Plant and Soil Nematology in Australia and New Zealand during the period 1975 to 2008

The history of plant and soil nematology in Australia and New Zealand was discussed in a paper by Stirling *et al*. (2008). This article focuses on the period from 1975 to 2008.

Nematology has a long history in Australia but in terms of its breadth of interests, the discipline peaked in the mid to late 1970s. About 40 people had some interest in nematodes and they were employed in approximately equal numbers by universities, CSIRO and State governments. Most of them were working on plant-parasitic nematodes but there were also scientists studying insect-parasitic nematodes, free-living soil nematodes, and nematode parasites of marsupials, marine mammals and livestock. Many of them had taxonomic expertise.

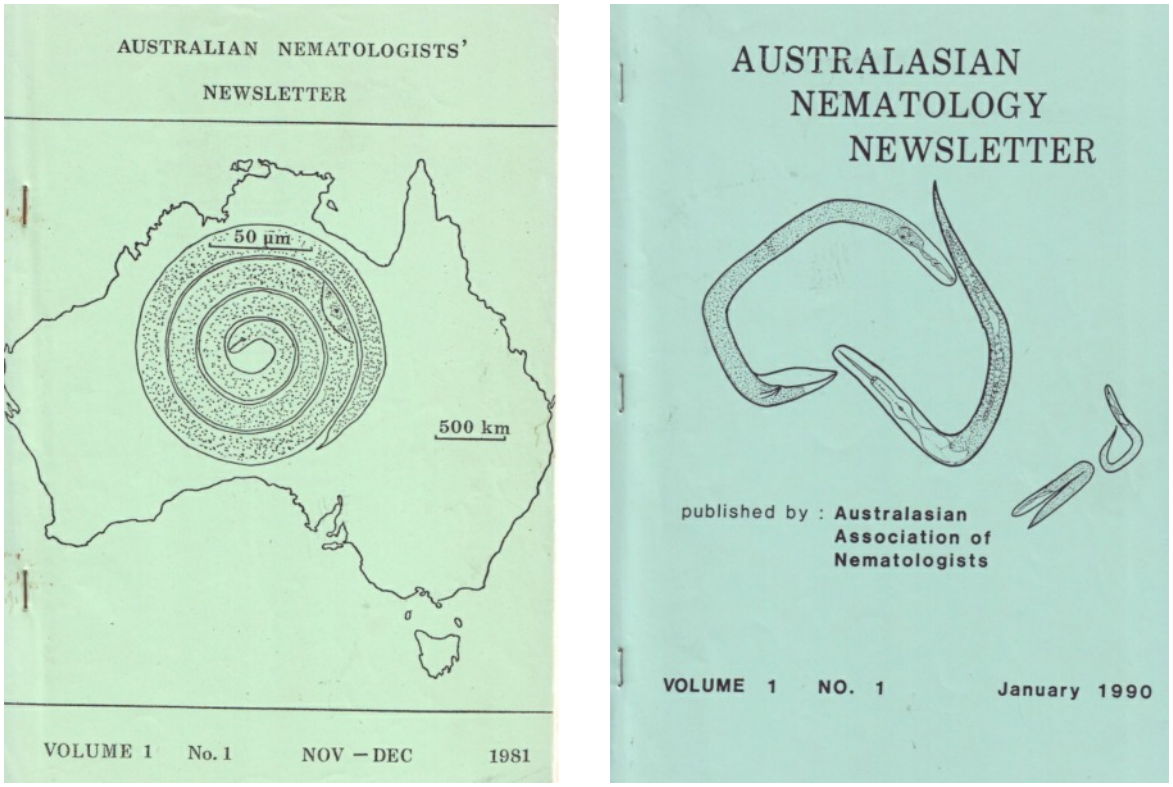
There were several reasons why plant nematologists were the dominant nematology group. First, cereal cyst nematode (*Heterodera avenae*) was causing heavy losses in the cereal industry and nematologists were looking at control methods such as crop rotation and nematicides, and also searching for resistance genes that could be deployed in wheat and barley cultivars. Second, stock losses from annual ryegrass toxicity caused by the bacterium *Rathayibacter toxicus* and an associated nematode (*Anguina funesta*) were causing concern to livestock producers in the wheat/sheep belts of South Australia and Western Australia. Third, soil fumigants were readily available and they enabled nematologists to demonstrate to growers that nematodes were causing serious losses on perennial horticultural crops and vegetables. Fourth, the advent of non-volatile nematicides such as fenamiphos offered new nematode control options, and so trials were being undertaken on sugarcane, various vegetables and many other crops. Most of the people who were working on plant-parasitic nematodes at the time are pictured in the photograph below.

