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INSECT OUTBREAKS IN EUCALYPTUS GLOBULUS PLANTATIONS

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1. Executive Summary

- All available information about insect problems in globulus plantations in South western Australia is reviewed.
- Nine insect species (actual or potential pests) have so far been recorded in globulus. This is, however, an underestimate as few specimens have been collected and the taxonomy of some species requires clarification.
- Four species are of most concern: Wingless Grasshopper, African Black Beetle, Leafblister Sawfly, and Spring Beetle. The grasshopper and black beetle are known to cause tree mortality through defoliation and bark chewing respectively. Leafblister Sawfly and Spring Beetle probably only cause growth loss.
- Information on the recognition of the feeding stages of each insect species, their life cycle, control and other aspects is summarized.
- It is recommended that a Professional entomologist and Technical assistant be appointed to the Entomology Research Program to take charge of research into the management of these pests.
- Interim measures, involving minor redeployment of staff with Entomology Research Program, are proposed. Nevertheless these changes are insufficient to cope with the problem.
- A review of interstate and overseas experience with plantation entomology is appended.

2. Introduction

My brief (P. Christensen, pers. comm.) was to summarize what is known about actual and potential insect problems in globulus plantations in Western Australia and to provide expert advice about these problems and how they might be overcome.

3. Injurious insect species recorded

Nine species have so far been recorded, based on specimens held in the CALM Forest Insect Collection (CALM FIC) at Como and Manjimup. The identification of two species could not be verified as no specimens were lodged in the above Collection. One species was identified from a colour transparency supplied by J. Bartle. Attempts to get NAP staff to collect specimens in the course of daily duties were unsuccessful.

All available, relevant information about the species is arranged under the following headings: Preferred common name, (1) other common names, (2) scientific name-genus, species, Authority, Order, Family, (3) recognition of feeding stage, (4) habitat, (5) life cycle, (6) distribution, (7) current status, (8) damage, (9) cause of outbreaks, (10) history of outbreaks, (11) control, (12) references used in compiling the species account. It needs to be stressed that knowledge about these insects is quite unsatisfactory.

WINGLESS GRASSHOPPER

1. Nil

2. *Phaulacridium vittatum* Sjöstedt Orthoptera, Acrididae.

3. A brown grasshopper up to 20 mm long, with orange hind legs. Most individuals have one pair of small, nonfunctional wings. Newly hatched nymphs are 2 mm long and black.

4. Foliage. Any green material will be eaten.

5. Normally one generation per year. Eggs are laid in pods (*c.* 12 eggs/pod) in bare, sandy soil during summer. They hatch September-December. Nymphs mature over 5 stages from November onwards.

6. Australia; possibly endemic to WA, where present from Dandaragan to Esperance.

7. Kentish, Serpentine 12/89 (NAP). At Pemberton, recorded only from 11/89 to 3/90.

8. A serious pest of lucerne, summer green pasture and many tree species growing on agricultural land. Nymphs will feed on capeweed. Worst damage (G. Ellis, pers. comm.) was seen at Albany on *Eucalyptus grandis* and at Hartridge's, Scott R where globulus to 1 m was killed. Globulus is fed upon as a last resort (J. Bartle, pers. comm.).

9. After November, dry annual pasture becomes less acceptable as food and the hoppers depend on trees for shade and the moisture necessary for egg production.

10. Possibly a wet winter (resulting in lush pasture growth) and a wet autumn (increasing the availability of green feed during egg laying).

11. Insecticide - effective only at the young nymph stage, before dispersal begins. A 2m wide cultivated strip around plantations can be used for baiting. See McFadden (1986) and Grimm (1987) for recipes. According to R. Fremlin (pers. comm.), Fenvalerate is more effective than Maldison (recommended by WADA).

    Silviculture - reduce the amount of bare, sandy ground by encouraging ground cover. Seedlings established in furrow lined or scalped areas seem to be attacked more readily than those on mounds or riplines (G. Ellis, pers. comm.).

    Biocontrol - ineffective, despite considerable research (now terminated) by WADA.

