PHYTOGEN

A
NEWSLETTER
FOR
AUSTRALIAN
PLANT SCIENTISTS

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PHYTOGEN

Volume 12: Number 1

In This Issue

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

A message from the editor

Dear Fellow ASPS Members,

Here is the first issue of Phytogen for 2010. Subsequent issues for this year are planned for August and November.

This issue starts with reports on 2009 activities -- the President's report delivered at the Annual General Meeting during ComBio held last December in Christchurch, New Zealand; my report on my first year as editor of Phytogen and some of the highlights of the ComBio meeting. Included in the latter are accounts by Barry Osmond of key elements of his JG Wood lecture and by Joanne Tilbrook on the research that won her the ASPS-FPB Best paper award. I am sure you will find both articles interesting and informative. Thanks Barry and Joanne for these contributions. This issue also continues the section reflecting on our society's history that was instigated by the Golden Jubilee celebrations in 2008. Under the title *" Our Society – An Historical Perspective"* you will find a reproduction of Peter Brownell's invited essay and autobiography first published in the 1999 Membership Directory. In addition there are reflections about Peter, his contributions to Australian plant science, to his students and to colleagues.

For this issue I couldn't entice any PhD students to come forward with accounts of their key findings and experiences as students which is a bit disappointing as I know you are out there. However, we have two excellent reports from the 2009 recipients of the RN Robertson Travelling Scholarships. Thank you Foteini and Bianca for your reports. It is clear that you have benefited greatly from the experiences gained through the opportunity to work in another laboratory and with other plant scientists. I am sure that *"Sir Bob"* would be giving his nod of approval if he could read your reports.

Next issue we will have "State of Affairs" back, most likely with a contribution from our NZSPB colleagues together with a continuation of "Discipline Highlights" complimenting the account by Oula Ghannoum and David Tissue entitled *Eucalyptus Growth in Past and Future Climates* that appeared in Vol 11 Number 3 last December. In addition, a position paper on *"Women in Science"* is under preparation that we hope will be ready for the August issue.

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

Tina Offler

AUSTRALIAN SOCIETY OF PLANT SCIENTISTS

President's Report, 2009

Awards and grants

The Goldacre Award was presented to Ben Trevaskis (CSIRO Plant Industry) at ComBio2009 in Christchurch. Ben gave a plenary lecture on "The molecular basis of vernalisation-induced flowering in cereals" and was awarded a medal and a cheque sponsored by Functional Plant Biology.

The Teaching Award was won by Amanda Able (University of Adelaide) who presented a paper in the Education Symposium.

The FPB Best Paper Award for an early-career scientist was won by Joanne Tilbrook (University of Adelaide).

Student Science Prizes were won by two PhD students from Brisbane: Karl Pioch (CSIRO) and Hsiao-Hang Chung (UQ) for their posters.

Two students received awards from the RN Robertson fund. This assisted Foteini Hassiotou (University of Western Australia) and Bianca Kyriacou (Flinders University) to travel to other laboratories to broaden the research for their PhD projects.

The Society also provided travel grants to twelve students to attend ComBio2009.

Two specialist conferences were sponsored last year, and one for the coming year.

Membership is up, due to the new web-based payment system, which needed a new web manager. Total membership = 505 including 176 student members which is very encouraging.

Finances are sound after receiving distribution from past ComBios.

Phytogen

Three issues were published this year, under the new editorial leadership of Tina Offler from Newcastle University. The March issue was a particularly notable one, as it celebrated the Jubilee Anniversary of our Society, with information on the inaugural members of 1958. We are particularly grateful to Martin Canny for his Recollections (he was an inaugural member) and to Paul Kriedemann for collecting the original photos.

Functional Plant Biology

The journal is attracting papers with higher impact, particularly from Australia and USA. The publication of a special issue on Plant Phenomics (November 2009) and a continuing virtual special issue on The Evolution of Plant Functions has generated interest. The latter is useful for teaching and

free on-line. Twelve papers have been published so far in this evolution series, and can be obtained by a click on the home page (www.publish.csiro.au/journals/fpb).

Plants in Action. A decision was made to not publish a second edition in hard copy, and instead to consider an electronic form of publication, possibly a moderated Wiki. The Society thanks Brian Atwell, Susanne Schmidt, Mark Tester and Paula Jamieson (representing the NZSPB) for their planning towards a second edition.

FASTS

The society subscribes to the Federation of Australian Scientific and Technological Societies. This year they produced a report on Women in Science which is a disburbing document. This shows that the progress of women in senior positions has stalled over the past 15 years despite encouraging improvements in participation at undergraduate and postgraduate levels. The report can ben downloaded from their website http://www.fasts.org/

Global Plant Council

Barry Pogson is our new reprentative on FASTS. At the ASPB Hawaii Meeting, he attended the founding meeting of a Global Plant Council of international plant science societies, to highlight the importance of plant science research in global food and energy supply.

Future Society Meetings:

- OzBio2010, Melbourne, 26 September – 1 October
- ComBio2011, Cairns, September
- ComBio2012, Adelaide, September

Other Meetings

International Botanical Congress, Melbourne July 2011

Rana Munns, President ASPS,
Report presented at the Christchurch Convention Centre, 9 December 2009

Phytogen 2009 Editors report

Three issues of Phytogen, Volume 11, have been published this year, the first in March followed by June and November issues. I am aware that this schedule has deviated from that of previous years and plan to return to issues before and after OzBio in 2010.

This has been my learning year as editor. I inherited a well-organized format from Helen Irving who had done an exceptional job of producing Phytogen for five years. I have essentially retained that format with some style and font changes. While for the most part retaining sections like "State of Affairs", I have added some new sections as detailed below and have been supported strongly by contributors to make this happen. The added sections have meant that the three issues have different combinations of articles. There was a one-issue hiatus in "State of Affairs" but we have now been provided with truly excellent articles from South Australia (June issue) and ACT (November). "Twigs and Branches" had a 2-issue break but is now back in the November issue thanks to Helen Irving. Sections like Conferences and Functional Plant Biology feature in all issues.

Sections introduced throughout the year are:
Our Society – An Historical Perspective -- The commencement of my editorship coincided with the 50 Year Jubilee. Paul Kriedemann and Martin Canny had gathered a wealth of information about past events and members. They willingly provided me with this information and some appears in the March and June issues. My intent is to continue to use some of this material in subsequent issues of Phytogen. In the June issue I reproduced with permission an account of the early history of the Society by Tom Neales which covers events of significance and data on membership up to 1974. Should someone feel inclined, a similar account of the Society's history from then to the present would be a valuable contribution towards preserving our heritage.
Our New PhDs -- Our recently completed PhDs who are the future of plant science and our society are encouraged to provide highlights of the research that earned them their new degree together with comments on their experience as a PhD student. Six recent PhDs have contributed to this section and I hope that supervisors will encourage their students to contact me and offer an article. In addition, 2 further accounts of PhD research were included in SA's State of Affairs (June issue).
Robertson Lecture – Hans Lambers presented the Robertson lecture in Canberra last year. I invited him to write a synopsis of his lecture which he did with enthusiasm. I suggest that in future presenters of the Robertson, JG Wood Memorial and Annals of Botany lectures be invited to write synopses for inclusion in Phytogen.
Discipline Highlights – Having canvassed the opinions of the Discipline Representatives this section has been set up for articles addressing new advances/issues within plant science disciplines. The first article from Environment & Ecophysiology: Global Change is in the November issue. I hope this will be an ongoing series.
Education Section -- I was inspired by receiving materials from Geoff Burrows & John Harper illustrating their Online Teaching modules and have combined these with reviews of two books by Teri O'Brien focused on teaching plant anatomy. This section appears for the first time in the November issue. I hope that we can continue this section as I am sure you would all agree that teaching our science in imaginative ways is a crucial component of promoting plant science.

I welcome comments and suggestions for the development of Phytogen.

Tina Offler, Editor
4 December 2009

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Highlights from ComBio 2009 – Christchurch, NZ

JG Wood Lecture – Barry Osmond

Growing old in the shade: functional biodiversity of xanthophyll cycles

It was an honour to be awarded Life Membership of ASPS in 2008 and an honour again to be invited to give the JG Wood Lecture to a joint meeting ASPS and the New Zealand Society of Plant Physiologists in Christchurch, 9 December 2009. Coincidentally, the eve of this lecture corresponded to the 50th anniversary of Professor Wood's death. Wood was appointed Professor of Botany in the University of Adelaide in 1935 and was foundation President of ASPP (ASPS) 1958-9. He was held in great affection by students and colleagues alike. Described as *"an extremely energetic and highly strung individual"* (Turner 1960 *Aust Acad Sci Yearbook* pp. 28-33), he Wood seemed to be at ease among distinguished older colleagues in the front row of a 1935 group photo of the Adelaide Faculty, part of which is shown in Figure 1. A decade ago, in another Wood Lecture, his last PhD student told of Wood's enthusiasm *"when discussing work with Prof. Wood he would move around excitedly, grabbing reference material from his book cases, and at times had 3 cigarettes burning simultaneously in various ash trays"* (Brownell 1999 *ASPP Membership Directory* pp. 8-16). Wood clearly carried "fire in his belly" for plant biology.

Figure 1: JG Wood (*third from left*) in the front row of the Faculty of Biology and Medicine, University of Adelaide 1935, the year of his appointment as Professor of Botany *(cropped image reproduced with permission; University of Adelaide Archives Series 1151, University Photographs & Glass Slides: Item 310)*

In keeping with the ecophysiological theme of the lecture it was appropriate to emphasize Wood's early work with desert plants that had a pervasive influence on my own research and his subsequent PhD research in photosynthesis. Indeed, three strands of my postgraduate research in the field and the lab are evident in his camera-lucida illustration of an *Atriplex vesicaria* leaf in transverse section. Figure 2 (Wood 1925 *Aus J Exp Biol Med Sci* 2, 42-65) shows epidermal "bladders" into which most of the NaCl load in the leaf is excreted, insoluble calcium oxalate crystals (a visible component of oxalate dominated leaf cation-anion balance), and the "Kranz" (wreath-like) arrangement of mesophyll

and bundle sheath cells that underpins light stimulated β-carboxylation of PEP, now known as C_4 photosynthesis.

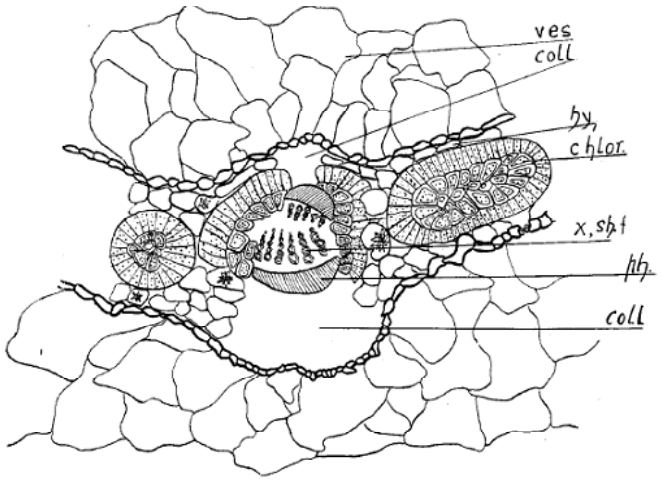

Figure 2: JG Wood's camera lucida drawing of *Atriplex vesicaria* leaf in transverse section with epidermal bladders (ves.) oxalate crystals (unmarked) and "Kranz" anatomy (chlor).