Attendees at a nematology workshop held at Mildura, Victoria in 1975. This photograph, together with the names of participants, can be found in Stirling et al. (2008).

Given the widespread interest in nematology and the fact that it was difficult to know what others in the same field were doing, Dr Alan Bird, an internationally respected nematologist from CSIRO Division of Horticultural Research in Adelaide, decided to put together a newsletter to foster communication amongst nematologists. The first edition (entitled Australian Nematologists' Newsletter) was published in November 1981. It was usually 20-40 pages long and was posted to recipients twice a year. The newsletter invariably contained a range of useful articles, as nematologists provided updates of their research programs, gave details of useful techniques, and provided taxonomic notes or keys to particular genera. Details of nematology conferences and reviews of new publications were also included.

The newsletter was produced by Alan Bird until 1986 when Warwick Nicholas (Australian National University) became the editor. To keep costs down, contributors were asked to type their article with a wide margin, make 50 photocopies, and post them to the editor. The editor's role was to compile the newsletter, add the cover pages, staple them together and post the final version to recipients (and also photocopy articles from those who only sent one copy!).

By 1988, the cost of producing the newsletter was becoming an issue. Warwick Nicholas indicated in an editorial that "our department (and probably yours) was bankrupt by the middle of last year". Thus, he found it difficult to pay for photocopying the articles that were sent to him as a single copy. Other concerns within the discipline of nematology were also starting to emerge. For example, an article by JM Fisher and RI Sommerville (both from the University of Adelaide) in June 1988 bemoaned the fact that with the retirement of Alan Bird, "CSIRO will have divested itself of all personnel who were working on plant-parasitic nematodes". Warwick Nicholas also expressed his concerns in the final edition of the newsletter (Volume 8, no. 1, January 1989). He believed that "universities were in a state of turmoil", indicated that "the Departments of Zoology, Botany and Biochemistry at ANU were to be abolished", and felt that that these changes "did not auger well for parasitology or nematology". In the same issue he also went to the trouble of preparing indexes to the first seven volumes of Australian Nematology Newsletter. Perhaps he was convinced that it was the beginning of the end for this publication?



Covers of the first editions of two nematology newsletters

The final edition of Australian Nematology Newsletter also contained an article by Graham Stirling, who was then with the Queensland Department of Primary Industries in Brisbane. He responded to Fisher and Sommerville's comments by arguing that the problem of diminishing resources for plant nematology was not only due to changes within CSIRO, as "tertiary institutions and state governments had also neglected our field of interest". He finished with a final comment: "Australian nematology suffers because it does not have a formal organisation to represent it".

Six months later (July 1989) the Seventh Conference of the Australasian Plant Pathology Society was held in Brisbane. Chris O'Brien and Graham Stirling organised a workshop entitled 'New Developments in Plant Nematology' and after that workshop the participants decided to form the Australasian Association of Nematologists. It was the first special interest group within APPS and its objectives were to advance and disseminate knowledge of nematology and its practice in the following ways:

- By fostering communication and exchange of information between members, and between local and overseas societies with similar objectives
- By organising scientific meetings, workshops and training courses
- By increasing political and public awareness of the functions and achievements of nematologists

The Australasian Association of Nematologists (AAN)

The first AAN management committee consisted of Chris Green (Chairman), Graham Stirling (Secretary) and Julie Stanton (Newsletter editor), together with John Curran, John Marshall and Chris O'Brien. The first newsletter was produced in January 1990 and by the end of 1990, 43 people had paid the $10 membership fee. As Julie Stanton indicated at the time: "not bad for what is thought of as a special-interest group". The newsletter had much the same format as Australian Nematologists' Newsletter and was edited by various members over the years. In an era when email and internet services were not widely available, it played an important role in fostering communication amongst AAN members.

