PHYTOGEN

A
NEWSLETTER
FOR
AUSTRALIAN
PLANT SCIENTISTS

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PHYTOGEN

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In This Issue

There are many interesting and informative articles in this issue of Phytogen.
Thanks to all the contributors for their great efforts.

APSP OFFICE BEARERS – 2009

ASPS Executive

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Australian Plant Phenomics Facility	www.plantphenomics.org.au

ASPS Newsletter Editor

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A message from the president

The ASPB meeting in Hawaii is very close, 18-22 July. After that it will be time to plan for ComBio2009 in Christchurch, on 6-10 December.

The abstract deadline is Friday 21 August 2009.

www.conference.canterbury.ac.nz/combio09

The organizing committee represented for plant scientists by Matthew Turnbull (NZSPB/ASPS) have planned a comprehensive and wide-ranging scientific programme with plenty of the traditional ComBio features. This ComBio is special in that in addition to the usual Plant Biology theme, Margaret Barbour and Owen Atkin will be heading a second plant theme entitled "Plant Ecophysiology and Global Change Biology".

This means that this year there will be two dedicated Plant Biology themes, as well as an Agricultural and Horticultural Science Theme.

ASPS will be providing substantial travel support for students attending the meeting. An application form can be downloaded from the ASPS website. This is available on the "About" page (http://www.asps.org.au/resources/TravelGrant.pdf). Tony Ashton, ASPS Treasurer, will provide further details.

Rana Munns, President, ASPS

A message from the editor

Dear Fellow ASPS Members,

Well here is the June issue of Phytogen – a very long issue, with a broad range of articles of interest. I hope that you will feel the same after reading it. The contributors have all produced requested articles with enthusiasm and on time. Thank you.

This issue is again a mix of familiar and new sections. The History of Our Society features an article by Tom Neales first published in the ASPP Membership Directory in 1994 that provides some insights into the origins and workings of our Society. South Australia has come through with a flourish to re-instate "State of Affairs" – thanks to Jason Able for being the "hound dog' and compiling the final document. Hans Lambers has generously put together the highlights of his 2008 Robertson Lecture that I know was enjoyed by many.

We have continued "Our New PhD" contributions with three articles and another two are embedded in "State of Affairs". This is a very important section of Phytogen as it heralds the future of the Society so please contribute if you are eligible, and supervisors could do a little encouraging too.

In our "From our Seed Banks" section you will find a comprehensive report prepared by Bob Furbank on the 1st International Plant Phenomics Symposium held in Canberra in April. Again please remember that reports from local, national and international meetings and book reviews relevant to plant science are welcomed for the "From our Seed Banks" section and keep sending them to me at tina.offler@newcastle.edu.au

And there is more !!

Next issue will see **ACT** deliver on "State of Affairs" and Helen Irving has agreed to do an article for "Twigs and Branches". I have approached discipline representatives about the concept of articles highlighting the significant advances in their fields and received a generally favourable response so next issue will see "Discipline Highlights" as a new section. I am also working with potential contributors to an "Eductaion" section.

Tina Offler

A Tribute to John Cram, Colleague and Friend

W. John Cram, 1940-2008

John Cram, who pioneered the use of control analysis in the study of tissue ion accumulation, sadly died after a short illness last December. John was trained in Cambridge where he was a contemporary of John Raven, Andrew Smith and Sally Smith in the Botany School (now the Department of Plant Sciences). He did his PhD in Enid MacRobbie's laboratory where he undertook one of the most thorough and comprehensive studies of ion compartmentation in higher plants using radiometric flux analysis, with discs of carrot storage tissue as his experimental material. His work helped to lay the foundation for understanding the important role of the vacuolar membrane in regulating ion compartmentation in plant cells.

After his PhD he spent a year at the University of East Anglia with Jack Dainty working on giant cells of characean algae, and then a year with the late George Laties at UCLA. In 1969 John was appointed to Lecturer in Biology at the University of Sydney and was promoted to Senior Lecturer five years later and a Reader in 1979. In Sydney, John continued to develop his interests in the homeostasis of solute content and hydrostatic pressure in plants, specifically applying control theory, working in close collaboration with the late Mike Pitman and Alan Walker. John was, rightly, very keen on strictly defining terms and on hypothesis-led science. Steve Tyerman was among those who John launched on a research career while at Sydney. Steve did both his Honours and PhD with John and has fond memories of John's encouragement and his passion for discovery. Steve credits John's early guidance for his approach to science and still remembers some key eureka moments from that time.

In 1984, John left Sydney to take up the Chair of Botany in the Department of Plant Biology, at the University of Newcastle upon Tyne in the UK, where he threw himself into the job at a time when organisational structures were changing, and management issues were complicated by traditional allegiances and lack of support from central administration. Having been made Head of the Department of Biology in 1988, he later joined the Department of Biological and Nutritional Sciences in 1992, and the School of Biology in 2002. During this period, John had a successful and productive collaboration

with David Clarkson (Long Ashton) and Chris Bell (Rothamsted) on sulphate transport, as well as supervising a variety of postgraduate projects on ion fluxes in more environmental contexts.

John made significant contributions to broader plant sciences, particularly through his role as Executive Secretary of the XIII International Botanical Congress held in Sydney in 1981, and was Chair of the New South Wales Higher Certificate Biology Examination Committee for that same year. He organised the 3rd International Workshop on Sulphur Metabolism in Higher Plants, in Newcastle upon Tyne in 1996, and was a stalwart at the Society for Experimental Biology's Plant Transport Group.

My first encounter with John was at an international symposium on plant ion transport held in Juelich in Germany in 1974. I was presenting my PhD work on the relationships between ion fluxes and ion-stimulated ATPase activities on the plasma membrane and tonoplast. I had used a tracer flux technique that Cram and Laties had published that potentially allowed the fluxes at the plasma membrane and tonoplast to be distinguished. I was aware that there were potential flaws in my application of the method because I had used ^{86}Rb whereas the method had been developed with ^{36}Cl and I had not tested whether the suggested timings for uptake and subsequent wash-out of tracer still applied. In question time after my paper, John rightly pointed out these deficiencies. Unfortunately, being rather uptight and nervous at the end of my first talk at an international conference I was rather dismissive of his points in my answer, an indiscretion which he kindly forgave and we became good friends from that day forward.

Following his retirement, John moved to Wuhan in China where he worked at the Huazhong University of Science and Technology in the laboratory of Professor Guangyuan He. This was a return to his early roots for he had been born in Wuhan where his father was a missionary. It was in Wuhan that I last saw John and he was revelling in the academic freedom he was enjoying and the supervision of the PhD students he had taken responsibility for. I last heard from him in 2008 when I invited him to my wedding in Adelaide. He was rather slow to respond and when I sent a reminder he told me the news that he had been diagnosed with cancer. Always a keen runner he had been taking longer to recover from exercise than was normal. He was advised to seek a medical examination which revealed multiple tumours, and he returned to Newcastle to seek medical help. Dale Sanders, of the University of York who visited shortly before his death, reported that he was very philosophical, and brave. He died peacefully, with his family, on the 20th December 2008.

Roger Leigh, University of Adelaide with assistance from Howard Griffiths, University of Cambridge and Steve Tyerman, University of Adelaide

OUR SOCIETY
AN HISTORICAL PERSPECTIVE

An early history of the Australian Society of Plant Physiologists

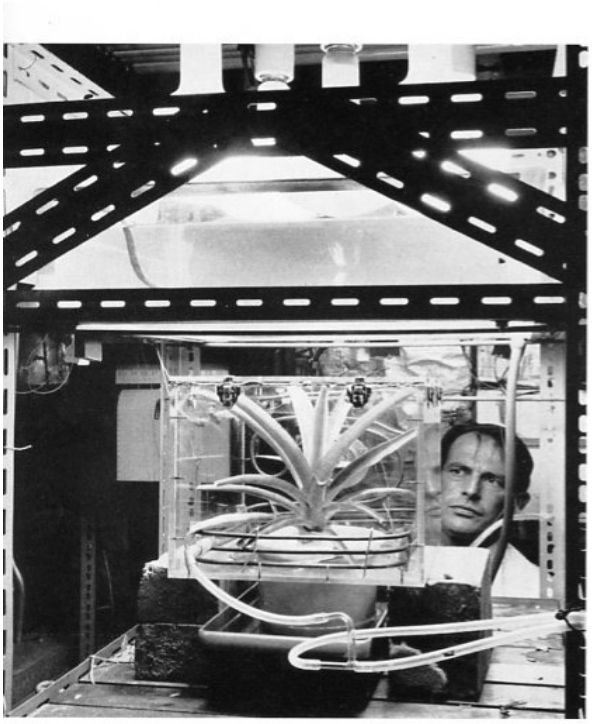
An invited essay by Tom Neales

first published in the

1994 ASPP Membership Directory.

(Reproduced with permission)

About the author:



This image (1967) comes from our CAM (Crassulacean Acid Metabolism) period when the advent of IRGA (I/R gas analysers) allowed the diurnal patterns of transpiration and CO_2 exchange to be continuously measured. The plant shown is a pineapple (Bromeliaceae) – one of the many we examined, including *Agave americana* and the Prickly Pear (*Opuntia stricta*). The CAM mode of photosynthesis was then in vogue, following the elucidation of C_4 photosynthesis. Watching the charts show increases in CO_2 uptake and in transpiration rate, after the lights went out, was one of those rare Eureka moments.

I came to Melbourne University in 1956, very green and ignorant, with the brief to teach plant and crop physiology to the Agricultural Science students – which included some very talented people. My interests then were in mineral nutrition (Mg and B). Much of my time was spent in teaching and initiating practical classes – which these days have nearly disappeared. Among other things, we then got interested in what we called the 'constipation hypothesis' - that the photosynthetic rate of leaves was dependent on a nearby sink. Balancing intellectual curiosity with the necessity to obtain research grants was always a problem.

More recently I have valued my continuing connection with the Melbourne Botany School, and a link with the Melbourne Royal Botanic gardens has, perhaps, at this late stage, nearly made me into a 'real' botanist.

ORIGINS AND EARLY YEARS OF ASPP Inc

by

Tom Neales, Botany School, University of Melbourne

"We may our ends be our beginnings know" Sir John Denham. 1615-1669.

INTRODUCTION

The Australian Society of Plant Physiologists (ASPP Inc) was founded on August 19th 1958, which was the date of the inaugural meeting of the Society at the University of Adelaide. This was a time when the physiological aspects of plant biology were beginning to grow rapidly and blossom in Australia, on a plant that was already thriving (Turner 1977, Robertson 1992). The Society was founded when there was great enthusiasm for plant physiology, and also a prevailing optimism, promised by the insights into the workings of plants.

This is an account of the events leading up to the formation of ASPP Inc, the development of the Society in its first few years, something of the people involved and some of the issues it faced. An earlier view of plant physiology in Australia, with a different emphasis, is that of Turner (1977).

Australian science in those days was much more parochial than now, although in the 1960s and 1970s the rapid development of air travel, both within Australia and overseas, was beginning to make scientific life in Australia much less state-based and more cosmopolitan. When I arrived in Australia in 1956, air travel by Vickers Viscounts (which lacked the range to cross the Nullabor) DC3s, DC4s and Lockheed Electras was an exciting novelty.

In those days the annual meeting of the Australian and New Zealand Association for the Advancement of Science (ANZAAS) was the principal forum to which most scientists flocked and contributed to the various sections of the society that catered for most branches of science- from Physics to Physiology (i.e. *Animal* Physiology). However, in 1958, the trend away from this all-embracing coverage under the umbrella of ANZAAS was already apparent. Specialist Australian societies were already in existence: the Australian Biochemical Society (as it then was named) was formed at the 1955 ANZASS meeting in Melbourne and had its first General Meeting in Sydney in 1956. The Genetics Society of Australia, which was founded in 1952 (McCann and Batterham 1993), and the NSW Society of Experimental Biology (NSW SEB) were very active; in 1956 and 1957, for instance, almost monthly meetings of the latter society were held (see Aust J. Sci. **19** and **20**).