The Trans-Tasman venue of the lecture also provided an opportunity to personally acknowledge the role of New Zealand scientists in my research. Foremost among these was Lloyd Evans who, by giving me an opportunity to attend the opening of the Canberra Phytotron in 1963, imprinted the importance of such facilities in ecophysiological research that led in the end to my engagement with the Biosphere 2 project. Another important "Kiwi" influence was my early career collaboration with John Troughton, one of the first PhD students in Ralph Slatyer's Department of Environmental Biology in the former Research School of Biological Sciences (RSBS) at ANU. On returning to New Zealand John facilitated access to natural abundance isotope ratio mass spectrometry and freeze fracture scanning electron microscopy in the DSIR Physics and Engineering Laboratory. These techniques integrated and illustrated C_4 pathway research in *Atriplex* and phases of CO_2 metabolism in CAM succulents, the unravelling of which depended on controlled environments in the Canberra Phytotron and the Madison Biotron.

The Kiwi influence persists to this day, and lurks behind the data presented in the Wood lecture on components of photoinhibition; on down-regulation of photosynthetic efficiency (ØPSII) in sunlight. This has been an active corner of photosynthetic research for some time (Powles 1984, *Annu Rev Plant Physiol* 35, 14-44) and key papers continue to appear in Australian journals. Another review that made all the connections (Öquist & Huner 2003 *Annu Rev Plant Biol* 54, 329-355) introduced the concept of "photostasis", the *"predisposition of photosynthetic organisms to maintain a balance between energy input through photochemistry and subsequent energy utilization through metabolism and growth"*, and focused on how the light and dark reactions of leaf photosynthesis adjust to light, the most dynamic component of their physical environment. The efficiency of photochemistry is highest in low light, and in sunlight is largely determined by the capacity of the dark reactions in CO_2 assimilation to use the products of photosynthetic electron transport. Whenever this capacity is exceeded, for whatever reason, "excitation pressure" builds up in chloroplast thylakoids and ØPSII declines, reversibly at first, with reversibility dependent on a "nested cascade" of processes that are differently sensitive to light intensity and duration of exposure.

Since the work of Demmig et al 1987 (*Plant Physiol* 84, 218-224) ecophysiological research has firmly established the near universal role of the violaxanthin (V) cycle (the light dependent conversion of V to antheraxanthin (A) and zeaxanthin (Z) and the reversion of these reactions in the dark) in stabilizing excitation dissipation in the antenna, thereby protecting reaction centres against damage arising from "excitation pressure". Usually measured as nonphotochemical quenching (NPQ) of chlorophyll fluorescence, the quest for mechanisms of photoprotection against photoinactivation has since attracted some of the most exciting, novel and controversial research in photosynthetic light reactions research. At the same time ecophysiological work has also explored "excitation pressure" arising from sunlight exposure at low temperatures, and the consequent photoinactivation of PSII reaction centre cores that then also themselves become quenching centres (Matsubara and Chow 2004 *PNAS* 101, 18234-18239).

A decade ago Shizue Matsubara found an additional, chemically analogous xanthophyll cycle, the lutein epoxide (Lx) cycle, in mistletoes on eucalypts. Our enthusiasm for this project was somewhat

dented when priority for re-discovery of the Lx-cycle went to a Kiwi working on dodder (*Cuscuta*) in Sheffield (Bungard et al 1999 *PNAS* 96, 1135-1139). Shizue was not to be deterred (Matsubara et al 2001 *Aust J Plant Physiol* 28, 793-800). Several papers later, and after submission of her thesis, she joined us briefly in Biosphere 2 where, by chance, she found that the tropical forest tree-legume *Inga sapendoides* (one of the targets selected for a remote sensing project; Ananyev et al 2005 *Global Change Biol* 11, 1195-1206) was also rich in Lx (Matsubara et al 2005 *J Expt Bot* 56, 461-468). This genus still sustains some of her research programs in Forschungszentrum Jülich Germany and the Smithsonian Tropical Research Center, Panama. Also by chance, work in Biosphere 2 alerted us that shade leaves of avocado were rich in Lx.

Meanwhile, Spanish ecophysiologist José García-Plazaola reported both cycles in Mediterranean woody plants and demonstrated that transient accumulation of photoconverted lutein (L) from Lx correlated with enhanced NPQ (García-Plazaola et al 2003 *Func Plant Biol* 30, 319-324). We collaborated on a review of broader aspects of these cycles in a wide range of plants (García-Plazaola et al 2007 *Func Plant Biol* 34, 754-779) and highlighted the peculiar situation in *Inga* spp. and avocado (*Persea*) in which Lx accumulates slowly in old, deeply shade leaves. Although Lx is readily converted to L if shade leaves are exposed to strong light, unlike A and Z in the V-cycle, L does not relax back to Lx overnight. This makes *Inga* and *Persea* spp. ideal for exploring the possibility that at least some of the L pool can substitute for A+Z, "locking in" photoprotection (Matsubara et al 2005). Shizue later confirmed José's work, showing that L from Lx sustained elevated NPQ after relaxation of A+Z in *Inga marginata* (Matsubara et al 2008 *Plant Cell & Environ* 31**,** 548-561).

Although ecologists have made plausible cost benefit analyses to account for the retention of old leaves in the shade (Poorter et al 2006, *J Expt Bot* 57, 355-371) there has been relatively little work on functional aspects, especially on the significance of two co-occurring, potentially photoprotective cycles in these leaves. It has been a privilege to examine these aspects in old leaves of avocado in collaboration with Britta Förster in Barry Pogson's lab at ANU (Förster et al 2009 *Plant Physiol* 149, 1179-1195). We have taken advantage of advances in pulse modulated chlorophyll fluorescence measurement systems (largely made possible by Uli Schreiber and H Walz GmbH). One of the most straightforward applications of these methods is estimation of ØPSII and photosynthetic electron transport rate (ETR) under field conditions. Leaves of avocado are most amenable to interrogation in this way and Table 1 summarizes spot measurements of photosynthetic parameters and pigment composition of mature trees in an orchard (Alstonville) and in a wooded rural site on the Smith property (at Rosebank) in NE NSW. Outer canopy leaves have high ETR at low efficiency in sunlight, and older inner canopy leaves have low ETR and high efficiency in deep shade. Outer leaves have high concentrations of V-cycle pigments, with very high de-epoxidation state (DS=A+Z/V+A+Z) indicating a highly photoprotective situation in sunlight whereas old leaves in the shade are Lx-rich with low DS. Similar data were obtained with avocado seedlings (cv. Edranol) grown in a tropical glasshouse (28ºC day/18ºC night) in Canberra with sun and shade (1,100 and 30 μmol photons m^{-2} s^{-1} respectively).

Table 1: Photosynthetic parameters and pigments in avocado leaves measured in the field in NE NSW.

Location	ØPSII	PFD	ETR	O_2 evol.	Lx	V+A+Z	DS
		μmol m^{-2} s^{-1}			mmol mol^{-1} Chl		
Alstonville sun (n=17)	0.35±0.02	1337±55	195±11	49	18.1±1.9	137±3.6	0.51±0.06
Alstonville shade (n=18)	0.81±0.00	5±1	1.5±0.2	0.4	50.3±10.5	50.1±2.9	0.24±0.01
Rosebank sun (n=8)	0.21±0.03	1529±80	130.8±7.1	32	12.8±1.3	174.1±16.1	0.71±0.03
Rosebank shade (n=12)	0.77±0.01	11±1	3.4±0.5	0.8	28.1±5.6	33.4±1.1	0.17±0.03

Avocado leaves that grow old in the shade remain remarkably responsive to light, and because they have such low rates of photosynthesis, their properties are best assessed by chlorophyll fluorescence, in spite of the many pitfalls (Logan et al 2007 *Func Plant Biol* 34, 853-859). For example, a large mature shade leaf of avocado collected pre-dawn shows early light saturation of ETR at very low rates (Fig. 3, *left*) accompanied by rapid development of NPQ (Fig. 3, *right*) attributed to high ΔpH that develops across the thylakoid lumen when CO_2 supply is restricted by closed stomata. This is termed

xanthophyll-independent NPQ. We know that stomata are closed because a smear of Vaseline (under a patch of plastic food wrap) makes no difference to the data obtained by chlorophyll fluorescence. However, 45 min in lab light (15 µmol photons m^{-2} s^{-1}) enhances ETR as a result of induction of CO_2 assimilation and lowers "excitation pressure", ΔpH and NPQ. A Vaseline patch applied to this part of the leaf now cuts access to CO_2, reducing ETR and strongly enhancing excitation pressure and NPQ. This simple test enables one to eliminate potentially confounding effects of stomatal closure and photosynthetic induction when searching for evidence that accessory pigments have key roles in photoprotection.

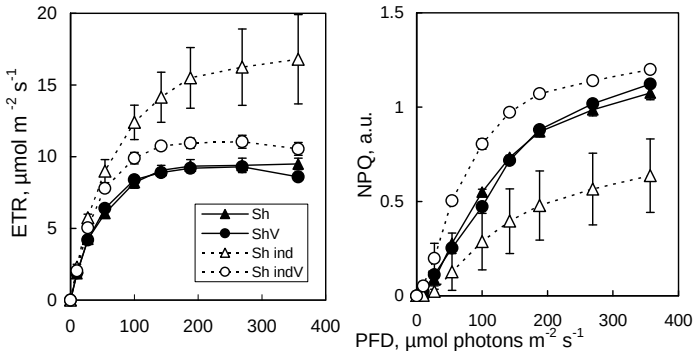

Figure 3: Light response curve analysis of photosynthetic induction and stomatal opening in a mature shade-grown avocado leaves using chlorophyll fluorescence. Photosynthesis (ETR) and photoprotection (NPQ) in control (Sh) and exposed areas were measured before and after 45 min induction at 15 µmol photons m^{-2} s^{-1} (Sh ind) with and without a Vaseline patch (V) on the lower epidermis to block stomata.

It is now well established that A+Z stabilizes and enhances NPQ in the presence of ΔpH. Normally A and Z relax back to V overnight, but in avocado, Lx does not relax back to L for many days in the shade (Förster et al 2009, *Plant Physiol* 149, 1179-1195). This feature of Lx-rich shade leaves of avocado, *Inga* spp. and *Quercus rubra* means one can test whether photoconversion of Lx to L can substitute for A+Z and effectively "lock-in" enhanced NPQ overnight. This is hypothesis now also seems well founded in avocado (Fig. 4). As little as an hour exposure to 200 µmol photons m^{-2} s^{-1} converts about 1/3 of the Lx pool to L and this persists for 48 and 72h (Fig.4 *left panel*). About the same amount of V is reversibly converted to A+Z in these treatments (not shown) but there is no lasting effect after 48 and 72h. Nevertheless higher NPQ persists with greatest effect at lower light intensities (Fig. 4 *centre panel*) and with little effect on the relaxation of NPQ in the dark (Fig. 4 *right panel*). In other experiments the elevated NPQ persisted for up to 48h dark, as long as Lx level was not restored.