In addition to producing regular newsletters, AAN carried out its mandate to advance nematology in Australia and New Zealand in many different ways.

Increasing awareness of the importance of nematodes

In an attempt to increase awareness of the economic importance of nematodes, three members of AAN prepared a paper that reviewed all the important nematode problems in Australia and New Zealand, discussed several potentially serious new nematode problems, and provided estimates of losses caused by nematodes in Australia. The paper was published in 1992 and is cited in the reference section below (Stirling *et al*., 1992).

In the same year, a submission on the status of plant nematology in Australia was prepared by AAN and forwarded to a review that was conducted by the Rural Industries Research and Development Corporation (RIRDC). The submission made a number of important points:

- The amount of money being spent on plant nematology in Australia ($2.3 million/annum) is insignificant compared with the estimated losses caused by nematodes (more than $300 million/annum)
- Only 15 tenured scientists were working on plant nematode problems, which is much less than other developed countries with comparable agriculture
- Nematodes were causing serious losses in many horticultural crops but very little research was being undertaken. Also nematode problems in sugarcane, pastures and turfgrass were being ignored
- The development of plant nematology in Australia was being hindered by its lack of representation in the tertiary education system
- The loss of expertise in nematode taxonomy and the haphazard state of important taxonomic collections was a concern

The AAN submission had some beneficial effects because for the rest of the decade, RIRDC provided some support to plant nematology in Australia.

Workshops

Training programs to improve the nematological knowledge of people working with nematodes were seen as a key way of improving the skills-base in nematology. Consequently, ANN organised a series of workshops and they were held in conjunction with the biennial conferences of the Australasian Plant Pathology Society (except for the workshop in 2004, which was a component of the Australasian Soilborne Disease Symposium). The topics at each of these workshops were: Nematode taxonomy (Sydney, 1991); Root-knot and cyst nematodes (Christchurch, 1995); Genes and microbes for nematode control (Perth, 1997); Morphological and molecular identification (Canberra, 1999); Screening and breeding for nematode resistance (Adelaide, 2004); Distinguishing and detecting native and exotic nematodes (Lorne, 2005); and Research and opportunities in pasture nematology (Adelaide, 2007). All the workshops were worthwhile but two of the most memorable were those on *Pratylenchus* (Hobart, 1993) and free-living nematodes (Cairns, 2001).

The workshop in Hobart occurred at an opportune time because a review by the Grains Research and Development Corporation (GRDC) in 1992 had shown that root-lesion nematodes were one of the most important soilborne pathogens in the grains industry. The workshop ran for 1½ days and the 25 papers presented covered areas such as culturing and inoculation techniques, species identification, damage assessment and control methods. The Proceedings, a booklet containing more than 140 pages, provides an excellent overview of our knowledge of root-lesion nematodes at that time.

The 2001 workshop was held at South Johnstone, about 80 km south of Cairns, and it was memorable because it occurred during the month when Ansett Airlines collapsed. This meant that some delegates were unable to attend because their flights were disrupted, while Gregor Yeates, who ran the workshop, had problems getting to Cairns from New Zealand. The workshop was also memorable because it was held in a laboratory where participants had access to microscopes and was led by someone who was one

of the world's leading soil ecologists. With the help of Tony Pattison (Queensland Department of Primary Industries), Gregor extracted nematodes from soils around Innisfail and participants had the chance to look at the nematode assemblages in five quite different ecosystems. The diagrams and keys in the booklet Gregor produced for the workshop (Diversity of Soil Nematodes as an Indicator of Sustainability of Agricultural Management) were widely used by attendees, particularly when they were attempting to identify an unusual bacterivore, fungivore, omnivore or predator.