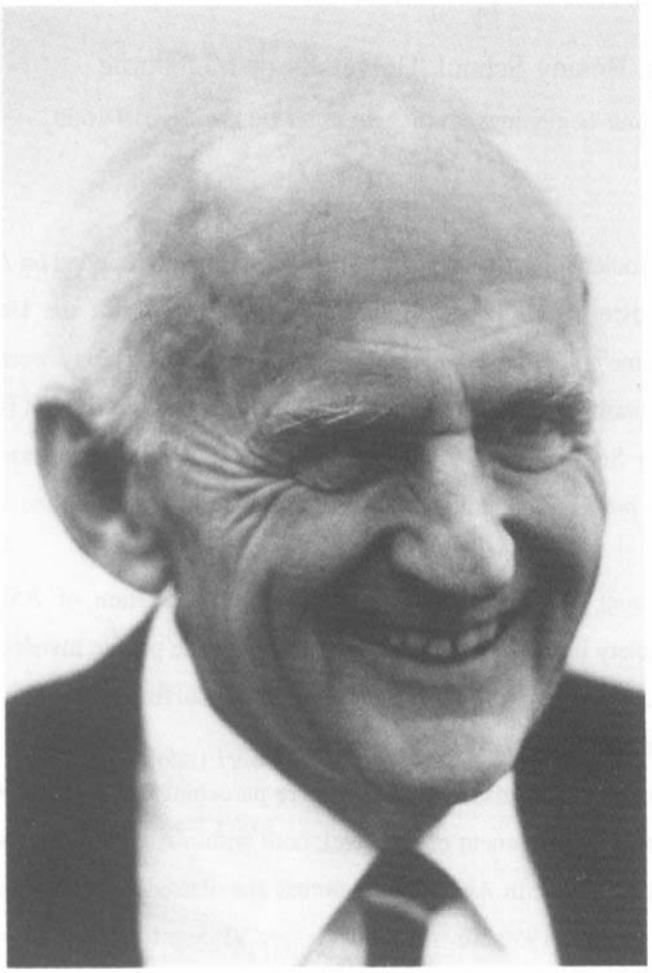
EVENTS LEADING TO THE FORMATION OF ASPP Inc

A lot of activity took place before the first meeting on Aug 19th 1958. It is reported (Robertson, Pers. Comm.) that Dr L.A.T. (Les) Ballard (CSIRO, Division of Plant Industry) and others discussed the formation of an ASPP Inc at a meeting of the NSW SEB in August 1956 – "the time was thought not yet ripe" (Robertson, Pers. Comm.). Ballard, a strong advocate for an ASPP Inc. was unable to participate fully in the next formative events in the Society's history because he was in California as visiting professor at UCLA in 1957 to 1958, and was unable to attend the inaugural meeting.

The first definitive move was made in July 1957 by (the then) Dr R.N. Robertson (RNR) (Plate 1) who was at that time the joint leader of the CSIRO/Sydney University Botany School Plant Physiology Unit. He wrote a letter (24/7/57) to nine leading plant physiologists around Australia, proposing that an Australian Society of Plant Physiologists (not Physiology) be formed. Of these nine, four (J.G. Wood, R.K. Morton, L.H. May and P. Riches), were in Adelaide (the University and the Waite Institute), three (J.E. Falk, L.A.T. Ballard and N.K. Boardman) were in Canberra (CSIRO Division of Plant Industry) and two (J.S. Turner and D.J. Carr) were from Melbourne University. One of the Adelaide recipients, Professor J.G. (Joe) Wood (Plate 2) had been Professor of Botany, with strong physiological and

ecological leanings, for 22 years and, incidentally, was the first native-born Australian to be a Professor of Botany (Turner 1960).

Plate 1

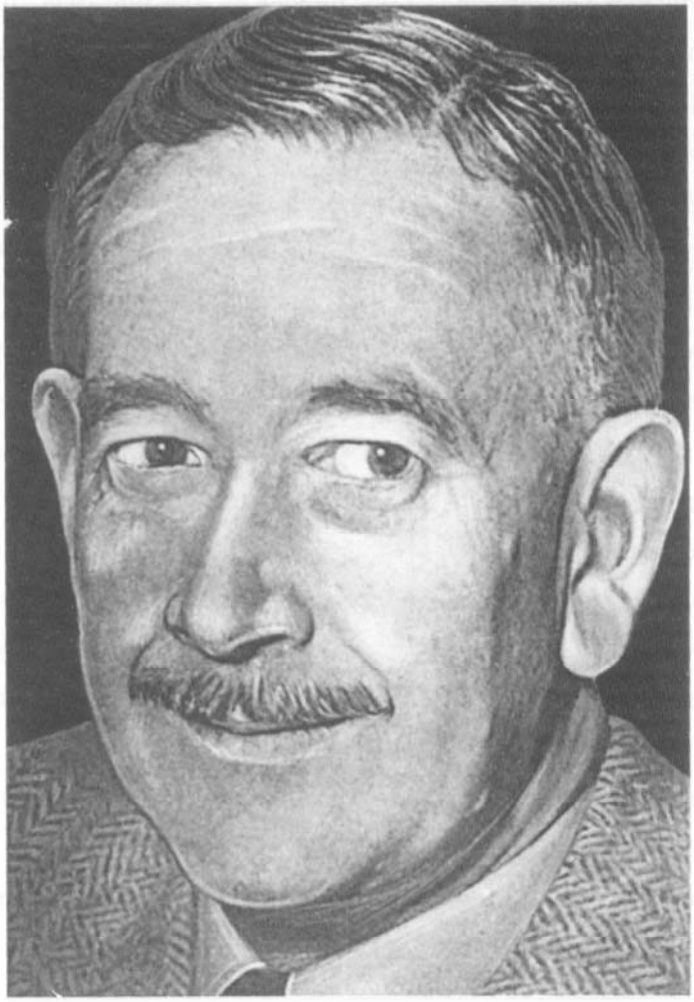


Sir Rutherford Ness (Bob) Robertson FAA FRS

Prime mover of events leading to the formation of the Australian Society of Plant Physiologists in 1958, and second President of ASPP

Comments of these nine correspondents (mostly favourable), were summarised by RNR and related back in another letter of 13/9/57. Among these comments was the suggestion (from both Adelaide and Melbourne) that the inaugural meeting should be held in Adelaide. Also in this letter of 13/9/57 was the suggestion that the Sydney group should draw up proposed rules and a constitution for the putative Society. This constitution was duly drafted by a committee chaired by Dr. J.F. Turner and despatched in a letter (20/1/58) to a wider list of those known to be interested in the workings of plants. The composition of this list (further discussed below) of 110 names gives an interesting insight into the state of plant physiology in Australia at that time (Table 1).

Plate 2



JG (Joe) Wood FAA (1900-1959)

First President (1958-1959) of the Australian Society of Plant Physiologists

(Reproduced with permission from the Australian Academy of Science Yearbook, 1960, 29-34, by the Australian Academy of Science).

From early 1958 to the first meeting (August 19th) the organization tended to become Adelaide based (Waite Institute). On January 29th (minutes of L.H. May), RNR (in the chair) met with a group of four at Adelaide (Wood, Morton, Riches and May). They appointed Lance May to be the organising secretary for the first meeting and, in February 1958, he sent out notification of the first meeting with a request for papers.

Table 1 Plant Physiologists in Australia 1958 compared with 1991

By State						By Institution				
	1958		1991			1958		1991	
	No	%	No	%		No	%	No	%
ACT	35	32	97	18	Universities	18	16	280	51
NSW	23	21	119	20	CSIRO	72*	66	91	17
SA	20	18	61	11	Waite Inst	9	8	#	-
VIC	12	11	78	14	Agr Agencies	10	9	70	13
QLD	10	9	88	16	Industry	1	1	52	9
TAS	7	6	10	2					
WA	2	2	43	8					
NT	-	-	6	2					
Overseas		-	55	10		-	-	55	10
Tot	119	100	548	100					

* 33% in ACT: 15% in Sydney (incl. Plant Physiology Unit, University of Sydney)
# Included under Universities

Sources:
1958 Mailing list (Jan 1958) notifying those thought to be interested in formation of an Australian Society of Plant Physiologists (RNR files, ASPP Inc. archives, Basser Library), and 1991 Directory of Members.

FIRST MEETING OF ASPP Inc

This was duly held in the morning and afternoon of August 19th 1958, on the day preceding the annual ANZAAS Meeting. Sixty four people attended and signed their names in the attendance book, which still survives. Presumably these are the foundation members of the society. A cursory analysis of these names, plus those in the AGM attendance book, and those who gave papers at the 2nd 1960 meeting in Canberra, is revealing. Among these names are (at least) twenty Professors, five FRSs, two Presidents of the Australian Academy of Sciences, four Chiefs of CSIRO Divisions and two Directors of the Research School of Biological Sciences, ANU. There is also a Director of the Royal Botanic Gardens, Sydney a Director of the Waite Institute, two chief scientific advisers to the Federal Government, and one (RNR) who was the founding chairman of the Australian Grants Committee. Moreover, a measure of the influence of Australian plant physiologists on the international scene can be roughly gauged from the number of contributions to the Annual Review of Plant Physiology (ARPP) from Australian laboratories, compared with the total number of review articles published. The Australian contribution to ARPP, 1950-1960 (ARPP volumes 1-11) was 3.7%, 1961-1970, 5.3% and 1971-1983, 10.0%.

Eleven papers were given at the inaugural meeting of August 1958. The first was by Harold Woolhouse (then a PhD student in the Botany Dept of Adelaide Univ.) and the last by Martin Canny. Other papers were given by Peter Brownell, John Pate, Ned Kefford et al., Nick Marinos, J.D. McLean and Jack Dainty (visiting the Sydney group from Edinburgh) and Alex Hope, G.A. Atkins, R.F. Williams and D.M. Paton.

My personal recollections of this meeting are rather dim, but I do remember Nick Marinos talking about *Oxalis*, on which, with many other gardeners, I have waged a personal war for the past thirty years.

After the first four papers of the morning, the Inaugural General Meeting was held, chaired by RNR. A Constitution was approved, and a Committee was elected, with Lance May as Hon. Secretary, Les Paleg as Hon. Treasurer and Professor J.G. Wood first President. Although 64 people attended the meeting, the Hon Sec reported shortly afterwards that there were 45 financial members – maybe things don't change much! Lance May, the first Hon. Secretary of the Society and the first professor of Plant Physiology at the Waite Institute (1964), died on 3/4/1965.

SUBSEQUENT EVENTS IN EARLY YEARS

The committee of 1958 arranged that the second meeting of the Society should be held in Canberra in 1960 over three days, from January 13th to 15th, and Ned Kefford was appointed the local organising secretary. Tragically, Professor J.G. Wood died about a month before this meeting (on 8/12/59), after 25 years as Professor of Botany at Adelaide. Thus, to my recollection, this second meeting started in a sombre fashion with an *in memorium* address by Prof J.S. Turner. Before the General Meeting, the Committee, chaired by Prefessor Brian Grieve (WA), used its constitutional powers and filled the position of President by nominating Dr R.N. Robertson as the second President of the Society.

At this second General Meeting, 53 members signed the attendance book passed round at the annual general meeting: "about 50 to 60% of the members" attended, the Secretary reported. 30 papers were presented, amongst which were those of the President (RNR), Alan Walker and Alex Hope, Ralph Slatyer, Lloyd Evans, Don Spencer and John Possingham, Les Paleg and Peter Goldacre. Lloyd Evans led an informal gathering to discuss the construction and functioning of the forthcoming Canberra Phytotron (opened in 1962), and to inspect some prototype growth cabinets. Dr Robertson continued as President until 1962, when he was succeeded by Prof. J.S. Turner.

So, on reflection, and after examining the archival files of the Society, it seems entirely appropriate that our first President should have been J.G. Wood – the senior professor and plant physiologist in Australia at that time, and a Professor in the University which hosted the first meeting, and that the second President was (and now) Professor Emeritus Sir Rutherford Robertson FAA., FRS, who as the files show unequivocally, was the prime mover in setting up ASPP Inc.

Since the foundation of the Society in 1958, there have been 17 Presidents – 15 male and two female; on this score, the Society so far rates only 12% on the equal opportunity stakes. L.G. Paleg has the distinction of being the only President to hold office for two different terms, 1969-71 and 1983-85.

TWO BATTLES

In the 36 years of its existence, the Society has fought for at least two notable causes. The first concerned the initial affiliation with ANZAAS and was an internal matter. The second was advocacy for establishment of an Australian Journal of Plant Physiology, a campaign that involved internal debate as well as canvassing the CSIRO Board of Standards – the body responsible for the publication of a range of Australian scientific journals.

(i) ASPP Inc AND ANZAAS

The first cause, that of 'cutting the apron strings' with ANZAAS, was influenced by the Constitution of the Society (1958), which directs that "The General Meetings, should, where possible, be related to meetings of ANZAAS and of the Australian Biochemical Society" (ABS). At the inaugural meeting of the Society, the Chairman (R.N. Robertson) expressed the view that "there was no conflict with either ANZAAS, who were now conducting the main symposia, or with ABS". Indeed, the President of ABS (R K Morton) was present at this meeting to convey the best wishes of biochemists for a successful inauguration. J F Turner, who helped draft the Constitution, reiterated the view that "as far as possible, the time of the ASPP Inc meeting should coincide with that of ANZAAS and (my emphasis) ABS". As

foreshadowed in this statement, it was clear that if ABS chose to meet at times and places other than that of the ANZAAS meeting, then there could be dissension on this matter within the Plant Physiologists.

This was to prove to be the case. From the early minutes of the Society, it is clear that one of the most lively issues that arose in the meetings of the first few years of the Society, appears under the sub-heading in the minutes entitled "The Next Meeting".

This issue was aired by C.T. Gates in Committee and by Lloyd Evans at the General Meeting at the 1962 meeting of the Society in Sydney, when J.S. Turner was President. The motion by C.T. Gates in Committee that "the next meeting be separated from ANZAAS", lapsed for want of a seconder. The following motion (carried), was that the "Society meet pre-ANZAAS *as usual* in Canberra in January 1964". It is not exactly clear what was meant by "as usual". At the General Meeting a few days later and in response to the President's opinion that "ASPP could associate with ANZAAS more closely if it wished", Lloyd Evans pointed out that "there was no plant physiology section in ANZAAS as there was for biochemistry". On a show of hands, "21 favoured continuing as at present and 18 were in favour of closer collaboration with ANZAAS". Another substantial objection of ASPP members to the ANZAAS connection was the desire to have regular annual meetings; ANZAAS meetings were held on a 15/18 month schedule.

