13041

SPECIAL LIFTOUT
SECTION NO 13

NATIONAL STRATEGY FOR CONTROL OF *SIREX NOCTILIO* IN AUSTRALIA

The strategy for control of *Sirex noctilio* commissioned by the Australian Forestry Council is intended to provide a framework to help forest entomologists and forest managers construct a detailed control program for their organisations. Some of the recommendations are "best estimates" and are subject to change as more results become available. This strategy will be reviewed annually by the National Sirex Coordination Committee. Detailed instruction sheets for specific operations are in preparation.

Individual growers in areas affected by sirex should consider a co-operative control program. The AFDI may well form the nucleus for growers; the ACT/Southern NSW Branch of the AFDI is currently planning such a program.

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INTRODUCTION

The outbreak of *Sirex noctilio* during 1987 in southeastern South Australia and southwestern Victoria has highlighted the need for a national strategy for sirex control. Over 5 million radiata pines *(Pinus radiata)*, with a royalty value of $10-12 million, were killed between 1987 and 1989. This severe outbreak was almost certainly a result of inadequate preventative measures. Releases of biological control agents prior to this outbreak were minimal and haphazard, and silvicultural controls were not implemented (Haugen 1990). A $1.3 million control program was completed during 1987 in response to this outbreak (Haugen and Underdown 1990); however, a comprehensive control program beginning in the year of detection would have been more cost-effective.

The National Sirex Trust Fund was established in 1962 to provide resources for survey and eradication of sirex, and later for research on control methods. This fund concluded in 1977, but the Australian Forestry Council (AFC) funded a program to culture and supply the biological control agents to all States. However, a few important aspects of sirex control have been inadequate or neglected, in that:

- Tactics and recommendations for sirex control were not integrated into a comprehensive strategy.
- Dissemination and interpretation of information on sirex control were deficient at national, state, and operational levels.
- Control procedures were not formalized and have been modified without testing their efficacy.

This strategy and the National Sirex Coordination Committee have been developed to overcome these problems.

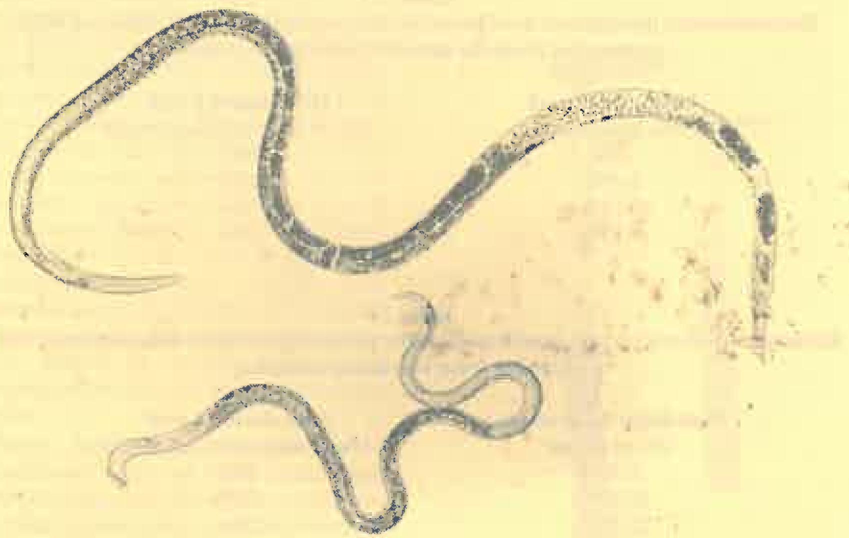
GENERAL INFORMATION ON SIREX

Sirex noctilio, a native of Europe, is the only one of a large number of woodwasp species able to kill relatively healthy pine trees. One of the tree species most susceptible to this insect, *Pinus radiata*, from California, was introduced into Australia during the nineteenth century and now forms the bulk of this country's 900,000 hectares of softwood plantations. After being accidentally introduced into New Zealand and causing epidemic outbreaks during 1945-1949, sirex was discovered near Hobart during 1952 and then near Melbourne during 1961. Since then, sirex has spread throughout Tasmania and Victoria, and has reached the Adelaide Hills in South Australia and Bathurst in New South Wales. The combination of a particularly susceptible tree species from the USA and the most damaging woodwasp from Europe, brought together in drought prone Australia is a recipe for disaster and indeed serious outbreaks occurred in Tasmania, Victoria, South Australia. If the control

