again as respiration returns the $CO_2$ to the atmosphere. About 1% of the $CO_2$ contains the heavy stable isotope $^{13}C$ which is discriminated against during photosynthesis. Consequently, as $CO_2$ is removed from the atmosphere, $^{13}C$ builds up and vice versa (A, lower panel). $^{13}C$ provides a signal that can be used to measure $CO_2$ diffusion from the atmosphere into a leaf and then into the chloroplasts (C). Susanne von Caemmerer and I are shown freezing $CO_2$ out from air collected during a measurement of photosynthesis (D). This technique was used to measure the conductance to $CO_2$ diffusion between intercellular airspaces and the chloroplast (B, $CO_2$ transfer conductance, now termed mesophyll conductance) (von Caemmerer and Evans, 1991).

While it was accepted that $CO_2$ should be able to diffuse rapidly through a lipid bilayer due to its high solubility, this has recently come into question. Peter Agre was awarded the Nobel Prize in Chemistry in 2003 for his discovery of the role of aquaporins. These are an abundant protein found originally in red blood cell membranes, but subsequently in many organisms. Plants have many genes in this family (Maurel et al., 2008). Initially, aquaporins were shown to act as a water channel, hence their name, but subsequently different genes have been shown to encode membrane proteins which transport a range of molecules, including $CO_2$ (Nakhoul et al., 1998). In leaves, aquaporins have been shown to be involved with altering membrane permeability to $CO_2$. Terashima (2006) suggested that aquaporins that transport $CO_2$ may be called 'cooporins' to highlight $CO_2$-porins that are cooperating with other photosynthetic components such as carbonic anhydrase. The relative importance of the plasma membrane and chloroplast envelope in limiting $CO_2$ diffusion inside leaves remains uncertain (Evans et al., 2009).

It is clear that despite leaves and lungs having similar rates of $CO_2$ exchange per unit surface area, they must have very different permeabilities to $CO_2$. There is a 40 mbar gradient in $CO_2$ partial pressure between the blood and air within the lungs. By contrast, in leaves the gradient is only 80 mbar from

intercellular airspace to the chloroplast. Assuming both lungs and leaves have a flux of 3 mmol $m^{-2}$ $s^{-1}$, then from Fick's law of diffusion, the conductance would need to be 3/40 = 0.075 and 3/0.080 = 38 mmol $m^{-2}$ $s^{-1}$ $bar^{-1}$ for lungs and leaves, respectively. That is, the permeability to $CO_2$ in leaves needs to be 500 times greater than that in lungs to account for observed rates of exchange because they operate with much smaller gradients in $CO_2$ partial pressure. The high permeability means that it is difficult to measure, but it is a target for manipulation in the efforts to enhance photosynthesis.

In C3 plants, there are considerable losses associated with photorespiration which could be reduced by increasing the $CO_2$ partial pressure at Rubisco. There are two ways this could be achieved without altering Rubisco. Firstly, membrane permeability to $CO_2$ could be increased, possibly by manipulating the expression of cooporins. Secondly, if a $CO_2$ concentrating mechanism were introduced into the chloroplast, then its efficiency would be enhanced by decreasing the $CO_2$ permeability of the chloroplast envelope.

The membranes in leaves involved with photosynthesis are lively. Their composition is dynamic, changing in response to the environment. The discovery of aquaporins has altered the way $CO_2$ is thought to diffuse through membranes and raises the prospect of being able to manipulate permeability. Sir Rutherford Robertson would have been excited to learn about these new discoveries and it would have reinforced his belief in the benefits that can be gained from interdisciplinary exchange in biology.

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# *The Goldacre, Best Paper and Teaching Awards*

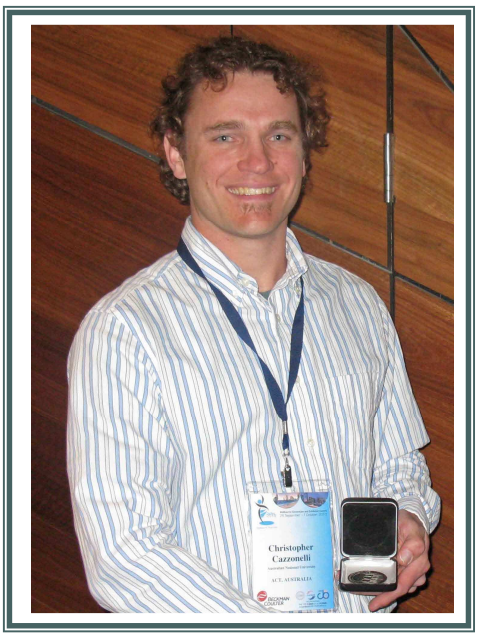
## The Goldacre Award -- Chris Cazzonelli

Peter Goldacre was a foundation member of ASPP, and an enthusiastic supporter of the Society from its inception. Peter was an enthusiastic researcher who was held in great respect by his peers. His tragic death in 1960 at age 34 shocked and saddened all his friends and colleagues. The Goldacre Medal was subsequently established as a lasting tribute to his contributions in plant physiology, and as an encouragement to young researchers.