The debate continued eighteen months later in Canberra when the Society was faced with the problem of the forthcoming ANZAAS meeting in Hobart in 1965. After the President had observed that "Hobart could be cold in August", it was eventually resolved on a motion of R.N. Robertson, who was the President of ANZAAS that year, that the Society meet with ANZAAS in 1965, running for approximately two days during the week.

At the 1965 Hobart meeting the debate was resumed in Committee. Dr Graham said that some members objected to paying ANZAAS dues to attend an ASPP meeting, and the President (L.A.T. Ballard) said the General Meeting must be asked its opinion. At this following meeting, it was first decided, on a motion by J.S. Turner, that the next meeting would be in Melbourne in 1967 with ANZAAS. In the ensuing debate, the Society (13 for, 11 against) directed the Committee to arrange another, intervening, meeting with ABS and without ANZAAS, in Brisbane in May 1966. John Hawker was appointed the organising Secretary for this Brisbane meeting, which was duly held, but there are no records on file in the minute book except the note: 'no AGM in Abstracts', which is strange as the President (L.A.T. Ballard) is recorded as giving a paper. However, these Abstracts show that about 85 members attended and 36 papers were given. One of these was by Hatch, Johnson and Slack entitled "Further Studies on a New Pathway of Photosynthetic CO_2 Assimilation and its Occurrence in other Plants" (see Hatch and Slack, 1966). It is also recorded elsewhere that 75 people attended a dinner at the Mt. Coot-tha restaurant at which one and a half gallons of sherry, five gallons of beer, four dozen bottles of wine and three of port were consumed. Obviously, both an important and successful meeting.

Returning to normality and to official record-keeping, the Society also met in Melbourne in January 1967, with ANZAAS. At the General Meeting, Lloyd Evans suggested a referendum to decide the issue regarding its Meetings policy. Rather obtusely, considering what followed, this motion failed and Professor J.S. Turner made a strong plea "to give ANZAAS one more chance". The meeting then quickly passed the subsequent proposal from the Chair (L.A.T. Ballard) "that a questionnaire be sent out based on the advice of appropriate members". One suspects that it was getting near the time for the Annual dinner. At the following 1968 Canberra meeting, the Committee noted that "the plebiscite …… showed a large majority in favour of regular annual meetings at the same place and at about the same time as ABS".

So the matter was resolved. What actually happened can be ascertained by examining the places and dates at which the three societies, ASPP, ABS and ANZAAS, met over the 17 years 1958 – 1974. In the first 8 years (1958-1964), the Society met six times (there were no meetings in 1959 and 1963); it joined

the ABS and ANZAAS three times, twice with ANZAAS without ABS, and once (1960) with ABS when there was no ANZAAS meeting. Over the next 9 years (1966-1974), however, only one meeting (1967) was held without ABS but with ANZAAS, on all other eight occasions it met with ABS; once (1971) with ANZAAS as well. By 1968 ASPP had clearly opted to meet with ABS and to abandon ANZAAS.

(ii) AN AUSTRALIAN JOURNAL OF PLANT PHYSIOLOGY

The minutes of the Committee and of the General Meetings record that, nearly from its formation, the Society pressed for the publication of an Australian Journal of Plant Physiology (AJPP). The matter was first aired by Lloyd Evans at the 4th General Meeting of the Society in Sydney in August 1962. Fittingly, success came eleven years later (in 1973) in the second year of Lloyd Evan's Presidency of the Society, when the persistent pursuit of this cause was rewarded. The first issue of AJPP, published under the auspices of the CSIRO Board of Standards, appeared early in 1974.

In 1962 and before, the Australian Journal of Biological Sciences (AJBS, first published in 1948) was one of the few outlets to which the increasing number of plant physiological papers by Australian scientists could be submitted. The problem, the Society claimed, was that AJBS was a mixed journal, and was not widely read overseas by other plant physiologists. Those who were in charge of the alternative publication, the Australian Journal of Botany (AJB, first published in 1953) were unable or unwilling to accommodate an increased flow of plant physiological papers. From 1968 to 1973 opinions within the Society were divided on the idea that an AJPP should be initiated. There were those (mostly the old guard) who were opposed to the proposal, and delayed the idea of an AJPP on the grounds that the *status quo* of the two established journals should not be disturbed. Expressions of doubt also came from the Board of Standards and the Editor-in-Chief on the grounds, initially, that an AJPP would not be viable, and if one was to be started what could they do with the residual papers submitted to AJBS?

Gradually the reluctance of the Board of Standards diminished in the face of repeated representations from the Society. Presidents conferred with Editors-in-Chief and in 1969 the Society's delegate (Lloyd Evans) demonstrated that over the past ten years 40 to 60% of the total papers in AJBS were plant physiological. In the next year at the General Meeting members voted overwhelmingly (65 to 3) for the proposal that an AJPP should be started. However, things did not move fast, and as late as 1972 Lloyd Evans (now President) reported that 'the new Board of Standards and a forthcoming new Editor-in Chief might be receptive' and that 'the best policy was to keep pressing'. Success followed in 1973, and the Society was asked to suggest names for an Advisory Committee for the journal, one of whom (L.G. Paleg) was elected by the Society to be its representative on the Committee.

J. G. WOOD LECTURE AND GOLDACRE AWARD

The sudden death of Professor Wood, in 1959 greatly affected the Society collectively and many individual members personally. The idea of a biennial J.G. Wood memorial lecture was mooted and approved unanimously by the Committee at the General Meeting of the Society on the next day. The first J.G. Wood memorial lecture was given by James Bonner at the 4th meeting in Sydney in August 1962: his title was 'Nuclear Structure and Function': the most recent (the 16th) included a version of this paper and was given to the Perth meeting in September 1993.

Tragedy again affected the Society, more indirectly, when Professor R.K. Morton the designated second (1964) J.G. Wood lecturer, died, at the age of 43, in a laboratory accident (an acetone explosion) on Sept 27th 1963. Professor Morton was an Australian Biochemist of distinction who had recently been appointed to the chair at the University of Adelaide. The J.G. Wood lecture scheduled for the meeting in Canberra, in January 1964, was cancelled.

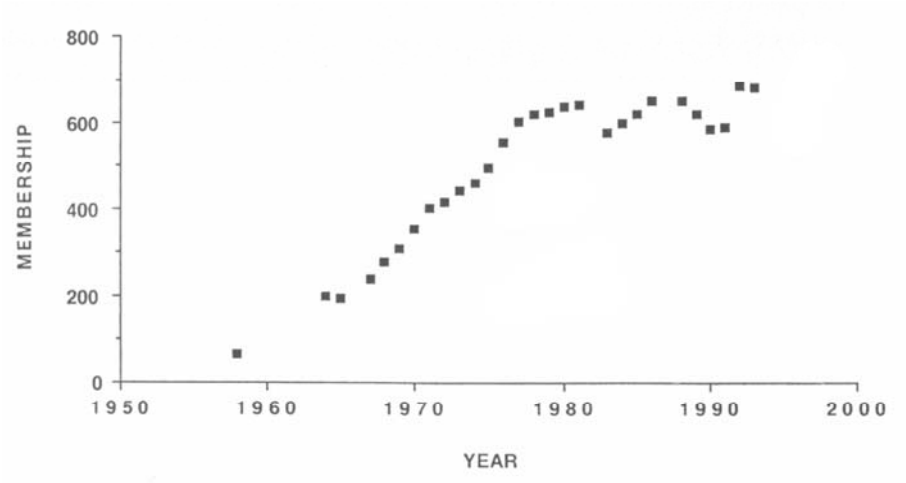
Also, it was the death on April 16thy 1960 of Dr. Peter Goldacre, who was a young and outstanding scientist at CSIRO Plant Industry and a foundation member of this Society, that led to the foundation of the Society's Peter Goldacre Award. This was to be for Australian plant physiologists, under 35 years old, who were deemed to have made an outstanding contribution to Australian plant physiology. The Society

in considering this idea, also at the AGM of its 3rd meeting (1961), "agreed to adopt the proposals in principle, the details to be left to the Committee to arrange". The first Goldacre Award was made in 1965 to Dr J. Giovanelli, and the most recent, in 1991, to Dr John R. Evans.

GROWTH AND COMPOSITION OF ASPP Inc.

Subsequent to the first meeting in 1958 (attended by 64 members), details of Society membership were not recorded in the minutes until 1964 when the Secretary reported that 'numbers approach 200'. Since then, the records are more or less complete. From 1958 until about 1976 the Society grew exponentially at about 12% per annum (Figure 1). In 1976 the membership was 555, and growth continued but at a decreased rate until 1987 (650), after which membership numbers varied somewhat. The discontinuity between 1981 (645) and 1983 (Brisbane meeting (580) is difficult to explain; the International Botanical Congress was held in Sydney in 1981, and there are no data for 1982, when the Society met in WA for the first time.

Figure 1. Growth of ASPP Inc 1958 – 1994



SOURCES: 1958-1989. The minutes of the Society
1990-1994. The total numbers of members listed in the records of the Society – from the Hon. Treasurer.

In attempting to explain this growth curve (Figure 1), a 12% growth rate in the earlier years presumably represents a growth of interest in plant physiology at that time. This can be attributed to (i) an increased awareness of plant physiology (particularly in Agriculture, Horticulture and Ecology), (ii) a large increase in the number of Universities and plant physiologists (the Research School of Biological Sciences, Australian National University, RSBS ANU, for instance was founded in 1967) and, (iii) to the freedom obtained by cutting the apron strings with ANZAAS.

Plant Physiology is a core subject for those interested in plants and, at the time when the Society was started, embraced (in a very defined way) the study of plant processes at all levels – from organelle, to cell, to organ, to whole plants, to communities and crops and to the global carbon cycle. However, the dispersion of these scientists into many different areas of problem-solving (and of grant-application) activities, and the exciting addition of the capacity to analyse and manipulate the genome of plants has inevitably meant a proliferation of scientific societies, within Australia and overseas, catering for this increased specialisation and diversification. This may account for the asymptotic value on the membership curve and, possibly also, a recent small decrease. It seems that this growth pattern might be not exceptional. The same occurs in the ephemeral popularity of various branches of science: consider, for instance, in our own subject, the changing fashions and popularity of the study of mineral nutrition, plant growth substances, translocation, leaf gas exchange studies etc. Could it be that the very same problems that faced ANZAAS in the 1950s and 1960s, when new specialized societies started independent existances, also now apply to ASPP? Arnon(1955) discusses these same problems in a

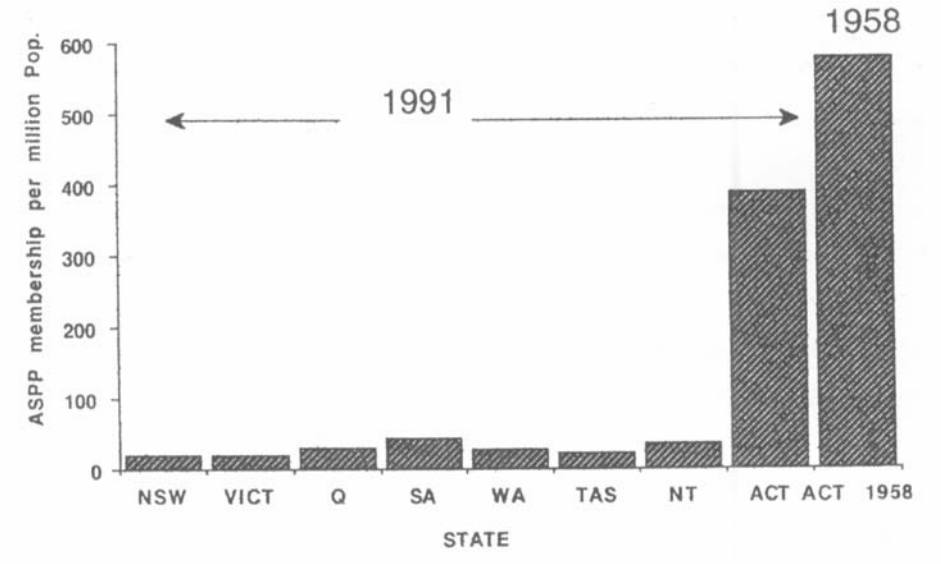
Preface to Volume 6 of the (then) Annual Review of Plant Physiology. Researchers were then debating the extent to which plant physiology was distinct from plant biochemistry, and whether a separate existence was warranted..

Plant physiology, and also molecular biology, are scientific tools (in terms of thinking and techniques) that start with a coherent burst of energy and originality; after which they become the essential stock-in-trade for a very wide range of applications in both pure and applied experimental biology. I suspect that in the long run the patterns of the development of many scientific societies are very similar.