A female sirex drilling a hole to lay an egg. Adults emerge during January-March.

Sirex larva in a gallery; behind the larva, the gallery is filled with a fine compact powder.

Sirex emergence holes, generally 3-6 mm in diameter.



Deladenus siricidicola, the infective form with piercing mouthparts (left) and the fungus-feeding form (right); average body length 1.2 and 1.9 mm, respectively.

measures outlined in this document had been implemented, these outbreaks may have been averted.

In Australia, sirex normally completes one generation per year (a small proportion of the population may take two years). Adults, which live for only a few days, emerge from December to May with the peak emergence in February or March. The female wasp drills her ovipositor into the outer sapwood of trees to lay eggs. At the same time she injects a symbiotic fungus and a toxic mucus which together cause the death of the tree. Sirex larvae feed on the fungus as they tunnel through the wood. Mature larvae pupate close to the bark surface and adults emerge about three weeks later.

Trees attacked by sirex begin to show conspicuous symptoms from April onwards. The entire crown turns light green to yellow then to reddish brown. Beads or dribbles of resin, resulting from wounds during egg laying, may be visible on the bark. As the fungus grows from the oviposition drill, fungal stains apppear in the cambium as long, narrow, brown bands along the grain, and eventually the fungus permeates every part of the tree. Larvae, galleries, or exit holes provide conclusive evidence of successful sirex attack. After a tree has been killed, the wood degrades rapidly and, if salvage is feasible, it should be done within six months of sirex attack.

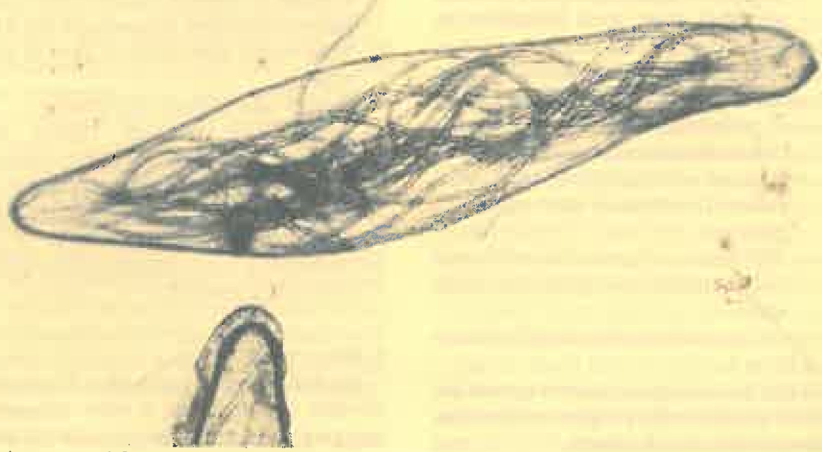
Pinus radiata is highly susceptible to sirex attack, but other *Pinus* species are also attacked. Susceptible plantations are generally 10-25 years old, and unthinned stands are more susceptible than thinned stands. Trees under stress (e.g., drought conditions) or injured (e.g., by wind, fire, or during logging) appear to be more susceptible to attack. Therefore, a major preventative measure is to increase stand vigour by thinning.