Functional Plant Biology now sponsors the Goldacre Award. The Award is made on the merit of original research in one area, the findings of which have been published, or accepted for publication, in the three years preceding the year of the Award. The work should have been done within 10 years of the candidate submitting their PhD.

Chris Cazzonelli was awarded the Goldacre Medal for his innovative and significant work on the mechanisms regulating carotenoid accumulation and plant development, and gave a brilliant plenary talk. Chris has provided the following article about himself and his research.

### A new wave of research on carotenoid regulatory biology




Chris is a great example of a passionate young scientist who loves to research plant biology when he is not racing his dirt bikes in competitive motocross and cross country style events. While growing up on his parent's crayfish farm (Boonjie Crayfish Park) in the town of Malanda in Far North Queensland, Chris was inspired by stories about a rapidly emerging field of science, called molecular biology and began to envision new wealth in understanding the molecular secrets of a plant cell and how these could be used to improve life.

After completing his PhD in plant genetic engineering and molecular gene regulation at the University of Queensland, Chris won a highly competitive United States Department of Agriculture Postdoctoral Fellowship to work in the Agricultural Research Service in Texas, USA. There he investigated the molecular nature of gene activation, gene silencing and remote sensing of plant stress events. In 2006, he was recruited by PEB to work with Prof. Barry Pogson and determine what regulates the production of a group of important molecules called carotenoids.

Carotenoids are colourful yellow, orange and red pigments synthesised by plants. Carotenoids form a valuable part of the human diet. A good example of this is the "β-carotene" humans get from vegetables like carrots, which is essential for vitamin A production. Lack of vitamin A can lead to blindness and other immune problems, which is a significant concern in developing countries. The Golden Rice Project, which increases the levels of β-carotene in rice, is a great example of a scientific program working to solve nutritional problems, a future possibility for this research.

In plants, carotenoids are necessary for photosynthesis, photoprotection and the production of phytohormone "signalling" molecules. Signalling molecules form communication networks within the cell and allow the plant to respond to internal and external cues, such as changes required for development or adapting to environmental stress.

One of Chris's achievements was to identify a genetic regulator that interrupted the production of carotenoids in plants, particularly in the shoot meristem (growth tip) and flowering tissues, which are active sites of cell division, differentiation and memory forming processes. This provided strong implications for a novel epigenetic mechanism by which plants regulate carotenoid levels and epigenetics is one of the hottest research areas of human and plant genetics. Epigenetics is a "memory process" where changes in DNA binding proteins, called histones, facilitate the opening of chromatin and regulate the level of gene expression without altering the DNA sequence. Chris and colleagues characterised a chromatin-modifying gene (SDG8) that promotes permissive expression of the carotenoid isomerase gene (CRTISO) thereby reducing the accumulation of the carotenoid, lutein. Lutein is the most abundant carotenoid in nature and limits macular degeneration of the human eye. The team found that the correct carotenoid concentrations were required to control developmental processes, such as shoot branching and root development in the Arabidopsis plant.

The publications that followed these discoveries, include a research paper in Plant Cell that, was highlighted as recommended reading by the Faculty of 1000 (www.f1000biology.com). In addition, several research papers were published in top shelf journals such as Molecular Plant, Functional and Integrated Genomics as well as Plant Signaling and behaviour. The impact of his work is credited as having started a new wave of research on carotenoid regulatory biology and opened an invitation to review the field of carotenoid regulation for Trend in Plant Science.

Chris aims to ride this exciting wave and continue to investigate the role of carotenoids in controlling flowering processes, fruit development as well as root and shoot architecture in agronomic important crops such as tomato. Due to the significant roles that carotenoids have been discovered to play in coordinating cellular regulation as well as plant growth and their implications for human health, the future possibilities for this research are extremely exciting.

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# ASPS-FPB Best Paper Award – Megan Shelden

This award is for a paper published by an early career scientist in Functional Plant Biology in each calendar year. The winner of the award is invited to present an oral paper at the ComBio conference in the year following the award. To be eligible for the award, the first author must be a member of ASPS or NZSPB and a PhD candidate or no more than 10 years post-PhD.

Megan Shelden received the award for 2009 from Rana Munns, Editor-in-Chief, FPB and gave an excellent talk on aquaporins in grapevines. Below is her account of her research and what it has meant to her to win this award.

I would like to thank the executive council of ASPS and the editorial board of Functional Plant Biology for the award. It is an excellent initiative to support Early Career Researchers and for me personally, it is very rewarding to have my research acknowledged by my peers and mentors. It was fantastic to be given the opportunity to present the research at Ozbio 2010, an international conference that was held in Melbourne. The paper originated from two chapters in my PhD thesis. I would like to acknowledge the co-authors on the paper, Steve Tyerman, Brent Kaiser and Susan Howitt. A would especially like to thank both Steve Tyerman and Brent Kaiser, for their supervision during my PhD and their guidance and advice in writing the manuscript. I greatly appreciate their continued mentoring and hope we have future collaborations.