STATUS OF PLANT PHYSIOLOGY IN AUSTRALIA

Changes to the status of Plant Physiology in Australia from 1958 to 1991 (Table 1) can be glimpsed from the composition of the mailing list (already referred to) used by RNR in January 1958, and from that published in the Directory of Members in July 1991. In 1958, 64% (72) of the recipients were CSIRO (including 33 in Canberra and 15 in Sydney). 16% (18) were in Universities (understandably, ACT was not represented). 8% (9) at the Waite Institute, 10% (11) were sent to heads of State Depts. Of Agriculture and 2 were in industry (one went to ICI, Martin Canny). In 1991, there were 548 members, 51% of which were from Universities, 17% in CSIRO, 13% in Agriculture and Conservation and 10% overseas members. Over this period the number of CSIRO members has increased but as a proportion of total membership, this has decreased from 66 % to 17%, being almost entirely accounted for by the increase in the University membership.

Figure 2. Plant Physiologists as a Proportion of State Populations



Sources: 1958: From the distribution list of the letter sent to those thought to be interested in the formation of an ASPP (RNR files, Basser Library)
1991 From the ASPP Directory of Members (alphabetical list).

Figure 2 provides a more revealing analysis where membership of the Society, State by State, is expressed as a proportion of the total State populations in 1958 and 1991. The high proportion of plant physiologists in the ACT, 0.06% in 1958, decreasing to about 0.04% in 1991, is still over 6 times the 'density' of plant physiologists in any other State, and is a quantitative reminder of the energy and success of Dr Otto Frankel (appointed Chief of the Division of Plant Industry CSIRO in 1951). Moreover, this figure highlights the foresight of the founding fathers of the Research School of Biological Sciences, ANU, in contributing to the establishment of an internationally recognised centre of excellence in plant science in the Australian Capital City.

ACKNOWLEDGMENTS

I am grateful to many correspondents who have answered my queries, to Dr Sophie Ducker, who critically read the manuscript and, especially, to Professor Emeritus R.N. Robertson and Dr Lloyd Evans for their comments, suggestions and criticisms. The permission of the Society is also gratefully acknowledged.

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Messages from our SustainingMembers

State of Affairs -- South Australia

Foreword:

From amongst other cities in Australia, Adelaide is arguably one of the leaders within the plant science community. The Waite Campus, in particular, is a powerhouse that underpins this reputation. Recently two new buildings were approved, one of which was completed late last year and one currently undergoing construction, which will ensure that South Australia remains at the forefront of plant science research for years to come. The first building – the Wine Innovation Cluster (WIC) was built with the purpose of being able to house as many wine related scientists under the one roof to foster an integrated collaborative atmosphere. Information relating to the research that is being conducted at this facility, along with some of the key players, can be found here: http://www.wineinnovationcluster.com/. The second piece of infrastructure (currently being completed) is the NCRIS funded Plant Accelerator Facility. This building will be a state of the art facility in which scientists from around Australia/internationally will be able to conduct measurements and experiments on the physical attributes of plants. Within the facility it is proposed that there will be up to 50 high-tech glasshouses and laboratories that will house around 1km of conveyor systems that will deliver plants automatically to state-of-the art imaging, robotic and computing equipment! These two highlights above are just a snapshot of the activity currently being undertaken at the Waite, with further exciting developments on the horizon. The following articles are submissions from various lab groups located on the Waite Campus at the University of Adelaide. While a large number of plant scientists were approached for this edition of "State of Affairs", including some of those from Flinders University and CSIRO, only those that responded in time have been included.

Jason Able

Developments towards Salt tolerant Crops

ACPFG Salt Focus Group

Salinity is a global problem affecting agricultural land. In Australia, it is estimated that currently 4.6 million ha of farmland are affected to some extent by salt. Due to poor land management practices, the area of saline-affected agricultural land is expected to increase to 13.6 million ha by 2050 (Australian National Resources Atlas, 2008, http://www.anra.gov.au/topics/salinity/impacts/index.html).

Current members of the ACPFG's Salt and Nitrogen Use Efficiency Focus Groups

The main toxic component of salt is the sodium ion (Na^+). High cellular concentrations of Na^+ in a plant, particularly in cells in the leaf, interfere with critical metabolic functions such as enzyme activity and protein synthesis. In addition, high concentrations of Na^+ can also cause osmotic damage.

In the Salt Focus Group at the Australian Centre for Plant Functional Genomics (ACPFG) we are investigating the three main mechanisms for tolerating Na^+ stress. The first, osmotic tolerance, is the plant's ability to maintain water relations and to continue to grow while stressed. The second is Na^+ exclusion, whereby the amount of Na^+ transported to the shoots from the roots is minimised through alteration of the movement of Na^+ throughout the plant. The final mechanism is Na^+ tissue tolerance, through compartmentation of Na^+ in tissues and cellular organelles, such as the vacuole, away from areas where the Na^+ can do damage. Through a better understanding of all three processes we hope to increase the salt tolerance of Australian cultivars of barley and wheat. We are identifying the genes and cellular processes involved in salinity tolerance, both in our current cereals and in other resistant plant lines, so that these traits can be introduced into commercially available crops.

In recent years, numerous varieties, lines and accessions of many plant species have been screened for salinity tolerance in order to identify the genes involved. Analysis of wild relatives of cultivated cereals, many which have evolved in saline conditions, provides us with a source of untapped genetic variation

which potentially could be used to identify genes involved in salinity tolerance. A highlight of this screening programme has been the use of the LemnaTec Scanalyzer to non-destructively measure the growth rates of lines of wheat, barley and *T. monococcum* and quantify through time the effects of salinity on growth and senescence (Fig. 1). In combination with measurements of shoot Na^+ concentrations, this has allowed us for the first time to calculate the osmotic tolerance and Na^+ tissue tolerance of a plant, in addition to measuring exclusion of Na^+ from the shoot.

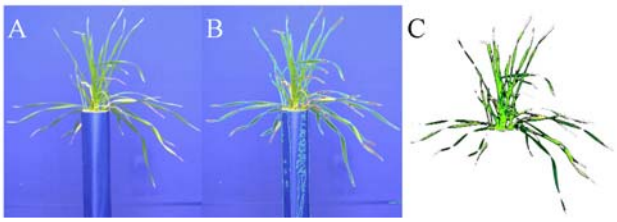


Fig 1. Image capturing and plant identification using the LemnaTec Scanalyser (Rajendran *et al.* (2009) Plant, Cell & Environment **32**: 237-249)

Several candidate genes and loci for salinity tolerance have now been identified in barley, wheat and Arabidopsis. Three gene families of particular interest are the *ENA* and *HKT* Na^+ transporters, as well as the vacuolar pyrophosphatases (PPases).

PpENA1 derives from the moss *Physcomitrella patens* and is responsible for the export of Na^+ from a cell. We have constitutively overexpressed *PpENA1* in a number of plant species, including rice and barley, in order to investigate the effect of this gene on plant salinity tolerance. Particularly exciting was the finding that, when grown under saline conditions, rice expressing *PpENA1* not only has lower shoot Na^+ concentrations than wild type plants, but also has substantially more biomass. Similar results are observed in barley, which shows increased biomass and fewer Na^+ toxicity symptoms than wild type plants when we overexpress Arabidopsis vacuolar pyrophosphatase (*AtAVP1*).

The *HKT* gene family is known to be important in regulating the transport of Na^+ throughout a plant. Previously, we had shown that constitutive expression of *AtHKT1;1* resulted in the hyper-accumulation of Na^+ in the shoot of Arabidopsis. A key aspect of increasing the salinity tolerance of crop plants, however, is control of the spatial and temporal expression of genes. Using tools developed at the ACPFG, which allow targeting of the expression of genes to specific tissues and cells, we demonstrated that when *AtHKT1;1* was expressed only in the vascular bundle of the root, the amount of Na^+ accumulating in the shoot could be reduced by up to 60% (Table 1). This reduction in shoot Na^+ accumulation was significantly correlated to an increase in the salinity tolerance of the plant. The focus of several projects currently under way is to determine regions in gene promoters important for both spatial and temporal gene expression in rice, Arabidopsis and barley.

Plant Line	Shoot [Na^+] mg.kg FW
Parent	3039 ± 450
Stelar specific *AtHKT1;1* expression	1278 ± 73 (n = 12)

Table 1. Shoot [Na^+] in 5 week old Arabidopsis plants grown in 50 mM NaCl for 1 week

Work in the group has now progressed to the delivery of salt tolerant crops to breeders. Accessions of salt tolerant durum and pasta wheat are currently being bred with Australian cultivars and elite breeding lines. These will be screened for salinity tolerance and grain yield. In addition, transgenic barley lines expressing transporters important in Na^+ transport are currently undergoing glasshouse trials, with field trials expected to start next year.

Contributed by Dr Stuart Roy

PLANT-PATHOGEN INTERACTIONS AND AFTER THE HARVEST:

THE UNIVERSITY OF ADELAIDE AUSTRALIA

A SUMMARY OF RESEARCH BY AMANDA ABLE'S RESEARCH GROUP

Our laboratory is based within the School of Agriculture, Food and Wine at The University of Adelaide and has two main foci: plant-pathogen interactions and postharvest physiology/pathology.

Plant-pathogen interactions

The main plant disease of interest for members within the Able lab is the net blotch disease of barley caused by two forms of *Pyrenophora teres*; *P. teres* f. *teres* and *P. teres* f. *maculata*; which cause the net form and spot form of net blotch respectively. Both forms induce a combination of brown necrotic spots/lesions and general chlorosis in affected barley leaves. Our group has shown that the brown necrotic spots/lesions are induced by host specific proteinaceous toxins (Sarpeleh *et al.* 2007, *Phytopathology* 97: 907-915; Sarpeleh *et al.* 2008, *PMPP* 72: 73-79) while the chlorosis has been shown to be induced by non-specific low molecular weight compounds (LMWCs) produced by the perthotrophic fungus (Sarpeleh *et al.* 2009, *PMPP, in press*). We are currently characterising these toxins and their interaction with plant proteins, in an attempt to identify potential defence mechanisms. Reactive oxygen species appear to be involved in signalling during the defence response of barley to *Pyrenophora teres* but contribute to cell death during susceptible responses to this hemibiotroph suggesting the fungus may be capable of 'tricking' the plant cell into undergoing a HR (Able 2003, *Protoplasma* 221: 137-143). As a result, our group has been functionally analysing a number of genes which may affect the redox status of the plant during its interaction with the pathogen. In particular, we are characterising a family of respiratory burst oxidases (Lightfoot *et al.* 2008, *Functional Plant Biology* 35, 347-359) and a CuZnSOD in barley.

Postharvest physiology

The two main areas of interest to the Able group in the field of postharvest physiology are: Firstly, understanding the genetic and biochemical basis for the barley grain disorder known as black point; and secondly, the physiology of fruit and vegetables in response to treatments such as 1-methylcyclopropene and controlled atmosphere (CA).

Black point of barley refers to a brown to black discoloration at the embryo end of barley grain. Our group has established a link between low temperature and high humidity during grain fill and black point (Walker *et al.* 2008, *Australian Journal of Agricultural Research* 59: 1021-1029). We hypothesise that this leads to swelling of the grain, pre-germination, wounding and subsequent mixing of phenols and peroxidases and subsequent formation of quinones. Indeed, using a proteomics approach, we have identified barley peroxidase 1 (BP1) is only identified in black pointed grain while a novel late embryogenesis abundant (LEA) protein is found in healthy grain but not black pointed grain (March *et al.* 2007, *Proteomics* 7: 3800-3808). A syntenic mapping approach has identified a number of candidate genes within a putative QTL for black point formation on 2H (March *et al.* 2008, *Functional Plant Biology* 35: 427-437). Potential regulators of black point formation are currently being identified through two approaches: mapping the expression of candidate genes from the 2H QTL (to establish *cis*- and *trans*-eQTLs), and secondly, the use of a Y1H approach to detect interactors with the promoters of candidate genes.

Previously the Able group has determined that the efficacy of 1-MCP in extending the shelf life of bananas is affected by seasonal changes and maturity (Moradinezhad *et al.* 2008 *Annals of Applied Biology* 152: 223-234). Our focus now lies in trying to understand the underlying mechanism for these changes. We are also interested in whether 1-MCP changes volatile production by banana fruit. The effect of 1-MCP treatment and CA storage on the levels of antioxidants in apples is also being studied.

Contributed by Dr Amanda Able

Plant Cell Physiology Laboratory

School of Agriculture, Food and Wine
University of Adelaide, Waite Campus

THE UNIVERSITY OF ADELAIDE AUSTRALIA

Nutrients accumulate differentially between plant tissues and within tissues, differentially across cell-types. For instance, in leaves of cereals ionic calcium is stored in epidermal cell vacuoles whereas magnesium is stored in the mesophyll. Our research is focused on discovering the mechanisms by which nutrients are stored preferentially in

particular plant cells and the possible functions that these cell-specific nutrient accumulation profiles may serve. The ultimate aim of this research is to facilitate biofortification of crops with key nutrients without adversely affecting plant productivity.