12. Anon (nd), Anon (1983), Grimm (1987), McFadden (1986), Sproul (1988).

SPRING BEETLE

1. Nil

2. *Liparetrus* spp. Coleoptera, Scarabaeidae

3 & 4. Larvae (white, curled) live in soil where they feed on roots of grasses. The adult beetle (main species is bronze brown, 5 mm long) feeds on foliage.

5. Eggs are laid in the soil. Pupation takes place in the soil. Adults emerge September-January

6. Indigenous. Probably several species involved.

7. Adults are mobile and fly in swarms from woodland/forest, particularly on very hot, calm days (G. Ellis, pers. comm.). Damage appears to be greatest adjacent to native forest e.g. Lake Unicup, Manjimup (G. Ellis, pers. comm.). Recorded at Wunnenberg's, E. Wellington 9/89 (NAP). Near Albany, damage to 0.5 year old

globulus has been patchy (B. Jordan, pers. comm.). Spring Beetles are ubiquitous and often cause heavy defoliation at a critical time (late winter) when the seedling is quite small (J. Bartle, pers. comm.).

8. Defoliation by adults.

9. Not known

10. No data.

11. Insecticide - Probably not feasible, given the mobility of adults. However it could be worthwhile to try to spray foliage weekly with Maldison or Malathion (500g/L product) at rate of 3 ml water, or Trichlorfom (Dipterex, Trifon) (600 g/L product) at rate of 1 ml water. Add detergent to improve coverage.

12. Anon (nd), Grimm (1987), Sproul (1988).

AFRICAN BLACK BEETLE

1. Nil

2. *Heteronychus arator* (Fab) Coleoptera, Scarabaeidae.

3. Adult beetle (12 mm long) is shiny black and slow moving. Larvae are of cockchafer type, to 35 mm long.

4. Adult feeds on stems of globulus near ground level. (Larvae live in soil and eat grass roots).

5. One generation per year. Eggs are laid in September. Adults are strong fliers - mass flights are recorded in late summer-autumn. Adults are present all year, but are less active during winter (S. Learmonth, pers. comm.).

6. Introduced from southern Africa. First recorded in WA in 1938 at Albany (Jenkins 1965).

7. Recorded at Wunnenberg's, E. Wellington spring/summer 1989; Kentish, Serpentine 12/89 (NAP). Also observed at Bamess', Pemberton; Johnson's, Unicup; Fitzpatrick's, Baldivis and Davies', Bridgetown (G. Ellis, pers. comm.).

8. The beetle kills small trees by girdling the stem at ground level. Seedlings die from droughting due to the girdling or continue to grow above the point of damage only to snap off later when they become top heavy. Most damage is done in summer and autumn. Light (2%) mortality over 50 ha was recorded at

Wunnenberg's. In the worst affected area (20 ha), up to 10% mortality was recorded. More than half of seedlings at Pemberton were damaged in 88/89.

9 & 10. No data. Possibly favoured by Kikuyu grass (G. Ellis, pers. comm.).

11. Insecticide - WADA recommends Lorsban (Chlorophyripos), which is phytotoxic. Inject into soil 2-3 cm deep at 2-3 points 10-20 cm away from tree at the rate of 6L/ha, diluted to 1:80 up to 1:160 with water.

Silviculture - retain unsprayed grass strips between planting lines to provide the beetles with alternative food.

12. Learmouth (1988), CALM (1990)

A CHRYSOMELID

1. Nil

2. It is not possible to identify the larval specimen to species.

3. Both larvae (5 mm length) and adult beetles feed on young foliage. Adults superficially resemble ladybirds in shape.

4. Native plant species

5. Eggs are laid in early summer. Larvae feed for several weeks, then pupate in the soil. Adults present October-March

6. Indigenous.

7. Only recorded (as larva) at Eckersley's, Harvey 12/88 (CALM FIC).

8. Larvae consume entire area of small leaves. Adults feed mainly on leaf margins. In Tasmania, several species of chrysomelids can cause heavy defoliation.

9 & 10. No data

11. Foliar spray as for Spring Beetle.

12. Anon (nd).

RUTHERGLEN BUG

1. Nil

2. *Nysius vinitor* Bergroth. Hemiptera, Lygaeidae.

