CONTROLLING SIREX WITH A NEMATODE

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Summary

Infection of the woodwasp *Sirex noctilio* (sirex) by a strain of the nematode *Deladenus siricidicola* sterilises the adult female. High percentages of infection occur in North Island forests and sirex numbers have been reduced. Before 1967 the nematode was not present in the South Island and successful introductions of this sterilising strain have been made there. Various methods were used, but since 1971 recently-killed trees have been inoculated with nematodes bred on cultures of the sirex fungal symbiont.

In North Auckland and Coromandel forests a benign strain of *D. siricidicola*, which does not sterilise the female sirex, also occurs.

INTRODUCTION

The nematode *Deladenus siricidicola*, which is parasitic on the woodwasp *Sirex noctilio*, was discovered in 1962 in the North Island of New Zealand (Zondag 1962; 1969). Since infection by the nematode can sterilise adult female woodwasps, and infection rates greater than 90% have been recorded, the nematode had obvious potential as an efficient biological control agent.

At present two strains of *D. siricidicola*, sterilising and non-sterilising, are known to occur in New Zealand. Infection by the sterilising strain results in atrophy of the ovaries and eggs, and hypertrophy of the testes. Each infected sirex egg contains 100-200 juvenile nematodes and the testes contain up to 40 000. The male sirex is not sterilised because spermatozoa pass to the seminal vesicles before nematodes enter the testes (Bedding 1972). Sirex infected by the non-sterilising strain also have hypertrophied testes, and although the ovaries are infected, the eggs are not. The difference between infection by the sterilising and non-sterilising strains can be detected only in the adult female sirex, not in adult males or larvae.

In order for the nematode to be passed from one generation of sirex to the next, it is necessary for both infected and uninfected sirex females to successfully attack the same tree, since only infected females are able to transmit the nematode.

The life cycle of *D. siricidicola* is complex (Bedding 1967; 1972). In the wood of successfully attacked trees nematodes are present in a free-living form which feed on the sirex fungal symbiont, and in a parasitic form, the females of which are able to penetrate the sirex larvae. These infective females produce young ovoviviparously at the time of host pupation and the juvenile nematodes invade the sirex reproductive organs.

The sterilising strain of *D. siricidicola* is well established in all the forests in the North Island, where infection levels of over 90% are not uncommon. Since it could not be found in any of the South

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Island forests, it was decided in 1967 to introduce it there. The methods of introduction and of checking establishment will be dealt with in this paper.

The occurrence of the non-sterilising strain was recognised in 1971 and it has been found only in a few North Auckland forests (Zondag 1973; 1975) and one forest in the Coromandel. In these forests the sterilising strain is also present.

METHODS

a. *Methods of introduction*

The simplest method of introducing the nematode to new locations would have been to place logs containing a high percentage of infected *Sirex* larvae in the forests. The emerging females would then spread the infection. The objection against this method was that a large number of uninfected *sirex* could be introduced into an area.

Trials of four methods of controlled introduction were carried out in 1967 in the South Island (Zondag 1971).

One of these methods was used from 1968 until 1970. Nematodes were extracted from wood of recently-killed trees, stored in vials filled with woodshavings, and the contents were then inserted in holes drilled in trees which contained *sirex* larvae. The main disadvantage of this method was that, because of their short storage life, the nematodes had to be inserted within 10 days of extraction.

From 1971 onwards the method developed by Bedding in Tasmania has been used (Bedding and Ackhurst 1974). The nematode is mass-reared on the *sirex* fungus, initially on potato-dextrose-agar and later on grain, and stored in flasks lined with malt agar in cool storage. Prior to introduction, the nematodes are transferred to cooled gelatine and then inserted with hypodermic syringes in holes made by punch-and-chisel-hammers in trees containing *sirex* larvae. The advantages of this method are that millions of nematodes can be obtained and that they can be stored for up to 4 months.