Our element of choice is calcium (Ca). Unique amongst macronutrients, Ca has critical structural and essential signalling functions in both animals and plants. Ca is the most abundant metallic element found in vertebrates and the third most prevalent in plants. Human calcium deficiencies result in brittle bones, osteoporosis and major health costs for developing countries, $7.4 billion per annum in Australia alone. In some, developing low calcium intake has led to rickets being prevalent. Horticultural calcium deficiencies result in crop losses and greater susceptibility to pathogens and abiotic stresses such as salinity. Ca concentration is tightly regulated and is divergent by orders of magnitude between different symplastic compartments and the apoplast. Therefore, a better understanding of how calcium is spatially regulated while performing diverse functions will provide a considerable insight into fundamental plant physiology.

Despite its ubiquitous functions, Ca can be stored at very different concentrations between different leaf cell-types. We have conducted a survey over 38 different plant species and there are at least 4 different Ca storage patterns. To investigate the dominant Ca storage pattern in dicotyledonous plants we have used Arabidopsis as a model. Using Single cell sampling and analysis (SiCSA) we have amplified RNA from two different Arabidopsis leaf cell-types, one that accumulates Ca within the vacuole (palisade mesophyll) and one that seemingly excludes Ca (adaxial epidermis). We have compared transcript profiles between cells and in leaves under different nutrient regimes using microarray and qPCR analysis and uncovered a number of differentially expressed Ca transport proteins. Mis-expression of several of vacuolar Ca-transport proteins has resulted in altered Ca storage across the leaf and has had severe effects upon leaf physiology including decreased transpiration and growth.

This work continues as we investigate other genes of interest uncovered through our microarray screen and use of T-DNA knockouts. We also have a collection of plants with cell-specific expression of GAL4-VP16, that allow us to mis-express our genes of interest in specific cell-types, some of which were obtained from other laboratories and some we generated ourselves. We are currently using these plants to alter the Ca accumulation pattern in leaves to see what affect this has on plant physiology.

In collaboration with Steve Tyerman, we are also studying how Ca within the apoplast (among other signals) can affect water movement through leaves. Through this work we are gaining a better understanding of how hydraulic conductance of leaves is regulated and is linked to the nutritional status of the plant.

We have a number of core techniques we use in the laboratory to answer questions regarding nutrient transport and storage such as SiCSA, ICP, XRMA, electrophysiology (patch clamp, oocyte TEVC), fluorescence and luminescence microscopy and spectroscopy, infrared gas-analysis and a range of molecular techniques from ATG to TAG. All the above work has either been submitted or hopefully will be by the time you read this so watch the appropriate space. We are also starting to extend our work into other macronutrients including magnesium, phosphorus and potassium partly as a consequence of the inevitable interactions between different nutrients as different nutrients are often stored in different cell-type vacuoles.

Current and *recent* group members have and are performing the work mentioned above and even more: Roger Leigh (XRMA); Matt Gilliham (XRMA, Ca nutrition); Simon Conn (SiCSA, Ca nutrition); Sam Henderson (GAL4-VP16 plant characterisation and development); Maclin Dayod (Hydraulic relations); *Brad Hocking* & Asmini Athman (Protein-protein interactions, Ca nutrition); Lucy Aukett, *Laetitia Ramanoudjame* & *Vaishali Panjabi* (Promoter isolation and GAL4-VP16 plant creation); Bo Xu (Weasley) (HKT protein function); *Elodie Hudik* (FLA protein function); *Ben Noll* (ROS and root development). Please contact us for more information. Also see our website or email for more information and references: http://www.agwine.adelaide.edu.au/plant/plant_phys/pcp/

Plant Membrane Biology 15th INTERNATIONAL WORKSHOP ADELAIDE 2010

We are also one of the laboratories convening the 15th International Workshop on Plant Membrane Biology to be held in Adelaide during September 2010. IWPMB2010 is an official satellite meeting of OZBIO2010 and will be held a week prior. A triennial event, IWPMB is the top international conference in the area of membrane biology attracting around 400 scientists from the world's leading laboratories. Sessions include:

- Membranes and water transport (and MIP biology)
- Membranes and Energy (Photorespiration) (Chloroplast/mitochondrial membrane physiology)
- Nutrient transport (Root uptake, long-distance transport, nutrient transporters)
- Growth and Turgor (Polar growth and turgor related transport and regulation)
- Structure-Function of Membrane transporters
- Biotic Stress and biotic interactions (pathogens, symbiosis)
- Abiotic Stress and environmental homeostasis (Drought, salt, heavy metals, guard cells)

- Membrane Structure and Development, Membrane trafficking, lipid metabolism and lipid-transporter interactions.
- Signalling related to solute transport

Workshops sessions are planned within the areas of: *Advances in imaging; Systems biology/modelling; Proteomic analysis; Phenomics; Practical/Applied outcomes of membrane biology; RNAi regulation; Natural variation.*

Visit www.adelaide.edu.au/iwpmb2010 for more information and pre-registration. It is quite a coup for Australia to host this event so if you have an interest in the area it is a great opportunity to present your work in front of leaders in the field from outside of Australia without having to travel a day or two on a plane.

Contributed by Dr Matthew Gilliham

Understanding the genetics of meiosis in cereals

The Genetics of Meiosis in Cereals research group is principally interested in understanding the processes of chromosome pairing and recombination control during meiosis in bread wheat. Led by Dr Jason Able, we secure our funding primarily from the Department of Innovation, Industry, Science & Research (DIISR) through the Australia India Strategic Research Fund (AISRF), the Molecular Plant Breeding CRC and the Grains Research & Development Corporation (GRDC). The group has a close affiliation with several members of the Australian Centre for Plant Functional Genomics (ACPFG), including Professor Peter Langridge. We also have excellent collaborative linkages both nationally with Professor German Spangenberg from DPI Victoria; and internationally with Professor Graham Moore at the John Innes Centre, Norwich, England, and Associate Professor Sanjay Kapoor at the University of Delhi South Campus, India.

The group has made some exciting breakthroughs in the past year, some of which has been published now (see Able *et al.* 2009; Boden *et al.* 2009; Bovill *et al.* 2009; Khoo *et al.* 2008, as examples). The success of some of this research has led to the work being highlighted in the recent issue of the bimonthly grains magazine known as '*Ground Cover*' (May-June Issue) – see http://www.grdc.com.au/director/events/groundcover for more details.

Two Research Snapshots:

- **Dr Scott Boden – (former PhD candidate awarded 08/08, now at John Innes Centre, Norwich, UK)**

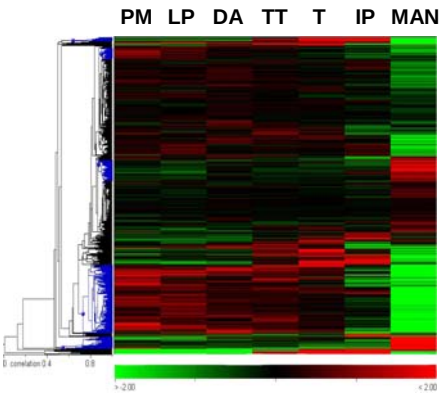
Investigating chromosome pairing during early meiosis in bread wheat using ASYnapsis 1 (ASY1)…

Mutants of *ASY1* genes in Arabidopsis and rice have a severely reduced ability to successfully synapse homologous chromosomes during the progression of early prophase of meiosis I. We isolated ASY1 from hexaploid bread wheat (coined *TaASY1*) to better understand the molecular mechanisms controlling homologous chromosome pairing and synapsis (Boden *et al.* 2007; 2009). Although bread wheat contains 3 genomes (A, B and D), during meiosis, chromosomes strictly pair with their homologue even though homoeologues are present (e.g. chromosome 1A will only pair with 1A, even though 1B and 1D are very similar at the genetic level). Through this research we have generated transgenic RNAi *TaASY1* mutants that are reminiscent of the *ph1b* mutant phenotype that is still used today for alien chromatin introgression strategies. The advantage of our transgenics is that we have only silenced one gene (ASY1) (when compared to *ph1b* missing some 80 Mbp – it is an x-ray induced mutant), have produced plants that are in a more 'user-friendly/agronomically superior' background – Bob White 26 (when compared to *ph1b* being a Chinese Spring mutant), and have a range of phenotypes when visualised during metaphase I of meiosis. This work is now at the point where we can assess these mutants in wide-cross hybridisation experiments.

- **Dr Wayne Crismani – (former PhD candidate awarded 02/09, now at INRA, Versailles, France)**

Getting a handle on the bread wheat 'meiome'…

This research project focussed on whole genome approaches to identify genes involved in early meiosis. To complete this research, we used microarray and Q-PCR platforms. The microarray was a time course with seven meiotic time points. The data generated from that experiment has provided a source of new meiotic genes from which to conduct further research (and which is being undertaken by other staff and students in the lab). Selection of candidate genes for further characterisation in Wayne's project was based primarily on the transcripts being meiotically regulated during the early stages of Prophase I (see Crismani *et al.* 2006 for more details of this research).



Hierarchical clustering of 1,350 meiotically-regulated transcripts

Other Research:

Members within the current lab group include Dr William Bovill (post-doctoral fellow) who is working on the project entitled – *Meiosis in wheat and rice: are the interactions and regulation of this process conserved between other diverse eukaryote organisms*; Hayley Jolly (final year PhD candidate) who is completing her research and dissertation on the *Functional characterisation of candidate genes with a role in chromosome pairing in bread wheat*; and Kelvin Khoo (second year PhD candidate) who is working on *Investigating the bread wheat proteome during meiosis, along with the functional characterisation of two key proteins known to be involved during early meiosis.*

Key Papers:

If you would like to know more about our research, we draw you attention to the following selection of papers that are accessible on-line or by contacting Jason.

Able *et al.* (2009), *Functional Plant Biology*. Vol. 36: (*in press, July issue*).
Boden *et al.* (2009), *The Plant Journal*. Vol. 57: 487-497.
Bovill *et al.* (2009), *Functional & Integrative Genomics*. Vol. 9: 219-229.
Khoo *et al.* (2008), *Functional Plant Biology*. Vol. 35: 1267-1277.
Lloyd *et al.* (2007), *BMC Plant Biology*. Vol. 7: 67.
Boden *et al.* (2007), *BMC Molecular Biology*. Vol. 8: 65.
Able *et al.* (2007), *Trends in Plant Science*. Vol. 12: 71-79.
Crismani *et al.* (2006), *BMC Genomics*. Vol. 7: 267.
Able & Langridge (2006), *Trends in Plant Science*. Vol. 11: 261-263.

Contributed by Dr Jason Able

2008 Robertson Lecture

Hans Lambers

Phosphorus nutrition of Proteaceae and Cyperaceae: strategies in biodiversity hotspots in old landscapes.

School of Plant Biology, Faculty of Natural and Agricultural Sciences, the University of Western Australia, Crawley, WA 6009, Australia

Western Australia was once part of Gondwanaland and some of the most ancient parts of the Earth' crust can be found here. This region has been above water since sea levels were at their highest known, 90 million years ago. Moreover, the landscape has not been glaciated for over 200 millions years, and the climate has been oceanically buffered since the early Cretaceous, 140 million years ago (Hopper 2009). The southwest of Western Australia is also one of only 25 global biodiversity hotspots; it is a region that is rich in higher plant species of which many are endemic and endangered (Myers *et al.* 2000). It is the only global biodiversity hotspot on severely nutrient-impoverished soils, caused by thousands to millions of years of erosion and leaching (Lambers et al. 2008a). Therefore, this environment offers a unique opportunity to study plant endemism and adaptations to nutrient-poor conditions.

A relatively large proportion of the species from the very phosphorus-poor soils in Western Australia cannot produce a symbiotic association with a mycorrhizal fungus, including most species belonging to the Proteaceae and Cyperaceae (Brundrett 2009). This appears paradoxical, as mycorrhizas are considered an adaptation to phosphorus-impoverished soils. Instead, many species in these families produce root clusters (Fig. 1). Root clusters release large amounts of carboxylates (*e.g.*, citrate, malate), whose role is that of mobilisation of phosphorus (P) and micronutrients (Lambers et al. 2006). All of the species we have investigated form these specialised roots only when grown at very low supply of inorganic P (P_i). The combination of the structure (many rootlets covered with root hairs or root hairs in a small volume) and functioning (considerably faster exudation rates than reported for species without these specialised root structures) allows for major accumulation of carboxylates, in the millimolar range, in the rhizosphere (Shane & Lambers 2005). Root clusters exude carboxylates in an 'exudative burst', thus minimising consumption by microorganisms before P has been mobilised. This pattern of vast release of carboxylates explains why non-mycorrhizal species with cluster roots are so successful in the most P-impoverished soils of the world. Mycorrhizas can enhance a plant's P acquisition when the amount of P is too low for roots to acquire sufficient amounts (Fig. 2); however, when the amount of P is even lower, most of the soil P is sorbed onto soil particles, and hardly or not available for mycorrhizal fungi. Carboxylates in high concentrations compete with P for binding sites in the soil, and thus solublise P, making it available for uptake by roots. The cluster-root strategy is effectively a "mining" strategy, as opposed to the "scavenging" strategy of mycorrhizas (Lambers et al. 2008a).