## Identification and functional characterization of aquaporins in the grapevine, *Vitis vinifera*.

Aquaporins are water permeable channels that facilitate the movement of water and other small neutral solutes across cellular membranes. Aquaporins are a highly conserved family of proteins that are ubiquitous in nature. Plant aquaporins are a large protein family called the Major Intrinsic Protein superfamily (MIPs), comprising 5 subgroups; plasma membrane intrinsic proteins (PIPs), tonoplast membrane intrinsic proteins (TIPs), nodulin-like intrinsic proteins (NIPs), small basic intrinsic proteins (SIPs) and X-like intrinsic proteins (XIPs; only found in dicots). The aim of the work was to identify and functionally characterize aquaporins from grapevine. Grapevines are one of the world's most economically important fruit crops and in 2007, became the first fruit crop to have its genome fully sequenced (Jaillon *et al.* 2007; Velasco *et al.* 2007). We identified candidate genes, by screening a *V. vinifera* cv. Cabernet Sauvignon cDNA library for both PIP and TIP aquaporins. We also identified 23 full-length MIP genes from the *V. vinifera* genome sequence of a near homozygous line (PN40024) that cluster into the four main subfamilies identified in other species.

Water transport capacity was determined for several of the PIPs and TIPs identified from Cabernet Sauvignon, by functional expression in *Xenopus* oocytes. Only VvPIP2 and VvTIP proteins were shown to function as water channels with the exception of VvPIP2;5. VvPIP2;5 differs from the water conducting VvPIP2;1 by the substitution of two highly conserved amino acids in Loop B (G97S,

G100W). Loop B is highly conserved and forms part of the water conducting pore. The amino acid substitutions in VvPIP2;5 were shown, by homology modeling to the crystallized structure of SoPIP2;1 (Tornroth-Horsefield *et al.* 2006), to likely form a hydrophobic block of the water pore. VvPIP1 proteins had no water transport capacity when expressed in *Xenopus* oocytes, and thus may transport another small neutral solute such as glycerol. The identification of aquaporins in grapevine will provide a basis for future molecular characterization of the water transport pathway in grapevines.

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# Teaching Award – Tim Cavagnaro

This award recognises excellence, innovation and/or contributions to teaching to undergraduate students at an Australian University in any area of plant science. The award is made annually when a suitable candidate is nominated. The recipient is invited by ASPS to give a short presentation on her/his teaching methods, innovations or contributions at the annual ComBio conference.

The Teaching Award was presented to Tim Cavagnaro and colleagues of Monash University for their course: It's a green, green world: Teaching plant structure and function. At OzBio Tim received his award from Rana Munns (see photo) before giving an inspiring talk in the teaching symposium. Tim, Patrick Baker and Martin Burd have provided the following article describing their course.

## Innovation and integration in botanical teaching

**Tim Cavagnaro, Patrick Baker, Martin Burd**
**Monash University**

The second–year unit, Plant Structure and Function, teaches students about plant anatomy and physiology. In 2006 we developed a new curriculum that integrates the study of plant structure andfunction with recent methodological advances, with elements of experimental design, statistical analyses and written communication. The major components of the unit include:

**Lectures.** The lecture course follows the increasing complexity and key innovations of plants in an evolutionary and life-history framework emphasising, in particular, the water–to-land transition. Topics are presented in two–week blocks addressing plant structures (eg, leaves, vasculature) in the first week and exploring how they work (eg, photosynthesis, water and nutrient transport) in the second. By using an evolutionary framework, students discover why certain groups of plants have become especially successful in certain ecosystems. By integrating anatomy and physiology lectures, we have found that students develop a much stronger appreciation of the links between plant structure and function and develop a deeper knowledge of how plants work. In the final four weeks of the unit the students apply the basic building blocks of plant structure and function to explore questions related to the life histories of plants.

**Practical course**: The practical component of our unit builds on, and extends, the integrated lecture structure. To engage students in plant sciences we believe three basic requirements exist. First, the students must grow plants. Second, they must see (and measure) how the same plant species responds differently to different growing conditions. Third, they must understand (and use) the basic analytical tools required to describe these differences. To this end, we have developed a semester–long sequence of practicals in which the students grow two native Australian plant species across a range of water and light availability. The practicals are conducted in two–week blocks, in which the first week is devoted to sampling and measuring anatomical, morphological, and physiological features of the plants and the second week focuses on the data management, statistical analysis, and report writing. The experiment is a replicated, fully factorial, multi-level design, which allows us to introduce the students to increasing levels of complexity in experimental design, data analyses, and botanical techniques over the course of the semester. The early practicals focus on simple two–level comparisons with t-tests, whereas the later practicals use multi–factor ANOVA to examine interactions of water, light, and species on plant growth. This stepped approach to experimental and analytical complexity allows the students to develop the necessary skills for understanding and interpreting data of considerable complexity over the course of the semester.

