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RESEARCH & DEVELOPMENT

Identifying and controlling the Sirex Wasp in Radiata Pine plantations

The Sirex Wasp (*Sirex noctilio*) is a major pest of Radiata Pine (*Pinus radiata*), which is extensively planted in south-eastern Australia, New Zealand and South America. The wasp was accidently introduced into Victoria in the early 1960s, and has now become established in all major pine-growing areas of south-eastern Australia (Figure 1). This has occurred despite widespread attempts at quarantining infested properties, burning infested trees, inspecting sawmills, and restricting the movement of Radiata Pine to material that complied with strict standards. The wasp must be regularly monitored in plantations and quickly controlled, as it can devastate commercial and amenity planting of Radiata Pine when favourable conditions cause a sudden increase in population levels.

This edition of *Research and Development* provides a brief guide to the identification and control of the Sirex Wasp. More detailed information is contained in the Lands and Forests Bulletin No. 29, *The Sirex Wasp in Victoria,* published in 1987.

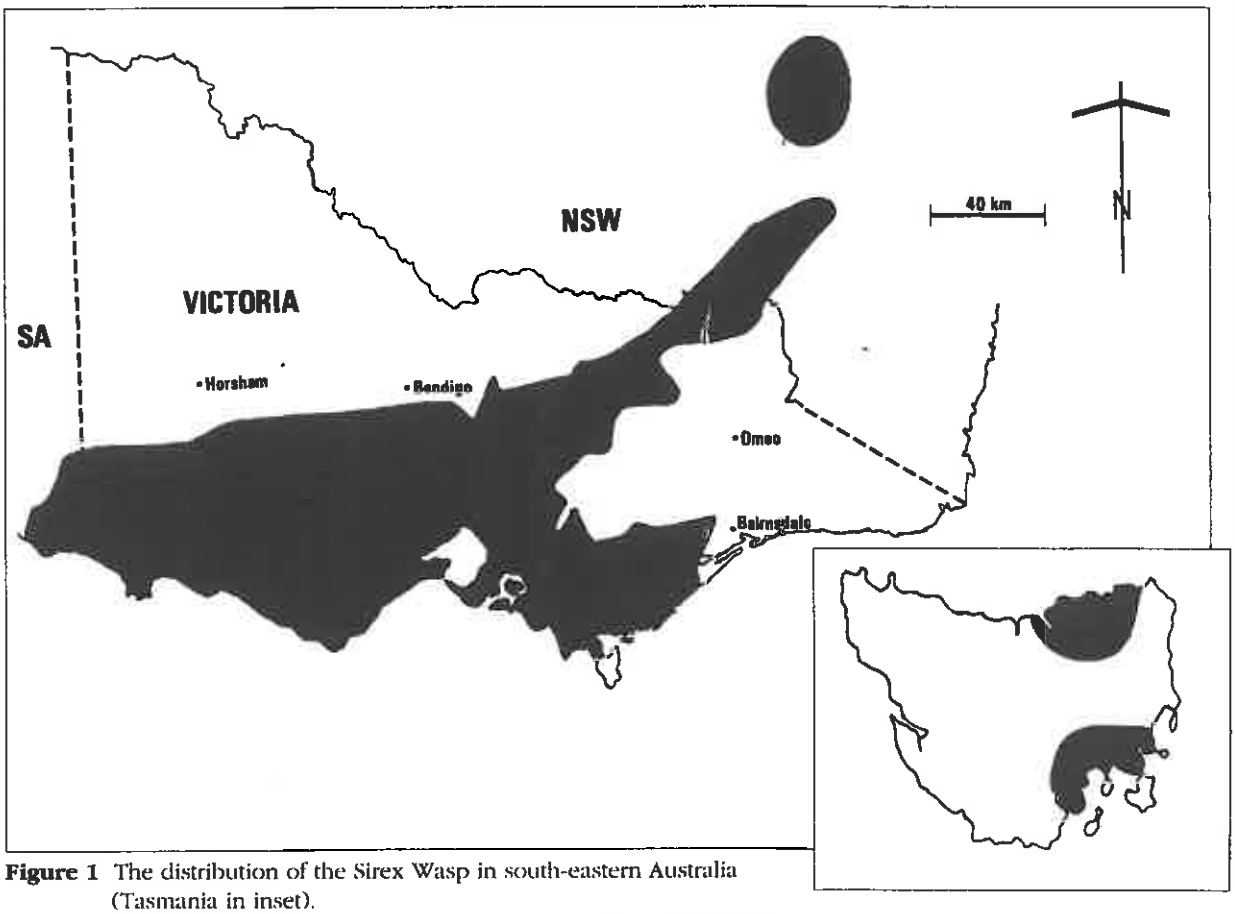

Figure 1 The distribution of the Sirex Wasp in south-eastern Australia (Tasmania in inset).

