# PLANTATION ENTOMOLOGY OF *Pinus radiata* AND *Eucalyptus globulus*

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## 1. Aim

The purpose of this brief review (written in September 1989) is to detail information on insect pests of radiata pine and globulus outside WA. The related topics of forest protection, monocultures and surveillance are also addressed.

## 2. Forest Protection

It is widely accepted that forest protection is an integral part of forest management (e.g. Cayford 1981, Hosking & Gadgil 1987). Yet, within CALM, forest protection has traditionally been equated largely with fire protection and disease protection. There is therefore an urgent need to re-appraise the protection aspect of forest entomology, and as Yule (1974) has suggested, raise it to a status commensurate with the impact of insects on forests. The latter is difficult to document as there is a great paucity of information available for insects in plantations in WA.

## 3. Monocultures

The orthodox view of forest entomologists is that even-aged monocultures are more likely to experience severe loss from insect outbreaks than mixed stands (e.g. Brimblecombe 1952, Campbell 1966, Friend 1978, Jones & Gibson 1966, Tooke 1935). The reason given is that a monoculture provides an unlimited food supply for potentially destructive insects (Ciesla 1988, Bennett 1961).

Despite this, some forest entomologists do recognize that the monocultural system is the most successful method of timber production (Jones & Gibson 1966, Knight 1971). Although pest problems are inherent in it, losses can be reduced to a tolerable level provided monocultures are properly managed. These management procedures (Bain 1981, Knight 1971, Tooke 1943) have been understood for a long time and are straightforward:

1. Plant the right species on the right sites. Fitting the species to climatic and edaphic conditions will help ensure that trees remain healthy.

2. Carefully tend plantations. Keeping trees in a vigorous and healthy condition and removing decadent material will ensure general forest hygiene.

3. Monitor plantations for damage. Competent staff should be able to recognize damage by all known pests and potential pests, take part in regular appraisals of their abundance, and watch for those potential pests that might be expected to become problems when and if introduced.

## 4. Pines

Pine plantations are of course the oldest monocultures present in SW Australia, dating back to the 1920s. Being exotic, their normal insect faunas were left behind in California and Portugal. Ohmart & Voigt (1981) sampled the arthropod faunas of the three mainland populations of *Pinus radiata* in California, some 8 000 ha of natural forest. They collected 110 species of insect. Spiders were the most abundant of all taxa, comprising one third of all individuals of arthropods collected.

The past 60 years, largely free of insect outbreaks, have lead to a complacent attitude concerning the entomological risk with SW Australian pine plantations.

A review of world literature has revealed several disturbing matters:

- There are already several insect pests in Northern Hemisphere plantations of *P. radiata.* In Spain (in which there are 200 000 ha of plantation) at least six major native pests have been recorded (Ohmart 1980). These are the Pine Processionary caterpillar *(Thaumetopoea pityocampa*, Lep., Notodontidae), *Hylobius abietus* (Col., Curculionidae), *Tomicus piniperda* (Col., Scolytidae), *Pissodes notatus* (Curcul.), *Dioryctria abietella* (Lep., Pyralidae) and *Rhyacionia buoliana* (Lep., Olethreutidae).

In the native populations in California, indigenous bark beetles (Scolytidae) are responsible for most insect related mortality (Ohmart 1982). There are 28 species of these beetles attacking *P. radiata* with four responsible for nearly all insect related mortality. These four species are *Ips paraconfusus, Ips plastographus, Ips mexicanus* and *Dendroctonus valens.* (The Ips introduced already to WA is a different species, namely *I. grandicollis.*)

Obviously, vigilant quarantine is necessary to prevent these species from being accidentally introduced to WA. The Lindsay report, however, urges some relaxation of quarantine standards.

This is an issue of great concern to many countries in the Southern Hemisphere e.g. Australia (480 000 ha of *P. radiata* plantations), Chile (700 000 ha), New Zealand (740 000 ha). In Chile, three species of European bark beetles were discovered in 1983 (Ciesla 1988). In New Zealand and Australia *Sirex noctilio* is the major introduced pest of pine, and in South Africa the pine Bark Beetle *Hylastes angustatus* and the weevil *Pissodes nemorensis* are the major introduced pests (Van V. Webb 1974).