Plant Nematodes of Australia

At an AAN meeting in 1992, concern was expressed that the Australian Quarantine and Inspection Service had not updated its host list of plant-parasitic nematodes in Australia. Funds were obtained from RIRDC and with the help of NSW Agriculture, the list was updated in 1994. Prepared by R McLeod, F. Reay and J (Fleming) Smyth, the booklet entitled 'Plant Nematodes of Australia by Plant and by Genus' remains a key resource for anyone wanting to know the plant-parasitic nematodes associated with particular crops in Australia.

International Federation of Nematologists (IFNS)

During the 1980s and 90s there were discussions about the need for an international organisation to represent nematologists. Finally, in 1996 it was agreed to establish the International Federation of Nematologists. AAN was one of the twelve Nematology Societies that were affiliated with the new organisation. John Marshall from New Zealand represented AAN and served on the first IFNS management committee.

Advisory services for nematode pests

When AAN was established there were discussions about whether there should be an accreditation scheme for diagnostic services in nematology. A working group led by Graham Stirling was established and it asked commercial and state-run laboratories whether they wanted such a scheme. Most were in favour but some thought it should be operated by AAN whereas others favoured the National Association of Testing Authorities (NATA). In the end it was decided that AAN should prepare a document that showed those providing nematode diagnostic services how samples should be processed. Funding was obtained from RIRDC and the book produced is cited below (Stirling *et al*. 2002).

Nematode collections

Prior to 1990, most Australian states had a nematode collection that was established by nematologists who were employed by State Departments of Agriculture. However, with the retirement of these nematologists (who all had taxonomic expertise), the collections were not maintained and fell into disrepair. The problem in Queensland was overcome by using a grant from RIRDC to restore some of the slides and transfer the collection to the Queensland Museum.

In 1995, Mike Hodda joined CSIRO Division of Entomology and one of his primary responsibilities was the development and maintenance of an Australian nematode collection. It was housed at the Australian National Insect Collection (ANIC) in Canberra and by 1998 the collection contained more than 14,500 permanent slides of plant-parasitic nematodes, together with many bulk samples of fixed nematodes and specimens stored in glycerol. Three years later, the collection had grown to nearly 20,000 specimens and had widened in scope to include insect-parasitic and free-living nematodes.

Short courses in Nematology

In 1999, 2001, 2003 and 2005, Mike Hodda (CSIRO) and Kerrie Davies (University of Adelaide) ran four successful five-day courses entitled 'Nematodes in Cropping Systems: Identification and Techniques'. The courses targeted professionals working in agriculture, quarantine and soil biology who needed to gain an understanding of the principles and practice of handling soil, plant and insect nematodes. Participants obtained hands-on experience in sampling, extraction, specimen preparation, culturing and diagnosis, and also had an opportunity to identify nematodes using morphological and molecular techniques.

5th International Congress of Nematology (5ICN)

The International Congress of Nematology is held every five years and following the fourth Congress in the Canary Islands in 2003, Mike Hodda, the president of AAN submitted a bid to hold the fifth Congress in Brisbane. That bid was successful and a committee of ten people from Australia and New Zealand was established to organise the conference. AAN set up as a separate entity (5ICN Inc.) to handle the financial aspects of the conference and loaned it $5,000 so that the company was financially viable until registration fees were received.

The Congress was held from 13-18 July 2008 and was certainly one of the best nematology conferences ever held. In fact Virginia Ferris, one of the speakers in the final plenary session indicated that

"it was a real highlight of her career". In the end, 365 nematologists attended and the Proceedings was a massive document consisting of 377 pages. One highlight was the Australian dollar peaking at US$0.98 during the conference, leading many Americans to comment on the high costs of everything in Australia. Six months later, the Aussie dollar was down to US$0.63!