Two kinds of biological agents are used to control sirex. The parasitic nematode, *Deladenus siricidicola,* is of greatest importance. This nematode has an extraordinary life cycle which enables it to breed up in vast numbers throughout the tree while feeding on the fungus; then it enters a sirex larva and begins reproduction when its host pupates. Nematode juveniles sterilise the adult female sirex by entering all her eggs. When nematode-infected sirex emerge and attack other trees, they transmit packets of nematodes instead of fertile eggs. Infection levels can approach 100% and lead to a collapse in the sirex population.

A number of parasitic wasps have been imported and released for sirex control. *Ibalia* species lay their eggs down the drills of sirex and into the developing eggs of sirex, eventually killing the sirex larva from the inside. *Rhyssa, Megarhyssa* and *Schlettererius* species drill deep into the wood to paralyse and then lay their eggs on sirex larvae, and the parasitoid larvae consume and kill the sirex larvae from the outside. The parasitoid complex does not usually kill more than 40% of a sirex population, and parasitoid activity alone is not sufficient to prevent sirex from reaching outbreak levels.

RECOMMENDATIONS

- **Before sirex is detected in a region:**
  - — Consider cost/benefit of sirex quarantine, and invoke where appropriate.
  - — Train forest, logging, and sawmill personnel to recognize sirex symptoms (with annual refresher sessions), and promote vigilant forest surveillance.
  - — Install trap tree plots in susceptible plantations (i.e., 10-25 years old and more than two years past the prescribed thinning age) near mills, major transportation routes, and the leading edge of expected natural sirex dispersal. The number of plots should be proportional to the risk of sirex introduction.
  - — Review the status of plantation thinning and comply with the optimum thinning guide for first and second thinnings.



A sirex egg with nematodes inside; up to a couple hundred juvenile nematodes per egg (egg is 1 mm long). Nematodes destroy the contents of the eggs, thus making the female sirex sterile.

- **Once sirex is detected, do the following annually:**
  - — Map the sirex distribution within the region (from forest surveillance and trap tree data).
  - — Estimate sirex-associated tree mortality in selected compartments by transect sampling.
  - — Review the status of plantation thinning and comply with the optimum thinning guide for first and second thinnings.
  - — Install trap tree plots for inoculation (10 trees/plot) during November-December at a minimum density of one plot per 25 ha of susceptible plantation within the sirex distribution. Inoculate the sirex-attacked trap trees with nematodes during May-June.
  - — Release parasitoids in appropriate compartments; record and map the pertinent information (compartment identification, species, number of males and females released, and date).
  - — Determine the percentage of sirex infected with nematodes and population levels of each parasitoid species by caging logs from sirex-infested trees in specific compartments.
  - — Evaluate samples from inoculated trees to determine the effectiveness of inoculations (i.e., the percentage of sirex infected with nematodes).
  - — Review data and reports of the sirex control program from the current year, and plan a work schedule for the following year.
- **If the annual sirex-associated tree mortality is >0.5% in a compartment:**
  - — If the nematode infection level of sirex from uninoculated trees had been quantified during the previous sirex emergence season, inoculate as prescribed in Table 1.
  - — If nematode infection level is unknown, take woodchip samples to determine level of presence in sirex-attacked trees and inoculate as prescribed in Table 2.
- **If the annual sirex-associated tree mortality is >10% in a compartment:**
  - — If unthinned, thin the compartment before the next sirex flight season to remove sirex-infested trees and reduce the stress of inter-tree competition.
  - — If thinned and greater than 20 years old, consider salvaging the dying trees.
  - — Or inoculate as prescribed in Tables 1 or 2.
- **After the biological control agents are well-established in a region and the sirex population has declined:**
  - — Select plantations for sampling that are 10-12 years old and geographically isolated from current populations of the biological control agents.
  - — Install trap tree plots in these plantations to confirm the presence of sirex.
  - — Evaluate logs from these trap trees to determine the percentage of sirex infected with nematodes and the presence of parasitoids.
  - — Make further releases, if the biological control agents are deficient.

