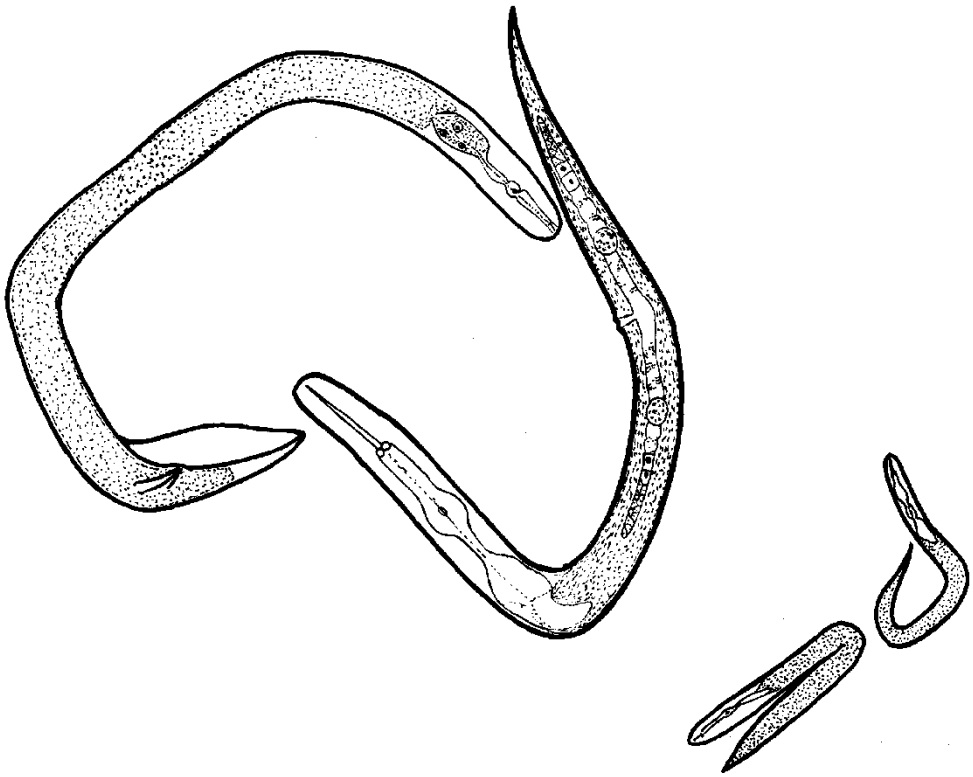
ISSN 1327-2101

AUSTRALASIAN NEMATOLOGY NEWSLETTER



Published by: Australasian Association of Nematologists

VOLUME 21 NO. 2 **JULY 2010**

From the Editor

Thank you to all those who made contributions to this newsletter.

January Issue

The deadline for the January issue will be the end of December 2010. I will notify you a month in advance so please have your material ready once again.

Kerrie Davies

Contacts

Dr Mike Hodda
President, Australasian Association of Nematologists
CSIRO Division of Entomology — Tel: (02) 6246 4371
GPO Box 1700 — Fax: (02) 6246 4000
CANBERRA ACT 2601 — Email: mike.hodda@csiro.au

Dr Sarah Collins
Secretary, Australasian Association of Nematologists
Department of Agriculture and Food — Tel: (08) 9368 3333
Locked bag 4 — Fax: (08) 9474 2840
Bentley Delivery Centre WA 6983 — Email: sarah.collins@agric.wa.gov.au

Dr Vivien Vanstone
Treasurer, Australasian Association of Nematologists
Department of Agriculture and Food — Tel: (08) 9368 1341
Locked bag 4 — Fax: (08) 9474 2840
Bentley Delivery Centre WA 6983 — Email: vivien.vanstone@agric.wa.gov.au

Dr Kerrie Davies
Editor, Australasian Nematology Newsletter
School of Agriculture Food and Wine — Tel: (08) 8303 7255
Waite Campus — Fax: (08) 8379 4095
University of Adelaide SA 5005 — Email: kerrie.davies@adelaide.edu.au

Association News

FROM THE PRESIDENT

On the international front, the main news has been the selection of the site for the next (6th) International Congress of Nematology in 2014 in April and May. There was an extremely strong field of cities and nematology societies bidding for the congress, including New Delhi, Sapporo, Beijing and Cape Town. The AAN has one vote, and I represent AAN. The proposals were not delivered in time for a general consultation with members, so I evaluated the proposals on behalf of AAN and discussed with the few people available before deciding to vote for Japan.

In the first round of voting, the results were: **China—2 votes; India—5 votes; Japan—7 votes;** and **South Africa—7 votes.** The election is a multiple round voting system, so a second round was held between the two highest vote-getters, resulting in **South Africa gaining 12 votes against 9 for Sapporo**. This means that the next International Congress will be in Cape Town in 2014.

Even better news is that we now have the Australasian Nematology Support Fund to support travel to events such as this. The first round of grants received one application, which was going to be funded until the applicant received all the required funds from another source. So the funds have been added to the pool, and larger grants will be available next time. Students can apply to this fund at any time for assistance in attending Australian or international conferences.

The next major event for nematologists in Australia is the Australian Soilborne Disease Symposium (ASDS) at Twin Waters from 9-11 August 2010. This promises to be a good meeting, and Graham Stirling is to be thanked for organizing it.

Then next year, there is the Australasian Plant Pathology Society (APPS) meeting in Darwin from 26-29 April 2011. This meeting is held in conjunction with the Asian Conference on Plant Pathology.

Traditionally, AAN has met at APPS, but with ASDS meetings becoming more frequent, fewer members attend any one meeting. After some discussion, we decided to hold one of the "traditional" nematology workshops in association with APPS, with a focus on tropical nematology and nematology in new areas. Barry Conde is thanked for local arrangements for the workshop. Contact me if you would like to contribute.

Unfortunately, amongst the exciting news of meetings and travel grants, there is also sad news in the passing of two important and influential figures in nematology.

Bob Colbran, for many years nematologist with QDPI and author of many Australian plant-feeding nematode species, passed away on April 12, aged 83. An obituary is presented elsewhere in the newsletter. I am sure I speak for all members of AAN in expressing my appreciation of his work over many years, and offering condolences for his family and friends.

Warwick Nicholas (Nick), nematologist at ANU, author of many Australian estuarine nematode species, and expert on *C. elegans* culture, passed away on May 5, aged 84. His obituary is also presented elsewhere in the newsletter. Nick will be missed, and the sympathies of AAN were expressed to his family.

Mike Hodda

FROM THE TREASURER

Membership of the AAN currently stands at 75. At the time of publication, fifteen of these members were un-financial, and I am not sure about six who pay through their APPS membership. Payments through APPS have been difficult to keep track of, as these are due at different times. I have also found that if people join through APPS, their details are not automatically passed on, so they do not appear on our mailing list. We need to consider some way of rectifying this, perhaps by including the AAN membership details form on the APPS membership site?

You will also note that all membership payments have now been aligned to a due date of June 1st each year. I would like to encourage electronic payments, as this I think makes life easier for members as well as for me. When requesting annual payments, I will provide AAN account information.