Both methods enable introductions to be made in winter and early spring when pine mortality associated with *sirex* attack shows up more readily.

Between 1971 and 1973 no introductions were made in Nelson or the northern part of Canterbury. This was to permit determination of natural spread in these areas.

b. *Method used to check on establishment*

Logs containing *sirex* larvae are collected from recently-killed pine trees and placed in insectaries or cages, and emerging *sirex* adults are dissected to check for nematode infection. Larvae, also, are collected and dissected. Such checks are made not only in forests where the nematodes have been introduced, but also in others to determine spread.

The low mortality of trees attacked by *sirex* in many South Island forests has hampered both the introductions of the nematode and the collection of logs for checking on the establishment.

RESULTS

Table 1 lists the South Island forests where the nematode has been introduced and recovered between 1967 and 1975.

Nelson

After the successful introductions in Rai-Whangamoa State Forest in 1967 the nematode was recovered in small numbers from Motueka State Forest and Pigeon Valley (Baigent's Plantations) in 1970, a

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natural spread of about 50 kilometres. In subsequent years natural spread resulted in establishment in other forests in the northern part of the region. In Golden Downs State Forest the nematode was introduced in 1973, although it had already been recovered from a few siren in the 1971/72 and 1972/73 seasons. In the 1973/74 season infection of over 90% was recorded in *Sirex* emerging from eight trees from Golden Downs.

TABLE 1: INTRODUCTIONS AND RECOVERY OF
D. SIRICIDICOLA IN THE SOUTH ISLAND

Forest	Introduced Year	No. of trees	First season of recovery
NELSON			
Baigent's Plantations	—	—	70/71
Braeburn Plantation	—	—	72/73
Fletcher's Plantation	—	—	73/74
Golden Downs State Forest	73	10	71/72
Motueka State Forest (Kaiteretera Block)	—	—	70/71
Rabbit Island	70	4	71/72
Rai-Whangamoa State Forest	67*	12	68/69
Tawhai State Forest	73	5	—
WESTLAND			
Hochstetter State Forest	74	5	—
CANTERBURY			
Ashley State Forest	68	16	69/70
	69	21	
Burwood Plantation	73	7	—
Eyrewell State Forest	69	7	—
Hinds (Railway Plantation)	72	3	—
Kakahu State Forest	71	2	—
Omihi State Forest	67*	14	68/69
SOUTHLAND			
Alexandra B.C. Plantation	71	3	—
Berwick State Forest	68	1	
	69	9	73/74
	71	8	
Dusky State Forest	68	8	74/75
Herbert State Forest	68	11	72/73
Longwood State Forest	72	3	—
Otago Coast State Forest	69	5	74/75
	73	2†	
Rankleburn State Forest	67*	19	—
	73	1†	
Tapanui State Forest	68	2	70/71

* Trial (Zondag 1971).

† Plus inoculated logs ex Herbert State Forest.

Canterbury

The nematode has been introduced into six forests, but recovered from only two, Ashley and Omihi State Forests. In Ashley, spread occurred throughout the forest but infection levels were low; no recovery checks have been made since 1973 as no recently-killed trees could be found. In Omihi only small numbers of infected siren were found in the 4 years after the initial introduction in 1967, and none in subsequent years.

Southland

The nematode has now been recovered from five of the eight forests in which it was introduced. In several of these, recovery took several years and the number of trees found with infected siren is still low.

CONCLUSIONS AND FUTURE PLANS

The nematode introductions can be regarded as successful in the northern part of Nelson where natural spread accounted for establishment in several forests, and infection rates of over 75% have been recorded. In Canterbury and Southland the known establishments are below expectations; no known natural spread to other forests has occurred and the number of trees with infected siren is low. Introductions of *D. siricidicola* will be continued in the South Island, so that it may become properly established in all forests and keep siren populations in check.

Investigations of the benign strain of *D. siricidicola* will be continued, since it is likely that it will spread to other localities in future years and could cause a setback in the biological control of siren.

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