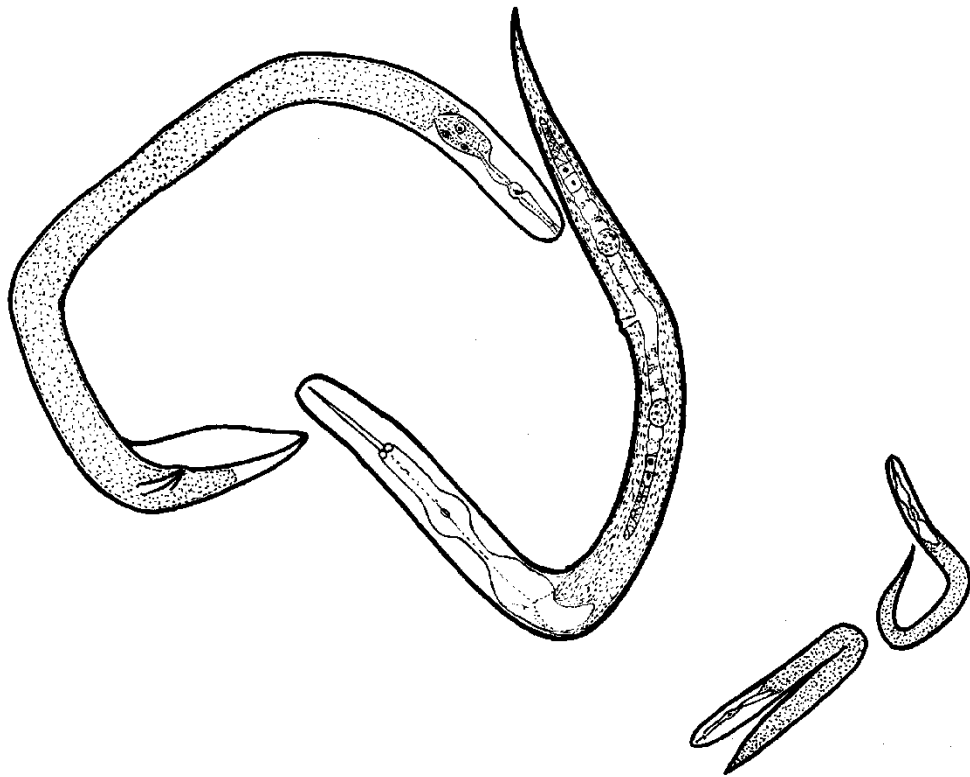


# AUSTRALASIAN NEMATODOLOGY NEWSLETTER



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# From the Editor

Special thanks to Katherine Linsell, who stood in for me as editor of the January issue while I was in the UK. Great job, Katherine! Thank you to those of you who made contributions to this current newsletter.

## January Issue

The deadline for the January issue will be late December 2012. I will notify you a month in advance so please have your material ready then.

*Kerrie Davies*

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# Association News

## FROM THE PRESIDENT

Another column that must mention the passing of a distinguished Australian nematologist: in this case John Fisher. Although out of nematology for some time, both his pioneering work and his supervision of students were very influential. His obituary is elsewhere in this edition, but John's stature is such that I feel compelled to formally record the loss to AAN and Australian nematology.

On a brighter note, the APPS conference is coming up in NZ. There is no specialist nematology session or workshop, despite Sarah Collins attempts to generate interest, and my missives in this newsletter. This is a great shame, as I think actually talking nematology—or other less important matters—face to face is most worthwhile. In the light of recent cut backs all over the place, having some sort of connection with other people in the field cannot be undervalued, especially when the going gets rough.

Even though there is no specialist session on nematodes, I know there are at least a few nematologists going. **Sarah Collins** is a definite at this stage (after all my recent travels—see the Canberra news—I am not certain of going) and **would like to make sure that the AAN group attending the APPS conference get together for a dinner and Biennial General Meeting. At the time of writing she was not sure which night would be best, but there is a free dinner as an inducement. After all, the aim of the AAN is to bring nematologists together and facilitate communication. Please contact Sarah if you would like to go or have any ideas.**

The response to the calls from both Sarah and me for expressions of interest in running or participating in a workshop at APPS was disappointing, and as a result we have no specialist workshop for the first time in many years. APPS has supported AAN in having workshops and special nematology sessions in the past, and they say they are willing to do so again in the future. Members do need to be just a little more active in making sure the activities happen. What with various stresses and issues at workplaces (they are euphemisms for cuts, restructures and redundancies) it is easy to ignore AAN activities, but it is amazing how little effort it can take to get things rolling. We as an association should do better next time. End of missive.

The next conference on the calendar is the 6<sup>th</sup> International Congress of Nematology in Cape Town in July 2014. These conferences are only held every 6 years, and all that I have been to have been thoroughly worthwhile as the biggest gathering of nematologists held. The fact that it is only nematologists does not mean that the congress is a narrow, specialist affair. Quite the contrary! If you want to find out the breadth of the field, and how what other people are doing in related fields can help you, then this is the one for you.