The following have joined AAN in the last 12 months –

- Anamika Kumar – PhD student, Department of Agronomy, Allahabad Agricultural Institute, India (vegetable crops, ecofriendly disease management)
- John Sagun – Darwin, NT (biodiversity, anatomy)
- Megan Wong – PhD student, Monash University, Victoria (ecology)
- Matthew Tan – PhD student, School of Biological and Environmental Sciences, Murdoch University, WA (molecular detection methods)
- Jyoti Rana – PhD student, School of Biological and Environmental Sciences, Murdoch University, WA
- Jacqui Nieuwenhuis – Lab Manager, Enza Zaden Australia Pty Ltd, Narromine, NSW
- Kazmi Munawar – Senior Scientific Officer, National Agricultural Research Centre, Islamabad, Pakistan
- Aaron Maxwell – AQIS, WA
- Paul Looby – Agricultural and Horticultural Consultant, Westgate Research, NSW (turf and horticulture)
- Frank Henry – Department of Primary Industries, Horsham, Victoria
- Sarah Dunstan – Sydney University, Department of Agriculture, Food and Natural Resources, NSW
- Dolf De Boer – Senior Plant Pathologist, Bioscience Research Division, Department of Primary Industries Victoria (nematodes of potato and vegetables)
- Matthew Ayres – SARDI, Plant Research Centre, Adelaide, SA
- Sonia Aghighi – PhD student, School of Biological and Environmental Sciences, Murdoch University, WA
- Suren Samuelian - National Wine and Grape Industry Centre. Charles Sturt University, Wagga Wagga, NSW
- Annabel Clouston - BioProtection Centre, Lincoln University, Christchurch, New Zealand

The WA APPS committee is keen to receive Pathogen of The Month (POTM) contributions. Some nematodes have already starred, but there is always room for more! Contributions seem to be 'drying up' and it would be great if this initiative could continue. This is not just for WA, but is designed to showcase pests and pathogens from all areas, including from our overseas members.

See http://www.australasianplantpathologysociety.org.au for an indication of the format and content. If you have any nematode ideas for future POTMs please contact Vivien (see address on page 1).

Vivien Vanstone

Regional News

NEWS FROM CANBERRA

Abdul Gafur had his PhD candidature at ANU confirmed and is currently in his home country of Indonesia collecting *Radopholus* specimens for his project. After sifting through a lot of soil samples collected from Queensland and NSW earlier in the year, he has so far managed to find 6 putative species of *Radopholus*. He also has some specimens from Fiji and will be comparing the populations from different geographical areas.

Sunil Singh, Mike's other PhD student is now settled in Canberra and is experiencing his first winter: it is a bit colder than his native Fiji, so Sunil is recognizable by his rugged-up appearance when not ensconced in his well-heated room. He has completed the first draft of the literature review for his project and is now collecting data on the distribution, host range and identification of plant parasitic nematodes for assessing biosecurity threats. Sunil also had a paper on weed hosts of root-knot nematodes in Fiji, published in Weed Technology. In the paper, a total of 45 potential weed hosts for root-knot nematodes is reported and the implications for nematode management are discussed. The paper is available online ahead of print publication on the weed technology website (http://www.wssa.net/WSSA/Pubs/WeedTech.htm).

In May, Mike and Kerrie Davies presented an intermediate-level course in nematode identification at the Australian National Insect Collection over 2 weeks. The course was sponsored by OCPPO, and intended for experienced nematologists. As such it was set at a higher level than the general introductory courses run by Mike and Kerrie and limited to 6 keen participants, including a number of familiar faces. This course even had a test at the end, which was passed by all with flying colours! If funding permits, there will be another test in a year's time.

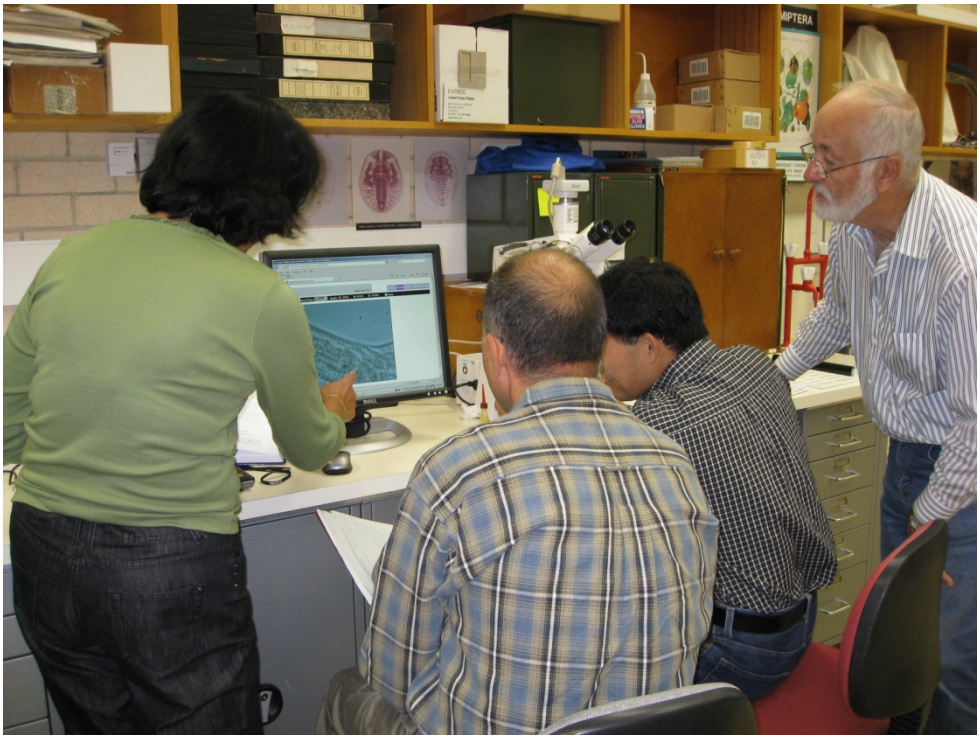
Congratulations to Mike for finishing his paper on the classification of all Nematodes (including Helminths) for a special biodiversity year volume of the journal *ZOOTAXA*. The paper lists over 260 families in 3 classes of nematodes. It will be available online from http://www.mapress.com/zootaxa/index.html later in the year. His other project on using genomic tools for assessing soil communities is also underway. This project includes other organisms, not just nematodes.

Mike has also commenced a project for the Australian Faunal Directory, checklisting the nomenclature of all nematodes of Australia.

Mike is now looking forward to attending a workshop on Potato Cyst Nematodes at Harper Adams University College (UK) in September, followed by the European Society of Nematologists meeting in Vienna straight afterwards. At ESN, he will be chairing the Ecology, Biodiversity and Evolution session and presenting on biosecurity issues. Although early registration has closed, general registration is still open. Further details about the conference program and registration are available online from the ESN website (http://www.esn-online.org/esn-2010-vienna).

Mike Hodda and Sunil Singh

Mike Hodda and participants at the April course in nematode identification, sponsored by OCPPO, held at ANIC, CSIRO Entomology. Mike seems to be begging the technology to work …..



Discussing the finer points of nematode identification, April 2010

NEWS FROM THE LESLIE RESEARCH CENTRE, QUEENSLAND

Nematology research at the Leslie Research Centre is in full swing. Our department had a name change in 2009 and we are now 9 departments rolled into one – DEEDI (Department of Employment, Economic Development and Innovation). Our email addresses have changed too (firstname.lastname@deedi.qld.gov.au). At a local level, we are called Agri-Science Queensland. Last year Dr Stephen Neate was appointed as the leader of our "Winter Cereals Pathology" team.