**Communication:** A major theme in this unit is the importance of effective communication. We have developed an essay assessment that asks the students to explain in layman's terms why various physical relationships expressed in mathematical equations (e.g., $E=mc^2$) are important to life on earth in a botanical context. We then use a double–blind peer–review process in which students review each others essays, providing them with opportunities to read similar essays (but on a different equation from their own essay) critically with the goal of providing constructive feedback to their peers. Many students find this quite confronting, as they have never read other students' work, but discover that it helps them to view their own work from a different perspective. Each student also receives at least one review from the teaching staff. The students are then given the opportunity to revise the essay prior to final submission and formal assessment.

**Impact.** The best evidence of success is the extraordinarily positive unit evaluations we have received in this unit in recent years, and a doubling in enrolments in 2010 (see Figs 1 and 2, Table 1). We have also seen a significant increase in student numbers in higher-level botany units, and the honours program in the School.

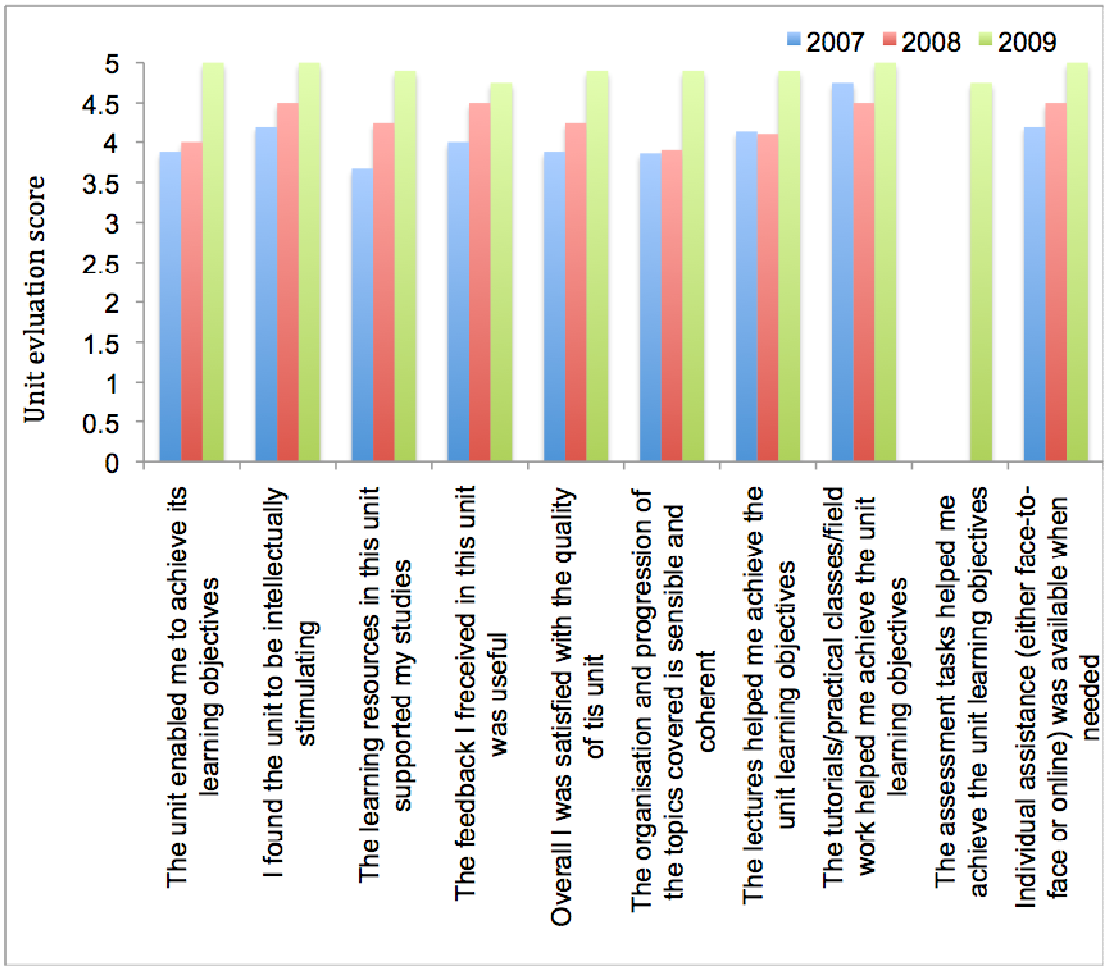


**Figure 1.** Unit evaluation data for BIO2282 in years 2007-9 inclusive. N.B. the question relating to assessment tasks was not available in 2007-8 data.


**Figure 2.** Student numbers in BIO2282 and the following unit BIO3082 in years 2007-10 inclusive. N.B. 2010 numbers based on current enrolments.