IDENTIFICATION

The adult male wasp has brownish translucent wings and a dark metallic blue body, except for chestnut-brown front legs and midlegs and middle abdominal segments. The female has translucent amber wings, amber legs, and a dark metallic blue body. The male also has thick and prominent hind legs, and the female a sheath projecting 2 to 3 mm beyond the abdomen and containing the ovipositor (egg tube) (Figure 2).

Size is not useful for identification because the body lengths of both sexes vary from about 10 to 35 mm, but the narrow waist that is typical of other wasps is absent in the Sirex Wasp.

The eggs are white, soft, smooth and elongated (Figure 3a). They average about 1.5 mm in length and 0.3 mm in width, but because of their small size they are not easily seen in the wood.

The larvae (Figure 3b) are creamy-white, deeply segmented and cylindrical, often curved into an S-shape. The abdomen has a conspicuous short black spine projecting from its rear. Three small brown sclerites (hardened skin patches) are present on the lower surface of the final abdominal segment in male larvae, as distinct from two sclerites in females.

The pupae of both sexes (Figure 3c,d) are initially creamy-white, but later develop the colouring of the female or male adult.

EGG-LAYING AND WASP DEVELOPMENT

The wasp eggs are deposited into 12 mm deep holes drilled into the wood by the female during summer and autumn. The female also injects a colourless phytotoxic mucus and a pathogenic nutritive fungal desiccant (the Sirex Fungus) into the wood.

The mucus and the fungus weaken the tree and make it more suitable for egg hatching and larval growth. Most of the eggs hatch within 14 days, and the resulting larvae feed on the fungus.

The larvae tunnel through the wood, mostly along the grain, leaving behind sickle-shaped galleries filled with tightly packed granular frass, which is mainly chewed wood (Figure 4). The size of the galleries increases as the larvae grow, typically from an initial diameter of about 0.3 mm to a final diameter of between 3.5 mm and 9 mm, depending on the size of the larva.

After tunnelling through the wood, usually between mid-summer and late spring, the larvae pupate in hollow chambers in the outer sapwood.

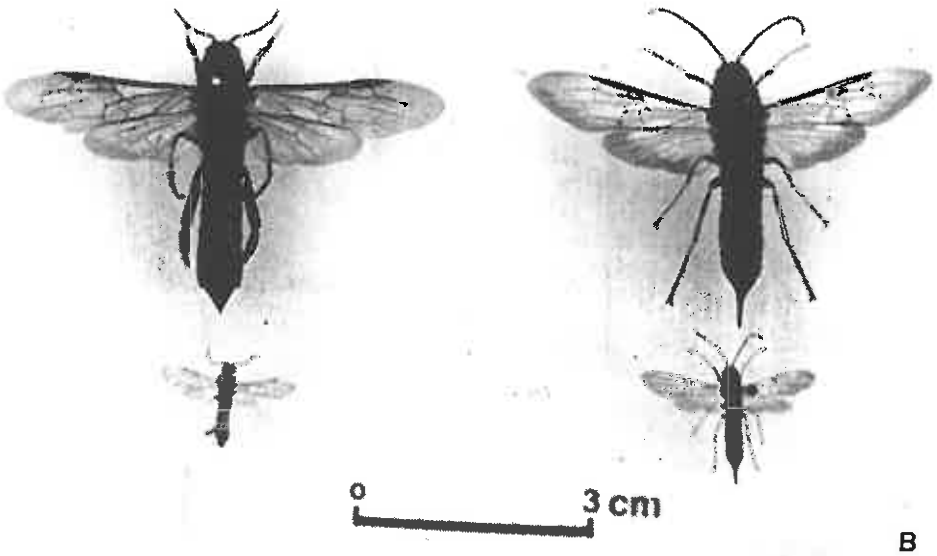

Figure 2 Dorsal views of adult males (a) and females (b) of the Sirex Wasp. Note the lack of a wasp waist between the thorax and abdomen in both sexes, the powerful hind legs in the male only, and the marked size difference that is possible among adults.