3. Adults are 3-4 mm long, narrow bodied, and with prominent black eyes. Body is grey-brown with darker markings. Wings are folded flat when the adult is at rest. Nymphs are dark red and more swollen in shape than adults. All stages emit an acrid odour when disturbed or crushed.

4. Seeds of crop cereals and rapeseed and weeds such as capeweed and thistle.

5. Eggs are laid on soil, on grass and on flowerheads of weeds. During summer, nymphs grow through 5 moults in one month. Winter is passed as an adult. Breeding commences in early spring. Outbreaks can occur in November-December

6. Native to all southern states of Australia.

7. Recorded at Fitzpatrick's, Baldivis 9/88 (NAP); Wellard 12/88 (CALM FIC); Unicup 12/89 (NAP) and Augusta 12/89 (NAP).

8. When pasture crop plants die off in late spring, large numbers of adults can infest pine and globulus. They suck sap, causing chlorosis and wilting of foliage and may kill small trees. (Note that the flightless nymphs only eat seed). At Baldivis, 10% mortality was recorded in 9/88 and at Unicup and Augusta 12/89 several hundred adults were recorded per globulus seedling (G. Ellis, pers. comm.).

9. Wet winter followed by mild spring allows lush growth of weeds.

10. No data

11. Insecticide - spray foliage with boom sprayer or ultra low volume misting with Maldison. Apply as bugs leave drying pasture. A mixture of Maldison 500 at 100 ml/L and 5 L water should be adequate for high volume boom sprays and ULV Maldison at 1L/ha for misters.

    Silviculture - deep plough weeds during winter/early spring to reduce numbers of overwintering adults. Plant alternative crops to prevent breeding.

12. Anon (nd), Grimm (1987), Sproul (1988).

A PSYLLID

1. ? Bluegum Psyllid

2. No adult specimens received - tentatively identified (J. Farr, pers. comm.) as *Ctenarytaina eucalypti* (Maskell). Hemiptera (Homoptera, Psyllidae).

3 & 4. Small, grey, lice-like nymphs 1.5-2 mm long, preferring whorls of juvenile foliage of globulus. In Tasmania, *C. eucalypti* nymphs produce large quantities of white, waxy secretions.

5. If *C. eucalypti*, then 4 nymph stages. All stages from eggs to adults are found throughout the year on globulus planted in New Zealand.

6. If *C. eucalypti,* then accidentally introduced from Tasmania.

7. "Yet to see a bluegum seedling which has not got the psyllid on it" (G. Ellis). Actual records: Esperance 11/89 (CALM FIC); Malcolm's, E. Wellington 12/88 (CALM FIC); Lindberg's, Augusta 2/90 (NAP).

8. The nymphs suck sap. In Tasmania, *C. eucalypti* infestations cause deformation and shrivelling of expanding young globulus leaves. This results in premature senescence and serious defoliation. In New Zealand, where *C. eucalypti was introduced in 1889, damage is minor only.*

9 & 10. No data

11. Insecticide - spray foliage with dimethoate (300g/L product) at the rate of 4 ml water. (Trade names are Cygon, Dimethoate, Perfekthion, Rogor).

12. Elliott and Delittle (1985), Grimm (1987), Zondag (1982).

AUTUMN GUM MOTH

1. Nil

2. *Mnesampela privata* (Guenée). Lepidoptera, Geometridae.

3. Caterpillars are pale yellow-brown with dark brown/green markings when young, becoming dark green/brown with age and developing 2 red patches containing 2 yellow swellings on each segment. Length to 30 mm.

4. Juvenile leaves of globulus and other blue-grey leafed eucalypt species are preferred.

5. Eggs (light green) are laid in batches of *c*.50 in February/March and July/August Caterpillars feed for 2-3 months and then pupate in the ground.

6. Most states. Indigenous.

7. Recorded at Griffiths', Many Peaks 8/87 (CALM FIC); on many farms (not plantations, isolated trees only) in Jerramungup area 6/88 (pers. obs.), and in 4/90 at Bamess', Channybearup (P89) and Graham's , Pemberton (P88).