- Indigenous insect species can adapt to *P. radiata* plantations.

Moore (1965, 1972) recorded nearly 90 insect species causing damage to *P. radiata* in NSW. More than 90% of there were indigenous. In Chile, by 1971 31 species of native insect were recorded feeding on *P. radiata* (Ciesla 1988).

In some localities, certain indigenous insects have formed outbreaks e.g. the Saturniids Pine Emporer Moth, Willow Tree Emporer Moth, Poplar Emporer Moth and Pine Bark Emporer Moth, the Lymantrid Pine Brown Tail Moth and Lasiocampid Cape Wattle Lappett Moth (South Africa, Van V. Webb et al. 1974); the Psychid *Hyalarcta hubneri* (Victoria, Minko 1961); the Geometrid *Selidosema suavis* (New Zealand, Gilmour et al. 1977); the Geometrid *Chlenias* sp. (Tasmania, Madden & Bashford 1977); and the Wingless Grasshopper (South Australia, Rawlings 1960).

On farmland in SW Australia Budworm *Heliothis punctigera* has on occasion severely defoliated young pines planted on former agricultural land.

In Victoria, comparison of the abundance of insects collected in native eucalypt forest, young pine ( < 10 yrs), intermediate age pine (c. 20 yrs) and mature pine (40 yrs +) produced surprising results. The total number of insects collected was 3 011, 4 556, 2 182 and 4 169 respectively (Suckling *et al.* 1976). It is not unreasonable to expect that eventually at least one of these indigenous insect species will find conditions highly suitable, resulting in an outbreak.

A study of the insect fauna of economically important crops around the world (e.g. sugar cane) has indicated that pest species accumulate to an equilibrium number within a few hundred years (Strong *et al* 1977). In Britain, the insect diversity of introduced tree species is a function mainly of the distribution of the plant. The time that the tree species has been planted is much less important (Strong 1974).

The number of indigenous pest insect species of *P. radiata* in relation to plantation area in each state in graphed in Fig. 1, using data from Neumann (1979). WA is unique in that *P. pinaster* contributes about equally to the pine plantation area of the State. The graph suggests that a plantation area of 60 000 ha should have accumulated about six indigenous pest insect species.

There is, therefore, little room in WA for complacency about the risk of outbreaks in pine plantations in the future.

## 5. Globulus

My review of world literature concerning globulus and insects confirms the two points established above for pine plantations.

- Globulus planted outside its natural range is vulnerable to introduced pest insects.

The most famous case concerns the weevil *Gonipterus scutellatus*, native to Queensland, NSW, Victoria and Tasmania. It was accidentally introduced to South Africa in 1916 (Richardson & Meakins 1986). In 20 years it spread 1 500 km across South Africa causing severe damage to 22 of 98 eucalypt species planted. By 1926 *E. vimminalis* and *E. globulus* were so severely attacked that further planting was not recommended (Tooke 1935). It took 10 years for parasitoids to be collected in Australia and released in South Africa. They spread quickly and after 25 years natural control was effective up to an altitude of 1 200 km. Unfortunately the largest globulus plantations were mostly above this altitude.

*Gonipterus* was introduced to New Zealand in 1890 and became a serious pest of globulus (Clark 1938).

A second group of cases concerns the accidental introduction to New Zealand of the Eulophid wasp *Rhicnopeltella eucalypti* in 1924. According to Clark (1938), attack by this species was so serious and so rapid that planting of globulus was largely abandoned. Two other introduced insects - *Eriococcus coriaceus* (1900) and *Paropsis charybdis* (1916) - preferentially attacked globulus and viminalis in New Zealand (Clark 1938).

A third case concerns the Cerambycid borer *Phorancantha semipunctata*, accidentally introduced from Australia to South Africa. In Australia this species attacks dead or very unhealthy trees belonging to many eucalypt species. In South Africa, healthy globulus was attacked during drought (Van V. Webb 1974).