Table 1
Recommended inoculation level based on the percentage of sirex infected with nematodes from the previous emergence season

Nematode Level (% infection)	Inoculation Level (% of sirex-infested trees)
0%	20%
1-5%	10%
5-10%	5%
>10%	0%

Table 2
Recommended inoculation level based on the percentage of sirex-infested trees with nematodes from woodchip sampling

Woodchip Assessment (% of trees)	Inoculation Level (% of sirex-infested trees)
<10%	20%
10-25%	10%
25-50%	5%
>50%	0%

DEVELOPMENT OF RECOMMENDATIONS

1. National Sirex Coordination

The National Sirex Coordination Committee was established by the Australian Forestry Council (AFC) in 1988 to scrutinize sirex developments. The committee meets annually and consists of representatives from state forest services, private companies, and research institutions. Duties of the committee are to:

- — Recommend the objectives, works program, and budget of the AFC Sirex Fund to the AFC.
- — Prepare an annual report of the Committee's activities, programs of the AFC Sirex Fund, and status of sirex in each state.
- — Review and update this strategy.
- — Review the selection, supply, and demand for biological control agents.
- — Provide information, upon request, on supply and cost of the biological control agents from available sources.
- — Maintain a list of people active in sirex control or research.

2. Sirex Awareness

Each forestry organization (state and private) should enact a sirex awareness campaign according to the risk of sirex introduction. The campaign should:

- — Educate forest personnel on procedures for sirex detection and control with annual refresher sessions, and promote vigilant forest surveillance.
- — Train logging and sawmill personnel to recognize sirex and its characteristic symptoms, and encourage them to report detections.
- — Distribute the National Sirex Management Strategy, new sirex literature, and written instructions of standardized control procedures to forest managers.

3. Quarantine

Sirex is unlikely to spread naturally more than 30-50 km per year. However, transport of sirex-infested logs or timber increases the rate of spread and provides access to areas that sirex could not invade by natural dispersal. Sirex can emerge from air-dried timber and CCA-treated products (copper-chromium-arsenate preservative applied under vacuum/pressure). Each state forest service should:

- — Consider the risks of natural dispersal and accidental introduction of sirex into each forest region.
- — Consider the effect of quarantine on timber markets against the risk of sirex introduction.
- — Invoke quarantine, where appropriate, to prohibit the transport of logs and specified timber products into uninfested regions from infested regions.

4. Sirex Detection

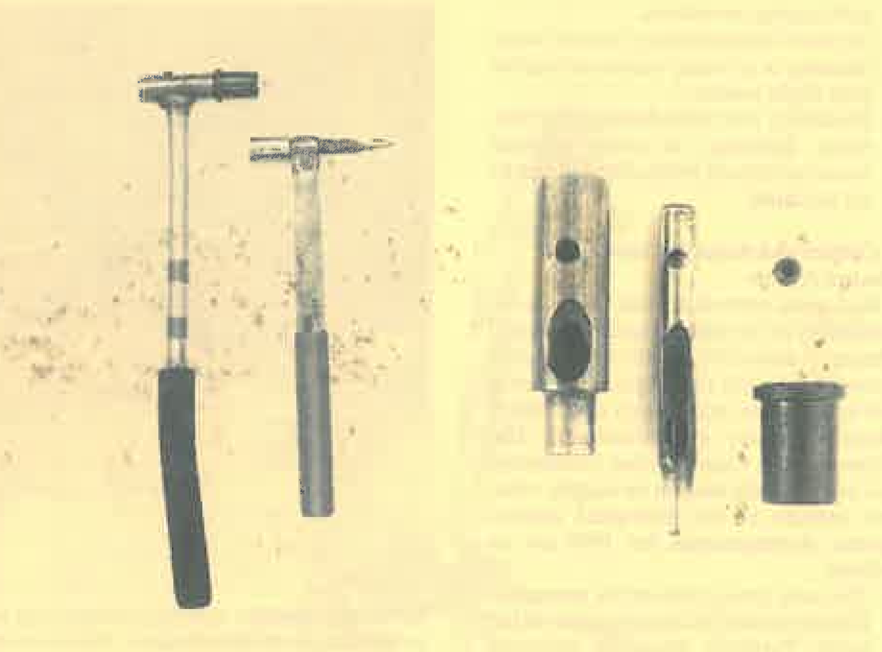
Detection at an early stage of sirex establishment provides the opportunity to release the biological control agents and to thin over-stocked stands before sirex populations can reach damaging levels. The objective is to detect sirex in a locality (i.e., a contiguous set of compartments within the same age class) before any compartment reaches 0.1% annual sirex-associated tree mortality (1-2 trees/ha in an unthinned stand).