The various themes and sessions have been announced, along with the session chairs. Have a look at the web site: [www.6thicn.com](http://www.6thicn.com) .

If you are thinking of going, now is the time to be contacting the session convenors and getting your contribution scheduled as a talk rather than a poster. Australasia seems to be punching above its weight so far because there are quite a few session convenors from AAN. I am convening the session on “Nematode Biodiversity”, David Wharton (U Otago) is convening “Physiology, Biochemistry and Behaviour of Nematodes”, Shashi Sharma (Murdoch) is convening “Regulatory Aspects of Plant Nematology” and Mike Jones is convening “Genomics and Plant-nematode Interactions”.

If you are a student, a reminder that the Australasian Nematologists Support Fund has allocated money to at least partially sponsor travel and attendance. Get your funding request in soon and use our grant to leverage money out of other funders. (Sadly, this is probably an essential part of training for young nematologists nowadays.)

Any comments or questions on any of this, please get in touch.

*Mike Hodda*

# Regional News

## NEWS FROM THE ACT

### CSIRO Ecosystem Sciences

The Canberra nematology group has had some of the busiest times ever, as anyone trying to contact Mike would know!

In February, Mike, Sunil and Natalie travelled to Melbourne for the Plant Pest Diagnostician's workshop, where Mike talked briefly about photographing symptoms of nematode attack on roots and Natalie spoke about metagenomics.

Dorota (Dee) Porazinska finished her year as a Distinguished Visiting Scientist and departed after a productive year in March. Everyone was sad to see her go, but her work lives on in the form of 2 papers from her work here, the first in internal review and the second in preparation. Full details when they are published later this year. After returning initially to Fort Lauderdale in Florida, Dee has moved to Boulder, Colorado, where (according to her emails) she is enjoying her new work immensely. We hope we will be able to get her back soon, although after the equivalent of going more than around the world in the last little while, Dee said the desire for more travel was not high at the moment!

Almost contemporaneously with Dee leaving, Mike and Natalie departed temporarily to deliver a nematode course in Thailand. This was a follow-up to previous visits, and involved some old friends as well as some new faces. Thailand, the Philippines, Viet-Nam, Cambodia, Malaysia, Indonesia, Singapore and Laos were all represented. It all went very well and everyone (including us) learned a lot: the similarities and differences in the nematode issues faced by our near neighbours are always illuminating. We hope that this activity can continue.

Straight after the week-long course, Mike and Natalie set out for some preliminary sampling as part of Natalie's Ph.D. project on nematode movement through trade networks, helped by Nuchanart Tangchitsomkid and Thanakorn Chanmalee ("Tom") from the Thai Department of Agriculture. Thanks to some great local knowledge and contacts, the sampling was hugely successful, and we are planning more. Readers will have to wait for the paper to learn what we found!

After a short time back in the lab., Mike was off again to Perth for a one-day seminar for local turf managers concerned with Sting and other nematodes attacking their grass. If that wasn't enough, Mike and Kerrie Davies (Uni. of Adelaide) also presented a special week-long nematology workshop. Many of the participants were DAFWA people otherwise unable to travel to workshops held elsewhere, but there were some non-sandgroper participants as well. Nuchanart & Tom from Thailand came along as well to learn about nematodes in Australia. After the week in Perth, they both travelled to Canberra to see how things were on that side of the country.



Mike Jones presenting Thanakorn Chanmalee with his certificate, with Nuchanart Tangchitsomkid and Mike Hodda looking on.

Shortly afterwards, Qudsia Tahseen (Aligarh Muslim University, India) came for a couple of weeks on a Fellowship from the Indian Academy of Sciences. While here, Qudsia gave a seminar, looked at our local nematodes from soil and bark, and made a start on sorting out the local *Aphelenchoides* by doing some SEM work. This work confirmed that there is a lot of diversity in the genus, and it will take some time to sort it out. We are planning future activities and visits.

Somehow in amongst all that activity, Natalie finished a draft of her literature review, and has had her candidature confirmed.

Likewise Kylie Crampton, Mike's other relatively new PhD student—and honorary Canberran even though at CSU Wagga Wagga—finished a draft of her literature review, while managing to set up cultures for her subsequent work. No small task.

Sunil Singh, one of Mike's more established Ph.D. students has completed all the work for his thesis. The thesis is by papers: one is accepted (EPP0 Bulletin, should appear in August), and the others are either submitted and under review (NeoBiota, Journal of Applied Ecology, Australasian Plant Pathology) or in internal review. He expects to submit the thesis in July.

The big news is that Abdul Gafur submitted in May. Abdul has now gone back to Kalimantan as his scholarship and visa expired. His thesis took the traditional, non-published form, and is still under examination at the time of writing. There will be an abstract in the AAN newsletter after it is passed.