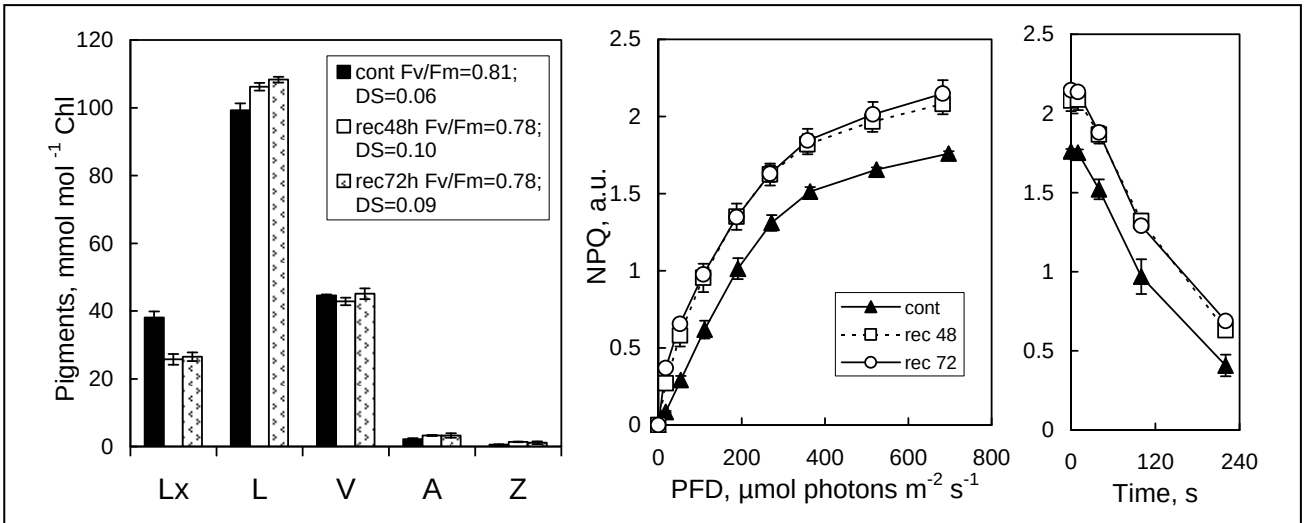

Figure 4: Photoconversion of Lx to L in shade-grown avocado leaves sustains increased photoprotection (NPQ) without photoinactivation for up to 72h in the dark (ØPSII= Fv/Fm; DS=A+Z/V+A+Z).

In our view, this is a small, but striking example of functional biodiversity in which natural selection has done yet another very interesting experiment. We have established that photoconversion

of Lx makes a small addition to the large L pool which is just as effective as A+Z in enhancing photoprotection and sustains enhanced photoprotection for days after a light shock. Unfortunately, *Arabidopsis* does not accumulate Lx, so the mutant approach that facilitated huge advances in the mechanistic understanding of V-cycle NPQ and photoprotection over the past decade or so has not helped understanding of the Lx-and V-cycle system. Until now, that is. After an exhaustive (probably expensive) program a Z-free, L over-expression mutant has been created in which a carotenoid cation radical (a putative quencher in NPQ) similar in most respects to that ascribed to Z can be detected in strong light (Li et al 2009, *Plant Cell* 21, 1798-1812), suggesting that *"lutein substitutes for zeaxanthin in NPQ"*. Once again it is fair to say that ecophysiology has given us a new-take on photoprotection before mechanistic elaboration using *Arabidopsis*; not that it has been acknowledged in a Berkeley lab well aware of the two xanthophyll cycles in *Inga* and avocado.

So it seems there may be some selective advantage for retention of inner canopy leaves that grow old in the shade, capable of only meagre rates of photosynthesis, rather than yielding to senescence to recover chloroplast N for new leaves in the outer canopy. In addition to the photoprotective roles of a strategically located part of the L pool in the light harvesting antennae, we think it may be a first line defence against photo oxidation as well, and Shizue is exploring indications that high Lx facilitates more effective light harvesting in the shade. This could make the Lx-cycle a perfect "switch" in old shade leaves. These potential advantages may have something to do with dynamics of canopy disturbance in the tropical environment where damaging winds, for example, potentially may expose shaded leaves to "excitation pressure". The orchard analogy is pruning, a practice widely used in avocado cultivation, but that is another story.

The above examples show, in a small way, that one cannot predict where the next needed insight will arise. Wild plants are the first responders and primary transducers of H_2O vapour, CO_2 and other gases in the face of global change and crops, not *Arabidopsis*, have to be improved to achieve food security. As plant biology recovers from its preoccupation with this small weed it seems likely that interactions between research in the lab, in the field and in targeted facilities can conspire to meet the challenge, but serious investment is needed. Resolution 2 at the International Botanical Congress in Vienna 2005 noted: *"We cannot simply continue to observe the uncontrolled global environmental change. As a matter of urgency, facilities for controlled, ecosystem-scale experiments are required now, supported by commitments that match those presently devoted to space and planetary sciences. Without such facilities, experiments, and international research activities, we have little prospect of understanding, anticipating, and taking advantage of the mechanisms that underlie functional biodiversity in plants…"*

In Australia at least we may yet recapture the vision of the 1950s that saw parallel investment in the CSIRO Canberra phytotron along with the Parkes radio telescope. Decades of truly creative interventions in the genome of *Arabidopsis* have confirmed that there are few if any magic bullets for manipulation of the functionally diverse physiological, biochemical and biophysical interfaces in the soil-plant-atmosphere continuum in other plants. Rather, it is now recognized that this work has created a "phenotyping bottleneck" that must be relieved by turning to new automated biophysical and engineering technologies. Recent responses to this need include large-scale renovation of the Canberra phytotron with "deep phenotyping" capabilities and an imaginative "plant accelerator" for cereal phenotyping on the Waite Campus of the University of Adelaide (Finkel 2009 *Science* 325, 380-381). One hopes this is just the beginning…….

Acknowledgements

In the 6th age one depends increasingly on the support and encouragement of others. One hopes that the research reported above will soon make it to the literature, but for now the active support from Cornelia Büchen-Osmond, Steve Dempsey, Britta Förster, Shizue Matsubara, Caroline Nichol, Barry Pogson, Julian and Vanessa Smith, Kotaro Takayama, and many others not directly engaged with these pursuits, is gratefully acknowledged.

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Roger Slack Lecture – Matthew Turnbull

Matthew Turnbull, Professor of Plant Physiology at the University of Canterbury was the recipient of the prestigious Roger Slack Award and presented the Roger Slack Lecture. The Roger Slack Award in Plant Biology is made annually by the NZSPB to one of its members in recognition of an outstanding contribution to the study of plant biology. The award is named after Dr Roger Slack in recognition of his outstanding contribution as a plant biologist and biochemist in New Zealand. Eligibility for the award alternates each year between researchers who are within 10 years of their PhD, and all members, regardless of the time since their PhD. Matthew's abstract is reproduced below.

Factors regulating the acclimation of plant respiration and photosynthesis along environmental gradients

Matthew Turnbull

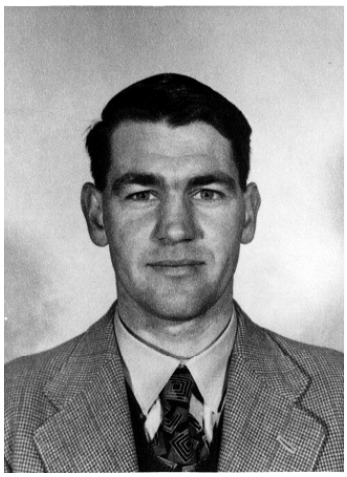
School of Biological Sciences, University of Canterbury, Christchurch, New Zealand

Understanding the processes and factors influencing seasonal variation in respiratory and photosynthetic parameters is critical for accurate modeling of CO_2 exchange between vegetation and the atmosphere. Leaf respiration plays a key role in determining the growth and survival of plants but also has a strong influence on net ecosystem exchange and atmospheric CO_2 concentrations. Plant respiration is associated with the production of energy and carbon skeletons essential for cellular maintenance and biosynthesis. Between 30 and 80% of daily carbon fixed by photosynthesis is respired back into the atmosphere, with a considerable proportion of whole plant respiration attributable to foliage. Plant respiration generally contributes between 60 and 70% of total CO_2 released into the atmosphere from terrestrial ecosystems. The extent of leaf respiratory CO_2 release is often studied under controlled-environments using constant temperature conditions – these may differ from natural conditions, which vary diurnally and seasonally. In the long term, changes in environment lead to acclimation, where an adjustment in the rate of respiration occurs that may compensate for the initial change in conditions (e.g. temperature). The degree of respiratory acclimation varies greatly within and between species but the speed of respiratory acclimation to changes in temperature is also critical in determining the rate of respiration at any given time. In this talk I will discuss the responses of respiration to environmental gradients, and the mechanisms that underpin these responses.

The Goldacre, Best Paper and Teaching Awards

The Goldacre Award -- Ben Trevaskis

Peter Goldacre was a foundation member of ASPP, and an enthusiastic supporter of the Society from its inception. With a Science Degree from the University of Sydney, majoring in chemistry and biochemistry, he took up a research position at what was then the CSIR Division of Plant Industry in Canberra in 1947. Peter was an enthusiastic researcher who was held in great respect by his peers. His tragic death in 1960 from stomach cancer 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.

The recipient of the Goldacre Award for 2008 was Ben Trevaskis, CSIRO Plant Industry, Canberra, for his work on how seasonal fluctuations in temperature and daylength influence flowering of cereal crops. Ben is pictured being congratulated by Rana Munns, President of ASPS who presented his award prior to Ben delivering the Peter Goldacre Lecture.

ABSTRACT

The molecular basis of vernalization-induced flowering in cereals.

Trevaskis B

CSIRO Division of Plant Industry, Canberra, ACT, Australia

Many plants respond to seasonal cues to synchronise flowering with optimal conditions.

For example, some plants flower only after prolonged exposure to cold during winter (vernalization), which reduces the risk of frost damage to cold-sensitive floral organs. In cereals such as wheat and barley the vernalization response is controlled by the MADS box transcription factor VERNALIZATION 1 (VRN1). Expression of VRN1 is activated by low-temperatures, a process involving changes in the state of chromatin of the VRN1 locus. Following vernalization VRN1 promotes the transition to reproductive development of the shoot apex. VRN1 is also expressed in the

leaves to allow long-day induction of FLOWERING LOCUS T, which accelerates flowering as days lengthen in spring. Microarray analysis of gene expression during long-term cold-treatment has identified other genes that act in the vernalization-response pathway in cereals. These include ODDSO2, a cereal specific transcription factor gene that delays flowering before winter but is down-regulated by vernalization. Overal there is little overlap between the genes which act in the vernalization-response pathway of cereals and those that mediate vernalization-induced flowering in the model plant Arabidopsis, suggesting that the vernalization response has evolved independently in these different plant lineages. Thus, molecular analysis of the vernalization response of cereals offers insights into the evolution of seasonal flowering-responses and provides a detailed understanding of the mechanisms that determine flowering time in economically important cereal crops.

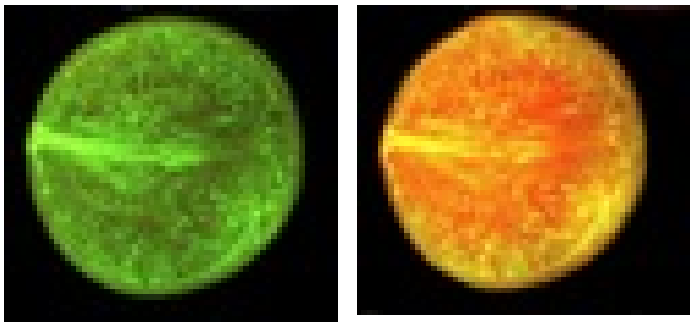
ASPS-FPB Best Paper Award – Joanne Tilbrook

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.

Joanne Tilbrook received the award for 2008 from Rana Munns, Editor-in-Chief, FPB (see photo below) and presented her work on cell death in grape berries at ComBio in New Zealand. Below is her account of her research and what it has meant to her to win this award.

Winning this award has been a privilege and a great confidence-builder for me as a scientist, culminating in the opportunity to speak at ComBio 2009 in Christchurch, New Zealand. I wrote the paper as a chapter for my PhD thesis; it was my favourite chapter because I thought the data were exciting and significant and the fluorescent images gave the story real visual impact. I still remember my excitement when I looked down the microscope and saw the intense, red fluorescent response that indicated loss of cell membrane competence within the berries. That enthusiasm was sustained through the analysis and writing stages because the hydraulic data - in conjunction with the dye studies - offered a new slant on cell vitality, xylem water transport and the physiology of ripening in grape berries used for winemaking and the table.