Detection methods and intensity of application should be based on the risk of sirex introduction or dispersal into each region. Priorities are to train appropriate personnel in forest surveillance, to install detection plots as the risk of sirex introduction increases, and to conduct aerial reconnaissance with trained observers. For example, if the nearest known sirex source is >200 km, forest surveillance is the most appropriate technique, but if sirex is <100 km away, trap trees should also be used. Once sirex is found in a region, the number of trap tree plots should be increased to enable mapping of the sirex distribution within the region.

Forest Surveillance. Attentive forest surveillance will most likely detect sirex establishment early enough to implement an effective sirex control program. Forestry, logging, and sawmill personnel should be instructed to collect and report any sirex signs (adult insects, exit holes, larval galleries, and dying trees with cambial staining). Initial detections are often associated with logging activities. Dead and dying trees injured by lightning, fire, wind, hail, and logging should be inspected for sirex.

Trap Tree Plots. Detection plots, consisting of five trap trees per plot, should be installed during November or December near areas of likely sirex introduction (e.g., sawmills, major timber transportation routes, and the front of natural dispersal). Plots should be located in susceptible plantations (i.e., 10-25 years old and more than two years past the prescribed thinning age). Trap trees can be inspected during June or July for evidence of sirex attack (cambial staining, oviposition drills, and larval galleries). A second inspection is required during the following April for exit holes. The number of detection plots should be commensurate with the probability of sirex introduction. If sirex is <100 km away, a density of at least one plot per 100 ha of susceptible plantation is recommended. If the probability of sirex introduction is slight, 5-10 plots per year in a major region is advisable as part of a sirex awareness campaign.

Aerial Observation. Aerial observation from fixed-wing aircraft, to map dying trees for subsequent ground checking, has been the traditional procedure for sirex detection. However, suppressed trees, which have the greatest likelihood of sirex attack, can be difficult to detect from the air. Aerial searching should be done when the highest proportion of sirex-attacked trees are showing foliage symptoms (e.g., September-October). Ground checking should be done after aerial searching to detect cambial staining, oviposition drills, or larval galleries, but any negative results should be re-examined the following April-June for exit holes.



a) SWAT inoculation hammer (top) and Gould punch (bottom).
b) disassembled SWAT hammer; hammer head, wad punch, allen screw, and rebound rubber.

5. Sirex Monitoring

Forest managers need to know the level of sirex-associated tree mortality to respond with appropriate control measures. The objective is to estimate tree mortality for specific compartments and monitor change in mortality from year to year. It is not feasible to monitor every compartment or locality, so susceptible compartments with a wide geographic distribution should be selected for sampling. Options for monitoring sirex populations are either expensive or inaccurate. Further research is needed to develop an accurate and cost-effective procedure.

Repeatable Transects. Transect sampling is, at present, the only satisfactory means that can be used to estimate sirex-associated tree mortality. A sample size of >500 trees in a compartment is recommended. The same transects should be assessed each year during October to record new tree deaths and to verify sirex exit holes in trees killed during the previous year.