If that was not enough, Mike completed a small project with Zheng Qi Zhao from Landcare NZ on what is and what is not known about the genus *Aphelenchoides* in both countries. They both hope that this will lead to some long, long overdue work on this genus. In his book in 1991, David Hunt pointed out that serious work was long overdue, and not much has happened since!

In amongst all that, Mike, Sunil and Natalie gave a seminar at DAFF, and Mike has continued working in SPHDS to make sure that diagnostics capability for nematodes and other plant pests is maintained or enhanced.

Whew! (But it is nice to see this much interest in nematodes.)

*Mike Hodda.*

## NEWS FROM SOUTH AUSTRALIA

### The University of Adelaide

Kerrie Davies had a great time in the UK during January and February this year. While away (mostly visiting family), she was able to catch up with various nematologists who have previously spent time at the Waite. Kerrie had a very enjoyable day near London with Adrian Evans and his wife Pat. Adrian is now retired from Silwood Park, but continues to do part-time teaching in a Master's course. She was also able to get to Germany (where it snowed), and to spend a few days with both Suzanne Charwat and Andreas Hensel. Both are well, and busy, but not with nematodes.

Since her return, Kerrie has worked on a review of *Fergusobia* (with Leigh Nelson, David Yeates, Gary Taylor, Robin Giblin-Davis and others), which has now been submitted. She is also completing the last 4 manuscripts she intends to write describing new species of *Fergusobia*. 'Fred' Bartholomaeus has returned to the lab. and together they are working on a revision of the genus '*Schistonchus*', which is paraphyletic.

In April, Kerrie flew to Perth, where she attended the workshops presented by Mike Hodda on turf nematodes, which were most interesting. She and Mike then ran another short course on "Nematodes in cropping systems - identification and techniques" – the tenth of a series that has been great fun to teach and most instructive for Kerrie.

John Sagun (Darwin) visited the lab. in June and July to work on his Master's project on entomophilic nematodes (*Heterorhabditis*). He is a part-time, external student enrolled at Ateneo de Manila University.

*Kerrie Davies*

## NEWS FROM WESTERN AUSTRALIA

### Murdoch University

The group at Murdoch University studying plant nematology is part of the Plant Biotechnology Research Group and is based in the WA State Agricultural Biotechnology Centre (SABC). The plant nematology group consists of the following:

#### **Researchers**

Prof Mike Jones

Dr John Fosu-Nyarko

Dr Leila Eshraghi

A/Prof Derek Goto (Distinguished Collaborator: Hokkaido University)

Dr Uma Rao (Indian Agricultural Research Institute) Australia-India Strategic Research Fund Project (now completed from the Australian side)

**PhD students**

Paul Nicol

Jo-Anne Tan

Sadia Iqbal

Harshini Herath

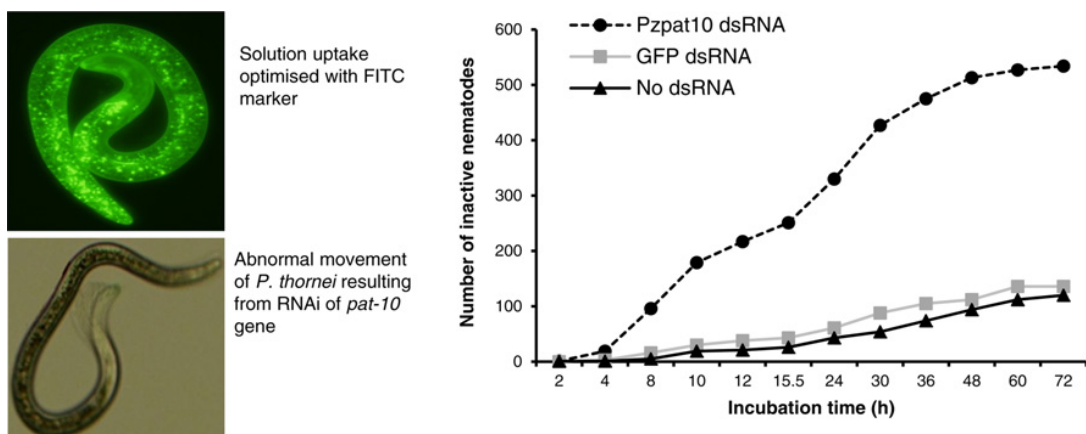
Malathy Rathinasamy

The focus of the work in the group is on the molecular basis of nematode-plant interactions and use of new approaches for nematode control. One focus is on root lesion nematodes and is described in the following publications:

Jo-Anne C.H. Tan, Michael G.K. Jones, John Fosu-Nyarko (2013). Gene silencing in root lesion nematodes (*Pratylenchus* spp.) significantly reduces reproduction in a plant host. *Experimental Parasitology* **133**, 166–178.