John Thompson is in the midst of negotiations with GRDC to fund a new 5-year "Genetic options for nematode control" project with involvement of Jason Sheedy and Ros Reen. They are looking forward to developing their previous work on resistance of wheat to root-lesion nematodes. Their current project is developing methods for resistance screening of wheat cultivars to multiple diseases (root-lesion nematodes, yellow spot, crown rot and common root rot) to enhance disease phenotyping. Jason, John and Tim Clewett identified *Paratrichordus porosus* in barley last year and with Mike Hodda have published a paper in *Australasian Plant Disease Notes* (see list).

Kirsty Owen's current project (with Tim Clewett and John Thompson) is now part of a GRDC-funded Northern Integrated Disease Management project which brings together 5 previously separate pathology projects. We are lead by Stephen Neate and Mal Ryley. In the field we have two winter crop rotation experiments at our *Pratylenchus thornei* site and we're busily extracting nematodes to characterise populations following the 2009 winter crops. As soon as it rains this year we'll plant tolerant and intolerant wheat cultivars on the plots. In the glasshouse we're looking at the hosting status of winter crops for *Merlinius brevidens*, *P. thornei* and *P. neglectus*.

John Thompson rounded-up our enthusiastic nematology team (and a couple of other interested parties including Nikki Seymour) in 2009 to start an Action Learning Group to improve our publications and provide a formal meeting for on-going learning opportunities. The meetings have been a great success and our recent publications include:

Sheedy JG, Clewett TG, Hodda M, Thompson JP (2010) First record of stubby-root nematode (*Paratrichodorus porosus*) associated with barley in Australia. *Australasian Plant Disease Notes* **5** 66–69

Owen KJ, Clewett TG, Thompson JP (2010) Pre-cropping with canola decreased *Pratylenchus thornei* populations, arbuscular mycorrhical fungi and yield of wheat. *Crop and Pasture Science* **61**, 399-410.

Thompson, JP, Clewett TG, Sheedy JG, Reen RA, O'Reilly MM (2010) Occurrence of root-lesion nematodes (*Pratylenchus thornei* and *P. neglectus*) and stunt nematode (*Merlinus brevidens*) in the northern grain region of Australia. *Australasian Plant Pathology* **39**, 254-264.

Thompson JP, O'Reilly MM, Clewett TG (2009) Resistance to the root-lesion nematode *Pratylenchus thornei* in wheat landraces and cultivars from the West Asia and North Africa (WANA) region *Crop and Pasture Science* **60**(12) 1209–1217 doi:10.1071/CP09159

Sheedy JG, Thompson JP (2009) Resistance to the root-lesion nematode *Pratylenchus thornei* of Iranian landrace wheat. *Australasian Plant Pathology* **38**(5) 478–489 doi:10.1071/AP09030

Jason Sheedy, Ros Reen, Tim Clewett and Kirsty Owen spoke at the GRDC northern grain region Grower and Advisor Updates in March this year. The information was well received and we've had a huge influx of samples to our "test your farm" service. The results are similar to those published in the Thompson *et al*. 2010 survey paper with just over 80% of samples having root-lesion nematodes and *P. thornei* being the most commonly identified root-lesion nematode. We're looking forward to continuing to raise awareness about root-lesion nematodes in the northern grain region in more meetings in later this year.

We welcome Jing Lin and Dr Yujuan (Jady) Li to our group. Jing has been working on the National Variety Testing project since 2009 and joined us from NSW DPI (now NSW I&I), Wagga Wagga where she worked with Diagnostic and Analytical Services and Wheat Breeders. Jady has recently immigrated to Australia from China. She completed her PhD in 2008 ("Responses of soil nematodes to plant community changes and above/belowground resource inputs in Ailao Mountains, Yunnan") at the Fudan University, Shanghai (see abstract below). Both have made very positive and happy contributions to our group.

We're all looking forward to the Soilborne Diseases Symposium. Jason Sheedy is on the organising committee and tells us that it will be a terrific meeting.

Kirsty Owen

NEWS FROM SOUTH AUSTRALIA

The University of Adelaide

In January, Kerrie Davies flew to Brisbane to meet Dorota Porazinska (Florida University, Fort Lauderdale Field Station) who was visiting to complete some work Dorota began in 2009 on interactions between soil nematodes and invasive plants. It was a busy and interesting week, with lots of field work and discussions. In February, Kerrie met Sonja Scheffer (USDA Baltimore) for more discussions and field work in Canberra. In April, she went back to Canberra to assist Mike Hodda in teaching an intermediate-level course in nematode identification, sponsored by OCPPO (see Mike's report above). This was the most stimulating teaching she has done, and she hopes the participants got as much out of the fortnight as she did. After the course, she did a couple of days collecting galls in the Hawkesbury and Hunter Valleys with Leigh Nelson (CSIRO Entomology). While present in the Hawkesbury area, no fresh *Fergusobia* galls were seen in the upper Hunter area, near Gunnedah or around Mudgee, all areas where they had previously been collected at a similar time of year. Victims of climate change????? Or another example of the vagaries of field work?????

Katherine Linsell continues to make good progress for her PhD on 'Genetic and physiological characterisation of resistance to root lesion nematode *Pratylenchus* sp. in wheat'. In late June, she flew to Turkey with Ian Riley. They will both be participating in the Fourth International Master Class on Soil Borne Pathogens of Wheat, being held in Eskishir. Thuis is funded in part by the Crawford Foundation. This will give Katherine a chance to meet Julie Nicol's students, and to learn more about the practicalities of root diseases of cereals, in an international context. Ian will be instructing, and it will be the fourth such international course he has been involved in.

Kerrie Davies

NEWS FROM NEW ZEALAND

AgResearch Co. NZ

Michael Wilson begins work with the Nematology Team at AgResearch in Hamilton, New Zealand on 1 July 2010. Michael is moving from the UK where he currently leads a research team at the University of Aberdeen. His recent research includes the development of the slug parasitic nematode *Phasmarhabditis hermaphrodita* through to the commercial product Nemaslug (http://www.beckerunderwood.com/en/products/nemaslug&rsp=n) which has involved a lot of basic biological and ecological work over a period of many years (eg Wilson et al 1996, Wilson et al 1999, Wilson et al 2004, MacMillen et al 2009). Michael co-edited the recently published book "Nematodes as Environmental Indicators" which is a valuable contribution to this branch of Nematology. He has supervised many PhD students and has a wide network of collaborators in Europe and the USA.

Michael will be working with Nigel Bell, Lee Aalders and Chelvi Rohan in the Nematology team and alongside the microbiologists Upali Sarathchandra and Gabriela Burch who are also in Nigel's wider team. On Michaels behalf Nigel has indicated both are keen to attend the AAN workshop in Darwin in April next year so hopefully Michael can meet you all then, if not before. Michael will be a very welcome addition to New Zealand Nematology and Nigel and his team are very excited at having a new addition not only for his experience and abilities but as someone else to talk to about nematodes!

While on the topic of the Hamilton Nematology team, Lee Aalders has recently returned from maternity leave after the birth of her son Felix. Much of the past year's research has concentrated on enhancing plant growth in the presence of nematodes by addition of bacteria as seed coats and drenches (eg Sarathchandra et al 2010). A recently established field trial with white clover has shown promising results and will be repeated next spring. Development of a bioassay with tomatoes (Aalders et al, 2009) has set the direction for further work in this area in collaboration with Lincoln University (Christchurch, New Zealand).