Aerial Survey. Procedures used in subjective aerial surveys from fixed-wing aircraft do not appear to accurately quantify tree mortality below 5%. At higher levels, aerial surveys have been useful to stratify compartments for ground surveys, but lacked accuracy in estimating tree mortality. Surveys from a helicopter appear to be more accurate (R.H. Eldridge, Forestry Commission of NSW, pers. comm.).

Aerial Photography. Infrared aerial photographs have been used to evaluate plantations with sirex outbreaks (e.g., McKimm and Walls 1980). Aerial photographs of sample compartments may be an efficient method for estimating tree mortality, but this technique needs further investigation.

Trap Tree Plots. Trap tree plots have been suggested as a way to monitor sirex population levels (Neumann *et al.* 1982). However, no procedure has been developed to collect and interpret these data.

6. Silvicultural Control

The objective of silvicultural control is to adopt tactics that, in conjunction with the biological control agents, will reduce the risk of a sirex outbreak. Healthy, vigorously-growing stands have a lower susceptibility to sirex attack; therefore, the key recommendation is to practise "on-time" first thinnings. Thinning as prescribed by an optimum thinning guide (e.g., Lewis *et al.* 1976) will reduce the potential damage of a sirex population. Thinned stands will not be totally resistant to sirex attack, especially during drought conditions, but they are less likely to sustain a damaging outbreak. Earlier or heavier thinnings than prescribed by the guide would make the stand even less susceptible, but with a reduction in stand productivity. Should markets not be available to achieve "on-time" first thinning, then non-commercial thinning should be considered.

Other stand factors appear to have an impact on sirex populations, but they have not been intensively investigated. Managers should be aware of these factors, which include:

— Potential for sirex populations to reproduce in residues from waste thinnings

and logging operations.
— Increased susceptibility of a stand when thinning or pruning occurs during the sirex flight season.
— Possibility that trees damaged by fire, wind, lightning, or other physical causes are sites at which sirex outbreaks are initiated.

7. Culture and Supply of Biological Control Agents

Biological control of sirex relies on the availability of the selected agents for initial releases. A nationally coordinated program is needed to supply these agents efficiently and to eliminate unnecessary duplication among forestry organizations. The National Sirex Coordination Committee will provide information on supply, cost, and sources of the biological control agents. Arrangements for 1990 are as follows:

— The mass production of the nematode *Deladenus siricidicola* to be done at the Keith Turnbull Research Institute (KTRI), Frankston VIC (request at least 3 months prior to desired delivery date).
— Backup nematode cultures to be maintained at CSIRO Division of Entomology, Canberra ACT.
— *Ibalia leucospoides* and *Megarhyssa nortoni* to be supplied from established field populations within Australia. Contact the secretary of the National Sirex Coordination Committee for further information (request at least 6 months prior to desired delivery date).
— Cultures of *Rhyssa hoferi, Rhyssa persuasoria,* and *Schlettererius cinctipes* to be re-established at KTRI during 1989/90 if the parasitoids are recovered in sufficient numbers. Parasitoids for field release should be available by November 1991 (request at least 15 months prior to desired delivery date).

8. Nematode Introduction

The nematode *Deladenus siricidicola* is the key agent for biological control of sirex. The objective is to introduce the nematode in sufficient quantities to result in a >20% infection level throughout a sirex population within three years after sirex detection. Trap tree installation and nematode inoculation should start promptly after sirex detection, so nematodes will have sufficient time to spread and increase to regulating levels before sirex causes damage. Severe outbreaks can occur if nematode introduction is delayed or is insufficient in quantity and distribution (McKimm and Walls 1980, Haugen and Underdown 1990). Techniques to artificially inoculate sirex-attacked trees (Bedding and Akhurst 1974) and to prepare trap tree plots (Neumann *et al.* 1982) have increased the efficiency of nematode introduction. However, inoculation procedures used from 1985-1988 failed to achieve high infection rates of sirex in inoculated trees. This may be due to changes from the original inoculation procedure of Bedding and Akhurst (1974). Changes in the number of nematodes per inoculation hole, gelatin concentration, and hole spacing have been made without testing the effects on infection rates. Until these modified procedures have been tested, the original procedure should be followed.