Jones, J, Jones, M.G.K. *et al.* (2013, in press). Top 10 plant parasitic nematodes in molecular plant pathology. *Molecular Plant Pathology*. This paper is one of a series on top 10 plant pathogens, with our contribution being on root lesion nematodes.

We are proud of Jo-Anne's paper which is a detailed study on gene silencing in root lesion nematodes. Here is a graphical representation of major results:



It demonstrates that

- *P. thornei* and *P. zae* are amenable to double stranded RNA-induced gene silencing via soaking
- using spermidine phosphate salt hexahydrate in soaking media results in more effective gene silencing,



- that silencing of the genes *pat-10* and *unc-87* of *P. thornei* reduces reproduction by 77–81% in carrot mini discs
- and that double stranded RNA from either nematode species silenced the corresponding gene in both species

We conclude that gene silencing (RNA interference) is a potential control strategy for root lesion nematodes.

In other areas, John continues to be the mainstay in the lab, and is involved in most research projects. Paul Nicol is writing up his thesis which has a bioinformatics focus, including analysis of transcriptomes of *P. zaeae* and *Heterodera schachtii*. Sadia and Harshini are undertaking detailed studies on different metabolic pathways in root-knot and cyst nematodes as potential targets for control, and Malathy is studying small RNAs in relation to gene silencing. Leila is developing ‘hairy roots’ systems for potential nematode maintenance and testing. We will update these projects as the work proceeds to publications – there are quite a few in the pipeline!

Kerrie Davies and Mike Hodda, with the help of Sarah Collins and the DAFWA group, ran a Nematode Workshop at Murdoch University this April, with about a dozen attendees. This is the second such course they have presented at Murdoch.

### ***International links***

In February, Mike visited India and gave a plenary address at an International Meeting at Kakatiya University (Warangal, AP) and visited Dr Uma Rao at IARI and other researchers at Delhi University (South Campus) to discuss joint research and publications. In May, as part of a short trip to the USA, he also visited Professor Eric (Rick) Davis at Raleigh, NCSU, USA who is focussing on analysing what nematode effectors interact with. Potential collaboration was discussed, and as a result we may well be able to persuade him to visit Perth in the future.

As a ‘Distinguished Collaborator’, A/Professor Derek Goto from Hokkaido University has visited the group twice this year so far. His focus is on host responses to *Meloidogyne hapla*, and on molecular events involved in giant cell formation and plant responses to nematode infestation. Derek was a former student of Mike’s at Murdoch University, and now that he has his own lab at Hokkaido University, and with his postdoctoral experience at Cold Spring harbour Laboratory in the USA, where he rubbed shoulders with the likes of James Watson, we can predict that he will become a new force in this field.

*Mike Jones*

### **DAFWA**

The DAFWA nematology team has contracted somewhat in 2013. In 2012 we were 8, now we are a staff of 6 and soon we will have 5... Signs of the times? Nevertheless we are hard at work with final reports for both GRDC and HAL projects on root lesion and root knot nematodes and keeping busy with glasshouse and field trials for current projects. New GRDC project funding has been secured for the next 5 years so we sigh with relief and continue nematology research for broad-acre cropping in WA.

We want to share some interesting findings with you from two trials conducted in 2012.

### *pH Trial*

Acid soils are prevalent across WA's broadacre cropping areas and are known to impact on nutrient uptake and increase plant vulnerability to pests and pathogens. A preliminary trial funded by GRDC in 2010 indicated increased multiplication of RLN in lower pH soils. In 2012 a larger trial was conducted to assess the effect of pH on *P. neglectus* multiplication and plant biomass. The trial aimed to determine if soil acidity negates cultivar resistance and increases RLN's ability to multiply on wheat. In consultation with DAFWA soil scientists (Grains Soils Management Group), soil from two field trial sites (Kellerberin and Wongan Hills), both with adequate and low pH soils, were utilised (Table 1). Six wheat cultivars considered more resistant (Wyalkatchem, Yenda and Tamaroi) or susceptible (Calingiri, Wylie and Brookton) to *P. neglectus* were assessed. Low pH soil treatments had significantly more nematodes than higher pH soils from both sites (Table 2 and Figure 1). Also importantly, pH did not affect root and shoot weight but variety and exposure to RLN did. This trial has important implications for broadacre cropping in WA as RLN impacts may be exacerbated in lower pH soils. Further research will be conducted in 2013-14 in conjunction with DAFWA Grains Soils Management Group.