A parallel example is some 20 000 ha of *E. nitens* planted in northern Tasmania. Originally from Victoria, this species is seriously infested by a chrysomelid defoliator indigenous to Tasmania.

- Indigenous insect species could adapt to globulus plantations in WA.

Good examples of native insect species adapting to globulus plantations come from South Africa. There, the Pine Emporer Moth and Willow Tree Emporer Moth (both Saturniids) have been recorded damaging globulus.

WA already has present two species of insect known to attack globulus in its natural range (Victoria and Tasmania). Autumn Gum Moth *Mnesampela privata* often completely defoliates globulus in Tasmania (since 1943) and Victoria (since 1900) (Elliott & Bashford 1978). Most defoliation takes place in Autumn and Winter, and can prevent the tree from building up its reserves to prepare for the next flush of growth in Spring. Trees < 5m are most frequently attacked. Gumleaf Skeletonizer *Uraba lugens* is a minor pest in Tasmania. In WA, populations of this species have expanded recently within the jarrah forest.

In addition WA has insect species closely related to proven pests in Tasmania (Bashford, pers. comm.). For example, the *Gonipterus* weevil is absent but a close relative *Oxyops* is widespread throughout the hardwood forests. In Tasmania, the borer *Tryphocaria mastersi* is recorded as sometimes killing trees up to 10 m tall. WA hardwood forests have the closely related *T. acanthocera*, already a pest of regrowth karri. In Tasmania *Paropsis porosa* (Chrysomelidae) occasionally causes serious damage to globulus at the juvenile leaf stage; WA hardwood forests have many closely related *Paropsis* species present.

## 6. Surveillance

One of the essential commitments of forest entomology is surveillance. Without this there is no method to detect increase in the abundance of important pests before serious economic loses have occured (Orr 1954). In addition, the forest entomologist must know all the insects in his district so that any new arrival may be recognized at once. Even unimportant insects must be known before they can be ignored (Rawlings 1960).

Knight (1971) distinguishes two components: (i) detection, best accomplished by planned surveys by experts; (2) surveillance, involving routine monitoring by forest staff. New Zealand seems to have achieved a standard far ahead of any Australian forest service. It has a team of 13 forest health officers whose job is to monitor all exotic forests for pest (and disease) problems and to survey high risk areas for the establishment of exotic insect pests (and diseases). All exotic plantations over 500 ha are aerially surveyed each year, and backed up by ground surveys. An extensive computerized database is also maintained (Hosking & Gadgil 1987).

## 7. Proposals

- In order to better protect pine and globulus plantations from insect infestation, I recommend that a Plantations Entomologist and technical assistant be appointed.

Duties:

1. Investigate the insect fauna (of foliage and wood) of *P. radiata, P. pinaster* and *E. globulus*. Compile an inventory of insect species present in each plantation type.

   Sample quantitatively.

   Evaluate, with reference to interstate and international literature, the likelihood of each species becoming a pest.

2. For pines, consider both biological control and chemical insecticides for those species judged to be potential pests.

3. For globulus, investigate the level of natural biocontrol and if necessary test appropriate chemical insecticides on potential pests.

- I also recommend that the duties of forest protection staff be redefined to include greater commitment to entomology and less to fire protection. These personnel best come under the Environmental Protection Branch. The Entomology Research Program would be willing to train staff in survey procedures, identifications, data basing & provide expert backup as required.

- These proposals would form an insurance policy for *P. radiata* and *P. pinaster* plantations in relation to insect damage. The Government softwood estate is worth in excess of $150 M (G. Malacjczuk, pers. comm.). In the 1988-89 fiscal year, *P. radiata* plantations generated $9.5 M; expressed in relation to area, this revenue is five times greater than the next most productive forest type (Karri) in the south-west.

- Radiata stands most at risk to insect outbreaks are those planted on marginal sites. These include the entire sunklands (10 000 ha) and about 25% of the Blackwood Valley plantations. This latter estimate is based on recent research carried out by J. McGrath.

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