Trap Trees. Trap trees are an efficient way to introduce nematodes into low sirex populations (<0.5% annual sirex-associated tree mortality) because searching for sirex-infested trees is eliminated. A minimum density of 4 trap tree plots (10 trees/plot) per 100 ha of susceptible plantation is recommended after sirex has been detected in a locality. Sirex-infested trap trees should be inoculated during May-July. Trap tree plots should be installed and inoculated each year until evaluations indicate that >10% of the sirex population is infected with nematodes. Trap tree plots should be well-distributed throughout the susceptible plantations and staggered in successive years. Any trap trees in detection plots that are sirex-attacked should also be inoculated.

Trees Naturally Attacked By Sirex. If the annual sirex-associated tree mortality is >0.5% in a compartment, nematode inoculations need to be done as prescribed in Tables 1 or 2. Inoculations should be done during May-July in trees with >50% moisture content (Bedding and Akhurst 1974).

Billets. Nematodes can be introduced by transporting inoculated sirex-infested logs (i.e., billets) from other areas. This is usually only cost-effective for compartments with poor internal access. The efficiency of a billet operation also depends on access to and proximity of sirex-infested trees for billet production. This method has a disadvantage of adding female sirex to the population in that locality, even though most should be sterile.

Ibalia leucospoides; a female laying an egg to parasitise a sirex egg. It uses the oviposition hole made by the female sirex. Adults emerge during February-April.

9. Parasitoid Introduction

The objective is to release the selected species of parasitoids in sufficient numbers to give each species a reasonable chance for establishment in each sirex-infested region. The selected species are:

Ibalia leucospoides
Megarhyssa nortoni
Rhyssa hoferi
Rhyssa persuasoria
Schlettererius cinctipes.

Initially, releases of 40-60 pairs of adults per site should be made into compartments with the highest sirex levels. The aim is to optimize the probability of establishment and the geographic distribution with the limited number of parasitoids available for release. Once a species is established in a region, its distribution can be extended by transporting logs containing larvae or by releasing adults collected from caged logs. Release sites should be about 8 km apart for *I. leucospoides* and 4 km for each of the other species in contiguous pine plantations. Ideally, releases of each species should occur within two years after the detection of sirex in a locality.

10. Evaluation of Biological Control Agents

An evaluation program should determine establishment, distribution, and population levels of the biological control agents. A locality is the basic unit for data collection and application of control measures. Results from the evaluation program are used to plan nematode inoculations and parasitoid releases. Release sites and localities with confirmed establishment should be mapped annually for each agent. This evaluation program has three components:

(a) Infection percentage of sirex emerging from inoculated trees

Cage Samples. Inoculated trees need to be assessed to ensure the inoculation procedures were properly implemented and to estimate the rate of nematode introduction into the sirex population. Sample logs should be collected from inoculated trees (naturally attacked or trap trees) and caged by compartment or locality. Emerging sirex, male and female, should be dissected to determine the percentage of sirex infected with nematodes from each cage. The number of cages depends on the number of trees inoculated and their geographic distribution. As a guide, at least 5% of the inoculated trees should be sampled if $<$10,000 trees were inoculated. Also, samples from uninoculated trees from the same compartment should be evaluated as a "control".

(b) Infection percentage of sirex emerging from uninoculated trees.

This evaluation provides data to make decisions on additional inoculations. Introduction of nematodes should continue until the nematode is well-established throughout a locality. Cage samples estimate the infection level of adult sirex from the last emergence season; whereas, woodchip samples examine the nematode distribution after those sirex have spread the nematode to the next set of trees. Currently, data from the cage samples is thought to be more reliable for making decisions than data from woodchip samples.