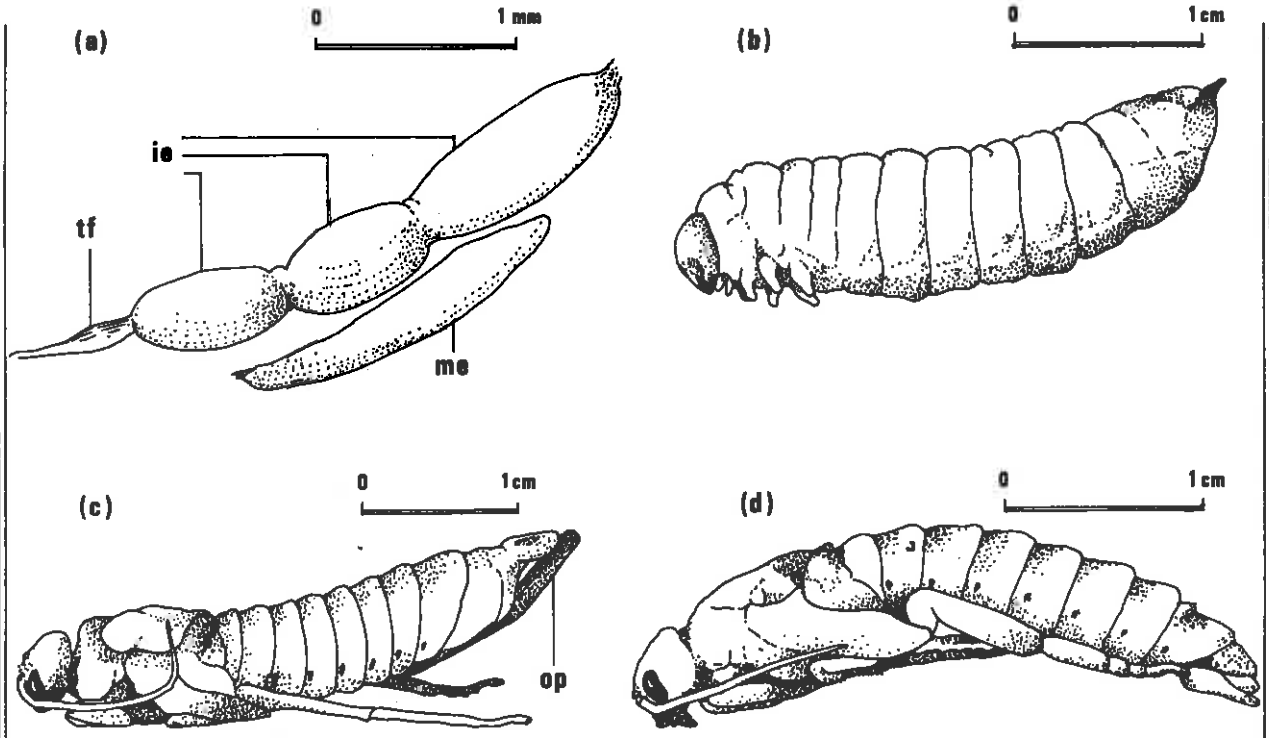

Figure 3 Immature stages of the Sirex Wasp: **a** mature egg (me) and an ovariole dissected form an unemerged female, showing terminal filament (tf) and three immature eggs (ie); **b** lateral view of mature larva; **c** lateral view of a female pupa with ovipositor (op); **d** lateral view of a male pupa.

Figure 4 Frass-filled larval galleries in transverse section with a male and female wasp for comparison.

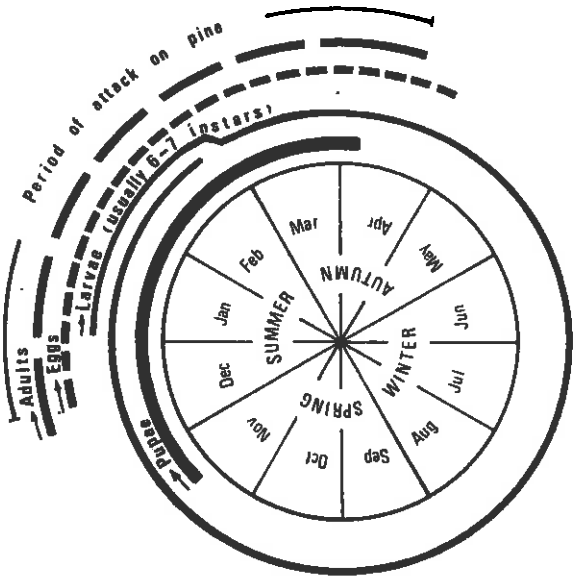

Figure 5 The predominantly annual life cycle of the Sirex Wasp in Victoria. A few individuals pass through cycles of two months or two years.