8. Young caterpillars feed as a group and skeletonize the leaf, leaving the veins. Older caterpillars consume the whole leaf. Only a few curled, brown leaves remain, in which caterpillars shelter during the day. In Tasmania, damage is most common on young trees up to 3 m tall. Severely attacked trees have a characteristic appearance with only the larval shelters remaining at the top of the defoliated branches.

9 & 10. No data

11. Insecticide - as for Spring Beetle

12. Anon (nd), Elliott and Bashford (1978), Grimm (1987).

PASTURE DAY MOTH

1. Nil

2. *Apina callisto* (Angas). Lepidoptera, Agaristidae.

3. Caterpillar is dark brown to black with 2 yellow spots near the posterior. Length to 60 mm.

4. Pasture

5. One generation per year. The adult flies during the day in autumn. Eggs are laid in pasture and hatch soon after the onset of rain. When fully grown, larvae burrow into the soil and pupate.

6. Native, occurring throughout the South-west (P. Michael, pers. comm.)

7. The only certified record is Wunnenberg's, E. Wellington 7/89. There were large numbers of caterpillars (up to $12/m^2$ over 75 ha, half of the plantation).

8. Defoliation. Broadleaved weeds (especially Erodium and capeweed) are preferred.

9 & 10. No data

11. Insecticide - the outbreak recorded at Wunnenberg's was sprayed with Ambush, to good effect.

12. Anon (nd).

LEAFBLISTER SAWFLY

1. Eucalyptus leafmining Sawfly

2. *Phylacteophaga froggatti* Riek. Hymenoptera, Pergidae.

3. Larvae mine leaves of eucalypts, feeding within the upper surface. A round, blotch mine gives the leaf a scorched appearance. Larvae are yellow with dark spots, up to 5 mm long.

4. The foliage of many eucalypt species, particularly of the subgenus *Symphyonyrtus*, are attacked.

5. Eggs are laid singly or in rows near the leaf midrib, but beneath the leaf surface. A small, raised, black lump on the upper side of the leaf marks the position of the egg. Each generation takes about 6 weeks. The larva pupates in an oval cocoon within the blister. Adult wasps do not feed and live about one week. The life cycle slows down in winter to about 8 weeks (T. Burbidge, pers. comm.).

6. Introduced to Perth in 1978, and thence to the whole South-west. Native to Victoria, NSW and Queensland.

7. Actual records: Albany 3/89 (NAP); Bowles', Waroona 2/89 (NAP); Graham's, Pemberton 3/90 (NAP).

8. At Waroona, most trees were affected with many half defoliated. At Pemberton, 99% of all P88 seedlings were affected but < 10% of the P89 seedlings were affected. The basal half to two-thirds of the crown is most affected. Heaviest damage usually occurs to foliage within 3-6 m from the ground. Small trees can be totally defoliated. Very extensive damage was noted in 1-2 year old globulus during 2-3/90 between Albany and Perth.

9. Undoubtedly the combination of an introduced insect with ineffective local predator/parasitoid control.

10. Since 1978 in the South-west.

11. Insecticide - spray as for Psyllid. Note that frequent application is necessary because of the many generations per year.

    Biocontrol - because the species is introduced to WA, support for medium term research in the eastern states could be investigated. The aim would be to introduce its parasitoids to WA. This option would be expensive and would require that no foliar application of any insecticide is used on globulus.

12. Anon (nd), Curry (1981), Farrell & New (1980), Kay (1986).

4. Potential insect pests

There are at least 5 native insect species that have the potential to outbreak in globulus plantations. They have not yet been recorded damaging globulus in south-western Australia

Gumleaf Skeletonizer *Uraba lugens* (Walker) - As this species prefers to eat older leaves of eucalypts, it has not yet had time to become a pest of globulus. This species was formerly a pest in the southern jarrah forest.

Bullseye Borer *Tryphocaria acanthocera* (Macleay) - A related species in the same genus has been recorded in Tasmania as killing trees up to 10 m in height. Bullseye borer is already a pest of Karri regrowth (Abbott et al unpubl.).