Cage Samples. A locality selected for nematode evaluation should have samples from at least 25 uninoculated trees. These samples should be collected and caged by compartment. Emerging sirex should be dissected to estimate the percentage infected with nematodes. These data should be summarized and used to decide if more inoculations are required as prescribed in Table 1.

Woodchip Samples. Woodchip sampling is a useful method to determine geographic distribution and extent of natural dispersal of the nematode. At least 20 sirex-attacked trees should be woodchip sampled during May-July in a locality selected for evaluation. At least five woodchips from each tree should be collected, bulked, and assessed for the presence of nematodes. The number of inoculations prescribed is based on the percentage of the sample trees that are nematode positive (Table 2). This procedure only surveys for the presence of nematodes in a tree, but the relationship between the nematode level in woodchips and the resulting infection of emerging sirex is under investigation.

Megarhyssa nortoni; a female laying an egg to parasitise a large sirex larvae. It drills its own hole up to 70 mm deep into the wood in search of a sirex larva. The main emergence period is during October-November, and a secondary peak in January.

(c) Parasitoid evaluation.

Cage Samples. Samples from sirex-infested trees should be collected near previous parasitoid release sites to determine successful establishment. After establishment of a parasitoid is confirmed, samples from other compartments can be assessed to monitor distribution and rate of spread. Data should be used to map parasitoid distributions and to select sites for collecting logs for parasitoid redistribution. The relative population level of a species is the proportion of that parasitoid to total insect emergence.

11. Continued Evaluation of Biological Control Agents

Evaluations should continue indefinitely, at a low level, to ensure the biological control system is maintained after the initial period of sirex control in a region. This system relies on natural dispersal of the biological control agents as sirex invades localities reaching the susceptible age. However, biological control agents may not disperse to geographically isolated localities as quickly as sirex, and additional releases may be needed.

The appropriate intensity for sampling is highly variable among regions depending on geographic and age class distributions of plantations. Localities should be selected for assessment, and trap tree plots installed to detect sirex in a locality. Sample logs from trap trees need to be caged to determine the percentage of sirex infected with nematodes and the presence of parasitoid species.

Releases of the biological control agents should be based on these results. If <10% of the sirex are infected with nematodes, additional inoculations are warranted as prescribed in Table 1. If any parasitoid species, which was previously established in the region, is not detected after two years of sampling, it should be released into the locality.

12. Research Priorities

The potential for further damage is high as sirex continues to expand its range within Australia. Research is needed to develop more efficient control procedures and to refine existing procedures. Important topics for investigation include:

- Liberation of the biological control agents and the resulting success of establishment, rates of dispersal, and rates of increase for each species.
- Low rates of nematode infection of sirex in inoculated logs. Possible reasons for this decline include changes to the inoculation procedure, moisture content of the trees, lower infectivity of nematodes through repeated subculturing, and timing of inoculations.
- Suitability of trap trees plots for sirex detection, monitoring of low sirex populations, parasitoid release sites, and sites to evaluate the biological control agents.
- Monitoring procedures for more accurate and efficient assessments of sirex populations.
- Effects of silvicultural operations (e.g., non-commercial thinning, pruning, and salvage of injured trees) on sirex populations and the associated cost/benefit of each operation.

13. Contacts

Contact your state forest service (listed in the State Government section of the telephone directory) to report a sirex infestation or to obtain more information. Further information on obtaining biological control agents is available from the secretary of the National Sirex Coordination Committee. The secretary during 1990 is:

Mr Mick Underdown
Woods and Forests Department
Jubilee Hwy. East
Mt. Gambier, SA 5290
Phone: (087) 24-2711
Fax: (087) 24-2798

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Photo 1:	not sirex, *Ibalia leucospoides*.
Photo 4:	infective form (bottom) and fungus-feeding form (top).
Photo 6a:	SWAT inoculation hammer (left) and Gould punch (right).
Photo 7:	not *I. leucospoides*, *Sirex noctilio*.