After metamorphosis the adult wasps emerge, mainly during the middle of summer. Some short life-cycle wasps emerge during autumn, only three months after oviposition (Figure 5).

A tree becomes susceptible to attack if it is predisposed through crown or stem damage, disease, or stress. This can occur if Radiata Pine stands remain unthinned, if unusually dry conditions reduce the available moisture in the soil, or if the tree is damaged by fire, wind fracture, hail, or defoliation. Pruning during the flight period of the wasp may also make trees more susceptible to attack.

Damage or stress can increase the amount of volatile compounds produced by a tree. Some of these compounds attract male and female wasps to the tree, and if the tree is susceptible eggs are deposited.

SYMPTOMS OF INFESTATION

Symptoms of Sirex Wasp attack before emergence are:

- progressive and irreversible needle chlorosis (yellowing), resulting in distinct copper-brown discolourations;
- sudden wilting and drooping of old foliage, and then of current generation foliage, especially at the apex of the main stem and branches;
- heavy needle fall with the onset of warmer weather in spring and early summer;
- numerous tiny resin blobs and, sometimes, small resin flows on the bark surface;
- distinct narrow bands of grey-brown fungal staining in the outer sapwood, mainly along the grain;
- single or multiple drills of around 0.14 mm diameter in the bark and outer sapwood;
- the presence of galleries that contain only one larva each, increase in diameter over their length, and are oriented mainly along the grain and filled with tightly packed granular frass. Imprints in the frass of the black larval spine may sometimes be seen in cross-section;
- dry, non-resinous inner bark and outer sapwood; and
- sapwood that weighs much less than wood from a healthy tree.

After emergence, important symptoms are:

- empty hollow pupal chambers in the outer sapwood; and
- circular flight holes between 3 mm and 7 mm in diameter, on stems and major branches.

PEST CONTROL

Successful control of the Sirex Wasp is only possible if sound plantation management practices are applied. One of the most important of these is the early detection of the wasp in a plantation. This can be achieved using aerial surveys and follow-up ground inspection of suspect areas between mid-winter and early spring in susceptible unthinned plantations more than 12 years old.

Aerial surveys are best carried out by two experienced observers in a high-wing monoplane flying in a grid pattern low over the plantation.

Monitoring the wasp through a system of highly attractive herbicide-injected 'trap trees' in selected high-risk plantations is also very effective. Early detection of the wasp should be followed by the release and/or inoculation of biocontrol agents near or into trap trees or other accessible infested trees between summer and early winter.

Sirex Wasp outbreaks usually occur only when conditions are adverse for Radiata Pine. Because green logs and large volumes of thinning or logging slash are also attractive to the wasp, the prevention of epidemics and substantial tree deaths is essentially a silvicultural problem, and the following measures are necessary:

- carry out timely selective thinning, especially on the better sites, to reduce competition between trees and to remove highly susceptible suppressed, deformed, or multi-stemmed trees and those dying or diseased;
- restrict high pruning and non-commercial thinnings to between May and November, which is outside the wasp's flight period;
- avoid planting on steep slopes or any other area where thinning cannot be carried out;
- quickly salvage trees of commercial size that have been damaged by weather;
- conduct routine surveillance of plantations throughout the year; and
- reduce the risk of injury to trees from fire and silvicultural treatments.

The use of local field staff (rather than visiting entomologists) for the detection of early symptoms of new outbreaks can reduce costs and ensure that responsibility for detection rests with those most familiar with local conditions.

Well managed, healthy plantations can only support small populations of the wasp, although local infestations can occur occasionally. But when there are no suitable host trees, these outbreaks usually decline naturally after causing little damage.

Small populations of the wasp may even be useful in well managed stands because they help the propagation and spread of biocontrol agents, and cause the death of a few scattered unwanted trees between scheduled thinning treatments.

Unfortunately, unthinned stands that are already 15 to 20 years old with stocking densities over 1700 stems per hectare may still occur in Victoria. Thinning may have been delayed because of poor markets or a large backlog in plantation areas scheduled for commercial thinning. These plantations contain large numbers of suppressed trees and some co-dominant trees with low resistance to the Sirex Wasp.