The Brisbane Convention and Exhibition Centre proved to be an ideal venue and the program covered all aspects of plant and soil nematology. The weather was great and the mid-week excursions (to the Gold Coast hinterland; the Sunshine Coast hinterland; and the Darling Downs) gave our overseas visitors a chance to see a small part of regional Australia. Despite the high value of the dollar, income from the conference balanced expenditure and so AAN did not suffer financially from taking on such a major project.

Special issue of Australasian Plant Pathology

In 2008, a special issue of Australasian Plant Pathology (Volume 38, Number 3) was produced to coincide with 5ICN. It contained 10 papers highlighting the nematological work being done in Australia and New Zealand and all those who attended the congress received a copy. Seven of the papers included in the special issue are cited in the reference section.

Major accomplishments: 1975 to 2008

During the period from 1975 to 2008, nematologists in Australia and New Zealand made important contributions in many areas of nematology.

- Annual ryegrass toxicity (ARGT) was first observed in 1955 and over the next 40 years it killed thousands of sheep and cattle in South Australia and Western Australia. During the period from 1975 to 1993, several nematologists and bacteriologists worked together to show that ARGT was a nematode-bacterium disease complex. They described both the nematode and bacterium as new species, identified the corynetoxins produced by the bacterium, and developed a range of control measures that minimised livestock losses (see review by Riley and Barbetti, 2008)
- The development of cereal cultivars with resistance to cereal cyst nematode and their widespread adoption in the 1990s resulted in this very damaging nematode becoming a relatively minor constraint to wheat and barley production (Vanstone *et al*., 2008)
- A book on biological control of nematodes (Stirling 1991) made an important contribution to international efforts to reduce nematicide usage by enhancing the suppressive services provided by parasites and predators of nematodes
- Gregor Yeates played a leadership role in the area of soil ecology by clarifying the feeding habits of various nematode genera, improving our understanding of nematode assemblages and developing methods that enabled nematodes to be used as biological indicators (Yeates *et al*., 1993; Yeates and Bongers, 1999; Yeates 2003)
- Research programs on *Pratylenchus thornei* and *P. neglectus* commenced and they soon provided cereal growers with rotation options that would reduce losses from the nematode. Sources of resistance to both nematode species were also identified and they became the foundation of future breeding programs (Vanstone *et al*., 2008; Thompson *et al*., 2008)
- In 1996, three separate incidents of cattle deaths in Japan were associated with hay exported from Australia. The deaths were attributed to annual ryegrass toxicity and this jeopardised a growing export hay market. A sampling/testing protocol for export hay was developed and accepted by the Ministry of Agriculture Forestry and Fisheries in Japan. This protocol, with minor modifications, is still used today.
- Integrated nematode management programs were developed for horticultural and vegetable crops and they reduced the need for soil fumigants and non-volatile nematicides (Stirling and Pattison, 2008)
- Plant-parasitic nematodes were shown to cause widespread losses in sugarcane and be one of the contributors to a serious yield decline problem (Blair and Stirling, 2007; Stirling, 2008)
- Plant improvement programs focusing on white clover (*Trifolium repens*), the foundation of New Zealand's grazed pasture systems, resulted in the development of cultivars with resistance and tolerance to *Meloidogyne trifoliophylla* and *Heterodera trifolii*, two widely distributed and destructive nematode pests (Mercer *et al*., 2008).
- Molecular methods of detecting and quantifying key nematode pests were developed and these tests were included in a world-first DNA-based testing service for soilborne diseases that was operated by the South Australian Research and Development Institute (Ophel-Keller *et al*., 2008)

Concluding remarks

In an era where universities and publicly-funded research institutions were reducing their support for specialist disciplines such as nematology, nematologists in Australia and New Zealand were able to fulfil their primary role (helping growers reduce losses from nematode pests) and also contribute to international efforts in areas such as soil ecology, biological control and molecular diagnostics. The International Congress of Nematology held in Brisbane was the culmination of a very productive period in Australasian nematology and demonstrated that although there were relatively few contributors, nematology 'Down Under' was alive and well.

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