**Table 1.** Examples of student feedback from end–of–semester unit evaluations.

| **Question** | **What were the best aspects of the unit?** |
|---|---|
| **Year** | **Student comment** |
| 2007 | The practical classes<br>Being able to peer–review essays and having ours reviewed also was helpful |
| 2007 | The essay was really interesting. I was doubtful at the start but I thought it was a really good topic to research. I also liked the peer review bit, it was really helpful. I also liked having the mid-semester exam |
| 2007 | The progressive analysis of the two plant populations grown under different treatments was good because it gave a chance to analyse long-term effects, and wasn't as disjointed as other practical programmes.<br>The idea of an essay review helped a great deal in the writing and structure of individual reports. The introduction to different statistical analyses garnered familiarity with the maths involved. |
| 2008 | All the attention given to improving writing skills was really helpful. |
| 2008 | Reviews of essays provided a good means to fine tune essays. |
| 2008 | I found the lectures and pracs interesting, I learnt a lot about data analysis and report and essay writing which are useful skills. I liked the experimental focus of the pracs and overall liked the unit and was motivated to pursue further study of botany at third year. |
| 2008 | The essay - it was different to all other essays that I've written at Uni (having to explain something complex in laymans' terms). It was a good exercise. |
| 2009 | The teaching staff were great. Really approachable.<br>The best part of the course was the long continuous study using the plants in the green houses. |
| 2009 | The organisation of the essay assessment meant that I found it very rewarding. Having students write a draft essay and receive feedback from staff and fellow students was very useful. The essay task not only improved my scientific knowledge, but my writing ability also (especially scientific writing ability). |
| 2009 | The teaching staff in this unit are amazing, and I'm very grateful for the amount of care and effort they have put into this unit. I felt like I was learning 'real world' skills with the assessment tasks, and I was encouraged to use my brain properly all the way through. |
| 2009 | The pracs and report writing. I think these are a great way to learn<br>and hone techniques. |

## Poster Prizes

Five students were awarded poster prizes. The standard of all 44 student posters was very high and the judges found it hard to choose the most outstanding. We thank the judges Ricarda Jost, Iain Searle, Tim Cavagnaro and Kim Plummer for spending so much time on doing this so well.

*Rana Munns*

Congratulations to the following students who received awards.

**Victoria Clarke** (The University of Sydney)
*Poster entitled:* 'Proteomic profile of the soybean symbiosome membrane'

**Edwin Lampugnani** (Monash University)
*Poster entitled:* 'Formation of second whorl organs in the Arabidopsis flower involves auxin influx and is sensitive to distortion of the flower meristem shape'

**Danny Liu** (The University of Sydney)
*Poster entitled:* 'Characterisation of putative plasmodesmata proteins of the Arabidopsis calnexin family'

**Pradeep Sornaraj** (Flinders University)
*Poster entitled:* 'An autoactive flax R protein is purified with ATP bound in its nucleotide binding pocket'

**Emma Meyers** ( Honours student, The University of Queens;and)
*Poster entitled:* 'OXI: a novel branching mutant in Arabidopsis thaliana'

## AoB PLANTS

***AoB PLANTS*** **– a new open access journal for plant biologists**

Authors are turning in increasing numbers to open access journals to publish their work. The attractions of doing so are several. They include having greater control over copyright, the appeal and flexibility of the latest publishing technologies and, above all, having papers made available without charge worldwide and thus freely available to anyone who wishes to read them as soon as they are published. The newly launched journal *AoB PLANTS* offers these and other attractive features. It covers all aspects of plant biology, is owned and managed by plant scientists on a not-for-profit basis and is published by Oxford University Press. *AoB PLANTS* publishes 'Research Articles', 'Points of View', 'Reviews', 'Mini-reviews' and 'Technical Articles'. Submitted papers are evaluated against published minimum criteria for acceptability using a double-blind refereeing system. Papers will appear online within 3-5 days of acceptance and benefit from a full typesetting and proofing service. For an introductory period, there will be NO CHARGE to publish in *AoB PLANTS*. This creates the ideal opportunity for authors to try the new journal and enjoy the benefits of open access publishing at no cost. For further information contact Mike Jackson, Chief Editor *AoB PLANTS,* E-mail: mike.jackson@bristol.ac.uk or visit the web site http://aobpla.oxfordjournals.org/.

# The Plant Nutrition Trust Awards

THE PLANT NUTRITION TRUST has been established to encourage and promote research and technology transfer in the mineral nutrition of plants, soil fertility and fertiliser and soil amendment technology, and includes areas where these impinge on other fields such as plant breeding.

THE TRUST invites applications for awards to assist in carrying out a study tour or to attend a conference or such other activity related to the stated objectives.

Awards will be made to an outstanding early-career scientist working in the areas mentioned above. More than one award may be made, depending on the applications received.