We have also been doing some work with *Pasteuria* as a nematode biocontrol and have been fine-tuning a bioassay method to evaluate its efficacy. In the biosecurity area we have continued looking at nematodes present in soil samples from beneath New Zealand native plants growing overseas in an attempt to see if this approach could be useful in predicting nematodes that are likely to be a risk to New Zealand plants if they became established here (Aalders et al 2009). We have also been looking at the risk soil on footwear poses to New Zealand's biosecurity by investigating nematode desiccation survival in soil (Aalders et al 2009).

We have been preparing and publishing work we have done in recent years looking at impacts of new agricultural technologies on non-target organisms in collaboration with colleagues in AgResearch (eg Bell et al 2009, Bell and Aalders 2010, Sarathchandra et al 2010).

Most of our programmes will be continuing for the next few years with the addition of some new work on slug nematodes which Michael will be working on, at least initially.

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Nigel Bell

NEWS FROM WESTERN AUSTRALIA

DAFWA

PCN Area Freedom Project

The final report to HAL for the project "PCN Area Freedom for WA: Evaluation of the current status of Potato Cyst Nematode (*Globodera rostochiensis*) in Western Australia" (PT04004 & MT04000) was submitted in March 2010 by Sarah Collins, Vivien Vanstone and Xiao Hui Zhang.

This project was funded by Horticulture Australia Ltd, Agricultural Produce Commission, Potato Producers Committee and the Potato Growers' Association of WA.

The aim of the project was to collect data to substantiate Area Freedom from Potato Cyst Nematode (PCN) for WA by proving absence of the pest in the State. The major steps conducted to obtain the data required were:

- Collation of State-wide records for PCN testing conducted over 24 years
- Intensive State-wide survey of all current potato production areas for detection of PCN
- Survey of the originally infested sites to determine eradication of the pest
- Bioassay of soil from the originally infested sites to determine survival of the pest.

An isolated incidence of Potato Cyst Nematode (PCN, *Globodera rostochiensis*) was detected on an area of 15ha in the Perth Metropolitan region of Western Australia between 1986 and 1989. Immediately, an eradication campaign was established and strict Quarantine protocols put in place. Detection of PCN resulted in national and international market restrictions on WA potatoes. State-wide surveillance for PCN has continued to the present day.

Since it is now 21 years since PCN was last detected in WA, data have been collected to provide evidence for State-wide absence of the pest in potato production areas. Intensive soil sampling and assessment was designed to determine the current status of PCN in WA. This involved sampling each of the originally infested Metropolitan sites, all places of production in the remainder of the Metropolitan zone, and specific surveys for detection in all production zones in the remainder of the State.

All sampling was carried out on a 5m x 5m grid, collecting a total of 400 50g soil cores per hectare. This resulted in soil samples averaging 20kg/ha, all of which was assessed for the presence of PCN. The soil sampling and assessment methodologies were highly sensitive, providing a 96.4–100% statistical likelihood of detecting PCN if present.

From the State-wide survey, 2.9t of soil was collected, from which 27kg of organic matter was extracted, and this entire amount was examined microscopically for PCN cysts. A total of 27,151 cysts were examined: none of these were identified as PCN.

From the survey of the originally infested Metropolitan sites 1,766 cysts were detected. Of these, 37 'suspect' cysts morphologically similar to PCN were identified. However, 17 of these were putatively identified as *Cactodera* or *Punctodera*. Twenty cysts morphologically identified as PCN were subjected to further testing. None of these were found to be viable in a hatching test conducted over seven weeks. Furthermore, when these cysts were subsequently dissected, 17 of them contained no eggs, while three cysts contained only 2–13 non-viable eggs. These eggs were degraded and had been colonised by fungi or were damaged and empty, further confirming their non-viable state.

Organic matter extracted from soils at the originally infested sites was used in a bioassay of a PCN susceptible potato variety over 2 seasons. Roots and tubers were inspected after each season, and after the second season the total organic matter (including all plant roots) from 1.8t of soil was assessed for PCN. No PCN was detected, reinforcing the hypothesis that the pest had been successfully eradicated from the originally infested Metropolitan sites.

Our data show that:

- PCN was successfully eradicated from the sites that were originally infested
- PCN did not spread to any other production area of the State
- PCN is absent from all potato production areas of WA.

Additional data (2,901 crop assessments and 28,906 bin and equipment inspections) for State-wide PCN testing conducted in all regions over 24 years also strongly support these conclusions.

This study supports the establishment of WA as a Pest Free Area for PCN. Methodologies and results will be published internationally, ensuring transparency of outcomes to foster recognition of the Pest Free Area.

Sarah is working on a paper for publication in a nematology journal, and also plans to present results to the Association of Applied Biologists, 3rd Symposium on Potato Cyst Nematodes to be held at Harper Adams University College, Newport, UK on 14–15 September, 2010. Conference papers will be published in *Aspects of Applied Biology*.

National RKN Project

Following the HAL "Workshop to develop research, development and extension priorities for nematode control in vegetable crops" (VG05026) convened in Tasmania by Frank Hay in July 2006, nematodes were finally prioritised by HAL, and the project "Managing the nematode threat" (MT09067) got underway in October 2009. The WA component began in June 2010. This will be led by Research Officer Sarah Collins, working under me, and backed up by our excellent team of Technical Officers (Helen Hunter, Xiao Hui Zhang and Lucy DeBrincat).

The project, expertly led by Frank Hay, involves nematologists, agronomists and industry in Tasmania, South Australia, Queensland, Victoria, WA and New Zealand.

Studies will concentrate on Root Knot Nematode (RKN), which occurs in all growing regions and is the most destructive nematode associated with vegetables and potatoes. (Note: for the purposes of HAL funding, potatoes are not classified as vegetables!). Work will concentrate on carrots and potatoes, as these are important crops in all regions, and are highly susceptible to RKN.

Nematode management decisions for vegetables and potatoes will be critical as chemical control options become limited. Withdrawal of at least some chemicals is expected in coming years due to increasing concern of environmental and health risks, as well as the known enhanced biodegradation (and therefore reduced effectiveness) of chemicals such as metham sodium and fenamiphos.

In WA, the RKN species *Meloidogyne hapla, M. javanica, M. incognita, M. arenaria* and *M. fallax* will be investigated. These species all occur in WA, although not all in the South West coastal vegetable and potato production zone. However, species such as *M. arenaria* can be found in Northern regions, so will be included to broaden the applicability of outcomes, especially for host range studies to determine rotational/break crop management options.

The main project areas applicable to the WA component of this project are briefly described below.

Cultures

Glasshouse cultures of all RKN species established on Tiny Tim tomatoes will be used as inoculum for host tests. Caroline Versteeg recently made a short return to DAFWA Nematology to impart her RKN expertise and to instruct us in establishing the glasshouse cultures.

Jenny Cobon (Queensland) has supplied us with specimens of *M. hapla, M. javanica* and *M. incognita* to establish cultures. New sources of *M. arenaria* and *M. fallax* were required. We had located these species in WA over the last few years (on boab and potato, respectively), and the nematodes had been identified by Jackie Nobbs (SARDI). Both farms have changed hands since our identification of these nematodes, but persistence by regional DAFWA staff has led to supply of infested soil and plant material, which will be used to establish new cultures, and shared with Queensland and SA project counterparts.

