Jarrah's native pest

Jarrah is a valuable forest eucalypt. But for years this Western Australian tree has been under attack by a tiny grey moth, only millimetres long.

The culprit is called *Perthida glyphopa*, or the jarrah leafminer, and is not, like so many other Australian pests, imported. Rather, it is native and has presumably been with jarrah a long time; indeed outbreaks of it were first noticed in the 1920s. Moderate to heavy infestation covered about 560 000 hectares by 1971 and 1·45 million ha by 1978. Estimates today suggest an even greater area, although fluctuations connected with the weather do occur.

Jarrah trees damaged by the leafminer, near Wilga, W.A.

Unlike dieback — another severe problem in jarrah, caused by a soil fungus that attacks the roots (see *Ecos* 15) — the jarrah leafminer does not kill the trees. However, damage to the leaves and premature leaf fall, by reducing the level of photosynthesis, inhibit growth. The resultant decline in vigour can be dramatic: infested trees may produce 60–80% less wood in a year than uninfested ones, with all too obvious economic consequences. Furthermore, leaf-bearing branchlets may die off, and so leave the tree with permanent crown damage.

The jarrah leafminer is so called because its larva, hatching from the egg deposited under the lower surface of the leaf, excavates a mine in the leaf tissue. In spring the maturing larva uses a portion of the mined leaf to construct a cell by fastening together with silk the upper and lower surfaces. Encased within this, it drops to the ground, then buries itself in the soil where it remains until the adult emerges the following April.

Much of the unravelling of the leafminer story has been done by Mr Zan Mazanec of CSIRO's Division of Entomology in Western Australia. He believes that the increase in the threat that the insect poses to the jarrah forests is due to human activity in the area.

The leafminer is more successful in situations where

new leaves are more abundant. And any disturbance, such as road-building or the forest management practice of thinning and partial clearing, directly stimulates a burst of fresh leaf growth. Also, prescribed burns, although killing the larvae in a local area, lead to new leaf growth in the following year.

Other factors, of course, are also important. These include temperature (cold and excessive heat restrict the females' ability to lay eggs), leafminer population (over-crowding reduces fertility), and rainfall, because in years following a drought growth of new leaves will be restricted.

As jarrah is a valuable hardwood, resistant to termites, easy to work, and used extensively for railway sleepers and in house construction, controlling leafminer infestation would be of considerable benefit.

Attempts at insecticidal control have been successful only on a small scale. Dr Murray Wallace, formerly of the Division's Western Australian laboratories, studied much of the biology of the leafminer. He found aerial spraying with an insecticide not only expensive but ineffective as well.

Fortunately, Dr Wallace found some jarrah trees that are resistant to leafminer. These could form the basis of an ideal method of long-term pest control.

Dr Wallace first noticed resistant trees growing among damaged ones in forests and on partly cleared land. And indeed, resistant and susceptible trees often grow side by side and eggs of leafminer are (usually) laid in the leaves of both. Have the resistant trees always been there, or is this a textbook case of evolution in action, in response to a strong selection pressure? And what exactly is the nature of the resistance, and how can we use it to improve the state of health of our jarrah forests?

Although in external appearance resistant and susceptible leaves do not differ, Mr Mazanec has succeeded in distinguishing three main types of resistance.

The first is resistance to oviposition — that is, the laying of eggs in the leaf. Most resistant trees had eggs laid in their leaves, but to a lesser degree than susceptible ones. One resistant tree was observed to escape all oviposition.

Its leaves lacked tannins — compounds that are normally considered to protect plants, as they taste bitter (at least to us, and probably to other mammals) and they attach to plant protein and thereby reduce its nutritive value to a leaf-eater. Jarrah leaves normally contain a large quantity of tannins, which, amazingly, appear not to hinder the leafminer larvae and even appear to be important in helping the female decide where to lay her eggs.

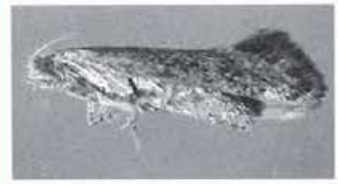
A second type of resistance observed was to egg development itself, but only in one tree. In this case, the leaves contained a large number of eggs, but most of them failed to hatch. Microscopic examination of sections of leaf tissue revealed a cicatrice — a scar tissue — around the original site of injury caused by the deposition of the egg. The pressure of further cell division caused swelling, which eventually pushed the egg literally right out of the leaf. The ensuing hole was then sealed to prevent infection.

This process of ejection happens most effectively to eggs laid just beneath the upper surface of the leaf. The female leafminer prefers to lay her eggs under the lower surface — perhaps an adaptation to one of jarrah's defences!

A third form of resistance involves the larva's feeding. On resistant trees, in comparison with a susceptible one, a higher proportion of the eggs failed to hatch and the larvae that did emerge died after excavating only a small mine. Their death seemed to be caused by a sensitivity reaction on the part of the leaf. The leaf cells around the larva — and for a distance of 1–2 mm beyond — collapsed and died. In turn, the dead zone around the larva effectively killed it by starvation.

Of the three types of resistant trees Mr Mazanec described, those resistant to the feeding larvae are the most common in the jarrah forest. At Murdoch University, PhD student Ian Bennett, under the supervision of Dr Jen McComb of the Department of Environmental and Life Sciences, has started a laboratory-based program of propagating these resistant trees by means of tissue culture.

The cloned trees have been successfully planted in the University grounds, and show the same level of resistance as the original tree. However, for them to be of use in some areas of the jarrah forest the problem of dieback has still to be tackled.



The culprit: a female jarrah leafminer moth. She is about 4 mm long.

For 5 years, Dr McComb and her group, in collaboration with members of the Western Australian Department of Conservation and Land Management, have been working on the screening and propagation of dieback-resistant jarrah. She feels that any long-term strategy for effective revegetation of some areas where dieback is a problem must include incorporating resistance to both dieback and leafminers into elite lines of jarrah, which could then be cloned. Such trees could then be planted in sites where rehabilitation is required, like bauxite mines.

All this adds up to a very long-term goal; for the moment the good news is that the mechanisms of leafminer-resistance have been unravelled, and that resistant trees can be cloned. And that's a successful first step.

Roger Beckmann

The larva's work! Jarrah leaves severely damaged by 'mines' and 'cut-outs'.

Influence of jarrah leafminer on the growth of jarrah. Z. Mazanec. *Australian Forestry*, **37**, September 1, 1974.

Resistance of *Eucalyptus marginata* to *Perthida glyphopa* (Lepidoptera: Incurvariidae). Z. Mazanec. *Journal of the Australian Entomological Society*, 1985, **24**, 209–21.

Eucalypt dieback in forests and woodlands. Z. Mazanec. *Proceedings of Conference, CSIRO Division of Forest Research, Canberra, 4–6 August 1980.*