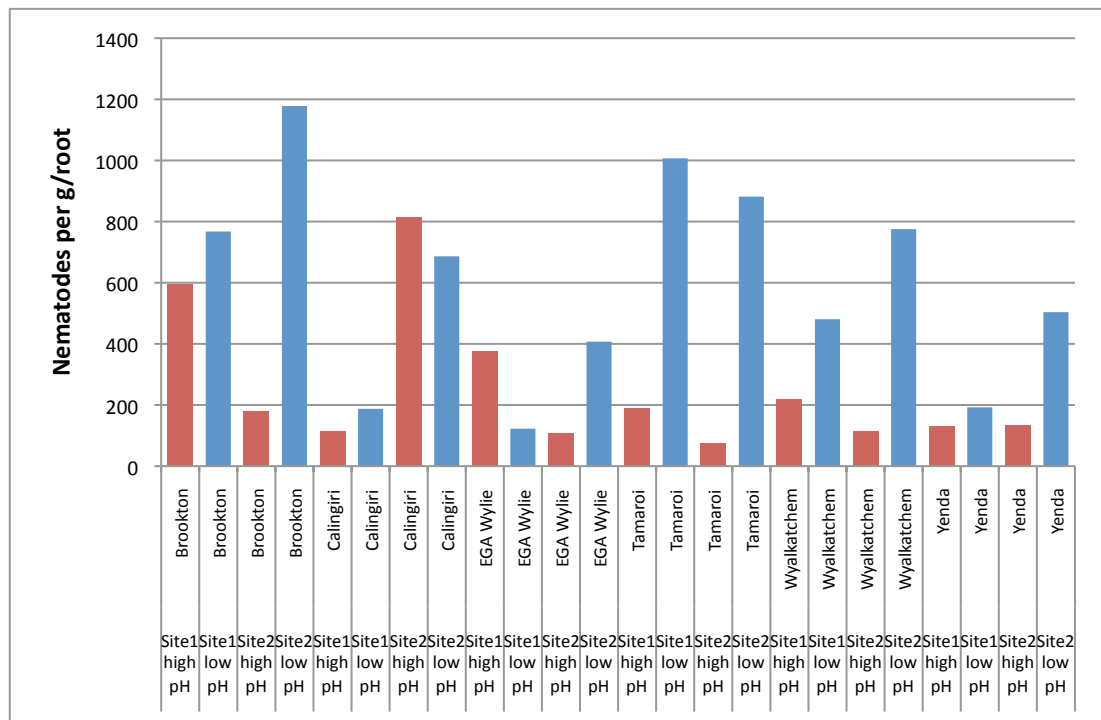
**Table 1:** Treatment description and pH levels for soils collected from two field trials sites managed by DAFWA Grains Soil Management Group

Site	Treatment	pH Level (CaCl <sub>2</sub> )	pH Level (H <sub>2</sub> O)
1 - Kellerberrin	adequate pH	6.3	6.9
1 - Kellerberrin	low pH	4.9	5.5
2- Wongan Hills	adequate pH	6.4	6.9
2 -Wongan Hills	low pH	4.5	5.6

**Table 2:** Statistical analysis

Soil treatment	Average Nematodes g/root <sup>a</sup>
Wongan Hills (adequate pH)	3.062 a
Kellerberrin (adequate pH)	3.962 a
Wongan Hills (low pH)	5.019 b
Kellerberrin (low pH)	5.048 b
<b>Fpr</b>	<0.001
<b>LSD (p=0.05)</b>	0.999

<sup>a</sup> Back transformed means are given as data was transformed (log<sub>10</sub> (x+1)) prior to analysis. Means with the same letter within a column are not significantly different to each other (p=0.05).



**Figure 1:** Glasshouse assessment of *P. neglectus* multiplication on six wheat cultivars considered more resistant (Wyalkatchem, Yenda and Tamaroi) or susceptible (Calingiri, Wylie and Brookton) to the nematode grown in either adequate or low pH soils from 2 sites.

### ***DAFWA Assessments of Technique - Soil Sampling Trial***

Several experiments are underway to assess DAFWA techniques to pinpoint areas for streamlining to improve efficiency and address PreDicta-B calibration questions. These included a trial that aimed to determine *a)* an estimate of variability in nematode measurement within a plot; and *b)* the most accurate soil sampling method (comparison of SARDI vs CSBP pogo).

One plot (1.5m x 10m) was assessed repeatedly (15 reps for each treatment). Three different methods were applied to this single plot to collect forty five 400-500g soil composite samples for SARDI PreDicta-B assessment:

- I. 10 samples across plot with CSBP pogo
- II. 40 samples across plot with CSBP pogo, mixed and subsampled to create 500g lots
- III. 40 samples across plot with SARDI pogo

Using PreDicta-B for analysis of nematode samples, results were highly variable even in the small plots utilised for the field trial (Table 3). The SARDI recommended sampling technique performed the best but was not statistically different from the CSBP 10 sample method. Sub-sampling gave the most variable results. The CSBP 10 sample method will be utilised by DAFWA nematology in future as ease of collection and time management is superior to the SARDI method.