We have investigated carbon metabolism of the cluster roots of *Hakea prostrata* (Proteaceae) and dauciform roots of *Schoenus unispiculatus* (Cyperaceae), including respiration and carboxylate exudation of root clusters during their entire development. Root-cluster respiration peaks at an early stage, providing the metabolic energy during rapid growth early in their development. Carboxylate exudation peaks later during their development, lasting a few days only, the major carboxylates being citrate and malate (Lambers *et al.* 2006). Active cluster roots of *H. prostrata* have more alternative oxidase (AOX) protein and express an additional AOX isoform of slightly lower molecular mass when compared with non-cluster roots. The role of the enhanced expression of the alternative oxidase is probably that of

oxidation of NADH that is produced during carboxylate production, when there is little requirement for ATP (Shane et al. 2004a).

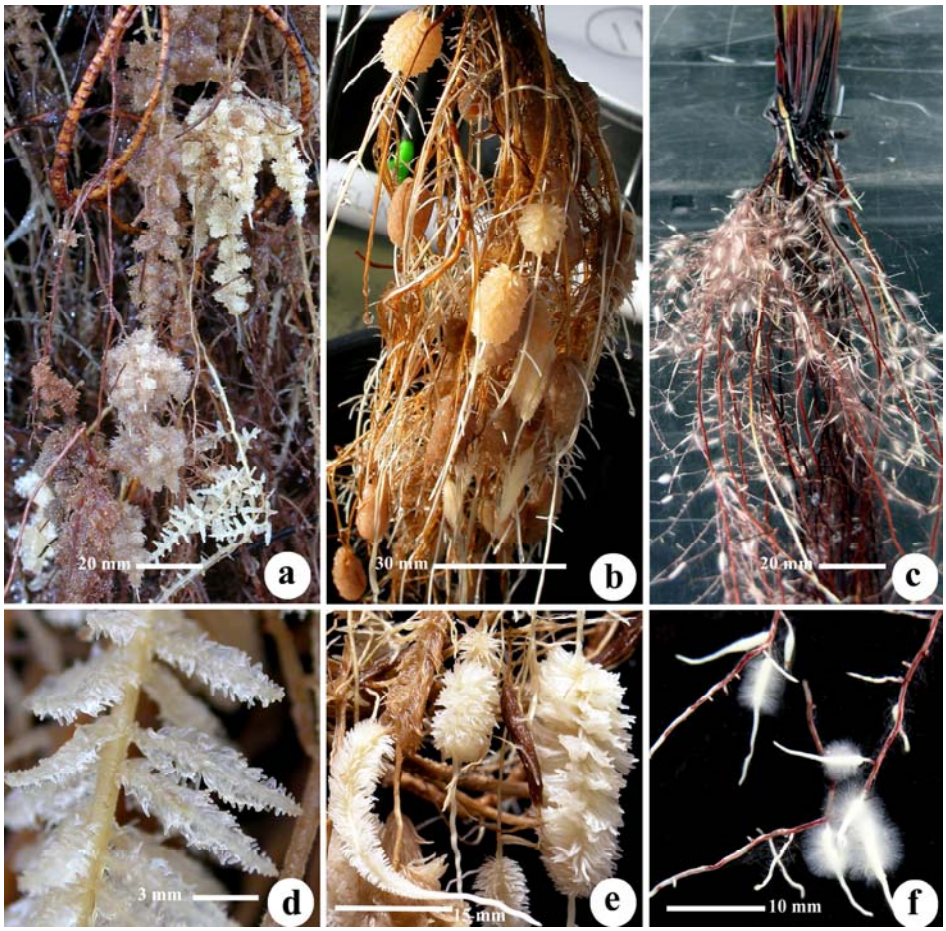


Figure 1. Root-cluster morphology of Proteaceae and Cyperaceae species. Plants were grown hydroponically at very low P supply (≤ 1 μM). (A) *Dryandra sessilis* (parrot bush) root system with "compound" "proteoid" root clusters; bar is 20 mm. (`B) *Hakea prostrata* (harsh hakea) root system with "simple" proteoid-root clusters; bar is 30 mm. (C) *Tetraria* (sedge) species root system with "dauciform" root clusters; bar is 20 mm. (D) Young, compound proteoid-root-cluster of *Banksia grandis* (bull banksia) terminates with 3rd order determinate, branch rootlets; bar is 3 mm. (E) Simple proteoid-root clusters of *Hakea sericea* (silky hakea) at various stages of development terminate with 2nd order determinate branch rootlets (white root clusters are young-mature, whereas brown ones are senescent or dead). (F) Higher magnification of dauciform-roots clusters of *Tetraria* species in C. Root-hair density is extremely high on individual dauciform roots; bar is 10 mm. (F) *Tetraria* species. (Lambers et al. 2008a; courtesy M.W. Shane, School of Plant Biology, the University of Western Australia; copyright Elsevier Science, Ltd.).

Proteaceae are not only very good at acquiring P, but also excellent at moderately high rates of photosynthesis at very low leaf P concentrations. Moreover, some *Banksia* species are extremely efficient at remobilising the small amount of P contained in their leaves (Denton et al. 2007). In fact, their remobilisation efficiency and proficiency is greater than that of any other species described in the literature (Lambers et al. 2008b). A similarly high P-remobilisation of P has been found for cluster roots of *Hakea prostrata* (Shane et al. 2004a). It would be interesting to discover more about the regulation of P_i transporters that play a role in the highly efficient P remobilisation in some Proteaceae. Equally, we hypothesise that the ability to operate at very low leaf P concentrations is associated with effectively

excluding P from leaf vacuoles; this must also involve P_i transporters about which we would like to discover more.

Many Proteaceae, including *Banksia* and *Hakea* species, are readily killed by P fertilisation (P-toxicity). The extreme P sensitivity of *H. prostrata* (Proteaceae) is due to its very low capacity to reduce its P_i-uptake capacity at slightly elevated P levels in the rhizosphere (Shane et al. 2004b). This low capacity to down-regulate P_i uptake capacity is therefore in tune with the P-impoverished soil conditions in Western Australia. Our current thinking is that the sensitivity to slightly elevated soil P is associated with the high capacity to remobilise P from senescing leaves and roots. Highly efficient remobilisation from senescent tissues might require that P_i transporters are not down-regulated. If so, this trait might inexorably lead to a high P sensitivity, but in a pristine and natural habitat, P toxicity would probably never be encountered.

Our detailed ecophysiological approach, in which we frequently use molecular techniques, is allowing us to gain insight into the functioning of very biodiverse ecosystems. Evolutionary biologists can enlighten us about when the different species in our global biodiversity evolved (Hopper 2009). To understand how that biodiversity functions requires the type of approach we are pursuing, in interactions with these evolutionary biologists and other plant scientists.

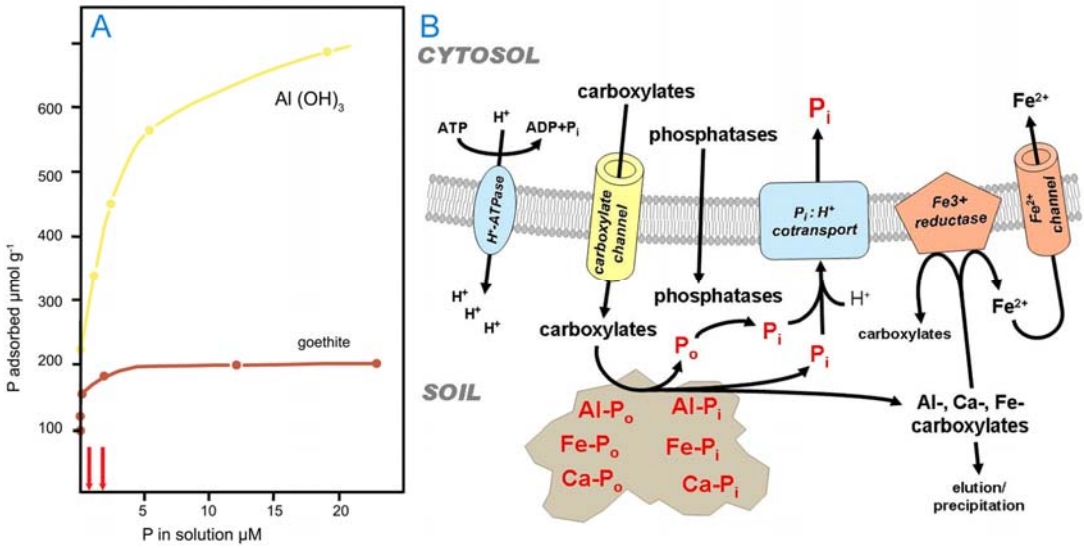


FIGURE 2. (A) P_i-sorption isotherms on goethite (at pH 6.3) and $Al(OH)_3$ (at pH 5.8), using $Ca(H_2PO_4)_2$. Goethite is a common, Fe-containing compound in soil. $Al(OH)_3$ was used for the sake of comparison, since no reduction of the metal was possible. Note that P_i is "not readily available" for *Lolium perenne* (perennial ryegrass) until about 40% of all the goethite is "covered". P availability then increases, reaching a maximum at 2 mM in solution, when 75% of the goethite is covered by sorbed P_i. Mycorrhizas increase the availability for ryegrass in the range 0.5-2 mM, marked by the arrows, when 60-70% of the goethite surface is "covered by sorbed P_i. (Lambers et al. 2008b; modified after Parfitt 1979). (B) Effects of carboxylates (and other exudates) on inorganic (P_i) and organic P (P_o) mobilisation in soil. Carboxylates are released via an anion channel. The exact way in which phosphatases are released is not known. Carboxylates mobilise both inorganic and organic P, which both sorb to soil particles. Phosphatases hydrolyse organic P compounds, once these have been mobilised by carboxylates. Carboxylates will also mobilise some of the cations that bind P. Some of these cations (especially Fe) move to the root surface for uptake by the roots. Others move down the soil profile. (Lambers et al. 2008b; modified after Lambers *et al.* 2006).

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COMBIO2009

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Matthew Turnbull (NZSPB/ASPS) and David Palmer (NZSBMB) invite you to join us at ComBio2009 in Christchurch. We are planning a comprehensive and wide ranging scientific programme with plenty of the traditional ComBio features. We also hope that you will take the opportunity to use Christchurch as a gateway to the fantastic New Zealand landscape.

Protein Structure and Function	Cells and Development	Signal Transduction and Gene Regulation		Genetics and Genomics
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Plant Biology	Plant Ecophysiology and Global Change Biology	Microbiology	Agricultural and Horticultural Science	Medical Science
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International Speakers

Sir John Walker FRS	Nobel Prize in Chemistry 1997	**Michael Karin**	Signalling in inflammation	**Yair Shachar-Hill**	Plant central metabolism and biomass production - metabolic flux analysis
		Doug Eaton	Why we don't drown every day; a new paradigm for lung fluid balance		
Vern L. Schramm	Enzymatic transition states and inhibitor design	**Misha Perouansky**	Mechanisms of anesthetic action	**John Grace**	Nitrogen and carbon cycles under climate change
Janet L. Smith	Enzyme domains in assembly lines for antibiotic biosynthesis	**Caroline McMillen**	Fetal and postnatal programming of obesity and metabolic disease	**Guillaume Tcherkez**	Isotopic fractionation in plant metabolism
David Ornitz	Fibroblast growth factors in development and disease	**Pankaj Sah**	Generation of patterned neuronal activity in the brain	**Brent Helliker**	Oxygen isotopes and the temperature of tree canopies
Benjamin Geiger	Mechanisms underlying environmental sensing via focal adhesions	**Tim Wiltshire**	Genetic variation in mice: modeling disease, pharmacogenetics, and basic biology	**Aled Edwards**	Genome-scale studies of the structure and function of protein families
Nadia Rosenthal	Regeneration of muscle in mice	**Wan Lam**	Title to be advised	**Terry Yamaguchi**	Wnt signaling in morphogenenisis
				Rudi Amman	Analyzing the microbial catalysis of biogeochemical cycles
Peter Lobel	Lysosomal Proteomics and Disease	**Chris Hawes**	Imaging secretory pathway dynamics in living cells		

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OTHER CONFERENCES

Annual Meeting of the American Society of Plant Biologists in Honolulu, Hawaii, 18-22 July, 2009

Registration is open for Plant Biology 2009, the joint annual meeting of the American Society of Plant Biologists. The deadline for early-bird registration was April 24, 2009. ASPS is a partner organization which means that members of our society qualify to register at member rates.

Major Symposia include Crop Functional Genomics, Evolution and Plant Biology, Photo morphogenesis and Plant Natural Products.

A Workshop to Evaluate Strategies for Engineering C4 Photosynthesis into C3 Plants. There is also a workshop following the main meeting on C3 to C4:
Organizers: Rowan Sage, Tom Brutnell and Bob Furbank. July 23, 2008, Hilton Hotel, Honolulu Hawaii. http://www.aspb.org/pb-2009

XVI International Plant Nutrition Colloquium, California 26-30 August, 2009

Plant Nutrition for Sustainable Development and Global Health
The 16th International Plant Nutrition Colloquium will highlight advances in fundamental and applied plant nutrition, and emphasize the role of plant nutrition in food systems and environmental sustainability. The colloquium will attract the worlds leading researchers in plant nutrition, leaders in extension and policy design from government and private organizations and representatives of leading commercial enterprises.