Sarah and Xiao have been 'practising' Jenny's molecular species identification methods. So far so good. We plan to be able to identify single RKN females without having to bother Jenny or Jackie too much.

Hosts

Agronomically suitable rotation/break crop/green manure species/varieties for each region will be determined for each RKN species in glasshouse trials, and later assessed at infested field sites. Potato varieties will also be tested.

Survey

Surveys of carrot and potato crops will be conducted to determine which RKN species are the most important for each region. This information, coupled with the host tests, will aid growers in making management decisions based on the use of appropriate rotation/break crops. Manual extraction and enumeration of RKN will be done at DAFWA, with duplicate samples provided to SARDI for DNA assessment of RKN numbers and species present.

Although the surveys will concentrate on RKN, other plant-parasitic species will also be identified and enumerated to complete the picture of nematode threats to vegetable and potato industries in each region. Root Lesion Nematode (RLN, *Pratylenchus*) species are widespread, so could be expected to occur in most samples from most areas.

These surveys will also provide essential information for biosecurity. We need to demonstrate to markets which nematodes are/are not present in a region, but in many cases survey data are absent. Without robust survey data, claims that production areas are free of a nematode are unlikely to be accepted, and additional testing is often required prior to export at a cost to growers and the industry.

DNA Test

RKN are difficult to identify to species, but species identity is important when determining rotation/break crop management practices, as each species can have a different host range. Soil samples will be provided to SARDI for calibration and validation of a pre-plant soil DNA test to assist grower decision making for RKN management. RKN species will be quantified (manually and by DNA) and identified (by DNA), and results related to marketable crop yield of carrots in a number of crops in each region. Seed potatoes with visible RKN damage will be collected in each region and also tested by SARDI. Seed potatoes provide a high risk pathway for soil-borne pests and diseases.

Field Trials

RKN economic thresholds will be determined, mainly for carrots and potatoes. Duplicate samples will be assessed to quantify (manually and by DNA) and identify (by DNA) RKN species. Yield and quality measures will be determined against RKN species identities and numbers, and effect of paddock history/agronomy on nematode levels and crop yield/quality determined.

Extension

There is little current information readily available to growers and agronomists on management of nematodes in potatoes and vegetables. By the end of this project, updated extension material will be produced nationally and for each region.

Planning/Update Meetings

The first meeting (hosted by Frank Hay) will be held in Burnie, Tasmania in mid-July, 2010. Project participants will discuss protocols and progress, among other things. Since we are only just embarking on this adventure, Sarah and I are looking forward to the meeting and especially catching up with everyone.

Other news

Janet Chen and Daniel Chen visited DAFWA in April 2010 on an industry funded trip to conduct a BAPHIQ (Bureau of Animal and Plant Health Inspection and Quarantine) audit of protocols to determine production area freedom from *Radopholus similis* for carrot exports to Taiwan. They were accompanied by members of DAFF and Biosecurity Australia. After inspecting and discussing laboratory procedures, they visited two of WA's largest carrot producers to observe growing, packing and storage conditions. From WA, they continued on to visit Jackie Nobbs in Adelaide and Jenny Cobon in Brisbane.

We began two new GRDC projects on July 1, 2010: "Western region nematology IDM research and development" and "Genetic options for the management of RLN species in Western Australia". Both continue with Root Lesion Nematode management research for WA.

Sarah, Xiao and I will be attending an APPS "Phylogenetics Short Course" at Murdoch University in late July (run by Phil O'Brien, Treena Burgess and Nicole White). We hope to unravel some of the secrets to obtaining the right data, analysing and blasting nematode sequences.

Sarah and I have been meeting with representatives of the WA turf industry to determine the best ways for the industry to deal with Sting Nematode (*Belonolaimus*/*Morulaimus*). With expert advice from Graham Stirling, Mike Hodda and Jackie Nobbs, we hope to assist the industry in developing hygiene and testing protocols for Sting Nematode.

Vivien Vanstone

Quarantine Issues

DITYLENCHUS DESTRUCTOR IN AUSTRALIA: CONFIRMATION FROM THE OFFICIAL RECORDS

Barrie Thistlethwayte

11 The Fairway Tura Beach NSW

In Australasian Nematology Newsletter 20 (2): 12-14, July 2009 I recorded points about the occurrence of *Ditylenchus destructor* Thorne 1945 in Tasmania during the 1960s. Biosecurity Australia denied the occurrence on the grounds that my points were contestable.

I am grateful to Dr Dean Metcalf, Senior Plant Pathologist, Tasmania Department of Primary Industries, Water and Environment for his tenacity in tracking down and retrieving items of correspondence and of work of the Division of Plant Pathology and other divisions of the Tasmanian Department of Agriculture during the early 1960s.

These records include an aerogramme dated December 2, 1962 from Gerald Thorne, Nematologist, sent from Estacion Experimental, Rio Piedras, Puerto Rico.

Thorne wrote ……"Your diagnosis is correct. These are Ditylenchus destructor, the potato rot nematode. The six lines of the lateral field coupled with the finely rounded terminus are diagnostic of the species"…….

Other official records are of the occurrence of severe damage, symptomatically by *D. destructor,* to Bismarck, Up-to-Date and Pinkeye potato tubers, confined to crops in a small area of sandy soil, from two properties near Tunnack, Tasmania for several years prior to 1962. The nematode induced typical symptoms in greenhouse tests with potatoes.

In two issues of Australian Plant Disease Recorder (13 (1):12, 1961; 15 (1):7, 1963) there is notification of these occurrences and in the latter issue there is specific reference to the identification of the nematode by its author.

The Chief Quarantine Officer (Plants) Tasmania notified the Director of Plant Quarantine, Commonwealth Department of Health of the occurrence of Potato Rot Nematode in Tasmania by memorandum dated 21 February 1963; acknowledgement by the Commonwealth was by memorandum, the date of which is blurred on the photocopy I have but seems to be 6 April 1963.

Thus, there are incontestable official records of the authoritative identification of D. destructor in Tasmania based on morphological characters (several of which were documented by Evans and by Evans and Fisher), syptomatology and pathogenicity.

Perhaps Biosecurity Australia denied the occurrence because specimens of the nematode cannot be found. If so, Biosecurity Australia is clutching at straws.

Who knows any cases of Thorne's identification of *D. destructor* being proved wrong by molecular or morphological criteria? I found none.

Who knows any cases of a *Ditylenchus* sp., apart from *D. destructor*, having 6 lines in the lateral field, the other documented morphological characters and the reproducible pathogenicity to potatoes of the Tasmanian population? I found none.

There is no evidence that *D. destructor* occurred anywhere else on Tasmania, despite my investigations, investigations by other staff in the Division of Plant Pathology and alerts, accompanied by photographs of diseased tubers from Tasmania, to field staff in the Divisions of Agronomy, Extension and port Inspection during the early 1960s. Nor is there any evidence from more recent surveys. These are the definitive points to be made by Biosecurity Australia and others concerned about the quarantine implications of the official records.