I would like to thank the ASPS and Functional Plant Biology for their active and friendly encouragement of early career researchers with this and other awards. Also, thanks are due to Steve Tyerman, who always encouraged my ideas for experiments and provided critical feedback on experimental design, methods of analysis and my writing.



No fluorescence on the cut surface was visible under UV light from a longitudinally sectioned Chardonnay berry at 110 days after anthesis and ~19.5° Brix with no dye applied (image not shown). Cells with competent membranes and functioning cytoplasm fluoresced green with the application of fluorescein diacetate (left). Up to this point in berry development, counterstaining with propidium iodide had shown no response, but now there was a dramatic red fluorescence that was sustained over 7 days (right). The response indicated a significant loss of membrane competence in cells across the berry mesocarp and endocarp as the dye accessed DNA and possibly RNA inside cells.

Below is Joanne's account of the key findings of her research.

Cell death in grape berries: varietal differences linked to xylem pressure and berry weight loss

The aim of the work was to test the hypothesis that membrane competence and vitality of cells across the pericarp of grape berries was maintained until harvest maturity was reached. For berry cells to counter negative xylem and apoplast tension generated by a transpiring vine, semi-permeable or competent membranes must be maintained. How much of that tension is transferred from the vine to the berry is dependent on the xylem hydraulic connection between the berry and the vine. Therefore the relationship between cell vitality and xylem pressure measurements in a berry/pedicel xylem system was examined. It formed part of a project to ascertain why Shiraz berries reach a maximum weight, to then have a net water loss of around 30% before they are considered ready to harvest for winemaking. Two grape varieties were compared to Shiraz: Chardonnay, a wine variety that does not generally lose weight and Thompson seedless, a table variety that we found to have very different xylem pressures to Shiraz and Chardonnay.

The loss of cell membrane integrity is an indicator of cell death, so vitality dyes were used to assess membrane competence on longitudinally-sectioned berries throughout development. Shiraz and Chardonnay berries maintained fully vital cells after veraison (berry softening) and during berry expansion until around the time berries attained maximum weight. At a single time point there was a vivid red fluorescent response to propidium iodide that was sustained over a week in the wine varieties. This suggested a sudden and significant loss of membrane competence across the mesocarp and endocarp of berries. It corresponded to a change in rate of accumulation of solutes in berries and the beginning of weight loss in Shiraz, but not in Chardonnay. Pixel analysis of the microscope images showed a continuous decline in mesocarp and endocarp cell vitality that began at the cell death event in both wine varieties and continued until normal harvest dates. Shiraz grapes classified as high quality and sourced from a different vineyard also showed the same death response at the same time after anthesis, but displayed a more structured pattern of mesocarp cell death.

The table grape, Thompson Seedless, maintained close to 100% vitality for all cells throughout development and well past normal harvest date, except for berries with noticeable berry collapse that were treated with giberellic acid. The high cell vitality in Thompson Seedless berries corresponded to negative xylem pressures (-24 KPa) that contrasted to the slightly positive pressures for Shiraz and Chardonnay, 4.7 and 11.8 KPa respectively, measured with a pressure probe connected to berry pedicels. We hypothesised that two variety-dependent strategies exist for grapevine berries late in development: (1) programmed cell death in the pericarp and loss of osmotically-competent membranes that requires concomitant reduction in the hydraulic conductance via the xylem to the vine; and (2) continued cell vitality and osmotically-competent membranes that can allow high hydraulic conductance to the vine.

Teaching Award – Amanda Able

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.

Amanda Able, School of Agriculture, Food and Wine, The University of Adelaide was the 2008 recipient of this award and delivered a presentation in the Teaching Session at ComBio.

Amanda receiving her award from Rana Munns in Christchurch, NZ (left) and her prize from the John Morris Ltd Adelaide representative in her laboratory (right).

ABSTRACT

Learning in action: Development of research potential

Able AJ

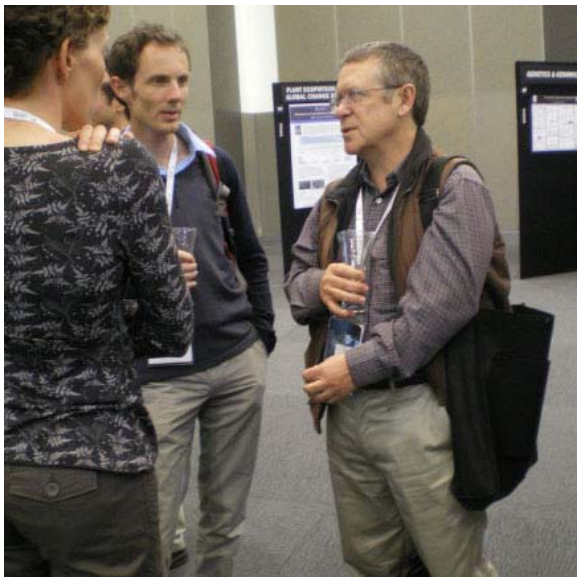
School of Agriculture, Food and Wine, The University of Adelaide, Waite Campus, PMB 1, Glen Osmond SA 5064 Australia

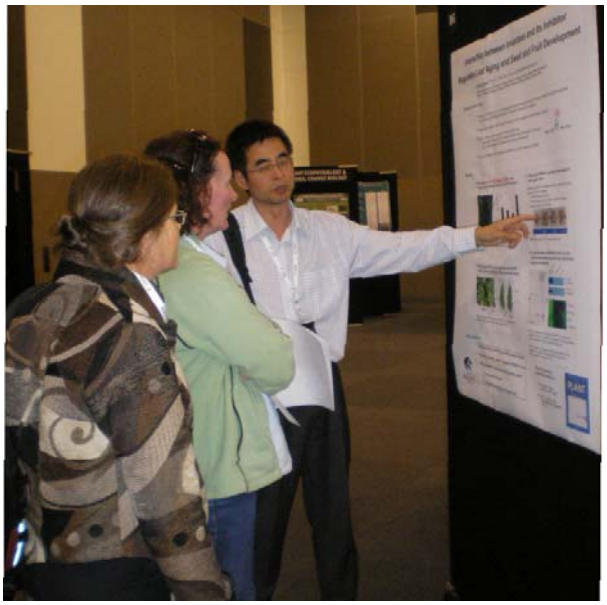
The principal means of learning for an individual is to perform a particular action and observe the outcome. Because moderation of the action changes the outcome, we learn the action that gives the best outcome and changes behaviour accordingly. This process is called action-based learning. Action-based learning is a subset of problem-based learning but is more directive and generative so that the student can develop relationships between subsets of information and fully integrate them into their understanding. Using action-based learning therefore relies upon setting a "real-world" task for students, providing demonstrations and analogies, and facilitating the problem-solving process. Action-based learning occurs because of the opportunity to build on other individual's ideas through discussion, hear how others deal with a problem, make mistakes and correct them, and engage multiple learning paths.

The use of action-based learning has proven successful for the development of research potential in undergraduate, postgraduate and vocational sector students in the field of molecular biology. This presentation will provide an example of each of these and discuss the elements that allowed facilitation of student learning. A project for undergraduate plant molecular biology students that allows them to develop their own research proposal from a literature review will be showcased. Three years of data collection from participants in the project suggests that the ability to apply theory to practice is greater and enhances their desire to pursue an Honours degree. Patchwork assessment also helps them through the process. The role of learning facilitation and action in the success of the professional development workshops for postgraduates and the DVD entitled *"Introduction to Molecular Biology Techniques: Theory and Practice"* will be discussed.

Poster Sessions and Poster Prizes

There were three poster sessions in the program which together with them being located near the food provided a good opportunity for viewing and discussion.





Michael Clearwater (NZSPB) and Steve Tyerman (ASPS) (top left) needed some refreshments to help their concentration during the poster session; Joanne Tilbrook (ASPS) obviously had some probing questions for Nick Gould (NZSPB) (top right) and Yong-ling Ruan (ASPS) was intent on providing a clear explanation of his results to Janet Wheeler and Helen Irving (both ASPS) (bottom left).

Poster Prize Winners -- Karl Pioch and Hsiao-Hang Chung

Congratulations to the poster prize winners Karl Pioch, CSIRO, Plant Industry, Brisbane and Hsiao-Hang Chung, The University of Queensland, School of Land, Crop and Food Science, Centre for Native Floriculture, Gatton. Unfortunately, I don't have access to photos but the abstracts of their prize-winning posters are reproduced below.

Karl Pioch

Characterisation of a tonoplast transporter from sugarcane

Pioch KA[1, 2, 3], Grof CPL[4], Critchley C[3], Rae AL[1, 2]

[1] CSIRO, Plant Industry, 306 Carmody Road, St Lucia, QLD, 4072; [2] CRC-SIIB, University of Queensland, St Lucia, QLD, 4072; [3] School of Biological Sciences, University of Queensland, St Lucia, QLD, 4072; [4] School of Environmental and Life Sciences, The University of Newcastle, Callaghan, NSW, 2308.

The aim of the project is to investigate the properties of selected sugar transporters from sugarcane and to unravel their roles in the process of sugar accumulation. These transmembrane proteins are frequently key control points in pathways of sugar transport. One of these transporters has been localised to the vacuolar membrane and has been functionally characterized. Experimental results established glucose uptake by the transporter when expressed in a glucose transport deficient yeast mutant. The transporter was found to be a proton symporter with a Km of 3.3 mM consistent with low affinity kinetics. This symporter would most likely function in export of glucose from the vacuole to the cytoplasm. Sugar accumulation in sugarcane is intricately linked to plant growth regulation and response to stress and this transporter is likely to be important in these processes. Net sugar concentration in the storage tissue of sugarcane is a product of transport into the vacuole and remobilization from the vacuole. Thus export of sugars from the vacuole may be important in controlling sucrose accumulation.

Hsiao-Hang Chung

The potential model species, *Calandrinia* sp. nov., for investigating pigment biosynthesis.

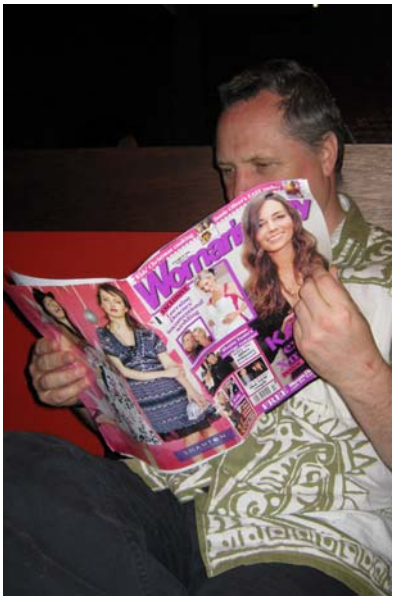
Hsiao-Hang Chung[1], Dion K Harrison[1], Daryl C Joyce[1], Richard R Williams[1], David H Lewis[2], Kathy E Schwinn[2] and Kevin M Davies[2]

[1] The University of Queensland, School of Land, Crop and Food Science, Centre fpor Native Floriculture, Gatton, QLD 4343, Australia. [2] Plant Pigments Team, Plant & Food Research, Private Bag 11600, Palmerston North 4442, New Zealand.