The effects of occasional severe droughts, partial defoliation, or nutritional deficiencies, may compound the stress from overcrowding. Even if belated thinning is carried out, the result may be windthrow and crown loss, particularly on high quality sites, and retained trees may be damaged by sun scorch, so that the trees remain susceptible to Sirex Wasp infestation. Biocontrol based on the release of thousands of Sirex-specific parasitic wasps can cause up to 30% Sirex Wasp mortality in overstocked stands.

Several species of such wasps have been established in pine-growing areas of Victoria. These wasps parasitise the eggs and larvae of the Sirex Wasp, so that fewer are able to develop into mature adults. The most effective of the parasitic wasps are *Ibalia leucospoides* and *Megarhyssa nortoni nortoni*.

A far more successful biocontrol agent is the parasitic nematode *Deladenus siricidicola* (Figure 6). This nematode causes sterility among Sirex Wasp females before they emerge. In plantations near Myrtleford during the early 1980s the nematode affected over 99% of the population within two years of treatment with nematodes.

The nematodes are cultured under sterile conditions specifically for Sirex Wasp control at the Land Protection Division's Keith Turnbull Research Institute at Frankston. They are inoculated into trees using a syringe, and disperse into the tree and find host larvae. Because nematodes do not disperse readily throughout a Radiata Pine stand, the use of trap trees is essential to ensure their rapid and extensive distribution within infested plantations.

Figure 6 Microscopic view of individual parasitic nematodes *(Deladenus siricidicola)*. Each minor division on the scale represents 0.032 mm.

A system of trap trees must be deployed over a minimum period of two years. You should select easily accessible groups of ten poor quality trees of between 10 and 20 cm DBHOB, about one kilometre apart.

These trees are injected basally in successive years with 20% w/v dicamba herbicide at a rate of between 1 and 2 mL per 10 cm of circumference. Use a suitable tool such as an INVjector®. The injections should be made between late October and late November. Although other herbicides such as fosamine (Krenite®) and MCPA can be used, dicamba is best for the purpose.

Between mid-autumn and mid-winter the injected trees should be felled and inoculated artificially with the nematode at a rate of 3 or 4 shots per metre of stem. Each shot should contain between 600 and 1200 viable nematodes in gelatin. The KTRI Biocontrol Unit can produce the quantities needed, provided several weeks notice is given. The unit can also provide instructions on tree injection and inoculation procedures.

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The remaining healthy trees should be inspected regularly for signs of infestation, and the aerial surveys and follow-up ground inspections mentioned earlier should be carried out as part of the normal plantation management program.

FURTHER INFORMATION

Public enquiries should be directed in the first instance to the appropriate Regional Office.

Information on the monitoring and control of the wasp and the supply of biocontrol agents can be obtained from:

Keith Turnbull Research Institute
(Biocontrol Unit),
Land Protection Division,
Dept. of Conservation, Forests and Lands,
Ballarto Road, Frankston 3199.
Telephone (03) 785-0111;

Research and Development Section,
Forest Management and Research Branch,
Lands and Forests Division,
Dept. of Conservation, Forests and Lands,
378 Cotham Road, Kew 3101.
Telephone (03) 817-1381.

Softwood Management Section,
Forest Management and Research Branch,
Lands and Forests Division,
Dept. of Conservation, Forests and Lands,
2 Treasury Place, East Melbourne 3002.
Telephone (03) 651-1000.

Detailed information on the wasp and its parasitoids is contained in the Lands and Forests Bulletin No. 29, The Sir*ex Wasp in Victoria*, by F.G. Neumann, J.L. Morey and R.J. McKimm.

The Bulletin is available for perusal in all Departmental libraries or in Regional centres, or can be obtained from the CFL bookshop at 240 Victoria Parade, East Melbourne 3002, telephone 651-4011.

FURTHER READING

Neumann, F.G., Harris, J.A., Kassaby, F.Y. and Minko, G. (1982) An improved technique for early detection and control of the Sirex woodwasp in radiata pine plantations. *Aust. For.* **45**: 117-124.

Neumann, F.G., and Morey, J.L. (1984) Influence of natural enemies on the Sirex woodwasp in herbicide-injected trap trees of radiata pine in north-eastern Victoria. *Aust. For.* **47**: 218-224.