Bardi *Phoracantha semipunctata* (F.) - This is a serious problem in South Africa, Spain and California where globulus plantations have been established. In Australia, however, this species is well controlled by parasitoids and predators. I would rate this species as a low risk. In Australia this species is more likely to be a secondary pest as it usually attacks already dead or dying trees. Thus the primary cause would either be the outbreak of another pest/disease causing tree decline or poor site.

Yellow-winged locust *Gastrimargus musicus* (F.) - Because globulus is being planted on ex-agricultural land in the irrigation districts of the Swan Coastal Plain, this species could transfer to trees.

Budworm *Heliothis punctigera* Wallengren - This is an polyphagous agricultural pest which attacks fruits of lupin, clover, lucene, linseed and rapeseed. Cereals are attacked when large numbers of caterpillars migrate out of drying, capeweed -dominated pastures. Previously recorded transferring to young pine plantations at Kinkin 12/86, Mandalay 10-11/86 and near Albany 12/89 when 200 ha were killed.

The greatest worry with all these species is that if they outbreak in globulus plantations, they could then transfer to native forests, augment any populations there and precipitate significant decline of Jarrah, Marri and Karri.

5. Severity of insect problems

No objective estimates of severity are available, but J. Bartle and G. Ellis have each provided subjective estimates.

Bartle's impression (Table below) is that problems with insect pests are slowly increasing from year to year, and that an overall figure of *c.* 6% of the globulus plantation area was infested badly enough in 1989 to require chemical treatment.

Year planted	**Area (ha) of globulus planted each year by**				**Estimated extent of insect outbreaks**
	CALM	**NAP**	**Other**	**Total**	
< 1987	-	-	400	400	nil
1988	2000	-	1000	3000	little
1989	4000	400	2000	6400	*c.* 5% Wingless Grasshopper 1% other
1990 projected	500	1100	1500	3100	

Ellis' estimates were derived by assessing insect problems in 39 globulus plantations, ranging in area from 0.5 ha to 60.0 ha and totalling 415 ha. A scale of 1-4 was used:

1. Presence of insect species recorded; no seedling deaths
2. Evidence of damage; mortality < 10%
3. Level of damage sufficient to warrant control measures
4. 100% mortality

Results were: 3 sites had no insect problems, 20 sites had 1 insect species recorded, 12 had 2 species and 4 had 3 species recorded. Frequency of insect species was as follows:

33 sites with Wingless Grasshopper. 11 of these rated 3; one rated 4.
11 sites with African Black Beetle. One of these rated 3.
2 sites with Spring Beetle One of these rated 3.
2 sites with Leafblister Sawfly. Both rated 2.
2 sites with Rutherglen Bug. Both rated 1.

The remaining species were only recorded at one site. However, two of these (Pasture Day Moth and "A native weevil") each rated 3. It should be noted that Leafblister Sawfly damage was under-recorded by Ellis. It has only been recorded in outbreak since March 1990. In plantations surveyed before then, it would have been overlooked.

6. Overcoming actual and potential pest insect problems

During 1989 my concern about plantation insect problems became so pronounced that I prepared a report for the Executive Director in September. My request for more resources to be directed into plantation entomology research was, however, met with indifference.

After having inspected various globulus plantations near Waroona, Boyanup, Manjimup and Pemberton in April 1990, I am convinced that if the problem continues to be ignored CALM can expect public debate about the impact of insects on tree planting in general throughout the south-west. This could lead to a waning in public interest in planting trees as well as productivity losses.

The opportunity exists for CALM to be proactive about globulus insect problems. I therefore recommend the following course of action:

Appoint one Professional entomologist and one Technical assistant, initially on contract. There should be little difficulty recruiting well qualified graduates for both positions from UWA or Curtin University.

Their duties should be:-

6.1 Devise a rapid, semi-quantitative assay for insect damage in globulus plantations. This index should be calculated for each insect pest species and for each cohort of leaves.

6.2 Use this index to monitor globulus plantations for insect damage.

6.3 Using the experiments set up by NAP, establish which factors promote outbreaks. (Factors include rainfall zone, soil type, weed abundance, plantation age, basal area, site preparation, fertilizers, proximity to native eucalypt stands). Also examine the 60 globulus stands studied by G. Inions and attempt to relate insect problems to site variables.