**Table 3:** Statistical analysis of three soil sampling techniques applied repeatedly on one plot (1.5m x 10m) (15 reps for each treatment) and used to collect forty five 400-500g soil composite samples for SARDI PreDicta-B assessment

Method	Mean Nematodes/g soil <sup>a</sup>	Minimum Nematodes /g soil	Maximum Nematodes/g soil	Variance	Median	s.d.
CSBP Pogo (10 samples)	63.01 a	38.8	89.4	176.6	64.59	13.29
CSBP Pogo (40 samples subsampled)	80.15 b	48.03	118.5	313.5	80.76	17.7
SARDI Pogo (40 samples)	72.79 ab	56.75	97.3	158.9	67.83	12.61
<b>Fpr</b>	0.01					
<b>LSD (p=0.05)</b>	10.8					

<sup>a</sup> Back transformed means are given as data was transformed ( $\log_{10}(x+1)$ ) prior to analysis. Means with the same letter within a column are not significantly different to each other ( $p=0.05$ ).

*Sarah Collins*

## NEWS FROM BELGIUM

### BSES

*Lea Meagher has an Erasmus Mundus Scholarship to undertake a Master of Science in Nematology at Ghent University in Belgium. She has sent the following report:*

I have just finished second semester which means I have completed the first year of my European Masters of Science in Nematology. It has again been a very busy semester with varied and informative lectures given by experts such as Gerrit Karssen, John Jones, Dirk De Waele, Wim Wesemael and Godelieve Gheysen. The ageing biology course I undertook, based on *Caenorhabditis elegans*, also had an excellent lecture from world renowned Christine Van Broeckhoven from the neurodegenerative brain diseases group at the University of Antwerp.

We were also fortunate this semester to have been present at the 65<sup>th</sup> International Symposium on Crop Protection where there were many lectures, including a very relevant one given by Deliang Peng from the Chinese Academy of Agriculture, on the current research status of the cereal cyst nematode (*Heterodera avenae* and *H. filipjevi*) in China. Another seminar day included lectures from Sue Hockland on the spread of plant parasitic nematodes in international trade; and from Vivian Blok on molecular techniques currently being used for the identification and quantification of potato cyst nematodes.

A component of our degree is a summer course that started at the beginning of July and involved visits to different laboratories and companies throughout Western Europe. Our first visit was to the Functional Genomics and Proteomics Unit at Leuven University where their molecular investigations involving nematodes were explained, along with a tour of their impressive facilities - the worm sorter and automatic agar plate pourer would be a welcome addition to many labs I'm sure! A long bus trip to the Northern German town of Kiel involved a visit to 'e-nema', the largest producer of entomopathogenic nematodes in the world. Ralf-Udo Ehlers, the founder of the company, is not only a brilliant nematologist and enigmatic entrepreneur but also ensures that the biological control he provides is environmentally sustainable and also thoroughly researched. A factory tour and presentations by Ph.D. students made for a very informative and interesting day. From Kiel

it was another long bus trip to the lovely city of Bonn, and seminars at the Laboratory for Molecular Phytomedicine, where there is a lot of research on *Heterodera* and *Meloidogyne* species, and made for an enjoyable afternoon. The final visit for the first week was to Syngenta Crop Protection in Stein. While it is an amazing company, with a ridiculously impressive profile and facilities, the extent of the work being conducted on nematodes certainly has room for expansion.

The second week included a trip to the Netherlands and presentations from several researchers from the Netherlands Institute of Ecology, Wageningen, on the importance of rhizosphere biology and how different factors and influences need to be recognised in relation to nematode life cycle and control. At Wageningen University we had several interesting seminars from Hans Heider and colleagues in the Nematology Department regarding molecular systematic. We also visited the Plant Research International at the University where Thomas Been introduced their research into resistance to *Meloidogyne chitwoodi* in potatoes. The Applied Plant Research Station at Lelystad was also interesting for seeing how research results are converted into practical information for growers. Whilst in the Netherlands we also travelled to the Department of Ecogenomics, Institute for Water and Wetland Research, at Radboud University, where their research related to plant defence against nematodes was explained. A final visit to BLGG AgroXpertus was very insightful for seeing how a company processes more than 500,000 samples per year and the different aspects of nematology they deal with. Once back in Belgium the course continued with a trip to Belorta, the largest cooperative auction house in Europe where more than 40% of Belgian Horticultural products are sold. It was extremely interesting to see how fluctuations in the market affect growers on a daily basis and how efficient such organisations need to be – and I have never seen so many forklifts travelling backwards at such speeds! This was followed by a visit to the Research Station for Vegetable Production and to several growers where different glasshouse and field methods for growing vegetables, particularly lettuce and tomatoes, was demonstrated.

My third semester, beginning in September, will be at the University of Evora in Portugal. I'm looking forward to courses such as Ecology of Meiobenthos and Nematodes, biocontrol of pests in agriculture and forestry, applied molecular biology and physiology of plants under biotic stress.

