PAROPSINE CHRYSOMELID ATTACK ON PLANTATIONS OF *EUCALYPTUS NITENS* IN TASMANIA

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ABSTRACT

Of the 36 species of paropsine chrysomelids occurring naturally on eucalypts in Tasmania, five species have been observed attacking the introduced eucalypt, *E. nitens* (Deane et Maiden) Maiden, which is the main eucalypt species used in commercial plantations in Tasmania. The chrysomelids are *Paropsis porosa* Erichson on seedlings; *Chrysophtharta agricola* (Chapuis) on juvenile foliage; and *C. bimaculata* (Olivier), *P. delittlei* Selman, and *P. charybdis* Stål on adult foliage. To date *C. bimaculata* has been the most significant pest causing extensive and severe defoliation on several occasions to *E. nitens* plantations in northern Tasmania. A preliminary appraisal has been made of the significance of attack experienced to date for plantation growth rates.

With current planting rates of *E. nitens* at about 3500 ha per annum and likely to increase in the future, integrated control and resistance breeding programmes are needed to keep these pests in check.

Keywords: paropsine chrysomelid; defoliation; plantations; resistance breeding; damage assessment; *Eucalyptus nitens*.

INTRODUCTION

Chrysomelid leaf beetles belonging to the sub-tribe Paropsina are a major native defoliating pest of planted eucalypts in Australia (Carne *et al.* 1974; Elliott & de Little 1984). Three species are known to have become established overseas — two in New Zealand (Bain 1977) and one in South Africa (Cillie 1981). *Paropsis charybdis* has caused serious defoliation to some species of eucalypts in New Zealand for many years and *Trachymela tincticollis* (Blackburn) has been a recent but serious problem on coastal eucalypt plantations in South Africa.

In Australia, where several hundred paropsine species occur on a wide range of eucalypt species, there are a number of natural enemies, both predators and parasites, which help to regulate natural populations. However, several outbreaks have severely defoliated young eucalypt plantations in northern coastal New South Wales (B.J. Selman, pers. comm.) and Tasmania. As Australia makes a greater commitment to planted eucalypts as a raw cellulose resource and for land rehabilitation and agroforestry purposes, the frequency and intensity of paropsine outbreaks is likely to increase.

Eucalypt plantations are important to Tasmania (Tibbits 1986) with an estimated estate of some 20 000 ha of mainly the southern blue gums, *E. nitens* and *E. globulus* Labill of subgenus Symphyomyrtus. The former species has become a very attractive proposition due to its rapid early growth in cooler, frost-prone, highland regions. It has been seen as having a niche in traditional "ash-group" (*E. delegatensis* R.T. Baker, *E. obliqua* L'Herit, *E. regnans* F. Mueller) environments, initially appearing less attractive to the insects which browse these species of the subgenus Monocalyptus.

When significant paropsine attack was first observed on *E. nitens* in the early 1980s, it was a surprise to find that the major culprit was *Chrysophtharta bimaculata*, a species which appears to be endemic in Tasmania, and which until this time had been observed in significant numbers only on monocalypts (de Little 1979). So far, *C. bimaculata* has been the most significant pest of Tasmania's *E. nitens* plantations. Severe outbreaks were widespread in the 1985–86 and 1988–89 seasons and localised outbreaks have occurred in other years. This species is also considered a severe defoliator of monocalypts in Tasmania (Greaves 1966; Kile 1974; de Little 1983).

Other paropsine species which have attacked *E. nitens* in Tasmania, causing noticeable damage, have been: *Paropsis porosa*, which attacks seedlings up to about 1 year old; *Chrysophtharta agricola* which atacks the juvenile foliage; and the sibling species *P. delittlei* (formerly, but incorrectly, known as *P. dilatata*) and *P. charybdis* which attack the adult foliage. Other paropsine species may still emerge as significant pests of *E. nitens* in Tasmania.

EFFECTS OF DEFOLIATION

The effects of defoliation by paropsines on the growth of young *E. nitens* have not been quantified. However, results from a study (H.J. Elliott, D. Bashford, A. Leon, pers. comm.) of *C. bimaculata* on 5-year-old *E. regnans* trees of 2.5–3.0 m height have revealed a height increment loss of from 40% (with "light" defoliation) to 90% (with "heavy" defoliation) in one season. Control trees were protected by regular spraying with the synthetic pyrethroid deltamethrin.