Research

DEVELOPMENT *OF ARTHROBOTRYS OLIGOSPORA* A PREDACEOUS FUNGUS IN *MELOIDOGYNE INCOGNITA*

Anamika and Sobita Simon

Allahabad Agricultural Institute (D.U.), India

Root knot nematodes cause high level of economic loss in agricultural crops worldwide. They can severely damage a wide range of crops, in particular vegetables, causing dramatic yield losses mainly in tropical and subtropical agriculture. Global annual yield loss of major crops by nematode damage is estimated to be 12.3 percent (Sasser, 1989) which may account for billions of rupees annually (Jayarajpuri et al., 1990). Such loss is critical for a developing country like India where nearly one-sixth of the world population lives. Nematicides, the chemicals used to control plant parasitic nematodes, are often toxic compounds causing both environmental and health problems. Use of biocontrol agents is the most natural, eco friendly and sustainable way of management of root knot disease. Nematophagous fungi comprise a group of fungi parasitizing nematode eggs, juveniles and adults, with potential for biocontrol.

Arthrobotrys oligospora is one of the most important predaceous fungi occurring widely in different types of soil. It produces hyphal bails and networks. As trapping structures, hyphal nets may be one to two or three dimensional and are formed through repeated hyphal anastomosis. These capture nematodes either via adhesive material present on the surface or due to physical entanglement. When nematodes pass through such hyphal bails, they are captured by the sticky substances. The nematodes struggle to escape capture but are usually entangled at several places of their body. The fungi begin to absorb the nutrients and finally kill the nematodes. Fresenius (1852) first reported *A. oligospora* as a common habitat of organic plant debris. The predatory relationship of *A. oligospora* was reported by Zopf (1888).

For studies on the development of *A. oligospora* in *Meloidogyne incognita* via a constricting ring formed on the growing mycelium, fungus was grown in 1:10 maize meal agar medium. One hundred freshly hatched second stage juveniles of *M. incognita* were inoculated in fungal culture and incubated for 12 hours at 25-30°C for ring induction. After incubation, the inoculated plates were observed under stereoscopic binocular microscope. The times for swelling of ring cells after ringing of nematodes were recorded. After trapping and swelling of the ring cells, the area of the trapped nematode was marked and observations on the time required for killing of the nematode was recorded. The time between killing of the nematode and development of the fungal mycelium in the nematode body after nematode trapping was also recorded. At least 20 trapped nematodes were observed in respective repeated experiments.

Observations on inflation of ring cells after ringing of a nematode by a single conidial ring in water indicated that 20-45 minutes were required for inflation of ring cells and real trapping of a nematode (Table 1). Before inflation of the ring cells, the nematode moved freely and normally. The time required for effective capturing via inflation of conidial ring cells was much longer compared to inflation of constricting ring cells formed on growing hypha in culture (Table 2). In

culture the inflation of ring cells immediately followed entry of a nematode into a ring. It was difficult to decide the actual timing required for the inflation of ring cells. The time required for killing of a nematode by a single conidial ring was also longer than for those captured in rings formed on the growing mycelium in culture.

For nematodes trapped by a single conidial ring in water, fungal infection was initiated through damaged cuticle by the hypha arising from the swollen cells that grew inside the nematode body. At this stage, the growing hypha was not clearly visible in the nematode body due to its granular content. The hypha growing into the nematode body consumed the internal content of the nematode resulting in clear visibility of the mycelium 35-60 hours after trapping (Fig). With time the nematode body was freed of internal content and left with fungal hyphae within and outside the nematode body. Predation of nematodes by *A. oligospora* and induction of constricting rings in response to different nematode population was also studied by Belder and Jansen (1997), Dreschler (1937), Gives (1994) and Heintz (1978).

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Table 1. Development of *A. oligospora* in *M. incognita* captured in sterilized distilled water in cavity blocks.

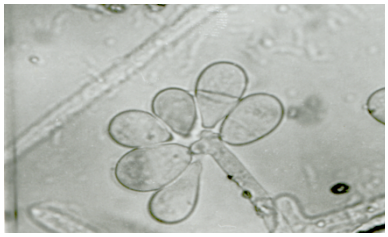
Swelling of ring cells	Death of nematode	Development of mycelium outside nematode	Ring induction on mycelium	Mycelium development inside nematode	Number of rings on mycelium
20 to 45 min	12 to 20 h	15 to 25 h	28 to 50 h	35 to 60 h	15 to 20

Table 2. Development of *A. oligospora* in *M. incognita* by mycelial constricting ring in MMA:water (1:10) medium.

Swelling of ring cells	**Death of nematode**	**Development of mycelium inside nematode**
Within one min	10 to15 h	30 to 45h

A

B



C

D

Figures: **A**. Swelling of ring cells and formation of trapping structure

B & C. Spores and mycelium of *A. oligospora*

D. Nematode caught in trap.

SURVEY OF ROOT KNOT DISEASE ON VEGETABLE CROPS GROWN IN THE MAJOR PRODUCTION CENTRE IN UTTAR PRADESH (INDIA)

Anamika*, Sobita Simon*, Rakesh Singh and Gautam Ghosh***

*Allahabad Agricultural Institute (D.U.), India

**Banaras Hindu University, India

Plant parasitic nematodes are ubiquitous and more than 1800 species have been recorded so far. They are obligate parasites; and parasitize all types of plants from algae to trees. A handful of soil around the roots of any plant will yield hundreds of plant parasitic nematodes belonging to at least 4-5 genera. Among plant parasitic nematodes, root knot nematodes (*Meloidogyne* species) are the major pathogen of agricultural crops throughout the world, impacting both quantity and quality of market yields. Root knot nematodes cause heavy economic losses in agricultural crops world-wide. Vegetable crops and weeds form part of the wide host range of these nematodes (Pajovic et al., 2007). Root knot nematode infection at the initial stage of plant growth causes more acute symptoms and severe damage than in plants in which infection is delayed. In later infection, plant growth is usually not so adversely affected despite severe infection. RKN annually destroy 29-30% of vegetable crops. In India, reduction of yield in Tomato due to root knot ranges from 26.5-73.3% (Seshadri, 1989). Losses in Potato, Tomato, Brinjal, Okra, & Pepper are 12.2, 20.6, 16.9, 20.4 & 12.2% respectively. Losses in bean are estimated to be 60-90% (Seshadri, 1989).

In the present study, attempts were made to investigate the occurrence of root knot disease on vegetable crops (by assessing incidence and intensity of the disease) in the year 2007-2009 in the major production centre in Uttar Pradesh (India). Root knot nematodes cause serious damage to brinjal, tomato, onion, bitter gourd, spinach, pumpkin, okra, beetroot and cow pea in different districts of U.P. State (India).

Highest incidence of root knot disease in the above surveyed crops was in tomato (76.4%) followed by brinjal (71.7%) and okra (58.2%). Minimum incidence was observed in cowpea (19.4%) followed by onion (25.8%). The disease incidence in other crops ranges from 35.6-52.9%. The overall incidence of root knot disease on vegetable crops in U.P. (India) was 44.6%.

Disease intensity was measured using a root knot index which ranged from 2.8 to 4.1 on a 0-5 scale, in accordance with the observation made by Nagesh et al. (2005) in Karnatka, India. Intensity was highest in tomato and beetroot (4.4) followed by okra and spinach (3.7); bitter gourd, onion and pumpkin (3.5) and brinjal (3.4). Average root knot disease intensity in U.P. (India) was 3.7. Root knot disease was frequent on different vegetable crops, and the incidence and intensity in general was high. These observations also confirm the results of Khan *et al*. (1984, 1985). Most of the fields surveyed were infested with root knot nematodes. This pest not only causes root galling but also increases the severity of *Fusarium* wilt (Ye *et al*, 2008). These results are in accordance with observations made in different parts of the world (Sasser1979).