Betalains are water soluble vacuolar plant pigments found exclusively in 13 families of the order Caryophyllales. Betalains are mutually exclusive to the much more common anthocyanins. Variation in the relative content of two betalain pigment subgroups, red violet betacyanins and yellow betaxanthins, provides a range of vibrant colours in flowers, fruits and other organs. Furthermore, betalains are prevalent in plants adapted to extreme environments and they have been suggested to assist in ameliorating abiotic stress. Due to tyrosine being the common precursor and there being few downstream enzymatic steps to the first coloured compounds, the betalain biosynthesis pathway is an attractive one for molecular studies. One of the best characterized enzymes in the pathway is DOPA 4,5-dioxygenase (encoded by the DODA gene) which converts L-Dopa to betalamic acid. Genes responsible for some of the other enzymatic steps have not yet been identified. An Australian native flower, *Calandrinia* sp. nov., contains all basic colours associated with betalain biosynthesis (i.e. violet, red-orange, yellow and white) within a single flower. This multiple colour phenotype is modulated developmentally and spatially. Pigment analyses by HPLC and LCMS revealed simple pigment composition. One betacyanin (betanidin) and two betaxanthins (dopa- and tyrosine-betaxanthin) were found in violet and yellow petal sectors, respectively. A mix of all three betalains characterized red petal sectors. Thus, *Calandrinia* flowers respresent a novel and simple system for studying betalain bniosynthesis.

ASPS, NZSPB Dinner

AND finally we all went to dinner at Nobanno for an evening hosted by Christopher Palma the owner and manager. There were 90 of us (the maximum the restaurant could accommodate) and we enjoyed a meal to be recommended. Many thanks to Dave Collings for organizing this great venue and overseeing proceedings during the evening. WE made a lot of noise!! Rather too much for some of us with graying hair. Photos supplied by Dave Collings.



EVERYONE WAS HAVING A GREAT TIME
Cassandra Collins, Amanda Able and Brent Kaiser concentrating on eating and drinking (top left), "the lads" Owen Atkin, Matthew Turnbull, David Collings, Hans Lambers (top right), two John's and the president elect, John Evans, John Patrick and Ros Gleadow (bottom left).

BUT !!!!
John Harper just needed some time out.

OUR SOCIETY AN HISTORICAL PERSPECTIVE

From 1948 – a wonderful time to be associated with plant physiology

An invited essay and autobiography from Peter Brownell

first published in the

1999 Membership Directory.

(Reproduced with permission)

Given Barry Osmond's reference to Peter Brownell as Joe Wood's last PhD student and that he delivered the JG Wood Lecture a decade ago, it seemed and appropriate time to celebrate the contribution that Peter made to Australian Plant Science and the ASPS. Thus, in addition to comments about Peter prepared by Paul Kreidemann and Martin Canny for the Society's 50th Jubilee are photographs provided by Chris Grof from a presentation prepared for Peter's 80th birthday, a reproduction of his invited essay and autobiography and reflections from students and colleagues.

ABOUT THE AUTHOR:

Introduced to plant science in 1948 via B Agr Sc lectures; Peter Brownell became a postgraduate (PhD) student with JG Wood and Ray Specht in Adelaide University Botany Dept (Na nutrition). Appointed in the early 1960s to the Department of Agricultural Biochemistry at Waite Institute, and then in 1967 as the first lecturer in plant physiology at the University College Townsville (later James Cook University). Peter died about seven years ago, but while in good health, he was able to contribute a moving essay on his life in plant physiology to the 1999 ASPP Membership Directory. He offers this charming anecdote on his own life during training for a PhD s "…as a student when discussing work with Prof Wood, he would move round excitedly, grabbing reference material from his bookcase, and at times had up to three cigarettes burning simultaneously in various ashtrays! He had a wonderful understanding of plant nutrition…I often think how excited Prof Wood would be to know of the recent discoveries in plant physiology…his unexpected death left a great vacuum…"

As a WWII aviator, Peter never lost his love of flying, and is shown here about to embark upon a session of open-cockpit flying for his 80th birthday!

Peter concentrated his research on the influence of sodium on enzyme reactions. In Adelaide he worked with Margaret Jackman on sodium deficiency in *Atriplex*. (Brownell PE, Jackman ME (1966) Changes during recovery from sodium deficiency in *Atriplex*. *Plant Physiology* 41, 617.

Growth cabinet, Botany Department, The University of Adelaide containing the famous *Atriplex* (above).

In 1966 Peter moved to James Cook University in Townsville. There he showed that sodium was essential for the operation of the C_4 pathway and in Crassulacean acid metabolism, but not for the C_3 pathway. Sodium was a requirement for the enzyme pyruvate orthophosphate kinase. The two young students, Mark Johnson and Chris Grof pictured with Peter (below left) were part of his C_4 team. In 1994 Peter was awarded a DSc from The University of Adelaide. The photograph (below right) is taken with Don Nicholas and Joe Wiskich.

From 1948 – a wonderful time to be associated with plant physiology

A autobiographical account from Peter Brownell

I marvel at the enormous progress that has occurred since my introduction to plant physiology by Professor J. G. (Joe) Wood in his 1948 lectures to our BAg.Sc course at the University of Adelaide. Even then it was an exciting field partly due to the many gaps of knowledge in the subject and questions to be answered. There are few more challenging endeavours than to attempt to understand how organisms function. I am most fortunate to have been associated with plant physiology during a period of exciting progress in my time as a student, researcher and teacher.

A delayed and indirect introduction to plant physiology

My introduction to plant physiology was delayed and indirect. As a youngster, I gained an interest in science from my father, a medical practitioner, who had a deep respect for the scientific approach and we would carry out projects in his laboratory such as distilling ethanol from fermented grapes that could be burned or drunk! Biology was not taught at my school and physics became my favourite subject. When I left school, the opportunity to proceed to a university required an excellent school performance and/or good financial support; I had neither of these. However, I was able to attend Roseworthy Agricultural College.

An agricultural interlude

At Roseworthy, we studied many subjects including animal husbandry, farm engineering, crops, wool classing and horticulture. We worked on the farm for one day and then had 7 hours of lectures on the following day. In our second year, we were given the responsibility of taking up to 12 horses to plough or cultivate a paddock. I seemed to have gained some lasting fame by successfully walking 8 horses abreast through a gate designed for 4 horses! Odd noises came from the team as they squeezed through the gate but they recovered on the other side. This was some years before we studied Bernoulli's theorem that describes the behaviour of fluids passing through orifices.

On a "dairy morning", two of us milked cows by machine and then removed the drum containing the milk. There was one problem. We had not removed the drum before running the Na^+ carbonate and calcium hypochlorite through the system to clean it. We decided not to mention this indiscretion and it was interesting to hear complaints from wives of staff members that their junkets would not set whereas it took almost a week to hear of problems with custards in the college kitchen. This was my first tracer experiment carried out long before the use of marker isotopes!

We had a great advantage in coming under the influence of our principal, Sir Alan Callaghan. He had an enthusiasm for agriculture that was infectious even to the most stolid students. This made me determined to complete my course after I returned from my interlude of three and a half years in the RAAF. I trained as a pilot under the Empire Air Training Scheme in Australia and Canada and was posted to the UK and joined Bomber Command towards the end of World War II. On returning, I completed the Diploma course at Roseworthy and then studied for a BAgSc degree. This was a well-designed course because we studied basic subjects including physics, chemistry, botany, zoology, geology, biochemistry and microbiology before specialising in agricultural subjects. At a 40-year reunion, it was amazing to see the diverse occupations that my fellow students had pursued. The group included a professor of psychology, a New York banker, an agricultural consultant, a sheep geneticist, a soil scientist and a plant biochemist; yet we had taken almost identical courses which had served us well for the wide array of occupations. I wonder if students today, specialise at too early a stage.

On graduation, working as a soil conservation officer, I advised farmers mainly with water erosion problems in the mid-north of South Australia on land where there had been a history of narrow, exploitative rotations. It was a help to have rocketing wool prices that made it easy to persuade farmers to broaden their rotations with the introduction of pastures. This led to soil improvement, but advice had to be given largely from anecdotal observations.

I remember a farmer claiming that the soils at Waitpinga, near Victor Harbour were "salt hungry". He actually applied NaCl to the pastures and claimed that they responded strongly to the salt.

Our work was rewarding, but after several years, I had an opportunity to pursue further studies in ecology and plant physiology in the Department of Botany, University of Adelaide with Professor Wood as my supervisor.

Ecology leading to physiology

My honours project was aimed at assessing the effects of copper and zinc on the growth of lucerne and subterranean clover growing in plots near Keith in the Upper South East of South Australia and to observe the distribution of these elements in these legumes. Ray Specht, who was then a Senior Lecturer, gave great advice and help. We had a difficult time preparing the plots using a very old tractor and plough we had been lent. It took a whole week to get the tractor to the site and the machinery finally gave up when ploughing the paddock. Ray and I worked hard to repair the tractor and to start the project. To prevent kangaroos from eating our pastures and spreading micronutrients between plots, we built a tall barbwire fence to exclude the animals but on the following visit, we found two kangaroos had entered the enclosure and could not escape. Their runway was too short! Samples from these plots were harvested and analysed for copper and zinc using an extremely unstable valve-operated polarograph. It was a great discipline using this apparatus after working with heavy agricultural machinery. At this stage, I saw truth in the statement that I found in an old textbook "Ecology is Physiology under the worst possible conditions".

Are Na^+ and/or Cl^- essential for higher plants?

Professor Wood suggested a PhD project to determine whether Na^+ and/or Cl^- might be required by plants in micronutrient quantities. Until then, the main role of Na^+ appeared to be as a substitute for some of the potassium needed for maximum growth but it was clear that a certain amount of potassium, not replaceable by Na^+ was needed by all plants. There was no evidence for Na^+ being an essential element.

In 1899, Pfeffer (1) suggested that Na^+ might be essential for plants in very small amounts. Little or no attention was given to this possibility until the early 1950s when Professor Wood suggested that Na^+ and/or Cl^- could be needed in micronutrient amounts. *Atriplex vesicaria* (bladder salt bush) was chosen as one of the experimental plants because it accumulates massive amounts up to (23 % on a dry weight basis) of Na^+ plus Cl^- in its leaves (2) and hence might require Na^+ and Cl^-.

In a preliminary experiment, we obtained a significant response to NaCl. We were in the middle of a large water culture experiment to determine whether the response was due to Na^+, Cl^- or both when Professor Perry Stout and Dr. Clarence Johnson arrived from Berkeley University, California, to work in the CSIRO Laboratories on their sabbatical leave. They had been part of a team that had investigated the possibility of cobalt being an essential element for tomatoes. When they used most rigorous methods to exclude cobalt from the environment of the plants, their plants developed severe deficiency symptoms that were prevented by addition of cobalt chloride. However, further work showed that the symptoms were due to Cl^- and not cobalt deficiency. They had inadvertently discovered Cl^- to be an essential micronutrient element (4).

In our large water culture experiment using *Atriplex vesicaria*, we were excited to obtain significant growth responses in all treatments containing Na^+ indicating that Na^+ might have an independent role as a plant nutrient. By analysis, we recovered several times more Na^+ from our plant material and remaining culture solutions than we had supplied in seeds and culture solution during the experiment. This suggested that Na^+ had been contributed to the plants, possibly via dust.

Soon after, Allen and Arnon (5), also at Berkeley University, demonstrated a specific requirement for small amounts of Na^+ in the cyanobacterium, *Anabaena cylindrica*. This was the first report of Na^+ being required for plant life. The results of our preliminary experiment suggested that Na^+ might also be essential for higher plants. In our subsequent experiments, we therefore took great care to exclude Na^+ from our plant during culture. We built a growth cabinet with transparent plastic panels which was pressurised with filtered air to exclude dust as a source of Na^+ and thus obtained a Na^+ free environment for plant growth. We went to extremes in excluding Na^+ from the plants, recrystallising some of the culture solution salts up to 10 times in silica or platinum vessels. The final concentration of Na^+ in the nutrient solution was less than 0.0016 ppm. Water was twice distilled, the final stage with a silica condenser and contained less than 0.0002 ppm Na^+ . Having just set up the experiment, I remember how after a late meeting of the

Medical Sciences Club, Harold Woolhouse and I took a look at the plants growing in the refined cultures and what a thrill it was to find the Na^+ minus plants were turning yellow. This was the first time that a Na^+ deficiency had been seen in a higher plant (6). Several developments at this time helped our work including: plastic materials which were virtually free of Na^+ and the invention of atomic absorption analysis. Initially, a flame photometer was found to be satisfactory for estimation of Na^+ in culture solution salts. However, with progressive purification of the salts, interference from other ions became too great to obtain reliable data. At this time, the atomic absorption method had just been invented by Sir Alan Walsh of CSIRO. He brought an atomic absorption instrument to our laboratories which enabled Na^+ concentrations to be determined relatively free from interferences.