On older plantations, evidence of an effect has emerged through continuous-forest-inventory data of APPM Forest Products. A 9-year-old stand which was heavily defoliated in the 1985–86 summer did not refoliate until January 1987 when foliage developed from epicormic shoots. The combined effect of the defoliation and following cool summer of 1986–87 has been that the mean annual increment has not significantly increased since 1986, although the current annual increment has shown a nett increase. The estimated loss of 2 years' growth has been 22 m^3/ha, worth A$275/ha.

INTEGRATED CONTROL

Because of the endemic nature of the problem, the approach to control must be an integrated one, with minimal interference to the natural biological control agents.

Adult beetles first appear on the foliage during spring, but significant oviposition does not take place until temperatures in excess of 20°C occur, above which oviposition is directly proportional to ambient temperature. Under settled warm conditions, adults will leave a site after 2–3 days of concentrated oviposition and move on to another site (de Little 1979). If settled weather continues, eggs will hatch after 8–9 days, the first larval stage will take 6–7 days, and the second stage a further 4 days. By the end of the second instar a larva has consumed only 10% of the total it will consume if it completes its larval development (Greaves 1966).

Under conditions outlined above, applications of spray should be timed for the first or second instars, giving natural biological control a chance to act (de Little *et al.* 1990). This gives a period of approximately 3 weeks from the onset of oviposition to prepare, if necessary, for a spraying operation. Constant monitoring of high-risk sites during late spring is needed to achieve good integrated control. In practice, unsettled weather conditions in late spring/early summer often interfere with the insect's development pattern, leading to the presence of all stages on the foliage together.

Aerial spraying of plantations with carbaryl, organophosphates, and synthetic pyrethroids has proved effective in giving good knockdown. APPM currently favours the use of the latter group of compounds as they appear to give a reasonable period of residual protection and are more environmentally acceptable. Extreme care must be exercised when using these compounds in the vicinity of running streams as both aquatic vertebrate and invertebrate fauna are susceptible to extremely low dose rates of the order of parts per billion. APPM has co-operated with the Tasmanian Department of Inland Fisheries in the monitoring of pesticide residues in inland waterways adjacent to sprayed plantations. In a spraying operation using cypermethrin, undertaken by APPM in December 1988, where care was taken to avoid spraying major waterways, the aquatic invertebrate fauna was significantly affected, and some trout were killed.

The development of the *Bacillus thuringiensis* strain "san diego" effective against Coleoptera offers the possibility of a new, more environmentally preferred control. Initial tests by the Forestry Commission, Tasmania (Elliott, Bashford, Leon, pers. comm.) have shown the "san diego" strain to kill larvae of *C. bimaculata* under field application conditions at higher than recommended application rates, but the appropriate operational rates are yet to be determined.

RESISTANCE BREEDING

Although progress in breeding trees resistant to insects has not been great (Hanover 1980), the host discrimination shown by many paropsine species, coupled with intensive breeding and clonal propagation work now being carried out with eucalypts, offers some hope for the development of resistance to some of the more serious pest species. In order to make progress in this area, however, it will be necessary to establish the basis of attraction of particular chrysomelid species to particular host eucalypt species.

In Tasmania, host discrimination by some of the more prominent paropsines seems to take place at the sub-generic level, with *C. bimaculata* attack on adult *E. nitens* foliage a notable exception to this observation. APPM is currently funding a research project at the University of Tasmania which is investigating the phytochemistry and, in particular, the essential oil composition of the major cool–temperate plantation eucalypts. Initial investigations indicate higher levels of the typical Monocalyptus oil phellandrene in adult foliage of *E. nitens*, together with lower levels of the typical Symphyomyrtus oils 1, 8-cineole and α-pinene (H.-F. Li, J.L. Madden pers. comm.). This may be an explanation for the *C. bimaculata* attack on adult *E. nitens* foliage.