In making an award an applicant's scholastic achievement and recent contribution to industry, research or technology transfer, and their potential for future contribution will be considered. The amount of each award will depend on circumstances but is likely to be under $2,000.

Applicants must be Australian citizens or permanent residents and be based in Australia,

Applications for the next round close on **28 February 2011**

Further details and application forms can be obtained from:

Dr Peter Ryan e-mail: Peter.Ryan@csiro.au
CSIRO Plant Industry
GPO Box 1600
Canberra ACT 2601
Fax: (02) 6246 5000

**About the Plant Nutrition Trust -** The Management Committee has included people associated with the Fertiliser Industry Federation of Australia, the Australian Institute of Agricultural Science and Technology, the Australian Society of Soil Science, the Australian Society of Plant Scientists and the Australian Soil and Plant Analysis Council. The funds come from surpluses from International conferences held in Australia and donations from The Sulphur Institute, ASPAC and individuals. **Further donations are welcome.**

# Conference Report

***Meeting reports provided by members from around the country***

## *IWPMB2010*

## 15th International Workshop on Plant Membrane Biology

The 15th International Workshop on Plant Membrane Biology was held at the National Wine Centre in Adelaide between the 19-24th September 2010. Two-hundred and forty three delegates attended, 106 from Australian institutions, 137 from overseas institutions.

IWPMB is the premier international triennial conference for anybody interested in processes related to plant membranes, an understanding of which is crucial to developing crops that will feed us into the future. Over the last 45 years, it has provided a healthy forum for scientific discussion, and exchange of ideas, for leaders in the field through to new postgraduate students. The last time it was held in Australia was in 1985 in Sydney.

Presentations at the conference discussed the science underpinning how plants acquire and use water and nutrients, and how they survive in marginal environments. Topics included the tolerance of plants to soils affected by salt, aluminium, boron and drought, bioremediation of soils contaminated with heavy metals, biofortification of crops with nutrients to improve human health such as zinc, iron and calcium, and increasing plant production through improving nutrient and water use efficiency.

The transport systems described were diverse ranging from the complex protein import machinery of mitochondria (Jim Whelan, Australia) to thiol transporters regulating glutathione synthesis (Chris Cobbett, Australia), to new hormone transporters (eg for ABA, Young-Sook Lee, Korea), peptide transporters (Doris Rentsch, Switzerland), and the "classic" transporters that were first described some 20 years ago such as CHL1, KAT 1, AKT and HKT1 but which are still full of surprises (see below). Regulation and interaction between membrane transporters and receptors also featured in presentations by Mike Blatt (Scotland) and Helen Irvine (Australia).

Workshop sessions were also run covering recent technical advances in certain areas of research including imaging, systems biology, membrane proteomics and phenomics.

The opening plenary lecture was presented by Professor Wolf Frommer from the Carnegie Institution for Science, USA. He addressed the exciting area of the membrane transport interactome (see http://www.frontiersin.org/plant_physiology/10.3389/fphys.2010.00024/abstract); and note the new on-line journal Frontiers in Plant Physiology. He also challenged delegates to lift their game in the use of sensors in membrane research. Many transporters can be modified to act as sensors using FRET for important metabolites such as sugars and amino acids.

The first full day of the conference started with a session on aquaporins with the keynote delivered by Francois Chaumont. The major take-home message from this session was the importance of the location of aquaporins, their selectivity and control.
Understanding the movement of water and carbon dioxide through plants, the ultimate source of all our food, is a high priority for researchers studying plants that will need to adapt to a future drier climate

with higher atmospheric $CO_2$. Aquaporins play diverse roles in plants. They are involved in the transport of water and also carbon dioxide, ammonia and important nutrients like silicon and boron. Aquaporins in plant membranes were discussed, amongst others by Professor François Chaumont (Belgium), Professor Urban Johanson (Sweden), Dr Menachan Moshelion (Israel) and Dr Christophe Maurel (France), and of course from a personal perspective this was a significant boost to my lab's research.

A general theme through the conference for all transport systems was the pipe-line of Gene-discovery/identification : Transport-function : Location : Structure : Regulation : Whole-Plant Function. The initial gene discovery could be via forward genetics, hypothesis driven, or simply examination of transporter genes identified from transcriptome analysis in response to various treatments. In this context, the importance of location linked to single cell transcriptomes was seen as a challenge to be addressed by the new sequencing technologies. Membrane protein structure was addressed by two of the international leaders in the area Professor Werner Kühlbrandt (LHCII, and ATP synthase) and Professor Per Kjellbom (aquaporin gating).

Several talks featured whole plant function of transporters, including Peter Ache (Germany) challenging the role of stomatal as the primary limiting conductance in water flow through plants; Ingo Dreyer (Germany) on the role of K channels used to store energy (like a battery) in phloem; long distance signaling (electrical: Lars Wegner, Germany, and hormonal: Christine Beveridge, Australia).