Questions to be answered

Two major questions arose from these results: What is the function of Na^+ in *Atriplex vesicaria* and do other plant species require Na^+?

From the pattern observed with other essential elements, we expected that Na^+ would be needed by all higher plants. Surprisingly, of the 30 species examined, including halophytes, other non-endemic species of *Atriplex*, only 10 Australian species of *Atriplex* were found to require Na^+ (7). At that time, these differences could not be correlated with any obvious differences between the species studied. We thought it was still possible that all these plants might need Na^+ but those plants which showed no Na^+ deficiency symptoms might need only extremely small amounts compared with the Australian native *Atriplex* species.

A new career as lecturer in plant physiology

After a brief time a the Department of Agricultural Biochemistry, Waite Institute, I was appointed to be the first lecturer in plant physiology at the University College of Townsville, which later became the James Cook University.

It was an adventure to go to the University College of Townsville in 1967 and to start lecturing. Townsville seemed cut off from the rest of the world and when students asked me where I was spending my first vacation, it seemed appropriate to reply "Back to Australia". I was fortunate to lecture in a wide field that gave me an awareness of many facets of plant physiology and helped me to see worthwhile directions in my research.

Developing courses and postgraduate programmes

In my first year, the little equipment we had consisted of only a nice Radiometer pH meter and parts of a Kjeldahl apparatus, making it difficult to present a course to 15 second year students and over a 100 first year students. I was fortunate to have great support from colleagues and technicians that allowed us to get through this difficult period. In my second year, the College supported the purchase of basic equipment and I also received generous grants with which we equipped a laboratory the following year. Chris Crossland joined us as a tutor

from Auckland and carried out a PhD on nitrogen metabolism in tropical pasture legumes. Chris is a tremendous enthusiast and we had a great time establishing undergraduate courses and postgraduate programmes. It was a challenge getting our research underway with increasing numbers of students taking our courses. At this time we focussed our efforts on nitrogen metabolism and abandoned Na^+ studies for a few years.

Nitrogen metabolism of tropical pasture legumes and cyanobacteria

In the summer vacation each year, until we established our own laboratories, I enjoyed the hospitality of scientists at Waite Institute. We studied nitrogen metabolism in tropical pasture plants and became particularly interested in the induction of nitrate reductase under different conditions. It was wonderful to return to the Waite Institute and the Botany Department on North Terrace in Adelaide to discuss our research progress. I had interests in common with Don Nicholas and Bill Wallace who were authorities on these enzymes. Others in the Waite Institute and Joe Wiskich of the Botany Department were also most generous with their help and support. In our early days at Townsville, we carried out our experimental programme for part of the year having time to think and pose many questions and really benefit from meeting our colleagues in the south.

The satisfaction of finding a correlation between C_4 photosynthesis and a need for Na^+ as a micronutrient

Our research has depended for its progress upon some exciting discoveries made by other workers. In the late 1960s after the discovery of the C_4 pathway by Hal Hatch and Roger Slack (9), Chris Crossland and I saw the possibility that C_4 plants might have a Na^+ requirement. To test this possibility Chris and I set up an experiment using C_4 plants from different families. We were able to establish a general correlation between the possession of the C_4 pathway and the need for Na^+ (10). Not only did this provide a rationale for the need for Na^+ for a restricted array of plants but it focussed on the C_4 pathway as the area in which Na^+ is involved in the metabolism of these plants. Due to the similarity of their photosynthetic pathways, it seemed likely that plants with Crassulacean acid metabolism (CAM) might also require Na^+ for their growth. When experiments with *Bryophyllum tubiflorum* were carried out under conditions that favoured CAM option, their growth was substantially increased in response to small additions of Na^+ (11, 12). In a later experiment, plants of *B. tubilorum* grown in untreated air, did not respond to Na^+ but when grown in CO_2-free air in the light and untreated air in the dark responded to the Na^+ treatment. Under the latter conditions, the plants could only photosynthesise by using the CAM system.

Is Na^+ involved in C_4 photosynthesis?

During C_4 photosynthesis CO_2 is transported to the bundle sheath cells maintaining a much higher concentration of CO_2 in the air outside. This results in a high

rate of photosynthesis. We found that symptoms of Na^+ deficiency were alleviated when plants were grown in elevated CO_2 concentrations. However, Na^+ replete plants showed little or no response to high CO_2, which suggested that under conditions of Na^+ deficiency, transport of CO_2 to bundle sheath cells is decreased, thus limiting photosynthesis. When plant are grown in concentrations of CO_2 elevated to about 1,500 $\mu L\ L^{-1}$, CO_2 enters bundle sheath cells by diffusion, thus by-passing the C_4 system (13).

Ross Nable found high levels of alanine in leaves of Na^+ deficient compared to Na^+ replete plants and suggested that this was due to a block in the conversion of pyruvate (in equilibrium with alanine) in its conversion to PEP (14,15,16). Further evidence for this block has been obtained in experiments using illuminated isolated intact mesophyll chloroplasts (17,24). The major steps in this process involve the transport of pyruvate into the mesophyll chloroplast, the enzymatic conversion of pyruvate into PEP within the stroma, and the provision of energy required for the conversion reaction. Surprisingly no effect of Na^+ nutrition on the activity of pyruvate phosphate dikinase, the enzyme catalysing the conversion of pyruvate to PEP, has been found.

In 1987, Jun-ichi Ohnishi and Ryuzi Kanai (18) discovered a Na^+ induced uptake of pyruvate into the mesophyll chloroplasts of *Panicum miliaceum*. This immediately suggested a role for Na^+ in C_4 plants. However, Mark Johnston and Chris Grof had obtained evidence of damage to the light harvesting photosystem, the source of energy for pyruvate transport and/or the regeneration of PEP. In Na^+ deficiency, they found lower chlorophyll *a/b* (19) and fluorescence (20) ratios and lowered photosystem II activity (21), with altered ultra-structure in the mesophyll chloroplasts (22). With the discoveries of the light and Na^+ activated membrane translocator system and of the damage to the energy-producing machinery in the mesophyll chloroplasts, research on the actual function of Na^+ reached an exciting phase. We still have to answer the difficult question of the primary function for Na^+. Is it needed to maintain the integrity of the light harvesting and energy transducing machinery in the mesophyll chloroplasts, or only for transport of pyruvate into the mesophyll chloroplasts? Aoki *et al.* (23) reported that sugar cane, sorghum and maize, utilise protons rather than Na^+ ions for the transport of pyruvate into the mesophyll chloroplast. This finding suggests that there may be rare exceptions to the general requirement for Na^+ by C_4 plants.

I have been asked sometimes why I concentrated on the study of Na^+ as a nutrient for so long. It requires careful techniques to remove it from the environment to show deficiencies and is unlikely to ever to limit plant growth under natural conditions. However, I was particularly fortunate to have started with a good question from Professor Joe Wood - Do Plants Require Na^+? It was a thrill to see early decisive symptoms of chlorosis that could be prevented by the application of a very small treatment of Na^+. The second question: Why do only some plants need Na^+ had to wait for the discovery of the C_4 pathway. It was exciting to observe the general requirement for Na^+ by plants with C_4 photosynthesis. This led us to look for lesions within the C_4 system of Na^+ deficient plants. It was most help-

ful to be working with the well defined C_4 system for which many techniques were available. We have found that many effects of Na^+ in metabolic experiments have been very decisive which has simplified the interpretation of results. It is satisfying to see a specific role for Na^+ in C_4 plants which was defined by Ohnishi and Kanai (18) and their co-workers.

Some concluding thoughts

In these times of sophisticated computer technology, it is suggested that the education of scientists will be carried out more and more by electronic teaching programmes. From experiences over many years, I feel that the personal aspects of my work have been a most satisfying part of my career. I have been unusually fortunate to work with many outstanding scientists.

For example as a student when discussing work with Prof. Wood, he would move round excitedly, grabbing reference material from his book cases, and at times had up to three cigarettes burning simultaneously in various ash trays! He had a wonderful understanding of plant nutrition and we made exciting plans for our work. He had designed and built equipment to answer questions in his research over many years. We had little modern equipment that wasn't 'home-made' apart from a flame photometer, a colorimeter and the dreaded polarograph. However, we did acquire a UV spectrophotometer in 1959. I often think how excited Prof. Wood would be to know of the recent discoveries in plant physiology if he were still living. His unexpected death left a great vacuum.

Professor Bob Robertson followed as Head of Department. He has strong interests in the role of membranes in ion transport and energy transduction and made significant advances to the conceptual understanding of these processes prior to Peter Mitchell's publication of his chemiosmotic hypothesis (26). He attracted some excellent people and famous visitors which was most stimulating at that stage of my career. It was also a treat to have access to some modern equipment including a refrigerated centrifuge and a new Warburg system.

Professor Donald Nicholas, an authority on mineral nutrition of microorganisms and nitrogen metabolism, had moved to the Waite Institute and there I spent several happy years in his department learning about working with the nitrogen metabolism of blue-green algae. This was a special time for me as I was helped by generous, gifted colleagues.

After moving to Townsville, I was again lucky to have good colleagues from different disciplines. In addition, we had wonderful support from our friends in Canberra including Hal Hatch and Barry Osmond. We have had excellent postgraduate students and I have enjoyed the challenge of working with young people with new approaches and much energy. It has been a very happy time to work with such people.

My study leaves were also very rewarding experiences. My first time was in 1973/4 when I worked with Harold Evans at Oregon State University. We both had strong interests in mineral nutrition and nitrogen metabolism. While I was there, we found evidence suggesting another pathway for the assimilation of nitrogen from am-

monium to amino acids. I then worked with Joe Varner at the Washington University in St. Louis. There we studied the effect of gibberellic acid on the fate of metabolites in germinating Himalaya barley grains. He always asked interesting questions and used novel techniques to answer them. From there I went to England where I worked for several months with Eric Hewitt at Long Ashton studying the role of molybdenum and tungsten in maintaining the integrity of the nitrate reductase molecule. For my second study leave I spent my time at the Institute of Photosynthesis at the University of Sheffield with Professor David Walker. There I met legendary workers in photosynthesis including Dr. Robert Hill and was introduced to modern techniques for studying photosynthesis. I really enjoyed lunches with David and hearing much about the history of science and singing carols in pubs with him and some of his friends.

It has been a great pleasure meeting people whom I knew only by their papers. I hope in the future that these personal encounters are not lost with computer methods of information transfer. Although the computer has revolutionized science, it does not substitute for the friendly, critical but encouraging and stimulating companionship of real people which have made my association with plant physiology a truly wonderful experience.