6.4 Using the family/provenance trials established in 1989 by the Silviculture Research program, investigate the relative susceptibility of globulus provenances (and other eucalypt species) to insect damage.

6.5 Conduct efficacy trials of appropriate, available insecticides in order to establish

- optimal method of application
- optimal rate of application
- optimal timing of application
- optimal frequency of application

It would be most useful if one or two insecticides could be used against all insect pests.

This research should entail close liaison with entomologists in WADA.

6.6 Devise sequential sampling schemes so that sharefarmers/CALM operational staff can forecast the severity of infestations and know when to implement chemical treatment.

6.7 Set up manual defoliation/disbudding experiments to mimic insect defoliation in order to quantify their impact on globulus growth. Alternatively, control insects using insecticide and compare their growth with infested trees.

6.8 Prepare a 4-8 page, full colour pamphlet detailing in plain English the life history of each globulus insect pest and provide authoritative advice about chemical treatment. (A good model is Curry and Moulden 1981). This cannot be done immediately as colour photos of most of the pests are lacking. I do not support publication of a manual of insecticide treatments without including colour photos to facilitate identification of insect pests. This pamphlet would cost c$2K for 2000 copies.

I estimate that both appointments should cost about $70K p.a (Prof. salary $32K, Tech salary $25K, vehicle and travel $7K, lab expenses $3K). This expenditure could be obtained by forgoing the planting of only 140ha of globulus p.a. (calculated at $500/ha).

Both staff should be based at the Manjimup Research Centre, where they could share use of the newly constructed insectary. Also, most globulus plantings occur south of Collie, so location at Manjimup should minimize travel costs.

I have some misgivings about items 6.5 and 6.6 in that reliance on chemical control is environmentally unsound. Ideally greater emphasis on items 6.3 and 6.4 would lessen the need for insecticide use, as would investigation of biocontrol options. However, if these concerns were to be fully addressed, the two positions sought should be permanent, not contract and the cost of research would increase considerably.

7. Interim arrangements - Entomology Research Program

Janet Farr and myself could partly re-organize commitments. Dr Farr's group (3.0 FTE) in the past 2 years has spent c 30% of time on Gumleaf Skeletonizer outbreaks. These outbreaks have now subsided, so much of that research can be placed on a maintenance basis (c 10% p.a.). This would result in c. 20% of her group's time being available for globulus insect research. (It should be noted that I was planning to direct her to studying Bullseye Borer in Karri regrowth - another important but neglected problem).

In my research group (2. 4FTE), it is more difficult to make economies. However, substantial analysis of a long term study of insect defoliation in jarrah forest since 1984 should be completed by August 1990. I estimate that c. 10% of this group's time could be directed to globulus.

Taken together, such a redirection of effort sums to 0.2 Professional & 0.6 Technical FTE to address the globulus issue - well short of the 1.0 Profession & 1.0 Technical requested in Section 6. Consequently this is insufficient to enable all eight urgent tasks detailed in Section 6 to be commenced.

At best all of items 6.1, 6.7, 6.8 and some of item 6.2 are achievable between September 1990 and March 1991, the approximate period when insects are most active. At worst only 6.1, 6.8 and some of 6.2 would be accomplished in the same period. In addition, neither Dr Farr's group nor my group has sufficient funds to cover travel costs if monitoring of globulus plantations is to take place (Section 6.2).

It would also help if NAP and other CALM staff could during the course of field work put more effort into collecting insect specimens and sending them to Dr Farr or myself for identification. In the past year, an unknown number of specimens has been sent to WADA, which I consider to be inappropriate.

8. Balance between production and protection forestry

There is a marked imbalance between these aspects in the current globulus plantation scheme. Much more effort has been put into the production side, including site selection, establishment and fertilization. Protection aspects were not addressed when funding for the NAP project was sought.

If insect outbreaks develop further, they will reduce plantation productivity, and extend the rotation period. This would, of course, have important economic consequences.

9. Acknowledgements

I thank J. Bartle, T. Burbidge, G. Ellis, J. Farr, R. Fremlin and B. Jordan for providing information.

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