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The IPNC will be held in Sacramento, located in California's Central Valley, one of the largest and most diverse centers of agricultural innovation and production in the world. The conference venue is close to many world-class attractions including the Tahoe basin, San Francisco, Napa Valley. The University of California campuses at Davis and Berkeley are located 10 and 100 kilometers, respectively, from the convention site and transportation will be arranged for delegates wishing to visit these sites.

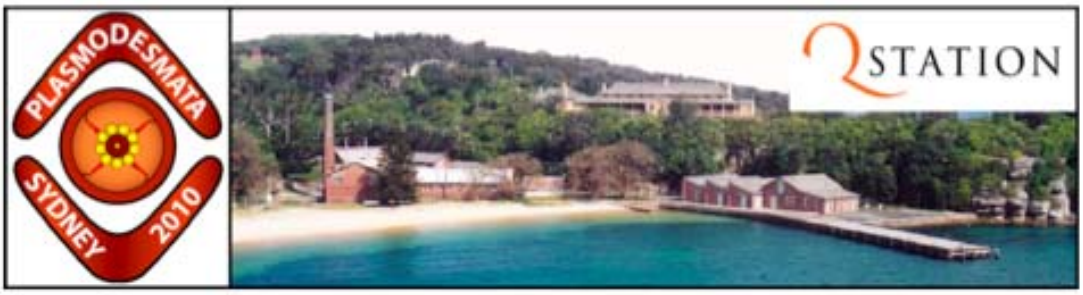
Program available at: www.ipnc.ucdavis.edu
Conference hosted by the Department of Plant Sciences and the University of California.

International Conference on Plant Vascular Biology 2010 July 24-28, 2010, Ohio State University, Columbus, Ohio, USA

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

Plant Vascular Biology (PVB) includes studies on the biogenesis, structure and function of transport systems in plants, under conditions of normal plant growth and development as well as of plant interactions with pathogens. The transport systems cover broadly the xylem, phloem, plasmodesmata and vascular cell membranes. The PVB concept has emerged in recent years to emphasize the integrative nature of the transport systems and approaches to investigate them. PVB 2010 will bring together junior and senior researchers working on various aspects of PVB (structure, biogenesis, signaling, proteomics, genomics, nutrition, biomass, plant-biotic interactions, etc) from around the globe to share the latest findings, develop collaborations and identify new directions of research. The conference will also strive to bridge basic and applied aspects of PVB.

For more information please visit the conference homepage (http://www.ced.osu.edu/pvbconference.html) after August 1, 2009.



After 35 years...*Plasmodesmata* returns to Australia

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PLASMODESMATA 2010
7th International Conference, March 21-26, 2010
Quarantine Station, Manly, NSW

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The first workshop to focus on Plasmodesmata was held in Canberra in 1975, at the beginning of a new era of research investigating plasmodesma structure and function. After 35 years, the 7th workshop in the series will return to Australia. We are expecting over 60 plant biologists and virologists to join us for around the globe to share their latest findings. This is a wonderful opportunity for Australians to learn about developments in this rapidly moving area and to showcase their science.

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Proteins in plasmodesmata
Mechanisms of transport through plasmodesmata
Intercellular signalling and regulation
Virus movement
Phloem transport
Intracellular and intercellular gene silencing
Plasmodesmata and coordination of development

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Tunnelling nanotubes
Lessons from nuclear pores
Plasmodesmata: models for nanofiltration engineers?

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ROBYN OVERALL, CHAIR LOCAL ORGANIZING COMMITTEE

From 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. Below are accounts by Drs Pip Wilson, Ben Gruber and Abby Cuttriss. I encourage others to send me their research highlights (see "Are you aware that …?, pp. 48)

Tina Offler

Investigating drought tolerance mechanisms via a drought tolerant Arabidopsis *mutant*

Pip Wilson

How plants respond to stress and what makes a plant drought tolerant are still largely uncharted, but rapidly developing, areas of plant biology. Given Australia's predisposition for drought and the challenges brought by climate change, a thorough understanding of drought tolerance will be an important step in the development of drought resistant crops for the future.

Dr Pip Wilson (left) and Prof. Barry Pogson (right)

The approach to this problem taken during my PhD was that of forward genetics, focusing on the drought tolerant *Arabidopsis* mutant, *alx8*. This mutant was originally isolated by Dr Bart Rossel for its increased expression of the antioxidant enzyme ascorbate peroxidase 2 (APX2) under normal conditions and also after high light stress. Positional cloning indicated the *alx8* point mutation was located in the SAL1/FRY1 gene, which codes for a bifunctional phosphatase, active against inositol polyphosphates and bisphosphate nucleotides. The SAL1 protein has been implicated in the negative regulation of stress response pathways, RNAi, and light control of cell elongation and flowering. The *alx8* mutation resulted in a null mutant, with complete lack of SAL1 protein in leaf material.

One of the challenges my field has encountered in the last decade is performing experiments that are biologically and ecologically relevant; bridging the gap between the 'eppies' and the field. A key illustration of this was that a previously identified mutant in SAL1, *fry1-1*, had been described as drought sensitive as cut rosettes wilted faster than wildtype rosettes and mutant seedlings had more ion leakage when exposed to high levels of osmotica such as PEG-6000. However when we tested *alx8* and *fry1-1*'s survival in soil based drought experiments both mutants were significantly more drought tolerant than their respective wild types.

Drought tolerance of *alx8* (top) and wildtype (bottom) at similar developmental age after 9 days without water

I then set out to try to establish the cause behind *alx8's* drought tolerance by characterising its biochemistry, morphology and physiology. *alx8* turned out to be an unusual mutant. Despite over 5000 genes being expressed differently in *alx8* under normal conditions, few were those

commonly induced by the 'drought hormone' Abscisic Acid (ABA). This was surprising since SAL1 was thought to be active in an ABA-dependent pathway. Furthermore, double mutants of *alx8* with the normally drought sensitive ABA-insensitive and deficient plants were drought tolerant indicating *alx8's* drought tolerance is at least partially ABA independent.

The water use efficiency (WUE) of a plant is commonly described as how much carbon fixation occurs per unit of water lost through the stomata. The WUE of *alx8* was measured under well-watered conditions by carbon discrimination and found to be equal to that of wildtype. Preliminary results indicated that *alx8* also had improved WUE under drought conditions, indicating it has drought tolerance rather than drought avoidance. If the plant underwent drought avoidance you would expect the stomata to close to conserve water whereas a tolerant plant will continue to transpire. Since my PhD further research has been undertaken to understand *alx8's* drought tolerance, some of which is detailed in the paper below.

Due to it's unique phenotype *alx8* should continue to provide a useful tool for the dissection of drought tolerance and in particular understanding how biochemical changes such as transcription changes relate to physiological changes such as WUE and result in drought tolerance.

Research was performed collaboratively by those listed on the papers below. Work was supported by the ARC Centre of Excellence in Plant Energy Biology as well as a Technical Assistance Grant and PhD Scholarship from MLA Australia. Thanks to my PhD supervisor, Professor Barry Pogson, and the valuable advice of members of Plant Industry CSIRO and the Research School of Biological Sciences, ANU, most notably Dr Rana Munns and Prof. Susanne von Caemmerer. Having graduated from my PhD in 2008 I am now following my interests in drought tolerance in wheat as a postdoctoral Fellow with Dr Tony Condon at Plant Industry CSIRO.

Wilson, PB*, Estavillo, GM*, Field, KJ, Carroll, AJ, Pornsiriwong, W, Howell, KA, Lake, JA, Millar, AH, von Caemmerer, S, Pogson, BJ (2009) The nucleotidase/phosphatase, SAL1, is a negative regulator of drought tolerance in Arabidopsis. *The Plant Journal* 58:299-317 * equal first author

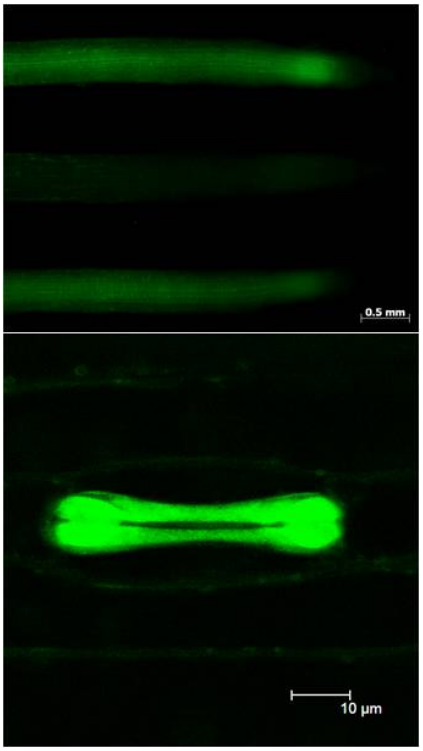
Exploring the function of ALMT1 from barley

Ben Gruber

Many members of the ALMT family of plant membrane proteins are involved in conferring aluminium resistance to plants by facilitating the efflux of malate from root apices. For example, Al that is present in the rhizosphere activates TaALMT1 from wheat to facilitate the efflux of malate. This malate binds toxic Al present in the rhizosphere thereby allowing root growth to continue. However, not all ALMT proteins are responsible for conferring Al resistance. This study aimed to identify an ALMT homolog from barley and to determine the role of this homolog.

The most similar gene to *TaALMT1* was identified in barley. The gene named *HvALMT1* was found not to be the major determinant of Al resistance as the expression did not correlate with resistance and the gene did not co-segregate with the major Al-resistance locus of barley. As *HvALMT1* appeared not to be the major gene controlling Al resistance further experiments focused on determining the function of the gene.
Using a *HvALMT1* promoter:GFP fusion the expression of *HvALMT1* was localised to the guard cells of stomata and to a region behind the root apex (see figure). The HvALMT1 protein was localised using

a HvALMT1:GFP fusion protein to the plasma membrane and to motile vesicles that moved with streaming of the cytoplasm.
When expressed in oocytes of *Xenopus laevis* HvALMT1 induced inward and outward currents indicative of the protein being an anion channel capable of transporting anions such as malate, citrate, fumarate and chloride. Interestingly the inward currents (assumed to be anion efflux) were negatively influenced by increasing extracellular pH and positively influenced by the addition of organic anions to the medium in which the oocytes were bathed.
Over-expression of *HvALMT1* in barley using a constitutive promoter produced plants with stunted growth and reduced root and shoot growth. Transgenic plants had elevated concentrations of calcium, ascorbic acid, pentanoic acid, serine and threonine and a decrease in the concentration of fumarate within leaves relative to non-transformed controls. Transgenic plants had a greater efflux of organic anions such as malate and succinate from root apices.
These results suggest that HvALMT1 is not the predominant Al resistance mechanism in barley, but that the ALMT homolog possesses other roles within the plant. The protein is an anion channel capable of facilitating the transport of organic anions such as malate, citrate, fumarate and succinate. As the gene is expressed in the guard cell of stomata and the elongation zone of roots it is possible the protein functions in regulating the turgor or pH of these cells. Indeed malate is important for the regulation of guard cell function as a counter-ion for potassium. Further work is however required to determine if HvALMT1 is directly involved in the function of the stomata of barley.



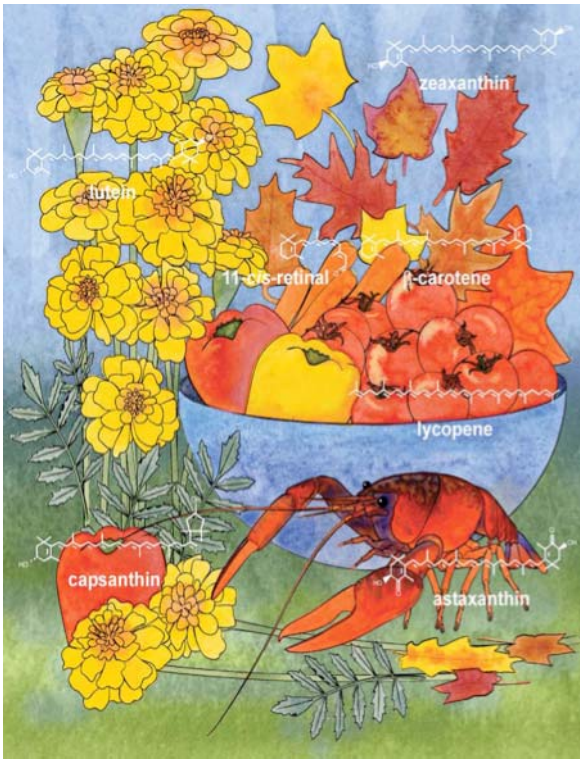
Localisation of a *HvALMT1* promoter:GFP fusion within the roots and stomata of barley

Undertaking a PhD was an enjoyable and rewarding process. As I had come from a rural background it opened me to new experiences such as international flights and conference attendance. There were of course challenges but these were what made my experience rewarding in the end and I was fortunate to be able to return to the farm on the weekend to relax when things got too stressful.
This project was conducted under the supervision of Dr Manny Delhaize, Dr Peter Ryan and Dr Alan Richardson from CSIRO Plant Industry, Canberra and Dr Susan Howitt of the Australian National University, Canberra. Collaboration was undertaken with Professor Steve Tyerman, Dr Sunita Ramesh, Dr Ute Roessner and Dr Harsh Raman. The PhD project was funded by a Grains Research Scholarship from the Grains Research and Development Corporation.