Acknowledgements: The author (Anamika) is thankful to Prof. (Dr.) Sobita Simon, H.O.D. Plant Protection Department, A.A.I. (D.U.), and Allahabad for her constant and constructive help during survey work.

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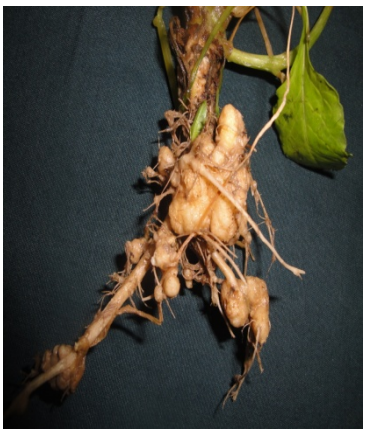
A  B 

C  D 

E  F 

G  H 

Figures: Symptoms of root knot disease in various vegetable crops grown in U.P. (India)

A. Bitter gourd **B**. Okra

C. Brinjal **D**. Spinach **E**. Pumpkin

F. Beet root **G**. Cowpea **H**. Onion

NEW RECORD OF ROOT KNOT NEMATODE (*MELOIDOGYNE INCOGNITA*) ON WINGED BEANS IN UTTAR PRADESH, INDIA

Anamika, Abhilasha A. Lal and Sobita Simon

Plant Pathology, Allahabad Agricultural Institute (D.U.), India

Winged bean (*Psophocarpus tetragonolobus)* is of rapidly increasing interest as a high-protein multipurpose crop. It could become as important as the soybean in world agriculture, with the added bonus of yielding substantial quantities of edible, high-protein root tubers. Winged bean is a legume and is a tropical plant native to the South Pacific Islands and Papua New Guinea. It grows abundantly in hot, humid equatorial countries such as Indonesia, Malaysia, Thailand, Philippines, India, Bangladesh, Burma and Sri Lanka. Once considered as a "poor man's food", the potential economic importance of the plant has attracted world-wide attention and is now recognized as 'A High Protein Crop for the Tropics'. Winged bean is of rapidly increasing interest in the humid tropics, where human diets are often deficient in protein. Like soybean, winged bean could be utilized as a source of edible oil and has potential as a substitute if commercial production could be developed. The plant produces an abundance of leaves and inflorescences of white, blue, deep purple or pink flowers which quickly develop into pods. The pods are 4-sided with fringed wings, 6-30 cm in length with 5-20 seeds per pod. The seeds are rich in protein and are comparable to soybean in composition and nutritional value with similar proportions of protein (30-40%), carbohydrates, oil (15-20%), minerals, vitamins, essential amino acids and other constituents (Venketeswaran et al, 1990). The high protein content of the root tubers, normally 12-15 per cent of the fresh weight, could help alleviate protein deficiency in local diets. In addition, the crop has exceptional ability to fix atmospheric nitrogen via bacteria in the root nodules, important given world shortages and rising prices of artificial nitrogenous fertilizers. Among the tropical beans, known for their protein-rich pods and seeds, winged bean is considered unique because of its multiple uses. It was introduced to India during 1979, and is grown in Assam, Tripura, Meghalaya, West Bengal, Orissa, and other southern States ('The Hindu' newspaper, 2002).

Root-knot nematode on winged bean had been reported from Mauritius, Philippines and Papua New Guinea. In India it was reported during a survey of plant parasitic nematodes on horticultural plants, Hessaraghatta, Banglore (Letter to the editor, 1979). Critical examination revealed *M. incognita* causing abnormal galls on both tuberous and nontuberous roots. The root-knot nematodes (*M.incognita* and *M. javanica*) can cause severe galling of roots; reducing tuber production and possibly affecting pod and seed yield. Damage to winged bean seems especially troublesome in sandy soils. Most of the Papua New Guinea lines are susceptible, and screening of the winged bean world germ plasm collection for root-knot resistance is needed (Venketeswaran et al, 1990).

During the survey of root-knot nematodes on vegetable crops in Uttar Pradesh (India) (see above) it was observed that winged bean was not commercially grown but innovative smallholding farmers were growing it in mixed garden cultivation or shifting agriculture. While the aboveground parts of the plants were usually free of pests and diseases, the roots were often severely attacked by root-knot nematodes (Figures). No assessments of reduction in yields of pods, seeds or leaves were made. Roots of winged bean were collected and kept in polythene bags for thorough examination for the presence of root knot nematode. Roots were washed clean and then immersed in an aqueous solution of phloxin B (0.15gm/l) for 15 minutes to stain egg masses

and then washed with tap water. Numbers of galls per root system were counted. Gall index (GI) was determined on the following scale (Taylor and Sasser, 1978) 0=0, 1=1-2, 2=3-10, 3=11-30, 4=31-100 and 5=>100 galls per root system. It was observed that roots were heavily infested with root knot nematode and incidence of disease ranged from 62.5 to 82.8% and the intensity in terms of gall index ranged from 3 to 5. Many plants were killed and roots were heavily galled and not fit for consumption. Damage was seen even in an area that had a very low level of infestation with the nematode at sowing time. Differential host tests indicate that the suspension inoculated to the host plant reproduced on tomato, brinjal and spinach crops but was unable to parasitize cotton and peanut. On the basis of perineal pattern characteristics, *M. incognita* was identified infecting winged beans. This result confirms the findings of several scientists (Phukan et al. 1985, Fortuner et al. 1979).

Acknowledgements : The author* is thankful to Prof. (Dr.) Sobita Simon, H.O.D. Plant Protection Department, A.A.I. (D.U.), Allahabad for her help during survey work and providing facilities in the department.

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A  B 

C  D 

Figures. Root Knot infestation (**A, B** & **C**); healthy roots (**D**) of Winged Beans.

Obituaries

VALE WARWICK L. (NICK) NICHOLAS

3 April 1926 – 5 May 2010

Warwick Nicholas (Nick) was one of the pioneering nematologists in Australia and the world. He died recently after battling cancer with his typical practical resolve since 2003. In addition to his scientific legacy, he leaves his wife Evelyn, 4 adult children and eleven grandchildren. Many colleagues attended his funeral in Canberra.

I knew Nic for thirty years, but this time covers barely half of his very long and wide-ranging scientific career, and it certainly does not cover all the different aspects of his work. Indeed, such was the range of topics, places and people involved that I cannot hope to do justice to them all.

Nick was born in England and had a far from settled childhood under the care of his mother and several relatives. His father died when Nick was quite young. At one stage he and his mother moved to Canada. He attended a number of different schools; from all reports only a few were happy experiences. At one stage, he had an enlarged lymph node removed, and was diagnosed with diphtheria, although after three weeks in diphtheria and scarlet-fever wards the diagnosis turned out to be tonsillitis. After finishing school during the 2nd World War, he trained to become a pilot, first in the UK, then in the USA. Nick had a great deal of flying experience, much of it solo, but the war ended before he took up active service. After the war, pilot training was ceased, and Nick returned to the UK for more training as a radar mechanic. He finished his military service in 1946 as a petty officer.

After demobilization, Nick took up the opportunity to go to university, where he studied zoology and other sciences at the University of Liverpool, graduating in 1951. He completed a doctorate at the Liverpool Institute of Tropical Diseases working on insect-vectored diseases in western Africa. Through various outside influences Nick was left to complete this research virtually unaided, but it was completed successfully and marked the beginning of a career-long association with nematodes. At the Institute, he found his true calling, and his life-long partner, his wife Evelyn.