In the context of cell specific expression, a highlight here was Dr Simon Conn's presentation on the sequestration of Ca in mesophyll cells, as opposed to epidermal cells of the leaf. Single cell transcriptomes revealed large differences in tonoplast located CAX genes. Knock-outs of two CAX genes resulted in a partial breakdown of the sequestration of Ca, and interestingly phenotypes that could be linked to lack of control over apoplastic Ca. These phenotypes included cell wall structure and stomatal control. This work has recently been accepted for publication in the Plant Cell. We wish Simon all the best in his new post in Grenoble France. Also of note was the cell specific transport of sugar for fruit loading (John Patrick, Australia) and water and sugar loading in the cotton fibre (Yong-Ling Ruan, Australia). Sally Assmann (USA) took the cell/tissue specific expression of genes to the systems biology level and concluded that genes that are cell/tissue specific are rare, but there are genes that have an average expression level in all cells/tissues but have higher expression in specific cells. This is referred to as "leptokurtic" expression, and Sally analysed those genes displaying kurtosis of expression in stomatal guard cells.

Stomatal regulation featured as it has done in many conferences before, and a highlight was the discovery from Julian Schroeder's lab (USA) (Annals of Botany Lecture, presented by Julian) that carbonic anhydrases are involved in the elusive sensing of $CO_2$. Another significant outcome was the development of a model "On guard" from Mike Blatt's group that integrates all known components of

guard cell homeostasis into a model linking their collective behaviour to stomatal dynamics. Alex Webb (UK) presented his work on using stomata to elucidate the role of cytosolic Ca in regulating the circadian clock.

Achieving salinity tolerance in cereal crops has been an international group effort. Multiple independent research groups from around the world have contributed knowledge and research into improving crops such as wheat, barley and rice. The HKT Na transporter genes, which are known to affect the ability of the plant to tolerate saline environments were prominent. HKT genes are present in all plants and the sodium transporting proteins they encode are responsible for ensuring that excess salt does not reach the shoot of the plant where it damages the leaves and reduces plant yield. In order to combat the ever-increasing levels of salinity in agricultural soils worldwide, research groups are finding increasing the level at which HKT genes are expressed reduces the salt being transported to the shoot and improves the salinity tolerance of cereal crops. Dr Darren Plett (Australia) from Mark Tester's group demonstrated that expressing an HKT gene in specific cells in rice resulted in significantly improved salinity tolerance since salt was trapped within the root of the plant, where it is less harmful to the plant. Scientists at the Universidad Nacional Autonoma de Mexico in Cuernavaca, Mexico led by Dr Omar Pantoja have identified several HKT genes in rice that appear crucial to the response of rice to salinity stress. In other research, Dr Rana Munns, lead researcher of a group based at CSIRO Plant Industry in Canberra, Australia showed that the yield of durum wheat could be increased by 25% under saline conditions. Dr Munns used traditional (non-GM) breeding to move DNA that confers improved salinity tolerance, called Nax2, from an old wheat relative, *Triticum monococcum*, into durum wheat which attracts a premium price for its excellent pasta qualities. Recently, a team of scientists led by Dr Matthew Gilliham at the University of Adelaide's Waite Campus has confirmed that the Nax2 locus discovered by Dr Munns and co-workers is actually an HKT gene. Finally, a collaborative program between the Institut National de la Recherche Agronomique in Montpellier, France and the University of York, UK, led by Dr Anne Aliénor Véry and Frans Maathius has revealed that increasing expression levels of an HKT gene via genetic modification in barley leads to increased salinity tolerance. A shoot to root transport context was provided by Sergey Shabala's (Australia) presentation on electrical changes in the stele and cortex in response to salt stress.

Functional characterisation of transporter genes featured in most talks using a variety of techniques, and although single channel recording using patch-clamp did not feature as strongly as in previous conferences, the reliable workhorse of Xenopus oocyte expression to determine transport function was featured in many talks and posters. If it was not oocytes there was a requirement for heterologous expression in yeast or plant cells to determine transport function.

The last day consisted of workshops around nitrogen use efficiency sponsored by the ACPFG. Plenary speakers representing the key international groups specialising in nitrogen use efficiency (NUE) and research presentations describing key rate limiting steps in NUE that are currently being targeted to improve the NUE in crop plants. Not surprisingly, nitrogen transporters appear to be critical in NUE as presented by Trevor Garnett and similarly phosphate transporters in phosphorus use efficiency as presented earlier in the conference. The regulation of the transporters involved is complex with some acting as receptors (transceptors), for example NRT1.1 (CHL1) as elegantly presented by Yi-Fang Tsay (Taiwan). Similarly the regulation of phosphorus transport to the shoot is tightly regulated by the PHO1 genes in rice as presented by David Secco (Switzerland). AND of course we should not forget the role of mycorrhiza in uptake of P by plants, with excellent and exciting new insights being presented by Maria Harrison (USA) identifying a gene (*STR*, encoding a half ABC transporter) that is involved in the development of arbuscules, and Andrew (FA) Smith (Australia) showing that AM mycorrhiza provide large amounts of P to plants even when there is no mycorrhizal growth response.