*Lea Meagher*

# RESEARCH REPORTS

## INTROGRESSION BREEDING - NEW SOURCE OF NEMATODE RESISTANCE TO AUSTRALIAN SUGARCANE

<sup>1</sup>Shamsul Bhuiyan, <sup>1</sup>Eunice Wong, <sup>1</sup>Barry Croft and <sup>2</sup>Graham Stirling

<sup>1</sup>BSES Limited, Woodford, Qld

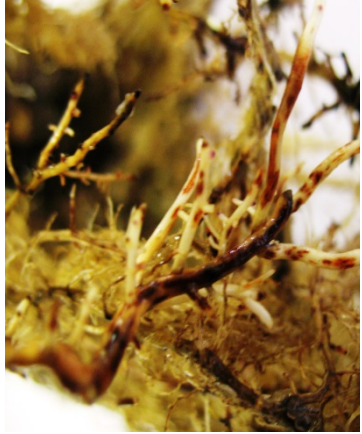
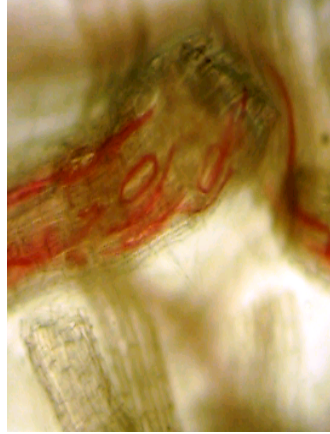

<sup>2</sup>Biological Crop Protection, Brisbane

Nematodes are serious pests of sugarcane, causing in excess of \$82 million losses per annum to the Australian sugar industry. The two most important nematode pests of sugarcane are *Pratylenchus zeae* (lesion nematode) and *Meloidogyne javanica* (root knot nematode). No Australian sugarcane varieties are resistant to these nematodes.

An Australian and Chinese collaborative project crossed wild species of *Erianthus arundinaceus* and *Saccharum spontaneum* with noble cane (*S. officinarum*) to successfully produce fertile progenies. A program has been established at BSES Woodford Pathology Farm to screen populations from various stages of introgression crossings against *P. zeae* and *M. javanica*.

Most of the clones of basic *E. arundinaceus* and *S. spontaneum* showed good resistance to both root knot and root lesion nematodes. Average levels of resistance tended to decrease with each successive back cross between the wild species and commercial sugarcane. However, individual clones with good resistance were found in families from back crosses with both *E. arundinaceus* and *S. spontaneum*. These individual nematode resistant clones will be further tested and may prove to be a source of resistance for commercial production, or as parents for further breeding.

Further screening is being planned for new introgression populations in coming years.

		
<p>Lesion nematode (<i>P. zae</i>) symptom on sugarcane root</p>	<p><i>P. zae</i> inside sugarcane root</p>	<p>Root knot nematode (<i>M. javanica</i>) symptom on sugarcane roots</p>

# Obituary

## JOHN FISHER

John Fisher (1932-2013) died on July 1<sup>st</sup>, after a long illness. John was born in Lane Cove in Sydney, and attended North Sydney Boys High School before winning a scholarship to study Agricultural Science at Sydney University. After graduation in 1953, John was employed by the NSW Department of Agriculture as a Plant Pathologist. He worked on Panama Wilt Disease of bananas at Murwillumbah, which would have showed him that nematodes were present and damaging. At this time, it was becoming evident that plant-parasitic nematodes had a major impact on agricultural crops, and The University of Adelaide decided to create a lectureship in plant and soil Nematology – the first such position at an Australian university. John was appointed to the position, at the then Waite Agricultural Research Institute, in 1956, and said that at that time he knew little about nematodes. He taught himself the basics of nematode biology and identification, and declared that there was nothing like teaching a subject as a way to learn it. In 1961, he won a Fulbright Scholarship to the University of California, Davis, to study with Merlin Allen and Dewey Raski, who ran courses in Nematology. In 1964, John was awarded his Ph.D. degree from The University of Adelaide, for his research on *Paratylenchus* in apple orchards.

John was an example of a well-rounded nematologist, with interests in biodiversity, taxonomy, biology and ecology. Early in his career, he surveyed agricultural and natural habitats, describing several new nematode species and identifying common plant parasitic nematodes in South Australia. John early recognised the importance of culturing nematodes in order to have a ready supply for experiments, and with Adrian Evans he established cultures of various isolates of the fungal-feeding nematode *Aphelenchus avenae*. This nematode became his lab. rat, and he used it in many of his studies on the biology and physiology of nematodes. In collaboration with Hedwig Hirschmann and A.C. ('Tasso') Triantaphyllou, he was able to show that cell divisions in the gonad primordium of the nematode were restricted to periods of lethargus in the second and third moults. He also showed that a minimal amount of feeding was essential before a moult could occur, and developed a technique for ligaturing nematodes to explore the role of ecdysteroid hormones in the moulting process. John also elucidated the life cycles of the plant parasite *Paratylenchus* and the insect associate *Fergusobia* (with Bill Nickle).