Carotenoids and plant development

Abby Cuttriss

Carotenoids are a diverse class of pigments that are critical for optimal plant growth and survival. It is therefore imperative that they are tightly regulated and carotenoid composition is finely-tuned in response to environmental cues. For my graduate studies at the Australian National University with Barry Pogson I studied the regulation of lutein, the most abundant carotenoid in photosynthetic tissue. Lutein accumulation was analysed in response to metabolite feedback, altered light regimes and biosynthetic mutagenesis.



Carotenoid diversity, from Cuttriss and Pogson (2004)

Transcriptional regulation. I analysed three lutein-deficient Arabidopsis mutants: *lut2* (epsilon-cyclase), *ccr2* (carotenoid isomerase) and *ccr1* (carotenoid and chloroplast regulatory 1). Analyses of mRNA abundance in wild type, *lut2* and *ccr2*, in response to light transitions and herbicide treatments identified two key rate-limiting steps in lutein accumulation: the carotenoid isomerase (*CRTISO*) and epsilon-cyclase (*εLCY*).

Novel regulatory mutant. To further investigate lutein regulation I characterised the *ccr1* regulatory mutant. This novel mutant had altered carotenoid composition; reduced lutein in photosynthetic tissue and cis-carotene accumulation in dark-grown seedlings, which was consistent with a concomitant reduction in *CRTISO* and *εLCY* transcript abundance. The *CCR1* gene has since been identified as *EFS* (early flowering in short days), which encodes a histone methyltransferase (Set Domain Group 8) that methylates histone H3 on Lys 4 and/or 36 (H3K4 and H3K36) and *ccr1* plants were confirmed to have aberrant methylation patterns surrounding the *CRTISO* translation start site (work by Chris Cazzonelli). Thus, lutein content appears to be regulated by a chromatin-modifying enzyme.

Carotenoids and plant development. I also examined *ccr1* morphology and discovered increased shoot and cauline node branching in comparison to wild-type plants. The changes in shoot branching were additive to previously characterised more axillary branching (*max*) mutants, suggesting the increase in branching is not solely due to changes in carotenoid derivatives, such as strigolactones. In addition to their roles in photosynthetic function, carotenoids were found to be essential for etioplast development in dark-grown (etiolated) seedlings, specifically the formation of the membranous prolamellar body (PLB) lattice. Herbicide treatments that alter carotenoid composition in wild-type and *ccr2* etiolated seedlings were used to demonstrate that the loss of the PLB in *ccr2* mutants was a result of perturbed carotenoid accumulation, not indirect secondary effects, as PLB formation could be restored in *ccr2* mutants by blocking carotenoid biosynthesis with the herbicide norflurazon.

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Plant Nutrition Awards 2009

The Plant Nutrition Trust was established in 1996 with the aim of encouraging and promoting research and technology transfer in the mineral nutrition of plants, soil fertility and fertiliser and soil amendment technology, including areas where these impinge on other fields such as plant breeding.

The Management Committee of the Trust has included people associated with The Australian Society of Plant Scientists, The Australasian Soil and Plant Analysis Council (ASPAC), The Fertiliser Industry Federation of Australia, the Australian Society of Soil Science and The Australian Institute of Agricultural Science and Technology. The funds come from surpluses from several International conferences held in Australia and donations from ASPAC, The Sulphur Institute and individuals.

Each year, The Trust offers one or more Awards. The Awards have been named in honour of Dr Alf Anderson, Prof. Jack Loneragan and Dr Sam Tisdale, three scientists who have made outstanding contributions in plant nutrition.

The first Awards were made in 1997 to Dr Anthony Whitbread (an Alf Anderson Award to attend the International Soils Congress in France) and to Dr Linda Tabe (a Sam Tisdale Award to attend the International Conference of Plant Molecular Biology in Singapore). So far 40 scientists have been supported to travel to International and Australian conferences, to make study tours or spend time gaining experience in other laboratories.

The 40th award was made this year to Dr Simon Conn. Simon was awarded a PhD in 2006 by Flinders University and is currently at the University of Adelaide. He won a Jack Loneragan Award that will enable him to attend the International Plant Nutrition Colloquium to be held in Sacramento, California, during August. The theme of the Colloquium is "Plant Nutrition for Sustainable Development and Global Health" and Simon's contribution will explore the genetic control of mineral element accumulation in plants with the aim of understanding how mineral nutrient concentrations can be altered to improve food quality. He will present a paper with the title "Genes controlling Ca accumulation in specific leaf cell types are also necessary for regulating apoplastic Ca, stomatal conductance and growth."

Dr Simon Conn

The Awards are open to Australian citizens and permanent residents who are based in Australia. The call for applications is usually made in November or December with a closing date in late February. Information about the Plant Nutrition Trust can be obtained from Dr Peter Ryan (Peter.Ryan@csiro.au)

From Our Seed Banks

Meeting reports provided by members from around the country

Report on the 1st International Plant Phenomics Symposium

Canberra 22-24 April 2009

The First International Plant Phenomics Symposium was a timely meeting of plant biologists focussed on using plant phenomics and functional genomics to address crop productivity. This conference was a particularly significant occasion for a number of reasons:

- It was the first International Symposium of its type – and the first time a group with diverse interests in plant structure and function have come together under a phenomics banner. The meeting was planned to help promote phenomics approaches and encourage development and spread of new techniques. The proceedings will be published in a special issue of the journal *Functional Plant Biology*.
- It was the first major scientific event of the High Resolution Plant Phenomics Centre, the Canberra node of the Australian Plant Phenomics Facility. The Facility represents a significant investment by the Australian government and partners in scientific infrastructure; and
- It launched a collaborative approach to international plant phenomics.

The Symposium was attended by 128 registrants – 46 were international, 47 interstate and 35 from within Canberra. Registrants came from all the major phenomics centres, included the Director of the Scottish Crops Research Institute, the Director of Phytosphere and the Deputy Head of the Forschungszentrum Julich, Germany, researchers from the University of Sheffield, New York University, University of Dundee, Washington State University and Stanford University. There were also presentations and representation by commercial groups, including Monsanto, Bayer Crop Science and BASF / Crop Design.

This geographic spread of plant scientists, from Australian and international groups, underscored the level of global interest in plant phenomics as a source of techniques for better understanding of plant growth, performance and yield at the crop and population level. It was evident from presentations by extant and prospective plant phenomics centres in the UK, Europe and America that the levels of investment taking place are very high. Nonetheless, the Australian Plant Phenomics Facility is acknowledged to be at the cutting-edge in technology and to be taking a leadership role in encouraging collaboration (more on other phenomics centres below).

The Symposium was structured to reflect the scientific questions the technology addresses, with sessions on biotic stress (including fungal pathogens), abiotic stress (including screening for drought tolerance), growth and yield and ecosystem dynamics and climate change.

The Symposium also saw 30 posters displayed and a number of short research talks presented.

Papers canvassed not only technological advances but also the application of new phenotyping approaches to understanding plant performance and selection for breeding. This was seen as particularly important in the light of escalating demands on agriculture, globally. The need for a transformational advance in cereal yields, over and above the incremental annual increases afforded by current plant breeding technologies, was recognised as a driver for new technologies, as were the challenges of drought and salt stress.

Despite the novelty of many of the techniques described at the Symposium, presentations were made showing the effectiveness of imaging techniques for screening large populations to identify mutants and germplasm adapted to environmental stresses. IR thermography is proving to be a useful tool in screening for stomatal function both in controlled environments and in the field. Bernard Genty (CEA France) described the use of this technique to identify mutants in guard cell function in Arabidopsis, while Xavier Sirault (APPF Canberra) illustrated its use in screening cereal germplasm for osmotic stress tolerance in controlled environments. In the field, Michael Malone (Monsanto, USA) used IR thermography to clearly determine thermal stress tolerance in transgenic soybean, while Lyn Jones (Dundee, UK) and Guo Yu Qiu (Beijing, China) both presented methods to assess drought tolerance and monitor transpiration using IR thermography.

Many presentations at the Symposium described the use of digital imaging of growth, often combined with spectral or chlorophyll fluorescence measurements to screen for mutants or assess abiotic and biotic stress tolerance. Achim Walter (Juelich, Germany) described a high throughput system for determining drought tolerance in Arabidopsis using combined digital imaging and chlorophyll fluorescence while Murray Badger (ANU) reported on the isolation of new classes of photorespiratory mutants in Arabidopsis using chlorophyll fluorescence imaging. The promise of chlorophyll fluorescence imaging in biotic stress Phenomics was presented by Julie Scholes (Sheffield UK) who described elegant experiments tracking the progression of infection by plant pathogens using this technique. In species with more complex morphology, 3-D digital growth analysis is proving to be a useful tool in screening for salt tolerance in cereals (Berger, Tavakkoli, Tester et al. ACPFG and University of Adelaide), and for examining growth dynamics and adaptation to light environment, such as in the C_4 plant *Flaveria bidentis* (Jasper Pengelly et al., ANU). The utility of this technique for following growth non-destructively in a wide variety of plant species, even when plant structure is complex, presents many opportunities in single pots and in the field (Hosoi et al., Tokyo, Japan; Culvenor et al, CSIRO).

There was general agreement at the Symposium that multiple simultaneous measurements systems offer the richest rewards in Plant Phenomics and leaf spectral reflectance and absorbance measurements offer an opportunity to examine a range of process, including chemical composition and metabolic function. The opportunities for these measurements in monitoring pigment composition and function at low temperatures (Ball et al, ANU) and chloroplast electron transport in intact leaves under stress (Kramer, Pullman, USA) were presented and there was enthusiasm about overlaying such signals with plant architecture, measured by Lidar or other 3-D imaging technologies.

As always, root phenotyping remains a great challenge. Determination of root growth and architecture in soil remains a difficult task, particularly in high throughput. Elegant but low throughput 3-D reconstructions of root structure were shown using X-ray CT (Gregory et al., Dundee) and MRI (Schurr et al., Juelich Germany), but despite physical limitations to root growth in thin layers of soil, higher throughput would still be possible in Rhizotrons using digital imaging and automated image analysis (Sirault et al., APPF Canberra; Faget et al., Zurich ,Switzerland and Yazdanbakhsh et al., Golm, Germany).

Looking to the future, it was agreed at the Symposium that a stronger vehicle for international collaboration should be established – and the International Plant Phenomics Initiative was launched. The Initiative will, over the coming months, develop an agenda and confirm priorities and actions at a meeting later in 2009. This will become increasingly important with the burgeoning world-wide interest in establishing Plant Phenomics Facilities. The agenda will likely include exchanging protocols, validating systems, exchanging staff for technical education and developing collaborative funding bids. The Initiative is being led by Forschungszentrum Julich and the Australian Plant Phenomics Facility.

Abstracts from IPPS are available at www.plantphenomics.org.au and a special issue of Functional Plant Biology containing articles from the Symposium will be published later in 2009. Information on the APPF capabilities, access and pricing are also available at the url above.

Bob Furbank

High Resolution Plant Phenomics Centre, CSIRO Plant Industry

Group Photo of Attendees

Functional Plant Biology

Editor-in-Chief: Dr Rana Munns Assistant Editor: Dr Yvonne Cheng

Update on Functional Plant Biology

Three new features:

- The Evolution of Plant Functions series has started, in June 2009. Further information on articles 'in press' and 'in preparation' is given on the Functional Plant Biology page on the ASPS website (www.asps.org.au), and in the editorial for the June issue of FPB (http://www.publish.csiro.au/?act=view_file&file_id=FPv36n6_ED.pdf).
- All reviews are free on-line for three months after publication. The Goldacre Award reviews are always open-access.
- Supplementary files may contain videos, including time-lapse photos and confocal stacks.

The numbers of high quality papers continues to increase. Despite an increase in the rejection rate (over 75% at present, which is very healthy), the numbers of good papers are piling up, so to maintain the rapid rate of publication for which FPB is well known, we are asking authors to aim for a moderate length paper of about ten journal pages and make use of the supplementary files.

Next year we will publish a series of Research Fronts, a cluster of papers on a common topic, consisting of a review or viewpoint article and about three original research articles. Topics lined up for early next year are soil salinity, acid soils, water and ion transport, and climate change. Let me know if you are interested in contributing to these Research Fronts.

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

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 in New Zealand), and contribute to their professional development in plant science. Support will vary from year to year depending on the Society finances, location of meeting and number of applications. The Treasurer will apply a formula in calculating individual entitlements and takes these factors into account. Applicants must be financial members of ASPS and presenting a paper or poster at the ComBio meeting.

- ***Postgraduate Section.*** We are proud to announce that student members who have recently completed their PhD and had their thesis passed can submit a summary that features in Phytogen. The editors 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).