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REFLECTIONS FROM STUDENTS AND COLLEAGUES

Peter Brownell - Scholar, Teacher, Gentleman

Peter instilled in me a number of key lessons that I have carried with me since I began working with him as an undergraduate student volunteer during holiday breaks. First and foremost was the need for meticulous attention to detail when designing and establishing experiments. This arose from the mineral nutrition work centred around the essential requirement for sodium by C_4 plants which entailed multiple re-crystallisation and purification steps to remove the Na salts contaminating the Hoagland's solution components. There was also a need for great ingenuity as we operated on a shoe string budget, and much of the equipment that I and other students used was designed and built by ourselves in the Biology workshop with the assistance of remarkably skilled tradesmen and under Peter's direction. These forays into the workshop revealed another side of Peter and reflected his thorough and broad understanding of a plethora of scientific disciplines including practical applications of physics and chemistry. We established a series of experiments on the roof of the Biology building to grow plants in different CO_2 environments which required a series of homemade glass manometers containing blue dyed water, mounted on a ply timber stand to monitor gas flow. One of the tasks of Mark Johnston or myself on a Friday afternoon was to ensure that a large bottle of blue dyed water was on hand on the roof for when Peter came to check the experiments over the weekend which inevitably resulted in him stepping on the spaghetti mass of plastic tubing leading to blue water being sprayed everywhere. The times I was on hand to witness this always proved most entertaining and also enlightening as I learnt a host of new expletives which served me well on the rugby field.

Perhaps the most fundamental understanding I derived from Peter was the benefit of teamwork in a research environment. The growth experiments which we established regularly required the planting of a large number of seedlings into meticulously washed plastic vessels. During these planting phases, everybody in the lab pitched in and the task was completed in a relatively short time. These plantings were invariably planned to be completed late afternoon and were often followed by a short celebratory drink at the Staff Club. The laboratory environment created by Peter, which was simply an extension of his personality, was one of strong scientific endeavour bolstered by great good humour, underpinned by a strong desire to pass on his collected wisdom, both scientific and worldly, to his students and colleagues, who all became inevitably his good friends. These traits are worthy of emulation and promulgation and I strive to do so.

Chris Grof

Letters to Peter Brownell on the Occasion of his 80th Birthday

Dear Peter,

It is with deep regret that the joint tyrannies of non-negotiable commitments and distance prevent me from being with you to share in celebrating your 80th birthday. I know that your family, both blood and numerous "acquired" members, colleagues and friends will be with you to mark this very special milestone. Many words will be spoken highlighting your scientific achievements and contributions to the different communities you have served so generously. Many stories will be recounted, not doubt with considerable elaboration and hilarity. My stories about Peter Brownell fit into what I suspect is a relatively unsung indirect, yet significant, contribution to the Australian plant science community. Peter

as I sit to write to you, my memory goes to Keith, South Australia, heathland vegetation, a lecturer with a booming voice and a person called Peter who was gentle and patient (very patient) as he taught a bunch of 2nd year undergraduate students plane tabling in order that their sampling transects could be set up in the required direction and didn't overlap. I was one of those somewhat bewildered students. I'm not sure that I could plane table then and I certainly couldn't now, but Peter you provided a much needed focus of support and now is the time to thank you for that. The Keith excursion was a significant event in shaping my career and I retain a love of heathland vegetation to this day. Peter I'm not exactly sure when you left the Botany Department, Adelaide for the long journey north to the tropics where destruction of glasshouses by cyclones is a legitimate excuse for gaps in otherwise continuous data sets! I think that by then I was a PhD student and our paths were destined not to cross for many years, until there you were in a bar at ANU at the start of a Canberra ASPP Meeting (I think my first in May1979). You were not alone; you were providing an opportunity for your young Honours students to experience a plant physiology conference (the real world down south) and to see for themselves what science was about. For their part, those two young devils, Mark Johnson and Chris Grof, were hell bent on ensuring that you would have difficulty making it back to St Georges College where the conference delegates were staying. These are not the only students you have cared for, supported and guided towards successful careers. Thank you for seeing the potential in the young and in supporting them. I have subsequently had the pleasure of working with, and being strongly supported by "Grofie" in bringing the International Conference on Assimilate Transport & Partitioning to Australia in 1999 and Chris is one of my valued colleagues and friends. The start of this friendship was at that conference in Canberra. Peter through your students you have contributed much to the Australian plant science community.

Congratulations Peter on becoming an octogenarian, thankyou for your support in the formative years of my career and for your continuing generosity and friendship since our paths rejoined.

Tina Offler

Dear Peter

Hearty congratulations and best wishes on your eightieth birthday. I very much regret not being able to join the celebrations to mark this landmark occasion on reaching what is surely the start of your teen years. I wish you and all assembled a hearty, and I am sure spirited, time of reflective good cheer.

Despite hours of searching ASIO, MI5 and RAAF databases (on principle, the CIA was not consulted), much to my surprise not a skerrick of 'hot' material on your otherwise very apparent existence could be found. The only recourse was to interrogate my rapidly fading memory that is littered with Brownell anecdotes.
The Brownell anecdote that I wish to share on this wonderful occasion undoubtedly finds a universal resonance amongst all those that have been privileged to share time with you. It certainly had a profound and positive impact on enriching both my career and personal development but one that you have no reason to re-call. In this alone, a hallmark of a person who has made a huge difference without any expectation attached to the outcome.

The 'incident' took place at the 1973 ASPP meeting convened in Canberra; my first ASPP meeting that I had participated in on returning from a three-year postdoctoral stint with Professor PF Wareing at Aberystwyth. This then young and still introspective chap from Newcastle (frequently greeted by O'h I did not realise there is an University at Newcastle) was bubbling over with self-doubt. He had spent most of the conference avoiding contact so that his poor appreciation of matters physiological, let alone anything else, would not become public domain. My luck at avoidance ran out one evening while negotiating a corridor in Bruce Hall when an imposing figure entered at the other end. There was no opportunity for escape as, rather than ignoring my presence, the stocky silhouette started to engage in

unusual body language that indicated a desire to make contact. Arms were raised alternately in a crab-like preening behaviour to effect tentative hand stroking of a balding head or a solid chin. Lit by a funnel of corridor lighting, it dawned on me with paralysing fear that this figure, clad in a Harris tweed sports coat with matching woollen tie falling down a rough blue cotton shirt, was no other than the one reverently acknowledged at the start of the JG Wood Memorial Lecture as the last PhD student of the Honoured JG. Undoubtedly a person of such distinction, raised to yet further heights of scholarly achievement by the pregenome discovery that sodium can induce CAM metabolism in C3 plants, must be a guardian of Australia's best in plant physiology. A person who surely would not tolerate any faltering understanding of physiological truths enshrined in the plant sciences. Bracing myself for the fatal blow, the hand was lowered from the chin and tentatively pointed toward me. Coincidentally an apologetic voice said something to the effect " I am sure I know you from somewhere linked with some terrific science but I am ashamed that I am unable to recall your name; err what is it". A pregnant pause followed as my mind raced to digest this unexpected development. A curt exchange of names bought time to verify that this shinny-eyed face did indeed belong to the Peter Brownell, the last PhD student of JG Wood and who can transform C3 to CAM metabolism with a touch of salt. Not satisfied with just a name, the mild interrogation continued along similar apologetic lines extracting information that allowed him to observe regrettably he had missed my talk through poor organization skills on his part and was keen to learn something about the field. Before long any residual fear had evaporated and unwittingly the introspective lad from Newcastle was engaged in a lengthy and stimulating conversation that ranged from plant science to extracurricular matters. I was no longer a stranger looking in but in some small way part of the plant physiology scene.

Peter that encounter was a landmark event in my professional and personal journey for which I will be ever grateful. The recognition you so generously gave that evening demonstrably lightened my load and gave me a foothold of confidence to forge a professional career in academe. Your company and wise counsel at subsequent ASPP meetings were sought out with eagerness. As opportunities have arisen in my own career I have put some modest effect to ensuring that the aspirations of early career researchers are recognised and fostered. The resounding feedback is the empowerment that these young people sense through simple recognition of their dreams and achievements. Peter a humble thank you for your special gift of generosity to others without any expectation of the outcome; it has touched countless numbers many of whom you will never meet.

In closing, enjoy the teenage years you are about to enter and take great care not to overdo it young fella.

With much respect and gratitude.

John Patrick

Messages from our SustainingMembers

RN Robertson Travelling Fellowships

The objective of the Professor R.N. Robertson Fund is to encourage young Plant Scientists to participate in mechanistically (functionally) orientated research in a discipline that differs from their own. The Fund has been used to set up The RN Robertson Travelling Fellowship to recognise and celebrate the sustained contribution made by RN Robertson (Sir Bob) in nurturing plant scientists in Australia spanning across four decades from the 1950s.

The Travelling Fellowship is focused on support for graduate students and recent PhD graduates to undertake research aimed at elucidating plant function and should enhance the current research of the applicant by providing access to expertise and facilities outside of that currently available to them. The fellowship should be undertaken at another institution outside of the Australian state in which their current research institution resides. For overseas applicants, the proposed host research institution must be within Australia.

The 2009 recipients of RN Robertson Travelling Fellowships were Foteini Hassiotou and Bianca Kyriacou both graduate students. Below are their reports on how they used their fellowships to enhance their PhD research and experience.

Foteini Hassiotou (2009)

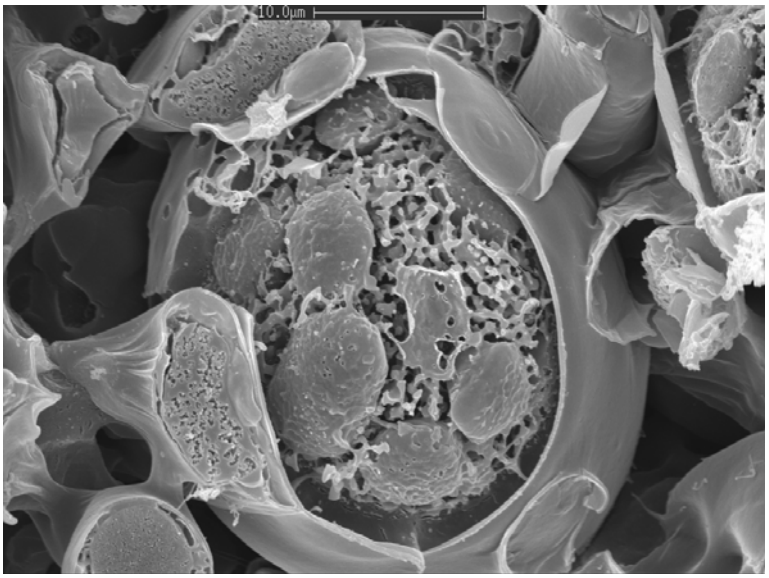
A R.N.Robertson Fellowship was offered to Foteini Hassiotou to support her research visit to the laboratory of Dr John Evans and Professor Susanne von Caemmerer (Research School of Biology, Australian National University) in March-April 2009. During this visit, Foteini conducted experiments related to her PhD project. In particular, she used state-of-the-art equipment to examine patterns of gas exchange in the Australian genus *Banksia*.

Foteini's PhD investigated the effect of sclerophyllous (hard-leaved) anatomy on photosynthesis and gas diffusion, exploiting as a model group the endemic to Australia genus *Banksia*, which is characterized by a diversity of leaf anatomies. Previous research has demonstrated that sclerophyllous anatomy has the potential to influence the conductance to CO_2 in the mesophyll, and Foteini has been looking into this photosynthetic parameter in *Banksia* species. Although in a previous research visit to Dr Evans' laboratory Foteini measured mesophyll conductance using combined gas exchange and fluorescence (Hassiotou et al., 2009; JXB 60: 2303-2314), in this visit she aimed at comparing those previous estimates with estimates obtained using a second independent approach. This involves concurrent measurement of gas exchange and carbon isotope discrimination and the necessary equipment to perform this technique is only available in a few laboratories worldwide. Foteini utilized this equipment comprising tunable diode laser absorption spectroscopy coupled with gas exchange to obtain estimates of mesophyll conductance in *Banksia* leaves of differing anatomy. She also examined the effect of varied CO_2 concentration and light intensity on mesophyll conductance. In addition, during her visit she used the cryo-scanning electron microscopy facilities of the Electron Microscopy Unit of the Australian National University to capture ultrastructural traits of *Banksia* leaves, being particularly interested in the mesophyll cell wall thickness and how it relates to mesophyll conductance.