There followed a period of career instability with various short-term positions and projects, including work on another group of small parasitic worms, the Acanthocephala, which was also to continue throughout his career. During this period Nick continued to work on nematode parasites of vertebrates, but also entered the then novel field of nutritional requirements and culture of nematodes.

Nick arrived in Australia in 1960 to take up a senior lectureship at the then Canberra University College, soon to become The Australian National University. Apart from brief periods on sabbatical, he remained at ANU for the rest of his long career. When he joined, the department consisted of a professor, his secretary, the chief laboratory administrator, six students, and Nick, all housed in a "fibro" hut shared with Botany, Chemistry and Physics. Those were true pioneering days.

At ANU Nick continued to work on culturing and nutrition of free-living nematodes, vertebrate-parasitic nematodes and Acanthocephala, in addition to supervising postgraduate students and

lecturing. Later, he added other types of nematodes and little known taxonomic groups to the list of animals studied.

He was, with the late Alan Bird, one of the early editors of the Australasian Nematologists Newsletter. He was instrumental in setting up the Australian Society for Parasitology. He served on many committees and advisory boards, including the ABRS advisory board. He led the Zoology Department at ANU for quite a few years in total over several intervals, although he was never appointed Professor, which was a disappointment to him.

For most of his career, Nick was passionate about the nematodes. He studied human, vertebrate and invertebrate parasites, free-living forms in beaches and swamps from Melbourne to Darwin. He studied feeding and energetics in the laboratory. He studied ecology, behaviour, epidemiology, biochemistry, and taxonomy. He described 35 new species and 5 new genera of nematodes, which is a sizeable chunk of the known nematode fauna of Australia.

Not content with that, he described 3 of the 12 species of gastrotrichs known from Australia, the last published only a few years ago. He worked on Nematomorpha and Acanthocephala as well. All these names may mean very little to most, but they demonstrate Nick's tremendous interest in real scientific problems, and starting from where nothing or very little was known never deterred him.

Nick literally gave the world the nematode *Caenorhabditis elegans*, which is used a model organism for studying nutrition, development and ageing. He and wife Evelyn travelled to America by ship in the late 1950's with vials of culture in his pocket and the recipe for keeping the cultures alive in his notebook. (Those were less biosecurity-conscious days.) Nick used his intimate knowledge of nematodes to choose this species carefully, so that it would both culture without any other organisms present, and survive the then lengthy travelling times. So good was Nick’s choice, that *Caenorhabditis* has been studied around the world ever since. The axenic cultures of *C. elegans* were an essential condition for the studies that lead to the 2002 Nobel Prize awarded to Horvitz, Brenner and Sulston. It is a measure of the importance of the cultures which Nick started, that right up to the present, he was still being contacted for information about their origin from around the world. His studies on energetics are still used as the basis for calculating energy flows and food requirements in nematodes.

Nick produced many things scientific. He wrote many papers over 55 years of scientific publishing; many of the 119 papers are still cited. Modern search tools list over 1000 references to his papers; it is a measure of impact that this is an impressive figure even though many papers were written and cited before the advent of the modern tools. He wrote a book which went through 2 editions. He had many PhD and Masters students; I was one. Such was the range of his interests that we, his students, have gone many different ways.

More than anything Nick produced ideas, and shared his experience. He was always open but forthright, and willing to share his time (except when his favourite soap opera was on!). Despite these achievements, Nick was always down-to-earth and dismissive of those seeking status for its own sake. His exploits and anecdotes enlivened the staff room at what became known as BoZo at ANU for many years.

By any measure, by his scientific impact, through his writings, by the students he has left, and in the personal and scholarly interactions we all had with Nick, the scientific community is lucky to have known him.

Mike Hodda

ROBERT C. (BOB) COLBRAN

3 August 1926 – 12 April 2010

Bob Colbran passed away in Brisbane in April at the age of 83 years. He is survived by his wife Pat, two children and five grandchildren. His achievements were outlined in Australasian Plant Pathology 37, 203-219, and the following is based on that article.

Bob Colbran grew up in the Brisbane suburb of St Lucia, only a few hundred metres from the campus of the University of Queensland. In 1948, he graduated with a BAgSc degree from that university and then accepted a position with CSIRO at Stanthorpe, an apple growing area about 220km south-west of Brisbane. Colbran was asked to 'find out why growers were having trouble replanting apple trees', and so he started his research by sectioning stained roots with a microtome. He noticed many red, worm-like organisms in the tissue that he thought could be nematodes. His supervisors and colleagues knew nothing about them, so Bob was forced to undertake research on his own.

By1953 he had published his first paper showing that lesion nematode (*Pratylenchus*) was present in the roots of most apple trees in the district; that the nematode stunted apple trees grown in pots; that treatment with dichloropropene-dichloropropane or formalin killed the nematodes and improved plant growth; and that all available apple rootstocks were susceptible to the nematode.

In 1954, CSIRO asked Colbran to move to Canberra. However, he wanted to stay in Queensland, and joined the Queensland Department of Agriculture and Stock (later the Queensland Department of Primary Industries). He was placed in the Entomology Branch because the Department 'didn't know where else to put him' and was told by his supervisor that 'I don't care what you do as long as you publish the results'. His paper on plant nematodes in Queensland (Colbran 1955) and his description of *Trichodorus minor* and *Hemicycliophora truncata* (Colbran 1956) were the start of a long and productive career with the Department.

In 1958, Colbran was awarded a fellowship from the Rockefeller Foundation in New York and spent 12 months at the University of California, Berkeley working in the laboratory of Dr Merlin Allen. This allowed him to learn more about nematodes and to refine his taxonomic skills. On his return to Australia, Colbran continued his taxonomic studies and also tackled the practical issues faced by growers trying to overcome problems caused by nematodes on a wide range of crops, including pineapple, banana, citrus, grapevine, tobacco, strawberry, ginger and numerous vegetable crops. In 1962, Colbran received his PhD from the University of Queensland for studies of nematodes on some of those crops.

Colbran was an excellent nematode taxonomist and in the 16 years from 1956 to 1971 he sampled many of the natural and agricultural habitats in Queensland, describing 36 new nematode species in numerous genera. He also published comprehensive records of the nematodes present in Queensland and, with the help of colleagues in other states, his host lists were later expanded to cover the whole of Australia.

Colbran's other major contribution was his work on nematode control. He began his career at a time when nematicides were first being introduced and his experiments with soil fumigants and non-volatile nematicides in the 1950s and 1960s formed the basis of the chemical control programs that were used in many industries for the next 30–40 years. However, Colbran declared that he got more satisfaction from his work on non-chemical controls: his

recommendations on hot water treatment of banana and ginger planting material, on the use of sawdust mulch as a control measure for root-knot nematode in ginger, and on the value of cover crops for managing nematodes in pineapple are still used by growers today.

In 1976, Bob Colbran was awarded the Agricultural Science Medal by the Australian Institute of Agricultural Science for his services to agriculture. He ended his career as Director of the Plant Pathology Branch of the Queensland Department of Primary Industries, retiring in 1986. He retained his interest in nematodes in retirement, e.g., collecting and sending flower bud galls with *Fergusobia* nematodes to Kerrie Davies in 1996. When asked in 2007 what aspects of his work gave him the most satisfaction, he replied without hesitation: 'finding and describing new nematode species and developing nematode control measures that were useful to farmers'.

Graham Stirling