Given the environmental effects associated with production and usage of nitrogen and phosphorus fertilisers, and the suggestion that we may be approaching peak phosphorus, increased food production will require crops that use fertilisers more efficiently, that is, we need to increase the nutrient use efficiency of crops. Nitrogen (N) is one of the biggest input costs for farmers and the price is increasing

because of the power used to industrially fix N from the atmosphere. Approximately 2 % of the world's energy is used to produce N fertiliser; this causes a considerable greenhouse gas contribution. Given the costs and environmental effects associated with production and usage of nitrogen and phosphate fertilisers, plants with increased nitrogen and phosphorus use efficiency are of great importance to future food security.

Heavy metal uptake and entrance to the food chain was also a highlight with Jian-Feng Ma (Japan) presenting recent work on newly identified Cd transporters involved in keeping it in the roots and in allowing hyperaccumulators to tolerate high levels in the shoots.

The IWPMB was organised by members of the Waite Research Institute at the University of Adelaide, the Australian Centre for Plant Functional Genomics (ACPFG) and Lara Birchby from the Meeting People as conference secretariat. Matt Gilliham was the driving force and pulled it all together on budget for what delegates expressed as an exciting, balanced and engaging set of topics. The venue, food and entertainment were excellent and the consensus was that the meeting was a great success.

We received media interest from the ABC Local Radio, ABC Country Hour (which ran an hour long special on the meeting), Stock Journal, the University of Adelaide magazine - The Adelaidean, Vector (ACPFG magazine), multiple scientific news websites and 3 print stories in Malaysia, The Borneo Post, the Daily Express and the New Sarawak Tribune.

There will be a special issue of the Journal of Experimental Botany produced from selected papers and workshop sessions presented at the conference. Scheduled for early 2011. For more information about the conference go to the website archive at http://www.adelaide.edu.au/iwpmb2010. The members of the organising committee would like to thank the generous sponsors of this event including DIISR, University of Adelaide, ACPFG, Journal of Experimental Botany, Waite Research Institute, Australian Plant Phenomics Facility, Plant Methods, ARC Centre of Excellence in Plant Biology, Annals of Botany and ASPS.

*Steve Tyerman*

## *Wolf's Challenge*

# CONFERENCES 2011

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# *Were you aware that….?*

- ***ASPS Website.*** The ASPS website has been thoroughly revamped and is being continuously upgraded.
  - Membership dues can now be paid on line.
  - You can advertise jobs, PhD scholarships, conferences, books by contacting Kiran Sarfaraz via advertise@asps.org.au. To cover the costs involved, the society has introduced a small charge of $30 for members and $70 for non-members ***FOR EMPLOYMENT ADS ONLY***. Advertising conferences and books (edited by society members or containing chapters written by society members) are ***FREE OF CHARGE***.

- ***RN Robertson Travelling Fellowship.*** This named Fellowship recognises and celebrates the sustained contribution made by RN Robertson (Sir Bob) in nurturing young plant scientists in Australia spanning across four decades from the 1950's. The Australian Society of Plant Scientists is indebted to Hank Greenway and Joe Wiskich who generated and championed the early development of the RN Roberston Travelling Fellowship.

- ***Student Travel Funds.*** Funds are set aside each year to sponsor student travel to our annual conference (2011, ComBio, Cairns), and contribute to their professional development in plant science. Support will vary from year to year depending on the Society finances, location of meeting and number of applications. The Treasurer will apply a formula in calculating individual entitlements and takes these factors into account. Applicants must be financial members of ASPS and presenting a paper or poster at the ComBio meeting.

- ***Postgraduate Section.*** We are proud to announce that student members who have recently completed their PhD and had their thesis passed can submit a summary that features in Phytogen. Members of the Council feel that this is an important opportunity for our postgraduate students to showcase their research. Such successful student members are advised that the summary can be accompanied by a key image in suitable format and that they should submit their items to the editor of Phytogen at any time for inclusion in the next issue.

- ***Society Funding for Workshops and Conferences.*** The society has a total of $10,000 available each year to provide seeding money and sponsorship for up to four conferences organised by members. The amount available to assist each conference will be about $2,500. For more details see the website: http:/www.asps.org.au and take the link to conferences.

- ***Corresponding and Life Memberships.*** Life Membership recognises an outstanding and sustained contribution to the Society by a long-standing ASPS member who, through their professional activities, has substantially enhanced the international profile of Australian plant science research. Corresponding Members are high profile overseas colleagues who have contributed substantially to plant science research within Australia. If you know of a deserving recipient for Life or Corresponding Membership, please consider putting a nomination forward. The procedure to follow is outlined on the ASPS website (see: http://www.asps.org.au and click on "About ASPS" where there is also a list of Life and Corresponding members).