John will be best remembered for his work on *Heterodera avenae* (CCN), which made a significant and lasting contribution to Australian agriculture. Over a period of 30 years, he and many post-graduate students and post-docs whom he supervised collectively investigated the egg-hatching process (with Bob Banyer), assessed the infectivity of second-stage juveniles under different temperature and moisture regimes, studied the impact of environmental factors on nematode development, examined the effects of nutrients such as manganese on nematode damage, determined economic thresholds by relating nematode population densities to yield loss, and examined the relationship between initial densities and nematode multiplication rates to establish host resistance and tolerance to CCN. He played a key role in identifying useful sources of resistance to CCN (with Chris O'Brien and others), and in developing laboratory assays which are still used to assess resistance. He was also involved in the work with ethylene dibromide which alerted the cereal industry to the importance of CCN to productivity. In the 1980's, with Robert Asiedu and the late Prof. Colin Driscoll, he developed a synthetic strain of wheat with resistance to CCN. This strain, now known as Line 6R(6D), has recently been shown to be highly resistant to *Heterodera filipjevi*, a serious pest of wheat in China (Yuan *et al.*, 2011; *Acta Agronomica Sinica*, **37**, 1956-1966). In 1987, John was awarded the Urrbrae Medal for the work that led to control of CCN.



Later in his career, John recognised the importance of *Pratylenchus thornei* to the cereal industry, and was involved in screening wheat varieties for resistance to it.

John's other significant contribution to agriculture was through his involvement in Annual Ryegrass Toxicity (ARGT). He said that when he first saw galled ryegrass with bacterial slime, he wondered whether the anguinid nematode and the bacterium could be involved in the toxicity to stock. Phillip Price then came to the Waite to undertake his PhD on the syndrome. In collaboration with Phillip and Alan McKay, the relationship between *Anguina* and *Corynebacterium* (now *Rathayibacter*) was confirmed, and the role of the nematode as the vector was understood. This led to studies of nematode population dynamics in the field, and contributed to development of methods of control of the disease.

We have fond memories of John's lab. in 'the dungeon', sharing the East Wing basement of the Waite Main Building with the plant virologists. Something was always happening in the lab., not always nematological – we remember white ants, floods and mouse plagues. John was a caring and enthusiastic teacher, who encouraged and motivated his students. His door was always open to students. John had a good sense of humour, and was interested in people, and loved to tease. For many years, he sported a big red beard, and when he finally shaved it off he derived great amusement from the number of people he saw every working day who walked past without realising who he was. A modest and self-effacing man, he did not attend overseas conferences, but did undertake two sabbaticals overseas – one in the USA with W.R. (Bill) Nickle, and one at Rothamsted working with scientists including Audrey Shepherd, Ken Evans, David Trudgill and David Hooper.

When the former Departments of Entomology and Plant Pathology at the Waite were amalgamated to form the Department of Crop Protection, John took the lead to set up the new subjects 'Plant Pathogen Interactions' for first semester final year students, and 'Plant Disease and the Environment' for second semester. These subjects ran from 1992 to 2005, until lack of staff and government cutbacks forced further changes.

John was a good all-round athlete. As a schoolboy, he held the records for the NSW State 440 yards and 880 yards races in Junior athletics. He played rugby for the Turramurra Rugby Club and Gordon Districts in Sydney, and enjoyed a game of tennis. His sporting prowess extended to soccer and cricket in staff/student matches. In later years, he regularly walked home and back for lunch.

John's honours and post-graduate students included Adrian Evans, Bob Banyer, Graham Stirling, Roger Dennis, Chris O'Brien, Walter Chit, Phillip Price, Alan McKay, Bharati Patel, Julie Stanton, Saria Meon, Robert Asiedu, Vivien Vanstone, Tony Pattison, Suzanne Charwat, Julie Nicol and Sharyn Taylor. Adrian was the first 'student Ph.D. candidate' in Australian Nematology. Earlier Ph.D.'s in nematology had been awarded to people who, like John, were actually staff members at the time of candidature. Kerrie Davies did three 'post-docs' with him. From the names of his students, and his role in developing control measures for CCN and ARGT, the range of his influence within Australian nematology and his contribution to Australian agriculture is obvious. His influence also extended to our near neighbours, as several of his students were from Asia and in 1984 he spent a year in Malaysia, teaching and training plant pathologists and nematologists there. He retired from the University in 1992.

In 1959, John married Greta Madigan, his former lab. assistant, and they were together for 53 years. He and Greta had three children, John ('Johnno'), Richard and Anne, of whom he was very proud.

Robert Asiedu wrote that John was 'a good and decent man who significantly impacted the lives of a lot of people in developing countries through the many foreign students that he trained so well'. John's scientific papers, and his students, form an impressive legacy. We miss him.

*Kerrie Davies and Graham Stirling.*