One of the breeding options currently being pursued by APPM in conjunction with CSIRO is the development of F1 hydrids between *E. nitens* and *E. globulus* which combine the superior frost tolerance and growth characteristics of the former with the superior cellulose producing qualities of the latter. In order to be operationally successful, these hybrids will need to be propagated by vegetative means (cuttings or micropropagation). When larvae of *C. bimaculata* were reared on adult foliage of *E. nitens*, *E. globulus*, and the F1 hybrid of the two species, under constant temperature and photoperiod, the developmental time on the hybrid was midway between that on the two parent foliages (Table 1). Since *C. bimaculata* is rarely observed on *E. globulus* in the field, the hybrid foliage may possess some of the resistance of this parent.

TABLE 1–Mean developmental times of larvae reared on adult foliage of *E. nitens*, *E. globulus*, and F1 *E. nitens* × *globulus* hybrids under constant temperature (23°C) and photoperiod (16 h). Four replicates of 20 larvae each were reared on each kind of foliage in petri dishes.

Replicate	Developmental times (days) of larvae on foliage of		
	E. nitens	*E. globulus*	F1 hybrid
1	11.60	15.60	12.95
2	11.55	15.75	13.36
3	11.46	15.64	13.76
4	11.75	16.29	14.00
Mean	11.59	15.82	13.53
Standard deviation	0.12	0.32	0.47

CONCLUSIONS

Defoliation by paropsine chrysomelids has been the most widespread and serious insect attack experienced to date on eucalypt plantations in Tasmania and has resulted in measurable loss of production. Although control by spraying of chemical insecticides is technically and operationally feasible as part of an integrated control programme, it is limited by possible undesirable environmental side-effects on other aspects of the plantation environment. Other options, including the use of environmentally acceptable biological insecticides and breeding for resistance, need to be further explored.

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REFERENCES

BAIN, J. 1977: *Paropsis charybdis* Stål (Coleoptera : Chrysomelidae) eucalyptus tortoise beetle. *Forest Research Institute, New Zealand Forest Service, Forest and Timber Insects in New Zealand No. 10.*

CARNE, P.B.; GREAVES, R.T.G.; McINNES, R.S. 1974: Insect damage to plantation-grown eucalypts in north coastal N.S.W. with particular reference to Christmas beetles (Coleoptera : Scarabaeidae). *Journal of the Australian Entomological Society 13*: 189–206.

CILLIE, J.J. 1981: The eucalyptus tortoise beetle *Trachymela tincticollis* Blackburn (Chrysomelidae : Coleoptera). *Directorate of Forestry and Environmental Conservation, Pretoria, Pamphlet 273 Pests and Diseases of South African Forests and Timber.*

de LITTLE, D.W. 1979: Taxonomic and ecological studies of the *Eucalyptus*-defoliating paropsids (Coleoptera : Chrysomelidae), with particular reference to *Chrysophtharta bimaculata* (Olivier). Ph.D. Thesis, University of Tasmania, Hobart.

——— 1983: Life-cycle and aspects of the biology of Tasmanian eucalyptus leaf beetle, *Chrysophtharta bimaculata* (Olivier) (Coleoptera : Chrysomelidae). *Journal of the Australian Entomological Society 22*: 15–18.

de LITTLE, D.W.; ELLIOTT, H.J.; MADDEN, J.L.; BASHFORD, R. 1990: Stage-specific mortality in two field populations of immature *Chrysophtharta bimaculata* (Olivier) (Coleoptera : Chrysomelidae). *Journal of the Australian Entomological Society 29*: 51–5.

ELLIOT, H.J.; de LITTLE, D.W. 1984: "Insect Pests of Trees and Timber in Tasmania." Forestry Commission, Hobart, Tasmania.

GREAVES, R. 1966: Insect defoliation in the eucalypt regrowth in the Florentine Valley, Tasmania. *Appita 19*: 119–26.

HANOVER, J.W. 1980: Breeding forest trees resistant to insects. Pp. 487–511 *in* Maxwell, F.G.; Jennings, P.R. (Ed.) "Breeding Plants Resistant to Insects". John Wiley & Sons, New York.

KILE, G.A. 1974: Insect defoliation in the eucalypt regrowth forests of southern Tasmania. *Australian Forest Research 6*: 9–18.

TIBBITS, W.N. 1986: Eucalypt plantations in Tasmania. *Australian Forestry 49*: 219–25.