Foteini's visit to Dr Evans' and Professor von Caemmerer's laboratory was very successful. She obtained novel findings on the internal anatomy of the unique *Banksia* leaves. She also found that mesophyll conductance measured with two independent techniques showed a dependence on CO_2

concentration and irradiance. A manuscript describing these findings and placing them in context with previous research on mesophyll conductance will soon be submitted for publication. This manuscript is also part of Foteini's PhD thesis as the final experimental chapter.

Foteini completed her PhD a few months after her visit to Dr Evans' laboratory. Looking back at her PhD experience, she is very grateful both to the Australian Society of Plants Scientists for supporting her in her research endeavors and to Dr Evans and Professor von Caemmerer for giving her the opportunity to utilize their advanced equipment, providing her at the same time valuable mentoring and support.



Cryo-Scanning electron micrograph showing a cross-section of a mesophyll cell of *Banksia integrifolia*.

Bianca Kyriacou (2009)

The Award contributed to flights required during attendance at a conference in Sacramento and a laboratory visit to USDA labs in Cornell, USA 2009.

The ultimate focus of my PhD project is to increase the concentration of Iron in rice grains as a tool to overcome human micronutrient deficiencies. Iron (Fe) accumulates in high concentrations in the embryo, scutellum and aleurone layers of rice grains. Very little accumulates in endosperm tissue that constitutes the bulk of milled or "white" rice. Around 75-80% of total Fe is lost during milling of rice grains. Many under developed nations depend on rice for up to 80% of their caloric needs; therefore, many people in these areas are prone to Fe deficiency. Approximately 30% of the world's population suffers from Fe deficiency, with the majority comprised of women and children. Gaining access to Fe supplements and food fortification tools to combat micronutrient deficiencies is often difficult due to location or cost. These difficulties have pushed biotechnology into the spotlight- illuminating cereal crop biofortification as a solution to micronutrient deficiency.

Recent studies on rice micronutritent biofortification have been limited to constitutive over-expression of barley nicotianamine synthase genes (*HvNAS*). I am currently working on Iron (Fe) accumulation in rice (*Oryza sativa* cv Nipponbare) endosperm using transgenic rice lines over-expressing the three rice NAS genes *OsNAS1, OsNAS2* and *OsNAS3*. Cell type specific expression of these genes is controlled at root stele, root cortex, lodicules of developing grain, ovary of developing grain and leaf shoot. ICP-OES analysis of T1 grains indicate up to two fold increase in Fe content in brown rice compared to

wild type. Polished grains retained up to 30% Fe in the endosperm post milling, relative to wild type. Of interest were several *OsNAS2* root cortex and *OsNAS3* developing grain lodicules lines, both demonstrating high Fe retention post milling and cooking. These preliminary studies are suggesting cell type specific over expression of *OsNAS2* in root cortex results in greatest Fe accumulation in endosperm compared to the other expression lines and wild type.

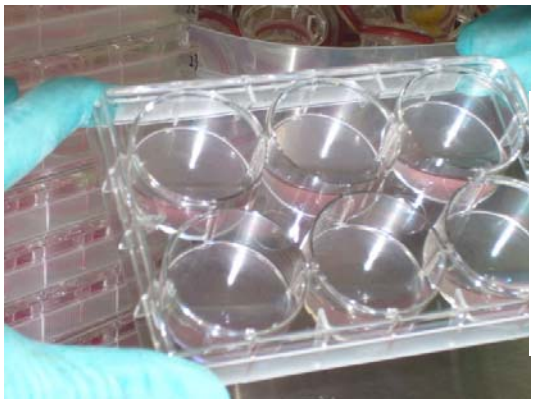
In August 2009, I visited the USA to attend The International Plant Nutrition Colloquium held in Sacramento. Thanks to funds administered from the R.N. Robertson Fund (through the Australian Society of Plant Scientists and University of Western Australia), I had the opportunity to meet with researchers highly regarded in the field of plant and human nutrition. From this conference, I travelled to visit Ray Glahn and his lab at the United States Department of Agriculture (USDA) at Cornell University, Ithaca, New York. Within Ray's labs I was given the chance to gain new experiences, primarily pertaining to methods for Caco2 modeling. These experiments are routinely used for rice iron bioavailability analysis in the Glahn lab, therefore, I was able to accurately measure the bioavailability of iron in my rice grains that already show increased Fe levels in endosperm. Such facilities, techniques and expertise are not available at Flinders University in Australia. Learning these techniques in New York has given me the chance to bring this new tool back to Flinders University, increase our knowledge bank and contribute greatly to new chapters in my thesis. Furthermore, the results accumulated have increased my publication potential and led to further research in my project.

I have also taken some of my transgenic rice lines to the Australian Synchrotron to obtain X-Ray fluorescence microscopy images. This will provide me with elemental distribution and valency maps of the rice grain sections. I believe these results will support the aforementioned hypothesis and will contribute to a major section of my thesis.

Many thanks to the Australian Society for Plant Scientists and the University of Western Australia for providing me the chance to obtain this extremely important information via the administration of funds via the R. N. Robertson Award.

Me preparing Caco 2 cells

The Robert W. Holley Centre for Agriculture and Health (home of USDA labs, Cornell, Ithaca)



Caco 2 monolayer cells grown in 6 well plates in preparation for incubation with rice samples.

The Glahn Lab; clockwise from left; Yong-Pei Chang, Ray Glahn, Elad Tako, Mary Bodis, Mercy Lung'aho.

Functional Plant Biology – An Update

Editor-in-Chief: Dr Rana Munns

The journal continues with an increase in the number of high quality papers submitted. To accommodate these while avoiding delays in publication, FPB is expanding by 20%. As well, all invited reviews will be Open Access without charge to authors. This includes Evolution Reviews and Evans Reviews.

The Evolution series is well established. This is a virtual special issue that can be accessed as http://www.publish.csiro.au/nid/103/aid/13408.htm. Coming articles include the evolution of plant hormones, plant vascular system, and C4 and CAM metabolism.

This year signifies a series of Research Fronts on important and rapidly moving areas of research. The first was a Research Front on *Drought and Water Use Efficiency: Improving adaptation to dry environments*, with guest editors Bill Davies and Manuela Chaves. The current one is on *Acid Soils*, with guest editors Peter Ryan and Jian Feng Ma. Coming soon are *Salinity* and *Pathogen Effectors.*

Ideas for other topics are welcome.

Rana Munns
Editor-in-Chief, FPB
www.publish.csiro.au/journals/fpb

A Review on Peer Reviewing – Worth a Read

In August last year Michael B. Yaffe, Chief Scientific Editor of *Science Signaling* shared some of his experiences and opinions about the current process of peer review of our science as we present it for publication under "Editorial Guides". Many of you may have already read his article but if not what he reports may have a resonance with your own experiences and may, in the future, influence your own reviewing style.

His abstract commences with the following and I quote:
"The peer-review process can be improved by having reviewers focu on improving the work rather than simply noting its flaws. The only thing scarier than being asked to review a paper that is directly in your research area is to actually get back the reviews on your own manuscript submission"

Paper reference is Yaffe, 2009. Re-reviewing Peer Review *Science Signaling* **2,** Issue 85, eg 11 (DOI: 10.1126/scisignal.285eg11).

In my opinion it is worth reading

Tina Offler, Phytogen Editor

A Message from Sapphire Bioscience

A Message from QIAGEN

The Rotor-Gene® Q by QIAGEN

The unique centrifugal rotary design of the Rotor-Gene® Q makes it the most precise, versatile real-time PCR cycler available. Each tube spins in a chamber of moving air, keeping all samples at precisely the same temperature during rapid thermal cycling. Detection is similarly uniform. When each tube aligns with the detection optics, the sample is illuminated and the fluorescent signal rapidly collected from a single, short optical pathway. This thermal and optical uniformity results in sensitive, precise, fast real-time PCR analysis. It also eliminates sample-to-sample variations and edge effects. These are unavoidable in traditional block-based instruments due to temperature gradients across the block and multiple, complex optical pathways. The rotary design delivers: well-to-well variation below ±0.01°C (20 times less than block cyclers), uniform detection eliminating the need for ROX reference dye, and fast ramping and negligible equilibration times for short run times. With up to 6 channels spanning UV to infrared wavelengths, the cycler delivers the widest optical range currently available. The Rotor-Gene Q supports multiple PCR tube formats to suit a range of needs. As well as tubes, Rotor-Discs™, circular plates of vertically-oriented reaction wells, are available for accelerated setup and higher throughput (96 wells with 4 reference wells).

For more information Ph. 1800 243 800, email orders-au@qiagen.com

2010 A YEAR OF CONFERENCES

There are a large number of conferences scheduled in the next 6 months, both in Australia and overseas. Most of these are advertised on the ASPS website: http://www.asps.org.au Deadlines for Early bird registration for some of these has passed but all remain open for standard registration.

OzBio2010 The Molecules of Life – from Discovery to Biotechnology

September 26 – October 1, 2010, Melbourne Convention Centre, Australia
www.ozbio2010.com

Early-bird registration extended to June 30; abstract submission deadline extended to July 28

International Conference on Plant Vascular Biology 2010

July 24-28, 2010, Ohio State University, Columbus, Ohio, USA
(http://www.ced.osu.edu/pvb2010conference/index.html).

Co-Chairs: Biao Ding (Ohio State University, Columbus, Ohio, USA); David Hannapel (Iowa State University, Ames, Iowa, USA)

Early-bird registration and abstract submission closed

11th International Symposium on the Genetics of Industrial Microorganisms (GIM 2010)

June 28 - July 1, 2010, Melbourne Convention and Exhibition Centre, Australia

Organizer: Bree Richardson e-mail: gim2010@arinex.com.au

Registration open and program available

20th International Conference on Plant Growth Substances

June 28 – July 1, 2010, Tarragona, Spain
www.ipgsa.org

Early-bird registration and abstract submission closed

Plant Membrane Biology (IWPMB2010)

September 19 – 24, 2010, Adelaide, South Australia
www.adelaide.edu.au/iwpmb2010/

Meeting Manager: Lara Birchby Phone: +61 8 8177 2251

Early-bird registration and abstract submission open

Signals, Sensing and Plant Primary Metabolism

October 6 – 9, 2010, University of Potsdam, Sanssouci, Germany
http://www2.hu-berlin.de/biologie/symposium/

Early-bird registration closes June 30; abstract submission by July 15

Australian
Plant Phenomics Facility

An Invitation to Australian Plant Scientists

Established under the National Collaborative Research Infrastructure Strategy (NCRIS), the Australian Plant Phenomics Facility (APPF) is a cross-institutional facility, which involves two quite different but highly complementary research centres; **The Plant Accelerator** in Adelaide and the **High Resolution Plant Phenomics Centre** in Canberra.

The Australian Plant Phenomics Facility invites expressions of interest from Australian plant scientists wishing to undertake **pilot projects** in its new facilities in Adelaide and Canberra. The projects will be aimed at validating data obtained through *high throughput* and '*deep*' phenotyping against data obtained by conventional methods in the field or in the laboratory.

Further information about the pilot project program is available here.

The deadline for expressions of interest for projects was 30 April 2010, but I have included this invitation in Phytogen to alert society members to the possibility of applying for pilot programs in the future.

Tina Offler

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/.

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 (this year OzBio, Melbourne), 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 OzBio 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).